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EFFICIENT STRUCTURAL DESIGNS FOR MASS TIMBER BUILDINGS: THE ENGINEER'S ROLE IN OPTIMIZATION

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ABSTRACT: Achieving the highest level of cost efficiency possible with mass timber requires an understanding of both material properties and manufacturer capabilities. When it comes to laying out a structural grid, the square peg/round hole analogy is pertinent. Trying to force a mass timber solution on a grid laid out for steel or concrete can result in member size inefficiencies and the inability to leverage manufacturer capabilities. Knowing how to best lay out the structural grid—without sacrificing space functionality—allows the designer to optimize member sizes, but cost efficiency for a mass timber building goes beyond column spacing. The structural engineer's role in optimizing a mass timber structural layout involves taking a system vs. product approach. This paper will describe that approach, along with other considerations, such as design parameters and challenges, connections, grid spacings, and lessons learned from built structures in the U.S., that can help engineers optimize their mass timber projects.

KEYWORDS: Cross-Laminated Timber, Structural Grid, Spans, Cost Optimization, Connections

1 INTRODUCTION

Mass timber products such as cross-laminated timber (CLT), nail-laminated timber (NLT), dowel-laminated timber (DLT), mass plywood panels (MPP) and glue-laminated timber (glulam) are at the core of a revolution that is shifting how designers think about construction. At no other time has the selection of materials been such an integral aspect of the building designer's daily responsibilities. In addition to its sustainability and light carbon footprint, mass timber has benefits that include enhanced aesthetics, speed of construction, and light weight, all of which can positively impact costs. However, to convince building owners and developers that a mass timber solution is viable, the structural design must also be cost competitive. This requires a full understanding of both material properties and manufacturer capabilities.

Mass timber is commonly seen in projects such as offices (Figure 1), schools, and tall mixed-use buildings, which often have assumed structural grids due to decades of construction tradition. Intended to meet the need for tenant flexibility, these "default" grids align with the capabilities of historically-used materials—i.e., steel and concrete. When it comes to laying out a structural grid for mass timber, the square peg/round hole analogy is pertinent.

Although a mass timber solution may work economically on many grids conducive to steel/concrete framing, some modification may be valuable. Trying to force a mass timber solution on a grid laid out for other materials can result in member size inefficiencies while negating opportunities related to manufacturer capabilities. As such, it is critically important to design a mass timber building as a mass timber building from the start. This requires a thorough understanding of how to best lay out the structural grid, without sacrificing space functionality, to optimize member sizes—but there's more to cost efficiency than column spacing.

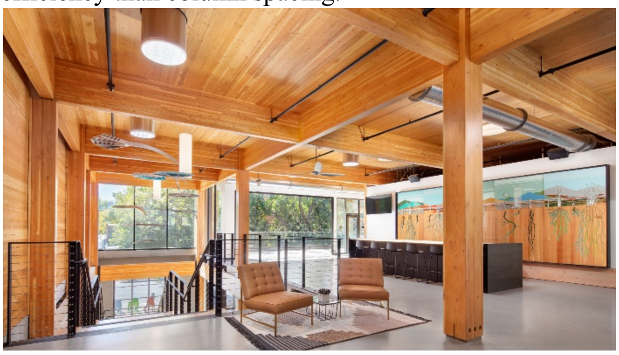

***Figure 1**: DPR Construction Headquarters Office Building, Sacramento, CA. CLT and glulam construction. Source: SmithGroup, Buehler Engineering; photo Chad Davies*

The following considerations are based on a post-and-beam frame for occupancies such as offices, mixed-use and multi-family; however, many also apply to bearing wall-supported systems in other occupancy types.

2 GRID SELECTION

Simplistically, there are two main grid options for mass timber buildings: square and rectangular. In deciding which to use, there are a number of factors to consider.

2.1 MASS TIMBER PANEL SPANS

To determine efficient grid spacing, it is important to understand possible span ranges for mass timber floor panels. Due to their relative light weight, allowable spans for these panels are often governed by vibration and deflection rather than bending or shear capacity. In addition to panel vibration design, vibration performance

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of the framing system as a whole, including beams, should be taken into account. Figure 2 illustrates example ranges 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.) It is also worth noting that the thickness options for CLT noted in Figure 2 are based on 2x laminations planed to 1-3/8-in. thick. Alternative lam thicknesses (and therefore panel thicknesses) are also available from some manufacturers. For example, 5-ply panels that are thinner or thicker than 6-7/8-in. may be available. Each manufacturer should be consulted for their range of products.

