Expert Tips

How to Create a Vertical Addition with Mass Timber

Examines the use of mass timber in U.S. projects, including code compliance, construction type, fire-resistance ratings, structural reinforcement and constructability

Two-story mass timber vertical addition on existing three-story building at 69 A

Street in Boston, MA / Margulies Perruzzi / McNamara • Salvia

There is much discussion in the building design and development community about how to build a more sustainable future. Renovations and additions to existing structures have both cost and embodied carbon advantages over demolition and new construction. Designing an addition in wood can add to these benefits.

While ground-up construction is often necessary, vertical additions and adaptive re-use can be an attractive option—especially in urban areas with limited lot availability. Mass timber is a natural solution for these projects due to its enhanced aesthetics, ease of installation on tight urban sites, and relative light weight. Using mass timber can eliminate the need to reinforce the existing structure and/or foundation. This can significantly reduce costs, and potentially allow the existing building to remain open while the addition is under construction.

When pursuing a vertical addition of any type, using any materials, there are considerations related to design, code compliance, and construction logistics. Will the addition be considered a separate building? Does the existing building have adequate fire-resistance protection relative to the added size and number of stories? Does the existing building have sprinklers and, if not, can they be added? Does the addition add enough weight to require a new lateral analysis, foundation reinforcements, or structural framing upgrades? Does the egress in the existing building account for the added occupant load from the new stories?

This article examines the use of mass timber for vertical additions in the U.S., addressing topics such as code compliance, construction type, fire-resistance ratings (FRR), structural reinforcement, and constructability.

ACME Timber Lofts—a two-story mass timber vertical addition in New Haven, CT / GOA / Odeh Engineers/WSP / Photo GOA

Construction Type Options

When creating vertical additions on existing buildings, it is necessary to consider the requirements of both the International Existing Building Code (IEBC) and the International Building Code (IBC). This article references the 2021 versions of both documents.

Section 502.1 of the IEBC notes that *“additions to any building or structure shall comply with the requirements of the International Building Code for new construction. Alterations to the existing building or structure shall be made to ensure that the existing building or structure together with the addition are not less complying with the provisions of the International Building Code than the existing building or structure was prior to the addition. An existing building together with its additions shall comply with the height and area provisions of Chapter 5 of the International Building Code.”*

In most cases, the IBC requires that a building utilize one construction type throughout the entire building. Although there are several special provisions that allow multiple construction types as noted in IBC Section 510, a building is generally not permitted to utilize two or more. In the context of vertical additions, this typically means the entire building (existing plus addition) must be classified as one construction type, unless the existing building can be classified as a Type I-A podium. This is discussed in the next section.

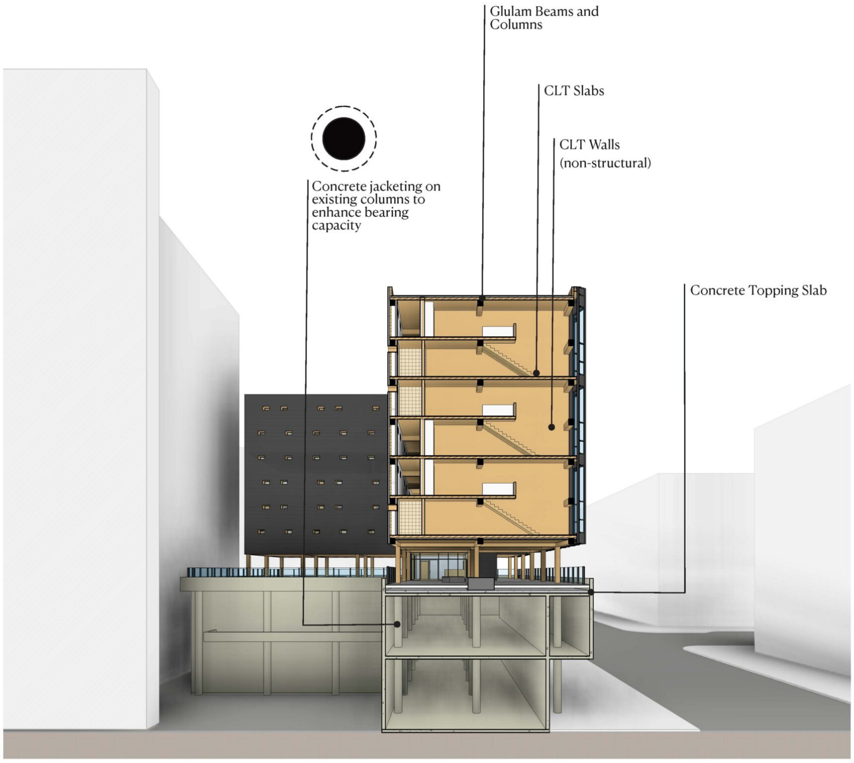
Mass timber elements are permitted in Types III-A, III-B, IV-A, IV-B, IV-C, IV-HT, V-A, and V-B construction. Specific material provisions for these construction types are as follows:

