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Integrating MEPF in Mass Timber Buildings

Techniques for Incorporating Building Infrastructure Systems in Exposed Wood Structures

The opportunity to leave structural elements exposed in a mass timber building offers tremendous design possibilities. It also brings creative challenges not seen with other building types, such as how to expose as much of a mass timber ceiling as possible and keep it relatively uncluttered to emphasize the beauty and biophilic properties of the natural wood panels. This requires careful attention to mechanical, electrical, plumbing, and fire suppression systems (MEPF), either to hide them in concealed areas or incorporate them in a way that suits the architectural design.

This paper explores strategies being used to incorporate MEPF in U.S. mass timber buildings. While there is no "best" approach, effective integration considers the impacts of services on all aspects of the project, including aesthetics, structural performance, fire protection requirements, grid utilization, reconfigurability, and cost. MEPF options should be considered early and often during the design of a mass timber building to avoid issues later.

Elements commonly left exposed:

- Ducting for forced air distribution and exhaust
- Sprinklers (piping and heads)
  - Easier to meet requirements for distribution, density, and coverage of sprinkler lines and heads
- Electrical conduit
  - Exposed more frequently in office and institutional buildings

Elements commonly concealed (e.g., with dropped ceilings, topping slabs, soffits, chases, and within walls):

- Plumbing supply and drain lines
  - Dropped ceilings common in bathrooms and kitchens, which are often stacked story-to-story
- Data and low-voltage cabling
- Hydronic piping
- Electrical conduit

Common Approaches to MEPF in Exposed Wood Structures

In a multi-family building, designers often expose mass timber ceilings in living rooms, bedrooms, dining areas, and hallways of dwelling units, and use dropped ceilings in kitchens, bathrooms, and corridors to conceal the heavier concentration of MEPF systems. In office, retail, assembly, and institutional buildings, it is common to expose mass timber ceilings in all areas except bathrooms, mechanical rooms, and other spaces with significant MEPF systems.

Photo Chad Davis

DPR Office / SmithGroup / Buehler Engineering

Methods of routing ductwork:

- Exposed ductwork
  - Maximizes mass timber exposure but may warrant a higher level of material and installation craftsmanship
- Concealed within dropped ceilings
- Concealed within raised access floor

Methods of routing electrical conduit and fixtures:

- Surface-mounted
  - Impacts the aesthetics but simpler to coordinate as few if any penetrations are required through mass timber members
- Conduit in topping slab, which drops through floor panels to lighting
  - Minimal impact on aesthetics but requires a high level of preconstruction planning and coordination
  - Minimizes ability to perform retrofit changes without removing the topping slab; assembly options include conduit within a thin bed of poured topping with an acoustic mat and second poured topping on top, or acoustic mat, welded fire mesh, conduit, and poured topping in a single pour
- Wall-mounted fixtures and outlets in lieu of elements mounted on horizontal surfaces
  - Low aesthetic impact since walls are not commonly mass timber, but may impact usability of space with wall-mounted systems only
- Conduit within raised access flooring

Methods of routing low-voltage cabling:

- On cable trays
- Concealed within dropped ceilings and soffits (commonly on cable trays)
- Within raised access flooring

Attaching MEPF Systems

Most of the MEPF systems discussed in this paper are attached to the underside of mass timber panels or beams. This requires the use of hangers, which are typically attached to the wood with screws or screw-in threaded inserts. Fasteners should extend into the member for the structurally required penetration. Where the exposed member is required to be fire-resistance-rated (e.g., 1 hour) fasteners should extend beyond the char layer. To avoid splitting, loads should be hung from or extend above the neutral axis or kept to within the top third of the member depth.

Concealed Spaces

Hiding MEPF systems from view in a mass timber building usually requires concealing them within soffits, shafts, or dropped ceilings. These areas are considered concealed spaces and extra care must be taken with their design. Specifically, building codes require protection of combustible materials—such as mass timber surfaces—within a concealed space. Options vary by construction type, but include sprinklers, covering combustible materials with gypsum board, and filling the space with noncombustible insulation. For more information, see the WoodWorks publication, *Concealed Spaces in Mass Timber and Heavy Timber Structures*.