Panel	Example Floor Span Ranges
3-ply CLT (4-1/8" thick)	Up to 12 ft
5-ply CLT (6-7/8" thick)	14 to 17 ft
7-ply CLT (9-5/8")	17 to 21 ft
2x4 NLT	Up to 12 ft
2x6 NLT	10 to 17 ft
2x8 NLT	14 to 21 ft
5" MPP	10 to 15 ft

Figure 2: *Example mass timber floor panel span options. Source: WoodWorks*

2.2 GRID OPTIONS

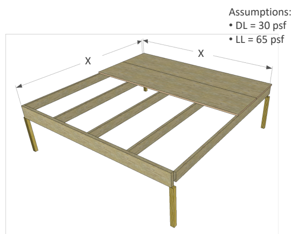
Based on completed buildings in the U.S., square grids tend to be in the range of 20×20-ft to 30×30-ft. Although a mass timber panel may be able to span the 20-ft distance between support beams in a 20×20-ft grid, an alternate method would be to include one intermediate beam within each bay to reduce the span and thickness of the mass timber floor panel. For example, a 20×20-ft grid could have one intermediate beam so 3-ply CLT floor panels spanning 10 ft can be used. This scenario was used for the Albina Yard office building in Portland, OR. Similarly, a 24x24-ft grid with one intermediate beam and 3-ply CLT was used at Denver University's Burwell Center for Career Achievement in Denver, CO (Figure 3).

Figure 3*: 24x24-ft grid at Denver University's Burwell Center for Career Achievement. Source: WoodWorks*

Larger square grids such as 28×28-ft or 30×30-ft with one intermediate beam can also be used. This typically results in the use of 5-ply CLT or 2×6 NLT or DLT floor panels, spanning 14 or 15 ft. This scenario was used for Clay Creative, also in Portland, OR. Alternatively, larger square grids such as 30x30 with two intermediate beams and 3-ply CLT can be used. This was the option used at Platte Fifteen in Denver, CO (Figure 4). 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 perhaps column) and connection costs, and additional intermediate beams also need to be coordinated with mechanical, electrical and plumbing (MEP) systems. As such, a cost analysis for thicker floors and fewer beams vs. thinner floors and more beams is often prudent. Further comparison discussion and project-specific cost analyses are provided in Section 6 below.

Figure 4*: Platte Fifteen, Denver, CO. 30x30-ft grid with two intermediate beams and 3-ply CLT. Source: Oz Architecture, KL&A Engineers & Builders, photo JC Buck*

Going much beyond a 30 or 32-ft span with glulam girders starts to require fairly large (deep) beams. It can be done, but economics and headroom issues may outweigh the benefits of longer spans. Figure 5 illustrates several square grid options and associated member sizes.



Approximate Member Sizes – Office Floor Framing

X	Mass Timber Panel	Glulam Purlin	Glulam Girder
20’	2x8 NLT or 7-PLY CLT	None	6-3/4”x21” 24F-V4
	2x4 NLT or 3-PLY CLT	5-1/8”x18” @ 10’ oc	6-3/4”x21” 24F-V4
25’	2x6 NLT or 5-PLY CLT	5-1/8”x24” @ 12.5’ oc	6-3/4”x30” or 8-3/4”x27” 24F-V4
30’	2x6 NLT or 5-PLY CLT	6-3/4”x27” @ 15’ oc	8-3/4”x36” or 10-3/4”x33” 24F-V4

Note: All member sizing needs to be confirmed by a licensed engineer for conditions of your project.

Figure 5*: Example mass timber square grid options. Source: WoodWorks*

Rectangular grids are usually in the 10×20-ft to 20×32-ft range. The main difference with a rectangular grid is that intermediate beams tend not to be used, often resulting in one-way beams which can simplify the approach to accommodating MEP systems. The narrower grid dimension is typically based on the span capability of the floor panel (usually up to ~12 ft for 3-ply CLT, and ~17 ft for 5-ply CLT).

The larger grid dimension is based primarily on programmatic layout, while taking into account economical spans for glulam. Projects that have used this scenario include the First Tech Federal Credit Union in

Hillsboro, OR, which used a 12×32-ft grid with 5-1/2-in. 5-ply CLT panels spanning 12 ft (Figure 6), and the 111 East Grand Office building in Des Moines, IA, which used a 20×25-ft grid with 2×8-ft DLT panels spanning 20 ft.

