Making Tall Timber Financially Viable: the Design-Build Approach

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Making Tall Timber Financially Viable: The Design-Build Approach

Abstract

As the tall building industry increasingly becomes interested in using engineered mass timber to construct high-rise buildings, the economical and construction-efficiency advantages need to be as well-understood as the environmental and aesthetic benefits. The author has compiled experience developing, designing, and constructing high-rise mass timber projects in several markets, noting the particular relevance of the design-build approach to drive efficiencies. This paper explores the applicability of the design-build approach to the prevailing and emerging techniques of mass timber procurement, prefabrication, and site assembly, as well as configuration of project teams. All of these are undertaken with the end goal of making tall timber “pencil out”—achieve financial viability.

Keywords: Constructability, Design-Build, Financing, Mass Timber, Prefabrication

Introduction

Whether you’re interested in the sustainability benefits, the construction efficiencies, or the increased rent potential driven by biophilia, mass timber construction has become a hot topic globally. But with many owners, architects, and builders trying their hand at this new technology, a disproportionate number of projects suffer from a “failure to launch.” The most common reason is an inability to make tall timber “pencil out”—to be cost-effective enough to meet the owner’s goals.

Tall timber, for the purposes of this paper, represents the use of one of the three new International Building Code (IBC) construction types (Type IV-A, Type IV-B and Type IV-C), in which mass timber is used for some or all of the structure. Mass timber describes a range of timber products, including glued laminated timber (glulam), laminated veneer lumber (LVL), nail-laminated timber (NLT), and cross-laminated timber (CLT), that are typically used as structural elements in construction. These products are manufactured and prefabricated off-site and offer inherent fire resistance, unlike traditional structural materials. Tall timber has become an attractive alternative to steel and concrete for a few key reasons:

• Environmentally, mass timber has a lower carbon footprint than its steel or concrete counterparts. With the drive to reduce carbon dioxide emissions globally and across the construction industry, a mass timber structure has a positive impact on carbon life cycle analysis, even before considering the carbon that timber naturally removes from the atmosphere.

• Socially, the biophilic impacts of mass timber structures have demonstrated qualitative benefits to occupant health, creating an overall better built environment. The construction process itself produces less dust and noise, and when planned properly, it also has a reduced construction time, meaning less impact on the surrounding community.

• Economically, the off-site manufacture and prefabrication of these elements delivers a high-quality product with reduced on-site labor and a shorter construction assembly period. This offsets the slightly higher material cost of mass timber, and should lead to lower construction costs than traditional approaches.

Despite the myriad potential benefits, mass timber projects are challenged to capitalize on these benefits due to a lack of experience and understanding throughout the industry. This is still a new technology, being used in new and innovative ways, with lots of lessons being
Without clear direction from the owner about why mass timber is desired before design commences, projects attempt to maximize for all benefits, at the expense of the budget. Projects tend to consider mass timber after entitlement, and stakeholders attempt to shoehorn a mass timber design into traditional building massing, ultimately missing many of the opportunities unique to mass timber. A well-intended design team without a strong design and cost management approach will often spin its wheels trying to solve design challenges without trade feedback, ultimately delivering an expensive design.

Engaging the supply chain too late can mean expensive redesign, but engaging too early can remove cost competition. Without the right construction methodology informing design, there is limited opportunity for construction schedule savings where a significant portion of the cost savings exist. The structural schedule savings, in addition to the opportunities for schedule compression for follow-on trades, need to be leveraged to make mass timber cost-effective.

So what does it take to make tall timber “pencil out?” A design-build approach allows for clear direction through client management, bringing together an experienced, innovative, and collaborative design and construction team driven by strong design, construction, and cost management, informed by a robust understanding and relationship with the supply chain.

What is Design-Build?

The Design-Build Institute of America (DBIA 2022) defines design-build as a condition in which “one entity, the design-builder, enters into a single contract with the owner to provide both design and construction services.” A design-build approach provides owners with a single point of responsibility, requiring designers and contractors to form an integrated team that fosters collaboration and teamwork, providing unified project recommendations to fit the owner’s schedule and budget (see Figure 1).

According to DBIA, “design-build unleashes the power of team to deliver projects faster, better, and for optimum cost and best value for the money, time, and effort invested. Owners find that when design-build is done right, their level of engagement with the entire team is more meaningful than is experienced with other delivery methods.”

However, where most design-build relationships in the US are partnerships between an architect and a contractor, Lendlease approaches design-build differently. The company operates as a design-led business with extensive delivery and ownership experience. As a design-builder, the company contracts design consultants directly, with the architect holding contracts with the architecture-specific sub-consultants to allow for accountability of budget and brief, bringing together a truly integrated approach (see Figure 2). It’s this expertise, and its design and cost management approach, that allows Lendlease to add value to projects through every stage.