- **Type III** (IBC Section 602.3) – Mass timber can be used in floors, roofs, and interior walls. Exterior walls must be constructed of noncombustible materials. Alternatively, fire retardant-treated wood (FRTW) framing is permitted in exterior walls required to have an FRR of 2 hours or less.
- **Type IV** (IBC Section 602.4) – Mass timber elements meeting the minimum sizes in IBC Section 2304.11 can be used throughout the structure, including floors, roofs, and interior and exterior walls. Because this construction type is based in part on the inherent and long-demonstrated fire resistance of large solid wood framing, light-frame wood materials (e.g., 2x wall framing and wood structural panels) are generally prohibited. However, there are two exceptions to this. Type IV-HT permits the use of light-frame wood wall materials for:
    - Exterior wall framing when the materials are FRTW and the required rating of the exterior walls is 2 hours or less
    - Interior partitions only when the wall has a minimum FRR of 1-hour per IBC Section 2304.11.2.2

Note that these allowances for light-frame interior partitions and exterior walls are not applicable to Types IV-A, IV-B, and IV-C projects. Those construction types require all structural materials and partition elements to be either noncombustible or mass timber that meets the minimum sizes of Type IV construction.

- **Type V** (IBC Section 602.5) – Mass timber can be used throughout the structure, including floors, roofs, and both interior and exterior walls.

There are two primary considerations for determining construction type: total building size including the addition, and materials used in the existing building.



Proposed four-story mass timber vertical addition on existing two-story concrete building / Image Julio Ramirez (2022). 'Mass Timber Vertical Addition Engine No. 2 (Washington DC). Institute for Advanced Architecture of Catalonia.

Allowable Building Size

Hypothetically, consider a two-story vertical addition to a three-story building. Each of the five levels has a floor plate area of 12,000 square feet, indicating that the total existing building area is 36,000 square feet, and the total building area including the addition is 60,000 square feet. The building will be group R-2 occupancy throughout. While the existing, three-story building could have been Type V-B construction (which allows three stories, 21,000 square feet per floor, and 63,000 square feet total), the building with its addition will be five stories and therefore cannot be Type V-B. (See Table 1.) Based only on building size, the viable construction types would be III-A, III-B, IV-HT, IV-A, IV-B, and IV-C.

TABLE 1 – Construction type allowances for Group B and R-2 occupancies

	III-A		III-B		IV-A		IV-B		IV-C		IV-HT		V-A		V-B	
Occupancy Group	B	R-2	B	R-2	B	R-2	B	R-2	B	R-2	B	R-2	B	R-2	B	R-2
Stories	6	5	4	5	18	18	12	12	9	8	6	5	4	4	3	3
Height, ft	85	85	75	75	270	270	180	180	85	85	85	85	70	70	60	60
Floor Area, sf	85,500	72,000	57,000	48,000	324,000	184,500	216,000	123,000	135,000	76,875	108,000	61,500	54,000	36,000	27,000	21,000
Total Building Area, sf	256,500	216,000	171,000	144,000	972,000	553,500	648,000	369,000	405,000	230,625	324,000	184,500	162,000	108,000	81,000	63,000

An alternative to classifying the entire building as one of these options is to use two different construction types by means of IBC Section 510.2 Horizontal building separation allowance. Often called "podium" or "pedestal" construction, this allows the existing structure and vertical addition to be considered two separate buildings, one stacked on top of the other. The lower building is required to be Type I-A construction and the upper building can be any construction type as long as it meets the allowable size limits. Stories in the upper building are counted starting from the top of the lower building, and the overall building height in feet is measured from grade to mean roof height.

Using the design example above, if the three-story existing building could be classified as Type I-A, and it meets all other applicable requirements of Section 510.2, the addition could be Type V-B as long as the overall building height (existing plus addition) is not taller than 60 feet. The implications of classifying the existing building as Type I-A are discussed further below.

Material Impacts of Construction Type Selection

While the materials noted for Types III, IV, and V construction provide options for the vertical addition, it is also necessary to consider which construction types allow the framing materials in the existing building. See Table 2 for options (not considering building size limits).