Figure 6: *First Tech Credit Union, Hillsboro, OR. 12x32-ft grid with 5.5-in. CLT panels spanning 12 ft between glulam beams. Source: Swinerton Mass Timber.*

There are several reasons to eliminate the intermediate beam(s) (also commonly referred to as filler beams or purlins), but the one often cited by design teams is easier MEP coordination. Since exposing the mass timber floor panels on the ceiling side is desired in most mass timber buildings, some creativity in how ductwork, sprinkler lines and other MEP services are accommodated is required. If there are no intermediate beams, the main MEP trunk lines can be run around a central corridor with branch lines extending into each grid bay. A benefit to this approach is that no intermediate beams means no or minimal penetrations through glulam purlins or girders to coordinate, drill, design for, etc. In mass timber buildings, where MEP is often exposed and must be coordinated with the structure, integrating a MEP approach early in the design process is especially important for mitigating conflicts and costly routing techniques.

One option that can help reduce the depth of long-span girders is to use double girders side-by-side. Keeping floor-to-floor heights the same, deeper beams result in less clear distance from finish floor to underside of beam. Head height can be a driving factor in grid selection, especially if ductwork and other MEP items are run below the glulam beams. Another consideration is the owner or tenant's desire for open, nearly column-free interiors (which usually comes at a cost premium) vs. willingness to accommodate interior columns (taking into account spacing of those columns). The ability to accommodate interior columns can vary significantly with occupancy. For example, multi-family projects can usually accommodate much tighter column spacings as most columns can be hidden within unit-demising walls or corridor walls. For example, Brock Commons, a mass timber-framed student residence building at the University of British Columbia, used a post and plate system with a column grid of 9x13-ft and columns hidden within unit separation walls (Figure 7). Office and mixed-use occupancies typically require more open floor plates, resulting in the need for grids in the 20 to 32-ft dimension in one or both directions.

***Figure** 7: Brock Commons, Vancouver, BC. Post and CLT plate construction in a student residence building. Source: Seagate Structures*

2.3 ALTERNATIVE GRID LAYOUTS

A variation on the traditional post, column and plate structural grid is that of double-stacked CLT panels, running in perpendicular directions relative to each other. The Rocky Mountain Institute's Innovation Center in Basalt, CO, used this approach. For this project, the structural framework consists of a 20x20-ft grid with 9-ply CLT panels, which are 4 ft wide and centered over the columns, spanning 20 ft. On top of and running perpendicular to the 9-ply panels are 3-ply CLT panels (Figure 8). The gaps left between the 9-ply panels were used to run MEP services, which were then covered with an inlaid birch-slatted ceiling system. By utilizing this double CLT system, the design team was able to eliminate beams; they estimate that headroom was increased by over a foot when compared to a system that utilized beams, CLT panels and a raised access floor.

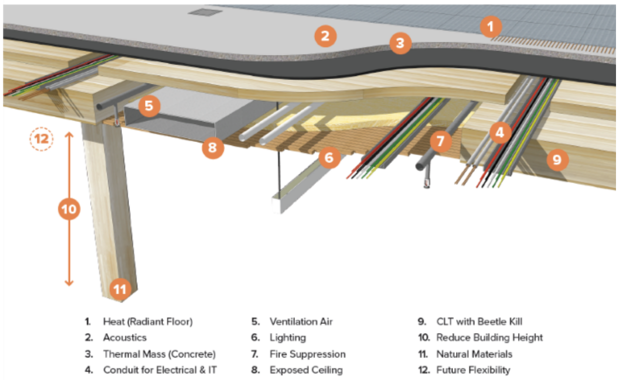


Figure 8: *Rocky Mountain Institute Innovation Center, Basalt, CO. 9-ply, 4-ft-wide CLT panels at 20 ft on center. Source: ZGF Architects*

Although not the focus of this paper, it is worth noting that mass timber floor and roof panel spans may be increased beyond the ranges noted above through the use of innovative composite systems. Composite systems may involve a mass timber panel acting compositely with a poured concrete topping layer, the two elements structurally connected through shear elements. This timber-concrete composite system was used at the John W. Olver Design Building on the campus of the University of Massachusetts (Figure 9). Alternatively, composite systems may consist of CLT floor panels acting in conjunction with parallel glulam beams, forming a ribbed panel scenario, as was used at the Catalyst Office Building in Spokane, WA (Figure 10).