A design-build approach uses cost planning and value optimization, not cost estimating and value engineering. Cost planners work closely with design managers and construction managers to proactively review the design for optimization against all value indicators for the project, not just cost. It’s about adding value, not reducing scope.

Design-builders undertake early and iterative cost planning to explore design options and provide quick cost advice on the impact of changes. These cost plans are informed by regular interactions with the extensive subcontractor market, to gather industry feedback and market pricing to inform cost plans and set up for a cost-competitive delivery outcome. They provide open-book transparency to clients, offering more cost clarity, earlier, to inform decision-making and the reduction of contingencies.
Bringing the effort forward to proactively add value early in design increases the design-builder’s ability to impact value and reduces the cost of any changes, ultimately de-risking the construction process (see Figure 3).

The design-build approach is valuable for all projects, and is especially valuable when working with something new and innovative that requires a truly integrated approach with a strong design focus on construction methodology and continuous cost feedback. It takes this design-build approach to make tall timber “pencil out.”

**A Success Story: McEvoy & Dupont Apartments**

As market-rate developers play with the financial metrics of new building technologies, the affordable housing industry is making real strides in sustainable and innovative construction as a means to solving the affordable housing problem on a small budget. These not-for-profit developers are taking the risk on new technologies as a way to keep construction budgets low, make funding applications competitive, and provide equitable opportunities for the residents.

First Community Housing (FCH) in San Jose, California, is at the forefront of these innovations, implementing new building technologies as a way of reducing construction budgets to remain competitive for funding. But as developer/owner/operator, FCH also focuses on delivering high-quality housing that responds to the needs of diverse communities and embraces environmental sustainability to keep operational costs low. The organization’s leaders believe that good design creates affordable, healthy, thriving, and environmentally sustainable communities.

The McEvoy & Dupont Apartments (see Figure 4) didn’t “pencil out” in terms of traditional construction, so FCH initially teamed with a Type-I steel-framed modular provider to reduce the construction costs. Unfortunately, upon submission of the entitlements, the modular building company changed its 25 King

Brisbane, Australia

Completion Date: October 2018
Height: 47 m (153 ft)
Stories: 11
Area: 14,921 sq m (160,608 sq ft)
Primary Function: Office

The world’s largest timber commercial CLT building at the time, this project demonstrated a cost-effective approach to MEP coordination with a 6-by-9-meter (20-by-30-foot) grid structure. Because mechanical, electrical, and plumbing circulation needs to be distributed throughout the building in the same plane as the timber structure, there are often conflicts. The resolution to these conflicts often adds structural floor depth and increased fabrication complexity, due to the need for structural penetrations, which can impact floor-to-floor height, increase timber volumes, and add costs.

The layout of 25 King was therefore developed with the aim of minimizing beam penetrations, with shorter-span, shallow beams providing a circular service “highway” around the floor plate.

The layout of 25 King, Brisbane. which allowed beam penetrations, with short-span, shallow beams making room for building MEP services to encircle the floor plate.
business model, so it was no longer compatible with affordable housing. FCH was left to look for a new partner to deliver much needed housing in San Jose, and turned to the design-build methodology.

“Design-build was chosen as a means to bring a new set of partners on in an intensely collaborative partnership that we believe was necessary for success,” says Mike Schaefer, construction manager, FCH.

Recognizing that FCH needed a partner that could deliver a building on budget, Lendlease offered a design-build approach that offered to look at a range of new building technologies, including mass timber, and modular and prefabricated light-gauge steel construction, to truly compare the qualitative and quantitative benefits of each solution. This approach allowed FCH to consider their options and land on mass timber construction as the preferred building technology.

The following 12 months, driven by strong design, construction, and cost management, informed by the supply chain and an innovative and collaborative design team, has led to two tall timber towers that “pencil out.”

Setting Up for Success

The choice of mass timber construction is best made before an architect puts pen to paper. The design principles that go with mass timber construction are different from traditional construction. Once a design is drawn with steel or concrete in mind, it is much more difficult to make it efficient for a mass timber solution.

Defining the Development Brief

To start, an owner/developer needs to define the development brief appropriately. A good design-build team will help a developer do this. The team needs to clearly understand what the key goals of the project are, what the required program is, and what the budget constraints are. It also needs to be clearly outlined why mass timber is of interest. This is critical to ensuring that the mass-timber design is optimized to suit these reasons, and

Figure 3. The design-build approach has the advantage of investing more effort at the start of a project, maximizing the ability to drive value and minimizing the cost of design changes. © Patrick MacLeamy

Figure 4. McEvoy & Dupont Apartments, a 365-unit affordable housing complex in San Jose, consists of two 13-story steel-timber hybrid mass timber structures, and is being delivered under a design-build contract. © SERA Architects
clearly understood by all stakeholders and the design team.