TABLE 2 – Material options for an existing structure by construction type

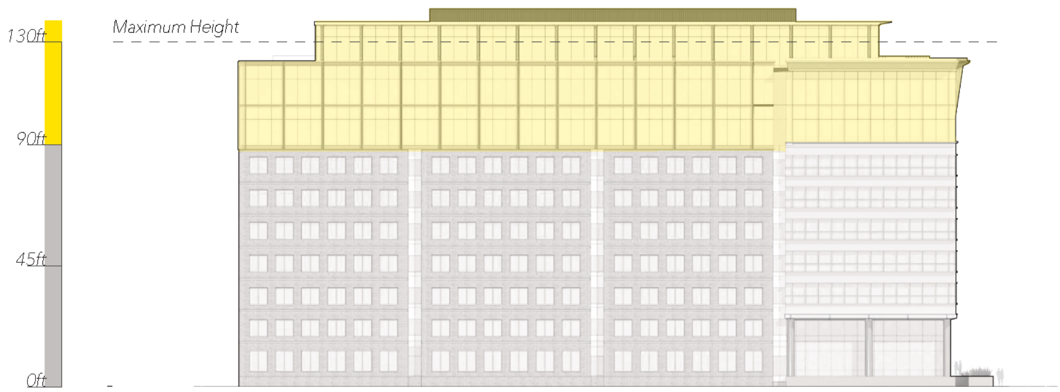
	I	II	III	IV	V
Noncombustible only	Yes	Yes	Yes	Yes	Yes
Light-frame wood	No	No	Yes	No	Yes
Light-frame wood and noncombustible	No	No	Yes	No	Yes
Heavy/mass timber	No	No	Yes	Yes	Yes
Heavy/mass timber and light-frame wood	No	No	Yes	No	Yes
Heavy/mass timber and noncombustible	No	No	Yes	Yes	Yes

Table 3 summarizes construction type options for the entire building (existing plus vertical addition). It also notes whether the podium option is viable (i.e., the existing building can be considered a podium and the vertical addition a separate ‘building’). These construction type options are based only on allowable materials. The designers and engineers must account for building size limits and FRR.

TABLE 3 – Construction type options for the entire building (existing + vertical addition)

Existing Building	Vertical Addition	III	IV	V	Podium Permitted
Noncombustible only	Mass Timber	Yes	Yes	Yes	Yes
Light-frame wood	Mass Timber	Yes	No	Yes	No
Light-frame wood and noncombustible	Mass Timber	Yes	No	Yes	No
Heavy/mass timber	Mass Timber	Yes	Yes	Yes	No
Heavy/mass timber and light-frame wood	Mass Timber	Yes	No	Yes	No
Heavy/mass timber and noncombustible	Mass Timber	Yes	Yes	Yes	No

Note that the vertical addition need not only be mass timber. It could be some combination of mass timber, light-frame wood, and noncombustible materials. If mixing materials, keep in mind the material allowances for Types III, IV, and V construction—most notably that Type IV-HT only allows light-frame wood materials for 1-hour-rated interior partitions and for exterior walls when using fire retardant-treated wood. Light-frame wood is not otherwise permitted in Type IV construction.



Three-story mass timber vertical addition on existing seven-story building at 80M St, Washington, DC / *Julio Ramirez (2022). ‘Superpositions: Sustainable Urban Density with Mass Timber Vertical Additions’. Institute for Advanced Architecture of Catalonia.*

Fire-Resistance Ratings

Once the construction type has been selected, the FRR of structural elements will be dictated by IBC Table 601, as well as code provisions related to occupancy, use, separation, and other applicable criteria. The FRR of the mass timber elements can generally be achieved through inherent large timber sizes without the need for additional material coverings. However, in projects that are taller than 85 feet above grade plane, some or all of the mass timber elements might require noncombustible coverings that also contribute to the FRR of the member or assembly.

IBC Section 703.3 Methods for determining fire resistance.

The application of any of the methods listed in this section shall be based on fire exposure and acceptance criteria specified in ASTM E119 or UL 263. The required fire resistance of a building element, component or assembly shall be permitted to be established by any of the following methods or procedures:

- *Fire-resistance designs documented in approved sources.*
- *Prescriptive designs of fire resistance-rated building elements, components or assemblies as prescribed in Section 721.*
- *Calculations in accordance with Section 722.*
- *Engineering analysis based on a comparison of building element, component or assemblies designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E119 or UL 263.*
- *Alternative protection methods as allowed by Section 104.11.*
- *Fire-resistance designs certified by an approved agency.*

When a building element or assembly is required to have an FRR (mass timber or otherwise), IBC Section 703.2 requires the rating to be determined by testing in accordance with ASTM E 119 (or UL 263) or via one of six alternatives listed in IBC Section 703.3.

These alternatives are options when the exact assembly has not been tested per ASTM E119 and therefore a test report is unavailable. They are all founded on ASTM E119 testing.

The two most common methods of demonstrating a mass timber member’s FRR are through ASTM E119 fire testing and through engineering calculations performed in accordance with Chapter 16 of the American Wood Council’s National Design Specification® (NDS®) for Wood Construction. Both of these options are explained below.