***Figure 9**: John W. Olver Design Building, University of Massachusetts, Amherst, MA. Shear connectors for CLT-concrete composite installed in top of CLT prior to concrete placement. Source: Alexander Schreyer*

***Figure 10**: Catalyst Office Building, Spokane, WA. A 30x30-ft column grid is framed with ribbed CLT panels, each of which has two composite glulam beams to form a double-tee framing system. Source: Hans-Erik Blomgren, Katerra*

3 MANUFACTURER INPUT

When selecting grid dimensions, another important consideration is manufacturer capabilities. Most North American CLT manufacturers certified to the PRG-320 Standard for Performance-Rated Cross-Laminated Timber are capable of producing panels between 4 and 12 ft wide and between 40 and 60 ft long. Minimizing the amount of waste from each panel (both width and length) is key to maximizing efficiency. For example, a grid with 20-ft increments could be very efficient for some manufacturers; it could use 40-ft-long panels or 60-ft-long panels (if the manufacturer is capable of producing those sizes). On the other hand, a 25-ft grid may not be as efficient for some manufacturers since it would either require 50-ft-long panels (for double spans) or cutting 15 ft from 40-ft-long panels. Grids that do not take into account manufacturer panel size capabilities may result in increased waste and reduced economy. When considering especially long panels, trucking logistics should also be taken into account; standard flatbed trailer lengths may limit economical panel sizes. For materials procured from international timber suppliers, panel sizes are often constrained by shipping container dimensions.

Adohi Hall, a student residence hall on the campus of the University of Arkansas in Fayetteville, AR, utilized a 20-ft grid increment for a 60-ft-wide building. The CLT manufacturer provided 40-ft-long panels, resulting in the use of one full-length and one half-length panel to achieve the full 60-ft building width (Figure 11). Because each 20-ft panel was simply a full-length panel cut in half, efficiency was high and waste was minimized.

***Figure 11**: Adohi Hall, University of Arkansas, Fayetteville, AR. 20-ft grid increments maximized 40-ft long CLT panels for minimal waste. Source: Leers Weinzapfel Associates, OxBlue*

While manufacturer capabilities differ, it is possible to create grids that are efficient for several manufacturers. An important step in mass timber building design is to consult with manufacturers to determine the most efficient panel layouts for their capabilities (Figure 12).

***Figure 12**: CLT press. An understanding of a manufacturer's production capabilities informs an efficient grid design. Source: DR Johnson*

4 CONNECTION DESIGN

Not to be overlooked when discussing grid options is the cost of connections, particularly beam-to-beam and beam-to-column connections. Connections in mass timber structures are required to perform multiple objectives, all of which affect their cost-effectiveness. Aside from transferring structural loads from one member to another, they must also provide the same fire-resistance rating as the members being connected (further discussion on fire-resistance rating of mass timber is given in Section 5 below). Aesthetics of timber connections is also a factor. Options range from simple bearing connections with little additional supplemental fasteners (Figure 13), to custom-fabricated steel hangers/saddles/knife plates to proprietary beam hangers and column caps. Not only does the cost of the hardware and fasteners used in these connections need to be taken into account, so too does their impact on aesthetics, head height and differential material movement. For example, simple bearing connections in platform-framed structures (e.g., glulam purlins bearing on dropped glulam girders over columns) may be the least costly connection detail; however, it results in lower head-heights to the underside of the dropped girders, and can introduce localized crushing and cumulative shrinkage of glulam members, resulting in net building differential movement over a multi-story structure. Concealed connections with flush purlins and girders can resolve some of the head height and crushing/shrinkage issues mentioned above. These concealed connections bring advantages of aesthetics, constructability, and often fire resistance, but they also tend to be more costly. As with the structural grid discussion, a final connection is typically achieved through multiple iterations and cost evaluations, balancing all of the objectives that connections must achieve. Specifically as it pertains to the interaction of grid choice and connection options, larger grids result in larger beam reactions, which results in the need for higher connection capacity. In general, it is fair to say that connection cost increases as reaction increases for all connection types.

