



Concealed Spaces in Mass Timber and Heavy Timber Structures

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 expert tip, *Sprinkler Requirements for Concealed Spaces in Light-Frame Projects*.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. Structural mass timber elements—including CLT, glue-laminated timber (glulam), nail-laminated timber (NLT), structural composite lumber (SCL), and tongue-and-groove (T&G) decking—can also be utilized and exposed in the following construction types, whether or not a fire-resistance rating (FRR) 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; however, framing and sheathing are permitted to be 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 where the required FRR does not exceed one hour; exterior columns and arches when 20 feet or more of horizontal separation is provided; and balconies, canopies and similar projections.

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 IBC, Type IV buildings were not allowed to have concealed spaces:

2018 IBC 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, 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, concealed spaces in roof/ceiling or floor/ceiling assemblies are now allowed in Type IV-HT (formerly Type IV) construction 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 board

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 FRR. To clarify this, the following language has been added to the 2021 IBC:

Section 602.4.4.3 ...*Exception: 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.*

Construction Types III and V do not have a prescriptive prohibition on concealed spaces, nor is there prescriptive guidance on how these spaces should be handled. Therefore, the information in IBC Section 718 for concealed spaces is directly applicable. Additionally, if the building is being equipped with an NFPA 13 or 13R automatic sprinkler system, guidance within those standards regarding the protection of combustible concealed spaces should also be followed.

IBC Section 718.2 provides requirements for fireblocking. The purpose of fireblocking is to “reduce the ability of fire, smoke and gases from moving to different parts of the building through combustible concealed spaces” (IBC Commentary). Notable instances requiring fireblocking are intersections of horizontal and vertical assemblies (i.e., a wall assembly intersecting a dropped ceiling cavity), within combustible wall cavities, and at exterior rainscreen systems with wood furring.

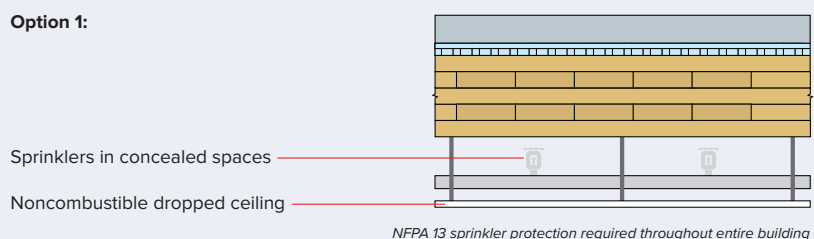
IBC Section 718.3 provides requirements for draftstopping, which has a primary function of subdividing floor/ceiling assemblies. For Group R occupancies (and others where fire partitions per IBC 708 are used),

718.3 references 708.4 for draftstopping requirements in combustible floor/ceiling assemblies. Section 708.4 requires the installation of draftstopping in a concealed ceiling space, aligned with fire partitions where those fire partitions do not extend to the underside of the floor/roof sheathing above. For occupancies other than Group R, IBC 718.3 requires the installation of draftstopping within combustible concealed spaces of floor/ceiling assemblies (i.e., a dropped ceiling below a mass timber floor assembly) to subdivide those concealed spaces to areas not to exceed 1,000 square feet. However, buildings equipped throughout with an NFPA 13 automatic sprinkler system are exempt from these draftstopping requirements.

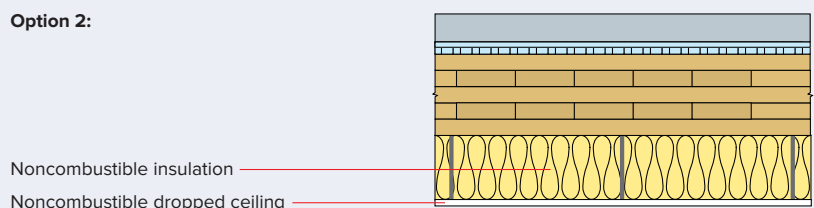
While most new buildings will receive this exemption, the NFPA 13 standard does provide requirements for protection of concealed spaces formed by mass timber. Section 8.15 of NFPA 13 notes that concealed spaces formed by combustible construction must either be protected by sprinkler protection or filled with noncombustible insulation. NFPA 13 also permits combustible concealed spaces to omit sprinkler protection if those spaces are compartmentalized to volumes not to exceed 160 cubic feet in wood joist and composite wood joist construction. It might be useful to discuss this option with the local Authority Having Jurisdiction to gauge the potential for acceptance. An alternative would be to cover all mass timber surfaces within the concealed spaces with noncombustible materials. Examples include gypsum wall board on the underside of mass timber panels that are part of a dropped ceiling assembly, or concrete floor toppings over mass timber panels that are part of a raised access floor system.