Structural Grid Options and Impacts on MEPF Integration

MEPF elements inherently interact with a mass timber structure in ways that require careful planning and coordination. If the structure is exposed, this may include laying out the structural grid with the goal of minimizing the aesthetic impact of the MEPF systems, minimizing penetrations through mass timber members, and providing flexibility for future renovations.

Structural grids can be loosely categorized as one-way or two-way beam systems. One-way beam systems utilize beam and column spacings that allow the mass timber floor/roof panels to span between them, so the beams exist in one direction of the building only (perpendicular to the floor/roof panel span). Columns are required at the ends of each beam to avoid the need for girders. Two-way beam systems utilize larger grid spacings that require beams in both directions. The intermediate beams in each bay, which are perpendicular to the panel span, are referred to as purlins, and the beams parallel to the panel span, supporting the purlins, are referred to as girders.

To determine efficient grid spacings, it is important to understand possible span ranges for the mass timber floor and roof panels. Due to their relative light weight, allowable spans for floor panels are often governed by vibration and deflection rather than bending or shear capacity. In addition to panel vibration design, vibration performance of the framing system as a whole, including beams, should be taken into account. Table 1 illustrates example panel span ranges for cross-laminated timber (CLT) and nail-laminated timber (NLT) based on panel size, assuming stiff supports. (Each project's specific span, loading, and support conditions, as well as manufacturer-specific design properties, should be accounted for when selecting panel thickness.) For information on the vibration design of mass timber floors, see the WoodWorks publication, *U.S. Mass Timber Floor Vibration Design Guide*.

Aligning MEPF with Architectural Intent

In buildings with exposed mass timber ceilings, designers typically hide services in concealed areas or incorporate them in a way that suits the architectural design.

Photo: Nick Johnson, Tour D Space

INTRO Cleveland

Hartshorne Plunkard Architecture / Forefront Structural Engineers / Fast + Epp

A dropped ceiling over the kitchen conceals air distribution and plumbing lines, while walls and soffits conceal sprinkler lines and routing. Openings for lighting in the mass timber ceilings were precut during fabrication.

Photo: Jane Messinger

11 E Lenox

Monte French Design Studio / H+O Structural Engineers

Placing MEPF systems below the structure minimizes the need for penetrations in the floor panels and structural beams. Electrical services are attached to the underside of floor panels, and most other services run below the beams.

Photo: Corey Gaffer courtesy Perkins&Will

T3 Minneapolis

MGA | Michael Green Architecture / DLR Group / Magnusson Klemencic Associates / StructureCraft

Exposed sprinklers, ducts, and electrical contribute to the industrial aesthetic of this seven-story office building without cluttering the space.

Photo: VRX Media Group

Ascent

Korb & Associates Architects / Thornton Tomasetti

To create an exposed timber ceiling entirely free of MEPF, services are concealed within walls, dropped ceilings, soffits, and poured topping slabs.

Photo: ©2026 Lincoln Barbour

TimberView

Access Architecture / DCI Engineers

Thoughtful exposure of MEPF maintains a clean, organized aesthetic. Electrical supply is mostly concealed in the walls and plumbing is within walls and dropped ceiling/soffit areas.

Photo: Brent Isenberger Photography

Star Lofts

ID8 Architects / KPFF

In this mass timber/light-frame wood hybrid, designers chose a mix of exposed and concealed MEPF in part to achieve affordability goals.

TABLE 1: Span ranges for mass timber floor panels

Panel	Common Floor Span Ranges*	
	Single Span	Multi-Span
3-ply CLT (4-1/8")	10 to 13 ft	12 to 15 ft
5-ply CLT (6-7/8")	15 to 18 ft	18 to 21 ft
3" SCL CLT	8 to 10 ft	10 to 13 ft
4" SCL CLT	10 to 13 ft	12 to 15 ft
5" SCL CLT	13 to 15 ft	15 to 18 ft
2x4 NLT/DLT (3-1/2")	10 to 12 ft	12 to 14 ft
2x6 NLT/DLT (5-1/2")	15 to 17 ft	17 to 20 ft
3-1/8" GLT	9 to 11 ft	10 to 13 ft
5-1/8" GLT	14 to 16 ft	16 to 19 ft

**Examples from efficient framing layouts, NOT for final design. Allowable spans depend on loading, panel grade and lay-up, and performance criteria.*

One-Way Beam Systems

One-way beam grids are usually in the range of 10×20 to 20×32 feet. The narrower grid dimension is based on the span capability of the floor panel (Table 1). The larger grid dimension is based primarily on programmatic layout while taking into account economical spans for the beam type. This condition can be seen in parts of the First Tech Credit Union in Hillsboro, Oregon.