Figure 13*: Beam-to-column connection. Column width is notched down to allow direct beam bearing. 90 Arboretum Drive Office Building, Newington, NH. Source: WoodWorks*

5 FIRE RATINGS AND CONSTRUCTION TYPES

5.1 SELECTING A CONSTRUCTION TYPE

For mass timber projects, selection of construction type is one of the more significant design decisions. While it's common to choose 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/mass timber should be Type IV—this approach can lead to additional costs. While Type IV construction can be used for exposed mass timber projects, a full understanding of the allowable use of materials in all five construction types, as well as the unique allowances and limitations associated with each, will help to inform the most efficient design. Construction type selection also has a direct impact on grid options and member sizes, which both ultimately impact project cost.

To optimize a building design from a construction type and level of fire resistance perspective, it is best to start from the lowest end of the spectrum, Type V-B construction, and work up as required. This avoids unnecessary defaults or assumptions—and unnecessary costs. The fact that certain materials are being used doesn't mean there is only one option for construction type. Similarly, a mix of occupancy groups doesn't dictate that certain materials, construction types or building configurations are required. For example, a mass timber building may have isolated steel, concrete or masonry structural elements, but this doesn't mean that Type I or II construction is necessary, nor does it mean that some or all of the building can't be framed with mass timber. Likewise, a building with mass timber elements has options other than Type IV construction. Note IBC Section 602.1.1:

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.*

This section permits the use of elements commonly used in a higher construction type without requiring that the entire building meet all of the provisions of that construction type. For example, if a building's size permits 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, as permitted by the definitions of those construction types in IBC 602.

As noted, from a cost efficiency perspective, it is usually best to start a building analysis with Type V-B construction as this provides the most flexibility in terms of allowable use of materials throughout the building while minimizing impacts of fire-resistance ratings on assemblies and structural elements. However, Type V-B is also the most restrictive in terms of allowable building size. All three of these factors—allowable building size, allowable use of structural materials, and required fire-resistance levels—are interconnected.

If Type V-B construction doesn't allow as large a building as desired, the next step is to check Type V-A. The main differences between V-B and V-A are fire-resistance rating requirements and allowable building size. If Type V-A doesn't allow the desired size, Type III-B is the next choice, with Type III-A following. Type IV construction has similar allowable building size limits as Type III-A; however, there are nuances to the selection of one or the other. For further information on these differences, see the WoodWorks article *When designing a mass timber building, what are the key design considerations related to fire ratings, panel thickness/member size, and occupancy?*[4]

5.2 FIRE RESISTANCE RATINGS & MEMBER SIZE

Since the fire-resistance performance of mass timber members and assemblies is directly tied to the size/thickness of these elements, efficient designs account for both structural and fire-resistance requirements. This is where construction type and associated fire-resistance ratings have a direct impact on structural design, grid options, and structural element sizes in a way that differentiates the design process for timber from those for steel or concrete. (Figure 14).

Figure 14*: Fire-resistance ratings can impact required member size. Shown here are glulam columns, pre- and post- 2-hour fire test. Source: David Barber, ARUP*

For example, if a building is classified as Type V-A construction, a 1-hour fire-resistance rating (FRR) is required for all structural elements. If exposed CLT floor panels are desired, the selection of panel thickness should account for both structural criteria and fire performance. Achieving a 1-hour FRR with a 3-ply (~4-in.-thick) panel would be difficult because the panel would likely not retain enough thickness and residual structural capacity during a fire—which is why 5-ply panels are often used. Knowing this, it would be most efficient to lay out the structural grid of the building to maximize the allowable spans of a 5-ply panel. As discussed above, this would typically mean floor panel spans in the 14 to 17-ft range, either in a rectangular grid, or 28 to 32-ft square grids with one intermediate beam per bay. Conversely, if using CLT floor panels in a Type V-B building, it may be worth performing a cost analysis of 3-ply panels with closer support spacings (usually 10-12 ft on center) vs. 5-ply panels with supports spaced further apart (usually 14-16 ft on center). Type V-B construction does not require an FRR for floor construction (unless otherwise required by code), so the thinner 3-ply panels may offer greater cost efficiency. For additional information and resources related to the fire-resistant design of exposed mass timber members, see the WoodWorks publication *Fire Design of Mass Timber Members.*[5]