CONCEALED SPACES: TYPE IV-HT

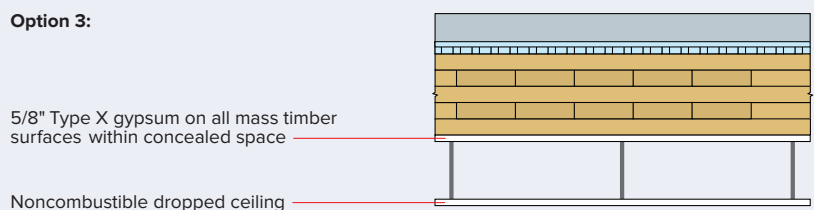
Option 1:



Option 2:



Option 3:





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

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 building elements—Type IV-A up to 18 stories; Type IV-B up to 12 stories, and Type IV-C up to nine stories. Concealed spaces are permitted in all three of these types under these conditions:

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.

Section 602.4.1.2 is the section requiring noncombustible protection of interior mass timber surfaces, typically two thirds of the required FRR of the element but no less than 80 minutes. This can be achieved with multiple layers of 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 703.3 with time assigned in accordance with 2021 IBC Section 703.6.

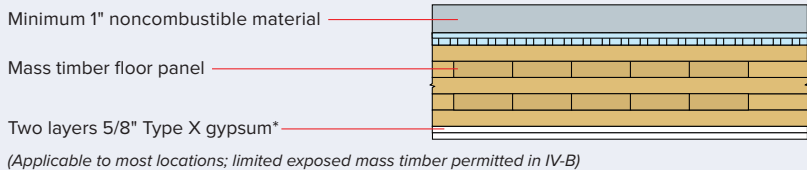
Type IV-C: **Section 602.4.3.5 Concealed spaces.** Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the International Mechanical Code, and shall comply with all 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 specified in Table 722.7.1(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 FRR, as shown in IBC Table 722.7.1(1) but no less than 80 minutes.

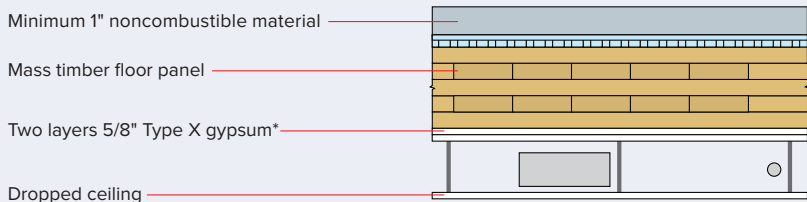
Section 722.7.1 provides assigned protection times for noncombustible covering materials, with two prescriptive options: 1/2-inch Type X gypsum is assigned 25 minutes, and 5/8-inch Type X gypsum is assigned 40 minutes. Concealed spaces are perhaps most common in the form of dropped ceilings below floor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

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

Without Dropped Ceiling



With Dropped Ceiling



buildings typically requires a 2-hour FRR (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 FRR. Where mass timber bearing walls are utilized and exposed 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.

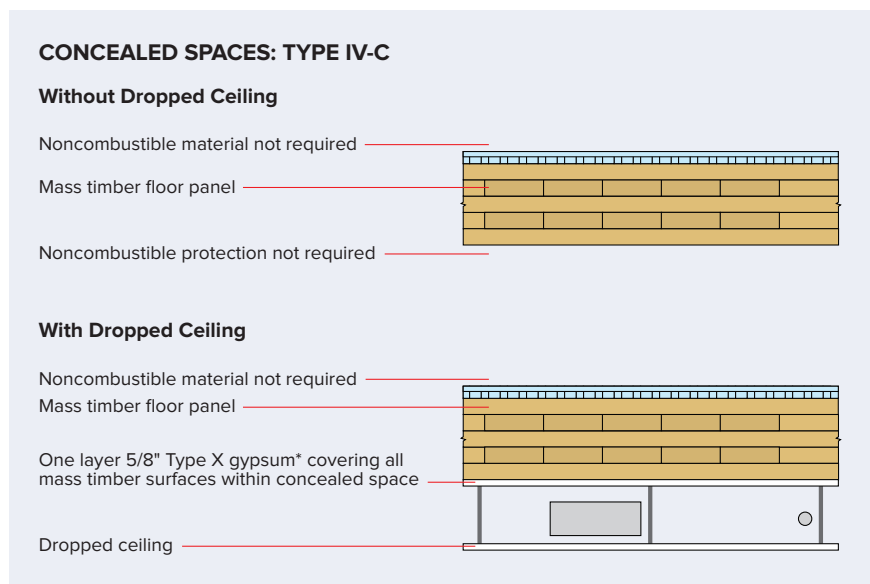
Bearing wall and floor assemblies in Type IV-C construction also require a 2-hour FRR. The difference is that all of the wood can generally be exposed, except in concealed spaces. As noted, Section 602.4.3.5 requires that, *Combustible construction forming concealed spaces shall be protected*

with noncombustible protection with a minimum assigned time of 40 minutes as specified in Table 722.7.1(1). 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 703.6 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 FRR) 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 <https://www.woodworks.org/resources/sprinkler-requirements-for-concealed-spaces-in-light-frame-projects/>

*Or other noncombustible protection with an equivalent contribution of noncombustible protection as determined in 2021 IBC Section 703.6

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