Table 4: Fire-resistance rating requirements for building elements (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE IV	
	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,c]	1[b,c]	0[c]	1[b,c]	0	3[a]	2[a]	2[a]	HT	1[b,c]	0
Bearing walls												
Exterior[e,f]	3	2	1	0	2	2	3	2	2	2	1	0
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 structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	1 ½[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	1 ½	1	1	HT	1[b,c]	0

Source: IBC 2021 Table 601[1]

ASTM E119 Testing Method

Successful fire tests have been completed on numerous mass timber elements and assemblies, achieving an FRR of 3 hours or more. Additional tests by manufacturers and others are ongoing. Most tests are conducted according to ASTM E119 or its Canadian equivalent, ULC S101. Both utilize the same time-temperature curve and performance criteria and, as such, ULC S101 fire tests are usually acceptable to U.S. building officials. However, each project's building official should be consulted if choosing this design route.

To help building designers compare options, WoodWorks offers a *Database of Fire-Tested Mass Timber Assemblies, which* is updated as new tests become available.

Calculation-Based Method

Item 3 of IBC Section 703.3, which permits the use of calculations in accordance with Section 722, is also frequently used to demonstrate the FRR of exposed mass timber. IBC Section 722.1 states: *The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AWC National Design Specification® for Wood Construction (NDS®).* Chapter 16 of the NDS can be used to calculate up to a 2-hour FRR for a variety of exposed wood members including solid sawn, glue-laminated timber (glulam), cross-laminated timber (CLT), and structural composite lumber (SCL).

Using the equations and data presented in this document, an effective char depth is calculated for all surfaces of the mass timber that are exposed in a fire event, based on the fire endurance required by the IBC. The mass timber member must be analyzed to determine structural adequacy under fire conditions. One of the main benefits of the char calculation method is that it accounts for heavy and mass timber's ability to form a char zone, which insulates the remaining wood cross section, allowing it to retain structural capacity.

For additional information on the fire-resistive design of exposed mass timber members, see the WoodWorks publication, *Fire Design of Mass Timber Members: Code Applications, Construction Types and Fire Ratings*.

As mentioned, Types IV-A and IV-B construction require noncombustible protection on some mass timber members. This protection, which is commonly multiple layers of 5/8-in.

Type X gypsum wallboard (GWB), can contribute to the net FRR of the member or assembly. For information on this topic, see the WoodWorks publication, *Demonstrating Fire-Resistance Ratings for Mass Timber Elements in Tall Wood Structures*.

Fire-Resistance Rating of Existing Building Members

The FRR of the existing building's members and assemblies also needs to be assessed for conformance to the FRR requirements based on the construction type chosen for the project. Depending on the materials used in the existing building, it might be possible to find a fire-tested assembly with components that match. Otherwise, a fire engineering analysis might be necessary. Resources for demonstrating fire resistance of historic materials and assemblies include:

- Appendix A of the 2015 International Existing Building Code (IEBC)
- US Department of Housing and Urban Development *Guideline on Fire Ratings of Archaic Materials and Assemblies*

Other requirements of the IEBC should also be evaluated for their applicability regarding fire performance of existing buildings in the context of alterations and additions.

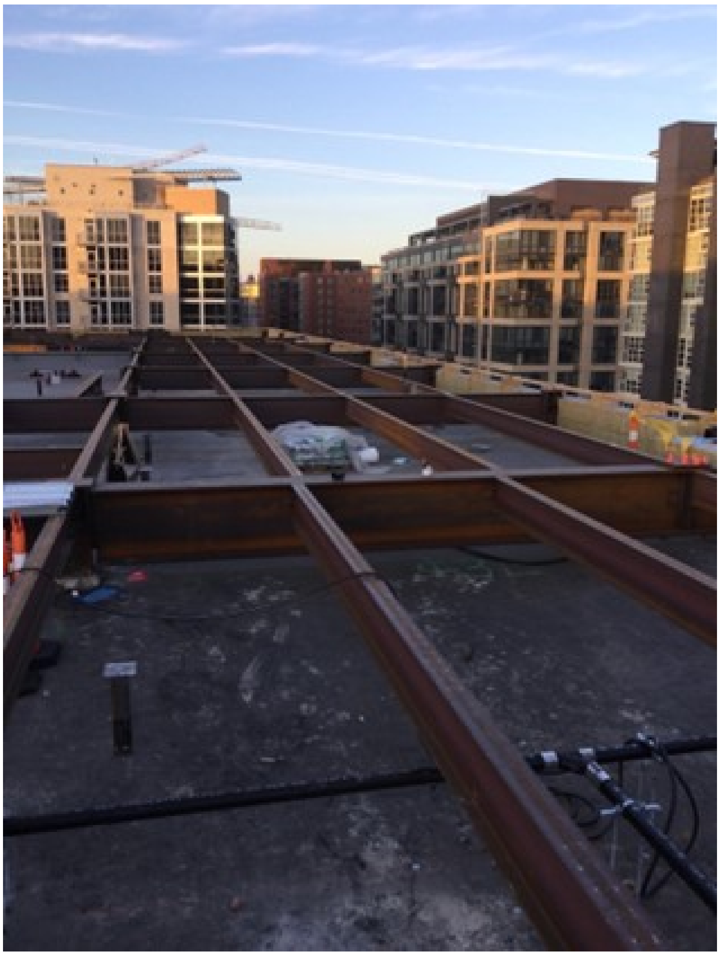
Vertical additions may result in a new mix of building occupancy groups. Mixed-use buildings can be analyzed using several code-presented options, and the presence of multiple uses within a building does not automatically require fire resistance-rated construction to isolate all occupancies. For additional information on the analysis of mixed-use buildings, including construction type and FRR impacts, see the WoodWorks publication, *Taking the Guesswork out of Mixed-Use Building Requirements.*