6 GRID COST STUDIES ON COLORADO MASS TIMBER PROJECTS

To test some basic assumptions about grid selection for mass timber structures, KL&A Engineers and Builders undertook a short conceptual study of the effect of different framing options on cost. The approach was to design multiple different configurations of a single structural bay to calculate the relative cost per area of each bay. The study was conceptually very simple: the selected bay was assumed to have identical bays extending in all directions. The costs were determined with input from real manufacturers and suppliers, with the understanding that those costs were simplified, representing a snapshot in time in an industry where a number of factors (commodity prices, current demand, distance to site, etc.) are variable. The costs in this study were established in mid-2019, so the relevance of the total cost values over time are questionable; as a result, the cost evaluations in this study are appropriate for comparing relative costs between different mass timber grid configurations, but not for comparison to other structural systems or materials. Timber costs in this study attempted to capture both manufacturing and installation costs. For CLT, KL&A used a reasonable but hypothetical model based on panel thickness and also a representation of the variable efficiency of different panel spans associated with waste (Figure 15). The study confirmed that optimal mass timber grids are not the same as those for steel or concrete.

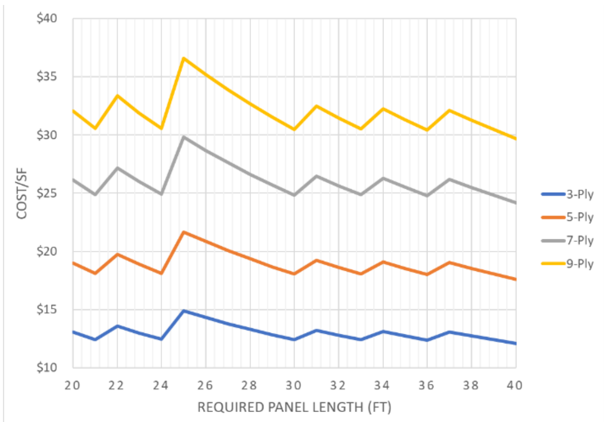


Figure 15: *Hypothetical cost of CLT panels for different required lengths. Source: KL&A Engineers & Builders*

The results of the study were summarized in a series of charts like the one shown in Figures 16, 17 and 19. In these charts, each vertical bar represents the cost per area of a particular grid choice, showing the contribution of wood, wood connections, and noncombustible topping. The height to the bottom of the deepest girder—assuming a 12-ft floor-to-floor height—for each grid choice is represented by a yellow line that relates to the right vertical axis.

Figure 16 shows the results for a "post beam panel" type grid with a 20-ft girder span and no intermediate beams, changing the CLT span between girders in increments of 2 ft. In this case, the longer the span, the more costly the system as wood volume increases with CLT depth. As stated in Section 2.2, such systems are best optimized by maximizing the span for the CLT required to meet fire-resistance requirements.

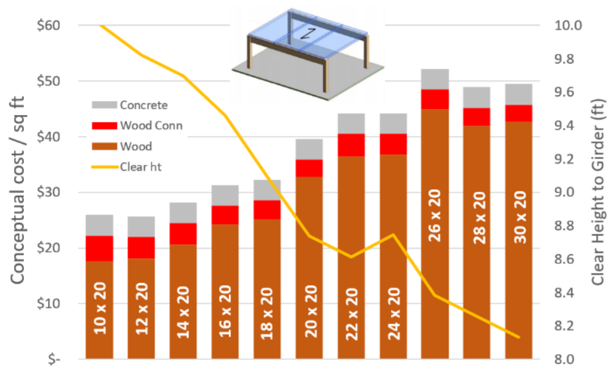


Figure 16: *Rectangular grid with a 20-ft girder and no intermediate beams. Source: KL&A Engineers & Builders*

Figure 17 shows the results of a study of a square grid with a single intermediate beam, increasing beam and girder spans simultaneously in increments of 2 ft. In this case there appears to be an optimal grid size around 24x24 ft. This is related to the span where the CLT jumps from 3-ply to 5-ply (keeping in mind that, in this study, CLT span = half of the overall grid dimension).

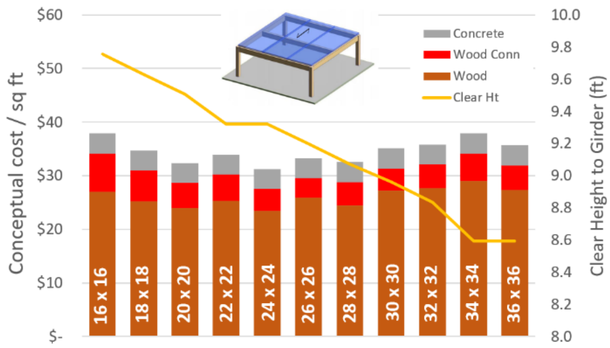


Figure 17: *Square grid with one beam centered in bay. Source: KL&A Engineers & Builders*