Photo: Jeremy Bittermann

One-way beam system at the First Tech Federal Credit Union / Hacker / Kramer Gehlen & Associates

Two-Way Beam Systems

Two-way beam grids tend to be in the range of 20×20 to 36×36 feet. Although a mass timber panel can potentially span the 20-foot distance between support beams in a 20×20-foot grid, a more common approach is to include an intermediate beam (or beams) within each bay to reduce the span of the floor panel.

For example, a 30×30-foot grid could have two intermediate beams (purlins) to allow 3-ply CLT floor panels spanning 10 feet. A similar scenario was used for The Beam on Farmer project in Tempe, Arizona. Alternatively, designers could choose a 30×30-foot grid with one intermediate beam. This typically results in the use of 5-ply CLT or 2×6-foot NLT, dowel-laminated timber (DLT), or glue-laminated timber (GLT) floor panels spanning 15 feet. In general, thinner floor and roof panels may result in lower material costs. However, lower horizontal panel costs may be offset by higher beam (and potentially column) costs, and additional intermediate beams require additional MEPF coordination and perhaps penetrations. A cost analysis for thicker floors and fewer beams vs. thinner floors and more beams may be prudent.

In terms of MEPF integration within a mass timber structural grid, a one-way beam system typically requires fewer beam penetrations, which lowers the structural impacts of the penetrations while simplifying preconstruction coordination of MEPF and structure integrations. Since the beams run in one direction only, there are more opportunities to run MEPF elements across the structure without having to penetrate beams.

Photo: Jason Roehner Photographs

Two-way beam system at The Beam on Farmer / RSP / PK Associates

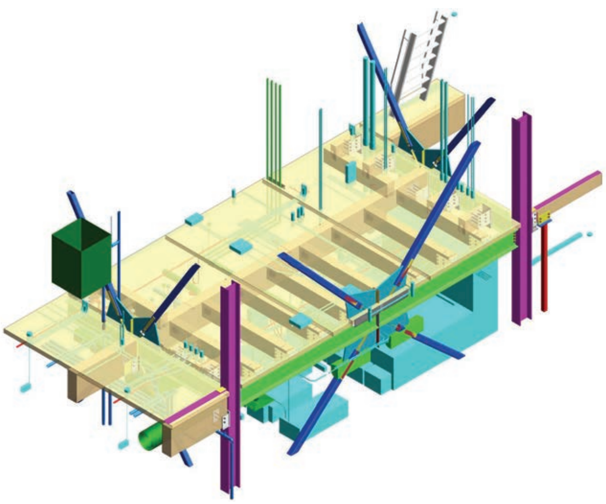
For double-loaded corridors in multi-family buildings and areas adjacent to the central cores in commercial and office buildings, shallower beams can provide extra room for larger MEPF lines. Branch lines would then be run into each unit, office bay, or commercial space within each structural bay without the need for beam penetrations.

Penetrations and Openings

It is advantageous to avoid penetrations in beams and other mass timber elements as much as possible due to the fire and structural impacts. For more information, see the WoodWorks article, *Holes and Penetrations in Mass Timber Floor and Roof Panels*.

Openings (holes) in mass timber elements are cut during fabrication to increase precision and avoid the need for field cutting. Careful coordination (by way of 3D modeling) during design and preconstruction is necessary to ensure successful integration of the MEPF system and structural members (see Figure 1).