It is often beneficial to bring on a design-builder with experience writing development briefs at this stage. These companies have the skills to help bring stakeholders together to clearly define goals and program, and can share early benchmarking information to build a reasonable budget.

Next, the team needs to decide upon the most appropriate mass timber building typology with respect to the relevant building code. In the United States, the 2019 IBC Amendment includes the Type IV A, B, C, and HT (heavy timber) mass timber building typologies, and currently limits heights and areas for these buildings, depending on occupancy. The choice of building typology is important, as it impacts the ability to expose timber and establishes the fire resistance, separation, and protection requirements. These building codes are still new, and it is also very important to understand what precedents there are with the authorities having jurisdiction (AHJ) to understand what they will accept for alternative means and methods requests.

Once the building typology has been chosen, the right structural system for the project needs to be selected. Of course, “mass timber construction” doesn’t refer to just one structural solution. There are a range of horizontal and vertical systems to consider, pending the layout and lateral requirements. It may also be beneficial to explore a couple of different lateral and vertical systems in concept design to assess for alignment with the project goals. In order to streamline approval in most jurisdictions, tall timber structures are likely to have timber or timber-hybrid vertical systems and a traditional steel or concrete lateral system.

The installed cost of mass timber is more material than labor (approximately 70 percent material and 30 percent labor) when compared to traditional construction, which is more evenly weighted (about a 50 percent material/labor split), so the need to choose the most material-efficient structural system

“The design-builder needs to consider options around just-in-time delivery, storage, certification, chain of custody, spare element availability, geography, and, if the materials are coming from overseas, panel sizing, logistics, tax, and customs implications.”
targeted to the owners’ objectives is important. Traditional lateral systems can be as much as 35 to 40 percent of the total structural cost, and therefore need to be a significant consideration in the design.

**Defining the Project Brief**

From here, the design-builder will develop a project brief to outline how the project will meet the development brief. This basis of design will also outline the mass timber principles to be followed, optimizing the design to meet the project goals. These principles are likely to include a range of Design for Manufacture and Assembly (DFMA) principles that are key to designing the manufactured mass timber systems.

It is only then that a concept design should be developed by the architect, but not the architect alone. Optimizing for mass timber construction requires the design-builder, architect, structural engineer, MEP designers, and often the fire engineer as well, to come together at this early stage to truly optimize the best solutions, and there may be more than one at this stage. Clearly outlining the concept design solutions, with assumptions to be explored during design, is a great design management technique to clearly track how these concept design solutions play out during schematic design.

Once the concept design solutions have been defined, an initial cost plan needs to be developed to outline these options. In traditional construction at this early stage, benchmarking is usually sufficient to build up an appropriate cost plan. However, given the nuances of mass timber construction, the variety of structural solutions, and the lack of historical data, it is best to undertake a more detailed cost plan of the mass timber elements at the early stage, to truly set up the project for success.

**Value Optimization Throughout Design**

Design-builders undertake cost planning, not cost estimating. Design-builders are able to plan out the costs for elements under design and provide ongoing feedback.

**International House & Daramu House**

*Sydney, Australia*

Completion Date: 2017 (International House); 2020 (Daramu House)
Height: 30 m (98 ft) (both projects)
Stories: 7 (5 stories timber over 2 stories concrete) (both projects)
Area: 23,774 sq m (78,000 ft) (International House); 37,795 sq m (124,000 ft) (Daramu House)
Primary Function: Office

Following the success of International House, Lendlease’s first mass timber commercial office and the first project using the company’s in-house timber fabrication modeling, its “big sister,” Daramu House, was envisioned to also be constructed in mass timber. Along with other lessons learned, the structural design changed from a 6-by-9-meter (20-by-30-foot) grid to a 9-by-9-meter (30-by-30-foot) grid using prefabricated rib decks. This additional prefabrication allowed for reduced time on-site, and broadened the range of potential tenants interested.

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*International House, Sydney.*

*Daramu House, Sydney.*
measuring the cost of the various design changes and options that occur. Lendlease typically has cost planners participate in all design team meetings to ensure they can continually capture any design changes, and advise on their cost impacts quickly. They track these on a running sheet that is shared not only with the design team, but also with the client for decision-making. This provides certainty to the client of the budget, but also ensures the design team can continue to find best value throughout design, and that the design stays within the budget.

This process aids in keeping a mass timber construction project on budget, but also helps flag and identify all of the impacts of small changes. It is important to remember that the choice of mass timber is not just a structural choice, but impacts other building elements like fire protection, acoustics, building envelope, finishes, etc. There is potential for significant additional costs, depending on how these aspects are detailed. With every design decision on a mass timber project, all of the impacts need to be explored and assumptions need to be clarified to ensure the cost impact is truly understood.