Construction Tolerances for Mass Timber on an Existing Structure

Mass timber materials are manufactured and fabricated to very tight tolerances. This is beneficial for several reasons, such as smooth and seamless installation, since materials fit together without adjustment on site. However, unlike structural steel and cast-in-place concrete, which offer multiple opportunities to "autocorrect" as construction progresses, mass timber buildings must be built on a plumb, level, and square foundation or have tolerances built into the initial connection interfaces. When installing mass timber on top of an existing structure, it is necessary to have a thorough understanding of the spatial location of all aspects of the top of the existing structure and interface with the new mass timber. A 3D building survey or scan is often used for this purpose.

It might be possible to fabricate mass timber elements that will be in direct contact with the existing building in varying dimensions to accommodate an uneven or out of plumb structure. However, it is typically more advantageous to establish a level surface on top of the existing structure first, and install mass timber elements off this baseline. This new level surface could be composed of grout beds, 2x sole plates or steel base plates on grout beds, or a new system of structural steel framing members, concrete beams, or masonry bond beams (among other options). It is important not to underestimate the significance and time required to establish the spatial locations of the existing conditions at the top of framing, and the work required to install new members as the baseline. The timing of initial building scans, installation of new members for baselines, and mass timber fabrication should all be coordinated. The key is to obtain the critical dimensions early to provide necessary details and dimensions to the mass timber manufacturer. Additional information on how these concepts have been applied to specific projects is described in the examples below.

A new concrete rim beam on top of existing brick exterior walls establishes a working surface for a mass timber vertical addition at 69 A Street / Photo McNamara • Salvia



New structural steel framing installed on existing sloped concrete roof slab to establish level working surface for mass timber install at 80 M Street in Washington, DC / Hickok Cole / Arup / Equilibrium / Photo
Hickok

Structural Implications of Vertical Additions

Regardless of the materials used to frame a vertical addition, the impact of the added weight on top of the existing building must be considered. As noted, mass timber's relative light weight can be advantageous. On several projects, this was one of the main reasons a vertical addition was even feasible; the increase in loads from the mass timber addition was not great enough to require structural upgrades of the existing building.

Sections 502.4 and 502.5 of the IEBC provide guidance on the structural analysis of existing buildings in terms of gravity and lateral loading impacts, respectively. Section 502.4 notes that additions or alterations that result in an increase of more than 5% in the gravity loading on a member require analysis and reinforcing of those members as necessary. In the context of vertical additions, the primary gravity load-supporting elements most commonly impacted are the existing building's columns and/or load-bearing walls, depending on the framing scheme of the existing building and addition. While mass timber is relatively lightweight, the addition of one or more stories will likely add more than 5% to the existing structure's loading. However, in mass timber vertical addition projects, the existing building columns and bearing walls often have adequate gravity support capacity to allow multiple new stories of mass timber without requiring reinforcement. Under these scenarios, the team should undertake a structural assessment of the existing columns, walls, and connections to determine their properties, followed by a structural analysis of their capacities. It is important to assess the structural impacts of added gravity loads, and perform site inspections and engineering calculations as deemed necessary by the structural engineer.

According to IEBC Section 502.5, if the addition is not structurally independent of the existing building (as is the case in vertical additions), the existing building and addition together must be analyzed for lateral loading design per IBC Sections 1609 and 1613. There is an exception to this requirement when the demand-capacity ratio of the existing lateral load-resisting elements is increased by no more than 10% when compared to the demand-capacity ratio of the element without the addition considered. Mass timber's relative light weight is also advantageous for lateral design purposes, since seismic forces are directly tied to a building's mass. Regardless of whether the existing building's lateral force-resisting system will require reinforcement, the vertical addition itself will require a lateral force-resisting system. The resulting forces must be adequately transferred through the existing structure and to the foundation.