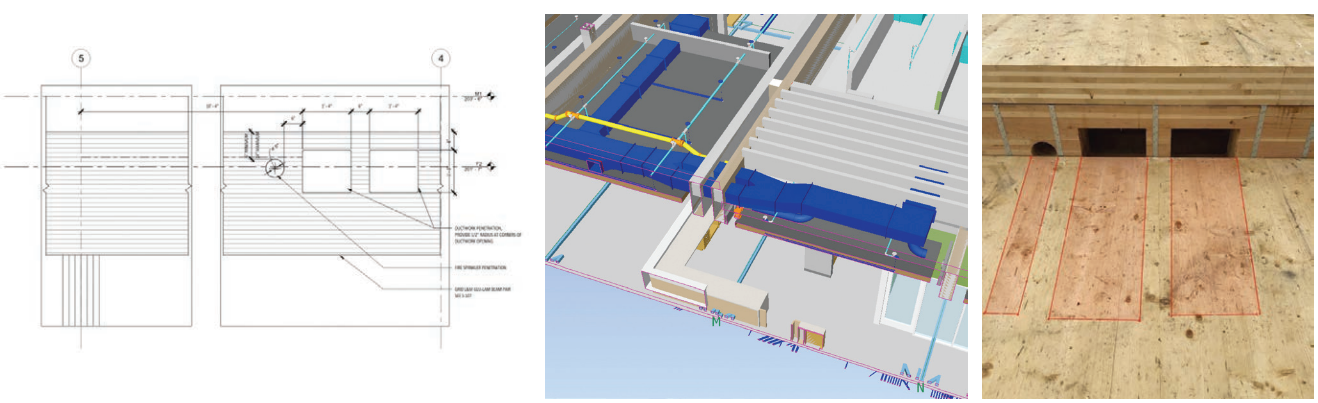
Shallower beams adjacent to a core accommodate larger MEPF lines at T3 Minneapolis / MGA | Michael Green Architecture / DLR Group / Magnusson Klemencic Associates / StructureCraft



Coordination with steel elements in a mass timber hybrid structure

Placement of services within an office unit

Images: Timberlab



Coordinating penetrations through beams

FIGURE 1: 3D modeling is used extensively to coordinate MEPF services.

Precut holes in a glulam beam for MEPF routing

An alternative to having MEPF elements run through penetrations in beams is to hang them below. This eliminates the need for cutting holes in the beams, but impacts the aesthetic of the mass timber ceiling as well as the clear height. This option may require higher floor-to-floor heights, which impact overall building height and cost.

Photo: ADX Creative

Ductwork and sprinkler lines hung below beams at Timber Lofts / Engberg Anderson Architects / Pierce Engineers

Stacked Beam Systems

Beyond the basic grid options of one- and two-way beam scenarios, there is flexibility in how MEPF systems and mass timber structures interact. One example is the stacked purlin on girder system, which is also referred to as a vertically-offset two-way beam system. While the beams in this approach span in two directions, they are not in a single plane, flush to the underside of the mass timber floor panels. Instead, purlins are installed flush to the underside of the panels and girders are installed lower down, creating space for MEPF without the need for beam penetrations. The bottom of the purlins can bear on the girders, or the purlins could be notched on the bottom and then bear on the girders. Platte 15 in Denver, Colorado used this approach, as shown below.

This approach does have fire protection implications as the top of the girder would be exposed in a fire event. The char surface would include all four sides for the girder, whereas the purlin is exposed on three sides (protected on top by the directly applied floor panel). For beams required to have fire-resistance ratings, the additional exposure should be included when performing char calculations using the information in Chapter 16 of the American Wood Council's National Design Specification® (NDS®) for Wood Construction.

Photo: JC Buck

Stacked beam system at Platte Fifteen / OZ Architecture / KL&A Engineers and Builders

Gapped Mass Timber Panels

Gapped panels are another alternative to beam penetrations for MEPF routing. Rather than installing panels tight to each other, installers leave space between them (usually 6 to 24 inches) to run smaller MEPF items such as conduit, low-voltage cabling, and sprinklers. These items run above the glulam beams, between the mass timber panels, without the need for beam penetrations. Designers can also use inlaid wood ceiling panels to hide services within the gaps while keeping them accessible for future renovations or changing tenant needs. Since the mass timber panels are not continuous in this scenario, they cannot be used as the fire-resistance-rated floor assembly, nor do they provide consistent acoustic separation as a floor assembly. If the floor or roof assembly does require an FRR, it is typically accomplished with a poured, continuous concrete topping layer over the mass timber.