Because most mass timber structures are prefabricated in controlled and largely automated conditions, and site assembly is relatively fast, cost drivers for mass timber structures are dominated by material more than on-site labor. This can be contrasted with steel structures where the cost of on-site labor will generally be greater than material cost. This simple observation usually means that mass timber structures will be more economical if less material is used, even if there is an increase in the number of pieces. For example, if a solution with timber panels spanning between girders without beams requires 7-ply CLT, and an alternate requires only 5-ply CLT with the addition of intermediate beams, the alternate may be more economical even though it has more pieces to erect.

Experience with steel structures suggests that rectangular grid solutions with long beams framing into short girders are typically more economical than the opposite. To investigate this grid aspect ratio effect for timber, a series of grids were designed starting with 15x15 ft and increasing the beam span in 5-ft increments up to 30 ft, then increasing the girder span by 5 feet and repeating up to a grid of 30x30. Beam spacing was set to keep all CLT 3-ply. The series is shown in Figure 18, and the resulting cost study is illustrated in Figure 19.

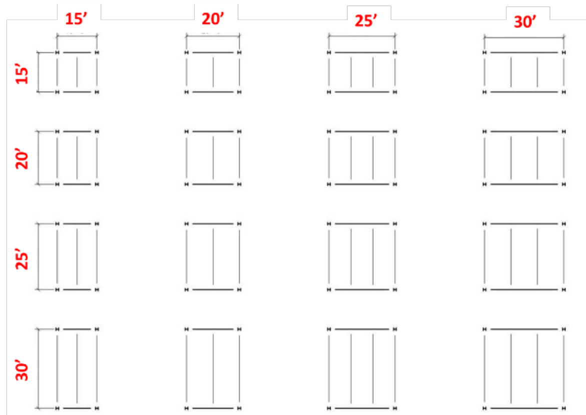


Figure 18: Mass timber grid aspect ratio study *Source: KL&A Engineers & Builders*

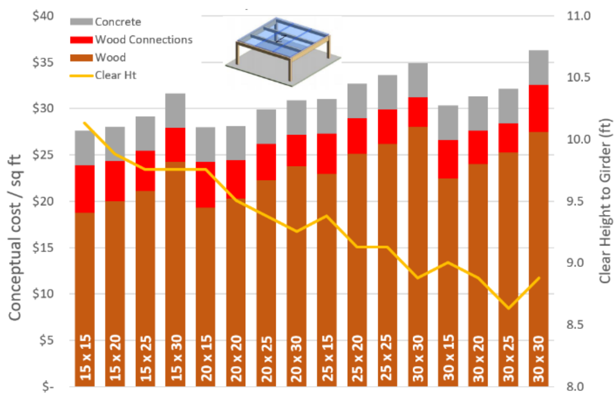


Figure 19*: Grid with 3-ply CLT. Source: KL&A Engineers & Builders*

Figure 19 shows the results of the grid aspect ratio study. For timber, cost tends to increase with beam span. Comparing, for example, the 15-ft girder x 30-ft beam with the 30-ft girder x 15-ft beam, the latter is less expensive, suggesting that the rule for steel may not apply to timber. This figure also illustrates that the effect of the less economical panel lengths near 25 ft (see Figure 15) can overshadow the aspect ratio effect. Because panel efficiency depends entirely on the manufacturer, this conclusion reaffirms the importance of early engagement of and collaboration with suppliers.

7 CONCLUSION

Selecting an efficient grid for a mass timber building is one of the most influential things a structural engineer can do to ensure its success. Proper grid selection should be done with the end results in mind—working within the capabilities of the chosen materials and manufacturer. There are a number of design criteria to consider when weighing grid possibilities, including timber span capabilities, construction type, fire-resistance ratings, connection solutions, trucking/shipping constraints, and other factors not discussed in this paper (e.g., acoustic performance, diaphragm capacity, aesthetics, etc.). Grid selection should be a collaborative effort between architect, engineer, owner and contractor (when possible) so that all parties are in agreement with regard to owner expectations and acceptable solutions. Many different grids have been used successfully on mass timber projects throughout the U.S. Although there is no one-size-fits-all grid solution, there are several parameters that can quickly help narrow down the options for a given project, while still providing a cost-feasible framing scheme.

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