Many vertical addition projects require upgrades to the egress components, most notably vertical circulation. When creating new or modified stair and elevator shafts, it is common to utilize the structure within the shaft walls as part of the vertical lateral force-resisting system. Examples include the new CLT stair shaft walls in ACME Timber Lofts and the new masonry stair and elevator shafts in 69 A Street, which also function as shear walls.

Example Mass Timber Vertical Additions

ACME Timber Lofts — New Haven, CT

Photo: GOA

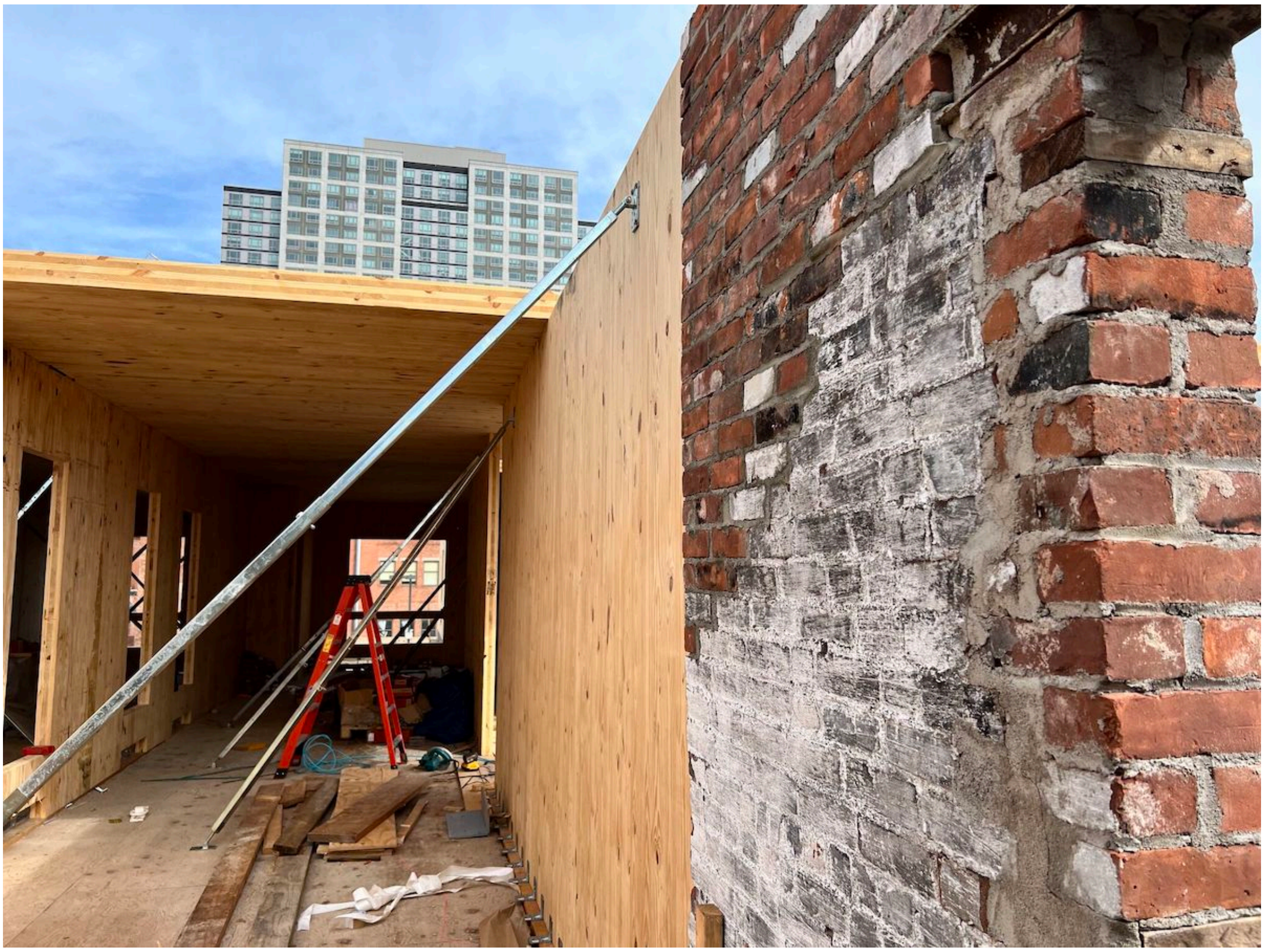
ACME Timber Lofts is a two-story story mass timber vertical addition on a three-story, 150-year-old historic masonry structure. Formerly a warehouse for furniture and other industrial uses, the building was converted into an 18-unit residential project with first-floor retail and amenity space.

The vertical addition consists of CLT exterior walls, interior walls, floors and roof, and the project includes a new six-story CLT shaft servicing the entire building.