Further to the design milestone cost plans and running sheet, it is also useful to keep updating a comparison of the mass timber solution to the traditional alternative. While the design for the traditional alternative is not progressed, the benchmarking information obtained is typically sufficient to continue cost comparisons. Undoubtedly, on a mass-timber project, one will be asked about how it compares to traditional construction, which this analysis provides for, but it is also useful to continue to check that the design is meeting the goals for mass timber, whether these pertain to cost or value in other ways.

Planning for Procurement

Cost plans are only as good as the up-to-date industry benchmarking and ongoing subcontractor feedback that the design-builder collects throughout the design.

Privatized Army Lodging Projects
Various military facilities in Alabama, New York, North Carolina, and Washington

Completion Date: 2021
Height: Varies
Stories: 4–5 (timber)
Area: 5 buildings for a total of approximately 119,000 sq m (390,000 sq ft)
Primary Function: Hotel

Lendlease has delivered more than 630 hotel units using mass timber on military bases across the United States. Structures on military bases have a unique design requirement to provide a level of blast resistance for the exterior walls, depending on the building setback from the secured perimeter. Cross-laminated timber was demonstrated to provide better blast resistance than hardened light-gauge metal walls (the traditional material of choice for hotels on military bases), and therefore allowed buildings with a larger footprint, offering an opportunity for improving unit yields. In addition, the ability to repeat very similar designs for the five buildings enabled incremental improvement on cost and speed: a 33 percent end-to-end cost reduction, and a near-doubling of erection speed.

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phase. On any project, it is critical that the design-builder has strong relationships across the subcontractor market to seek ongoing cost advice from a variety of trades to compare to project benchmarking prior to a formal bid process. Mass timber procurement is especially important, as the supplier and installer may be procured separately to minimize cost. The selection of the timber supplier can impact the structural design and the construction logistics.

Typically, project teams should engage with mass timber suppliers as early as possible. The design team will need to understand the manufacturing nuances between the suppliers, as well as the different material strengths, stiffnesses, and aesthetics to create an open specification for bidding. It is best to carry three to four options for suppliers until after design development, to keep the package as competitive as possible, while also providing succinct information to the design team. As part of the timber supply chain, the design-builder needs to consider options around just-in-time delivery, storage, certification, chain of custody, spare element availability, geography, and, if the materials are coming from overseas, panel sizing, logistics, tax, and customs implications.

Mass timber construction also benefits from less on-site labor and reduced schedule durations. But this means the design-builder needs to clearly define the construction methodology to inform the design and enable the cost plan to take advantage of schedule benefits. One should start with an overall construction methodology and seek feedback from the market as packages are formally bid. The chosen timber installer would then participate in installation workshops with any other structural trades to ensure there is an overall structural methodology that works. Importantly in the US, the protection of the timber also needs to be in alignment with the building codes, with consideration given to how this impacts the trades’ schedules as well.

General contractors that only bank the advantage of the structural time savings are leaving a lot of mass timber’s speed advantage on the table. Once structural works are taken off the critical path, however, there is still more opportunity for follow-on trades to commence earlier, so as to truly reduce the construction schedule. The precision and installed dimensional reliability available with CLT components creates more opportunity for other off-site pre-fabrication, and because the solid floor deck offers safe working conditions on the levels below, sub-trades can work concurrently in the building, acting as a multiplier to the speed advantage. A full-scale mock-up is incredibly useful for follow-on trades to visit, to demonstrate the difference in constructability and to push for a reduced cost and schedule benefit by working with mass timber.

There needs to be an overall focus throughout the design on reducing the overall project schedule and working closely with the trades to realize this cost saving. A design-build approach allows constructability to be front-of-mind for the design team and ensures an integrated approach to design.

In addition to experienced mass timber design managers, cost planners, and construction project managers in its design-build business unit, Lendlease has invested heavily in developing the mass timber market, through system testing, product development, supply chain agreements, and dedicated subject matter experts. The company is evolving to incorporate DFMA as a design philosophy, to enable high levels of manufactured and off-site built products, and is working with supply partners to refine and create products that fill the gaps currently creating barriers to mass timber delivery. A design-build partner with this level of insight on mass timber has all the necessary tools to complete tall timber projects on time and on budget.

A Design-Build Approach to Making Tall Timber “Pencil Out”

Lendlease has delivered 22 mass timber structures around the world since 2012, and has found repeated success using the integrated design-build model. With a design-build approach, the project will be set up for success with clear direction through client and project management. It will be value-optimized throughout design, with an experienced, innovative, and collaborative design and construction team, driven by strong design, construction, and cost management focus. A clear plan for procurement will be developed, with a robust understanding and relationship with the supply chain. It is recommended that owners and developers use a design-build approach to achieve the various environmental, social, and economic goals on a project, as this provides the best opportunity for making tall timber “pencil out.”

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References