Photo: Mike Sinclair

Gaps between panels create space for sprinkler lines at 111 East Grand / Neumann Monson Architects / Raker Rhodes Engineering / StructureCraft

Photo Dror Baldinger

In the aquatic center of the San Antonio Spurs' Victory Capital Performance Center, larger gaps between panels provide enough space for electrical and lighting / ZGF / Arup

Point-Supported CLT

Point-supported or two-way CLT systems eliminate all beams, leveraging CLT's ability to span in both major and minor panel axes simultaneously. They have denser column grids, typically in the range of 8x10 or 12x15 feet, with the column spacing in one direction set to match panel widths. Point-supported mass timber systems are subject to different stresses at different locations than one-way spanning panels (e.g., punching shear stresses are high at column supports in point-supported panels). For information on the structural design of this system, see the WoodWorks article, *Design for Two-Way Spanning Cross-Laminated Timber.*

From an MEPF integration perspective, point-supported systems can be simpler since there are no beams to avoid or penetrations through beams to coordinate. However, they are often selected for their ability to create thin floor structure depths, lowering both the floor-to-floor height and overall building height—and it is important to consider the impact of MEPF systems on these heights. Additionally, even though there are no beams to penetrate with MEPF, there will still be penetrations through the mass timber floor panels to run elements between floors. These openings can impact the structural capacity of the panels, and their size and location must be carefully considered.

Photo: Flor Projects

Point-supported mass timber panels at 1510 Webster / oWOW / DCI Engineers

Conduit in Topping Slab

It is possible to conceal electrical conduit within a poured topping layer over mass timber floor panels. While this option has minimal aesthetic impact (e.g., floor-mounted electrical boxes), it requires significant coordination of the conduit layout prior to pouring the topping and doesn't allow for easy renovations or changes to the electrical layout. The acoustic impact of conduit within the concrete layer should also be considered. If the topping slab serves structural functions (such as the diaphragm in a timber-concrete composite slab system or damping mass for vibration enhancement), its thickness may need to be increased to accomplish those functions while providing routing space for conduit.

Photo: Alex Schreyer

Conduit set above mass timber floor panels prior to pouring concrete topping slab / John W. Olver Design Building / Leers Weinzapfel Associates / EQUILIBRIUM / Simpson Gumpertz & Heger

Radiant Heat Tubing in Topping Slab

Similar to routing electrical conduit through a poured topping slab on a mass timber floor panel, some designers utilize the topping slab to route radiant heat tubing. Similar considerations exist in terms of pre-planning, limitations on future reconfigurations, and impacts on the acoustical and structural performance of the topping slab.

Raised Access Floor

Raised access floor (RAF) systems can be used to hide the majority of MEPF elements while providing future reconfigurability and helping with acoustic performance of the floor assembly. RAF systems utilize a series of pedestals that bear on a thin poured topping. The pedestals vary in height to create a range of chase sizes—e.g., from 6 inches to run electrical and low-voltage cabling or 16 inches (or more) for air distribution—and flooring panels laid on the pedestals create the floor/walking surface.

Note that these systems create concealed spaces, which must be considered in the design. Depending on the building's construction type, the International Building Code and/or NFPA 13 Standard for the Installation of Sprinkler Systems provide requirements for the protection of combustible materials within concealed spaces. Options include covering the combustible materials with non-combustible materials (e.g., covering the top of the mass timber panel with a poured concrete or gypsum topping or covering glulam columns with gypsum board), filling the concealed space with noncombustible materials (which can be difficult when the space is used for MEPF routing), or sprinklering the concealed space (also made challenging by the presence of MEPF elements). For information on the design of concealed spaces such as those created by a RAF, see the WoodWorks publication, *Concealed Spaces in Mass Timber and Heavy Timber Structures.*

Photo Global IFS

Raised floor in a mass timber building

Conclusion

While integrating MEPF systems is an important part of any building design, it is critical in mass timber projects because it impacts everything from aesthetics and structural performance to fire protection, grid utilization, reconfigurability, and of course cost. There is no single best approach to MEPF integration; the most appropriate solution is one that accounts for all of the impacted areas in the context of the project's goals.

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