New CLT shaft walls in existing lower three stories of ACME Timber Lofts / Photo WoodWorks

The existing building was constructed with wood joists and masonry walls using Type III construction. Since the new levels include CLT exterior walls, which are not prescriptively permitted in Type III construction, the design team and building official agreed on a variance that involved classifying the building as two levels of Type IV construction stacked on three levels of Type III.

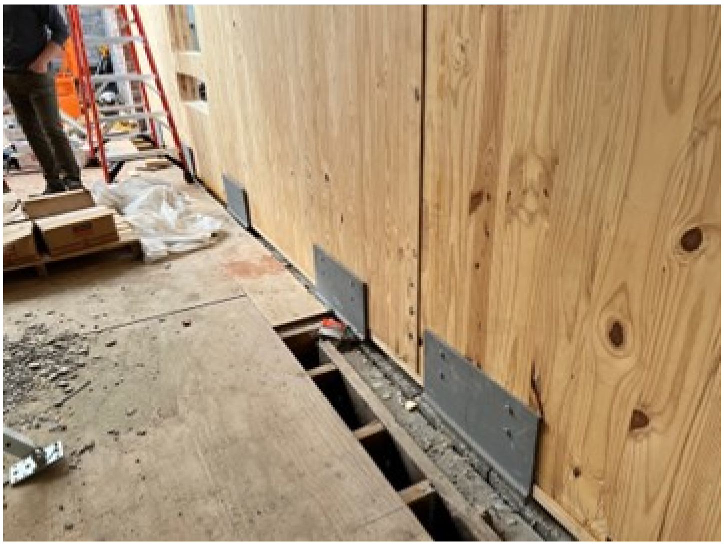
Prior to the vertical addition, the building was used for heavy storage. Due to mass timber's light weight, and because the heavy storage use was being eliminated, the engineer determined that the existing structure would not be exposed to higher load demand capacities than those permitted under the IEBC. As such, reinforcement of the existing structure was not required, with the exception of some existing second floor joists that received new loads from bearing walls due to reconfiguration of the first floor.



New mass timber framing adjacent to existing masonry wall at ACME Timber Lofts / Photo WoodWorks

Since the building consists of existing masonry walls and new CLT walls—both of which function as shear walls—the seismic design of the CLT shear walls used R=1.5 from the requirements for unreinforced masonry shear walls per ASCE 7 Table 12.2-1.

The design team noted that the most challenging part of the project was the interface between the existing building and new timber. The existing masonry walls were generally not square or level. Some surveying of the existing building was completed, and that information was fed into the mass timber fabrication modeling. However, it wasn't possible to obtain all of the spatial data points for the existing building. The roof had to be removed to facilitate installation of the new levels, and the team delayed this for as long as possible. To keep the construction schedule on track, the mass timber elements were fabricated without doing a 3D building scan, making site adjustment necessary once the existing roof was removed and the timber was on site and ready for installation.



New CLT exterior walls installed on top of existing masonry exterior walls, attached with L-shaped steel plates at ACME Timber Lofts / Photo WoodWorks

The new CLT walls bear on top of the existing masonry walls using an L-shaped steel plate attached to the underside of a wood sole plate (at the bottom of the CLT walls) and the outside face of the CLT walls. A threaded rod was epoxied down into the top of the existing masonry wall and this rod extends up through the new L-shaped plate to anchor it. The elevation of the L-shaped plate was determined using building controls and site surveys to set a level working surface for the mass timber. A grout pack was used between the top of the masonry wall and underside of the new steel plate with varying thickness as necessary.

Learn more about ACME Timber Lofts and its project team on the WoodWorks Innovation Network.

69 A Street — Boston, MA

69 A Street was a three-story, heavy timber-framed structure with exterior brick walls. Designers considered several systems for a vertical addition, including concrete, steel, and steel bar joists. However, the weight of any of these would have required the existing building to be structurally reinforced. Designers chose a two-story mass timber addition as its lighter weight made it the only solution not to require this step. The addition includes new masonry elevator, stair, and mechanical shafts running the full height of the building. New foundation work was required under the masonry shafts, but the addition did not otherwise require reinforcement of the foundation or existing heavy timber framing despite the addition of a concrete topping slab on each existing floor. The masonry shafts also functioned as shear walls. Another benefit of mass timber was its ability to accommodate a relatively small footprint for material laydown and crane access; the project is on a tight urban lot and disruption to the surrounding area had to be minimized.

Mass timber staging area adjacent to existing building at 69 A Street / Photo McNamara • Salvia

The existing building included a deteriorating brick cornice at the roof level, which was removed along with the roof structure. A new concrete rim beam was installed on top of the existing brick wall, and new glulam stub columns were installed on top of the existing timber columns. The existing building was laser scanned and the first pieces of new mass timber framing varied in height and length as necessary to work within its dimensions. These first pieces helped establish a level working surface on which the next level of mass timber framing was installed.

Coordination between the contractor and mass timber supplier regarding site measurements and the needed size of fabricated elements was necessary to ensure a good fit for these first mass timber pieces in particular.

The completed five-story building is primarily offices, with some retail on the first floor. Type III-B construction was used for the entire project.

Learn more about 69 A Street on the WoodWorks Innovation Network

Bottom of new stub glulam column on existing heavy timber column at 69 A Street / Photo McNamara • Salvia

Top of new stub glulam column on existing heavy timber column / Photo Greg Folkins

New mass timber framing at new concrete rim beam on top of existing exterior walls at 69 A Street / Photo McNamara • Salvia

80 M Street — Washington, D.C.

Mass timber addition at 80 M Street in Washington, D.C. / James G. Davis Construction

Before its addition, 80 M Street in Washington, D.C. was a seven-story, 286,000-square-foot office building located in the Capitol Riverfront District. The vertical expansion created two new floors and a habitable mass timber penthouse, adding 105,000 square feet of Class-A office space. The project was the first commercial office building in the city to feature mass timber construction.

80 M Street / Hickok Cole / Arup / Photo Maurice Harrington

With its three-story mass timber addition, 80 M Street rises to over 120 feet. At this height, prescriptive options for construction type are IV-B, which allows a limited amount of exposed wood, and IV-A, which doesn't allow any. However, the owner and design team wanted to maximize exposure of the mass timber columns, beams, and floor/ceiling panels in all three levels. They worked with city officials to come up with an acceptable solution for classifying the addition as Type IV-C (which allows full timber exposure) with an approved variance that allowed the structure to be taller than 85 feet (the prescriptive height limit for IV-C). As shown in Table 3, Type IV construction allows the use of both heavy/mass timber and noncombustible materials for the existing structure. As such, the city allowed the project to be considered one building for the purpose of construction type (existing plus addition), and the entire project was classified as Type IV-C. This meant the existing building was not required to be classified as Type I-A and follow the horizontal building separation provisions of IBC Section 510.2. However, it did meet the requirements of Type I-A, which was viewed as beneficial during conversations with city officials.

New steel dunnage frame on existing concrete sloping roof / Photo Hickok Cole

The roof of the existing concrete building was sloped, cast-in-place concrete, which made it challenging to establish a uniform surface. Several options were evaluated, and the eventual solution was to add a steel dunnage frame with short stub columns of varying heights to account for the slope. Prior to fabricating the new columns, the existing columns below the roof slab were scanned, as was the top surface of the sloping slab. Grout packs and oversized steel base plates were used to calibrate column elevations and provide a level working surface for the mass timber columns, which were installed on the steel dunnage frame. The space created between the existing roof slab and top of the new steel frame was utilized for routing mechanical, electrical, and fire protection (MEPF) services. Glulam columns were attached to steel knife plates field welded to the top of the new steel beams. A concrete slab on metal deck was installed on the steel dunnage frame, acting as the floor surface for the addition's first level.

The existing building did not require upgrades to fire-resistance ratings, nor did it require structural reinforcements due to gravity loads. The latter was one of the main benefits of mass timber. The owner required that the lowest six levels of the building remain fully open and functional throughout construction of the addition. Mass timber's relative light weight was leveraged to add three additional stories without exceeding the structural capacity of the existing building's columns under gravity loading. To verify the structural properties of the existing columns, core samples were obtained and tested. Foundation reinforcement was not required, but lateral system upgrades were. The addition utilized a steel braced frame at the core, and new steel columns were installed within the steel moment frame core in the existing levels below.

Learn more about this project and its team on the WoodWorks Innovation Network.

80 M Street / Hickok Cole / Arup / Photo Ron Blunt

Other Mass Timber Vertical Additions

Brewery Lofts – Tacoma, WA

Four-story mass timber vertical addition on top of existing three-story, 110-year-old building; part of the Brewery Blocks development

View on the WoodWorks Innovation Network (WIN)

Firehouse 12 – New Haven, CT

One-story mass timber vertical addition on top of existing two-story building; designed by GOA

View on the WoodWorks Innovation Network (WIN)

DPR Office – Sacramento, CA

One-story mass timber vertical addition on existing one-story building; new headquarters for DPR Construction

View on the WoodWorks Innovation Network (WIN)

843 N Spring Street – Los Angeles, CA

Four-story CLT and steel hybrid structure on top of existing two-story concrete building; designed by LEVER Architecture

View on the WoodWorks Innovation Network (WIN)

Stamford Media Village – Stamford, CT

Two-story CLT and steel hybrid structure on top of existing three-story concrete building; designed by CP Architects

View on the WoodWorks Innovation Network (WIN)

Adidas Headquarters South Building – Portland, OR

Three-story mass timber vertical addition on existing concrete parking garage; designed by LEVER Architecture / *Read the WoodWorks case study*

View on the WoodWorks Innovation Network (WIN)