Hybrid Tall Timber

Mass Timber Residential High-Rise Study

2023

PCL CONSTRUCTION

DCI ENGINEERS

WEBER THOMPSON

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Executive Summary

The emergence of mass timber construction in the commercial and institutional marketplace in addition to recent changes in building codes has created renewed interest in using mass timber for tall residential towers. Many developers and consultants in the Architectural, Engineering, and Construction (AEC) industry are now asking:

Is a mass timber residential tower financially competitive with a comparative concrete tower ?

We found that yes it is, if the design and construction team work collaboratively to optimize the prefabrication of mass timber while getting creative with delivery methods.

BACKGROUND

In the beginning of 2023, a team from Weber Thompson, DCI Engineers and PCL Construction came together to explore this question. It was a collaborative effort that leaned into the teams' collective strengths to seek out creative solutions and practical methods to make the case for or against mass timber in residential high-rise construction. We focused on the challenging under 180' tower height which is often overlooked due to outsized construction costs for concrete residential structures at this scale.

Early on we determined that a comparison between the structural systems of a mass timber vs. concrete building would be the most straightforward comparison as exterior skin and interior finishes would be similar regardless of the structural system.

A typical urban infill site in the Pacific Northwest was chosen as a starting point, driving the overall massing of the proposed building.

While there were many insights gleaned from this study, here are the **key takeaways:**

Optimizing wood fiber is only part of the story. Piece count, lateral system choices and crane time matter as they impact construction schedule and labor efficiency.

Flexibility on unit mix and bay size will yield a more efficient structure. Traditional unit plans may need adjustments to work within the most cost effective timber grid.

A timber and steel hybrid can be built faster if synergies between trades can be realized. The prefabrication of mass timber provides opportunities to reduce on-site labor and cost, especially if any steel elements and timber can be erected by the same crew.

Introduction

What's the draw?

INCREASED DENSITY AND AFFORDABILITY

In urban infill zones with floor area or height restrictions, residential towers under 200 ft have traditionally been challenging to make pencil in purely concrete construction. Mass timber construction could open up more sites with higher density for development if time and cost savings can be realized, creating an opportunity to address housing needs in the region.

BIOPHILIC BENEFITS

There is potential for residences with exposed mass timber to have substantial human health benefits. An intriguing study recently released by Harvard reinforces the positive impacts of biophilia – people's desire to connect with nature – on human health. Mass timber buildings with exposed wood create interior environments filled with biophilic connection. The allure of these health benefits along with the natural beauty of wood will differentiate projects in competitive leasing markets and potentially attract longer term leases.

EMBODIED CARBON REDUCTION

Viewed through a sustainability lens, concrete residential towers have a large embodied carbon footprint; and mass timber offers a new pathway to reducing this impact. The carbon sequestering qualities of timber, in addition to the foundation savings due to the reduced structural weight overall, yield a significant carbon avoidance for projects of this type.

ENTICING BUILDING CODE EVOLUTION

While some jurisdictions have allowed mass timber towers of this height under current codes, proposed future code changes will make these tall timber towers more enticing to develop.

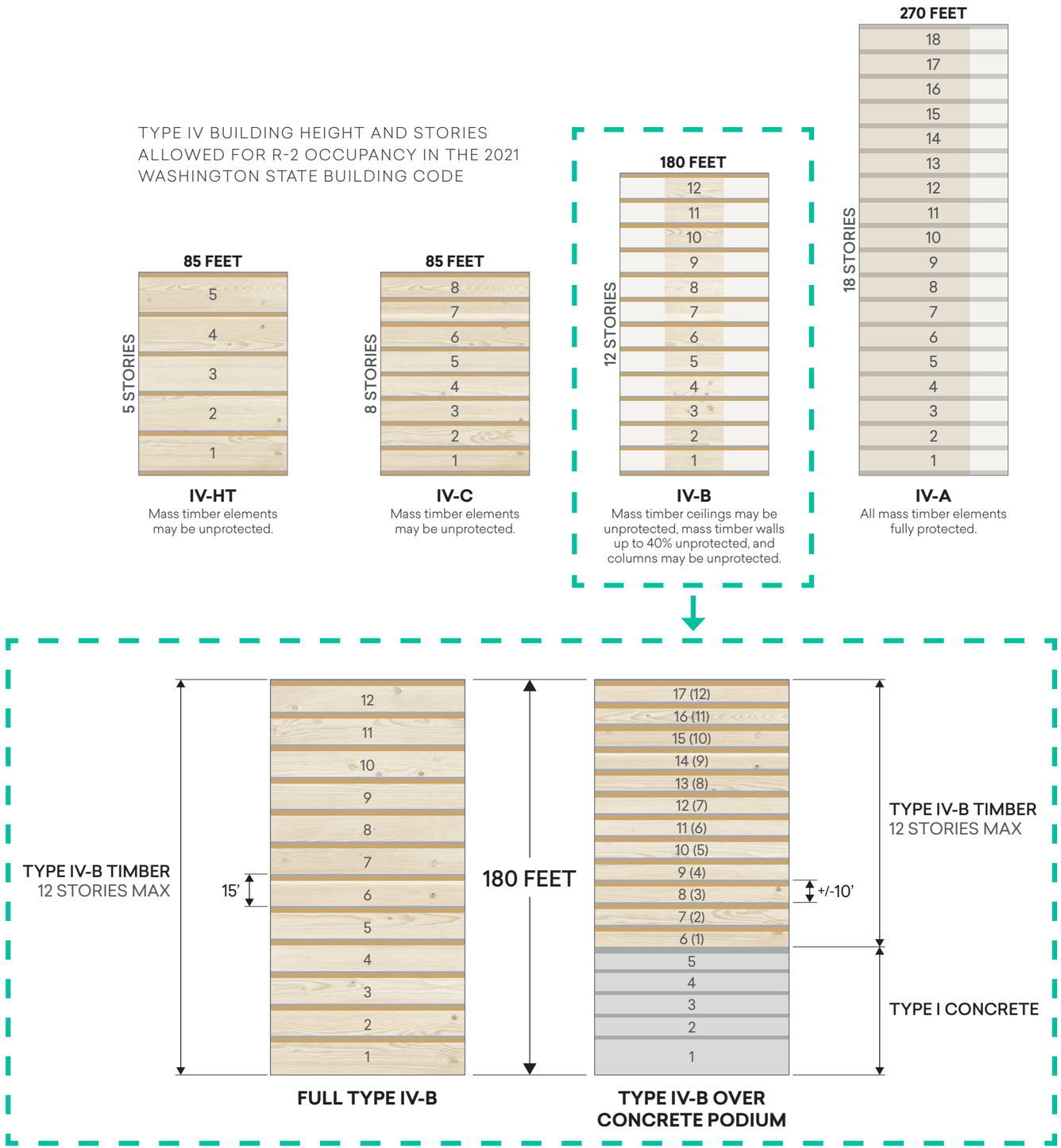
MASS TIMBER ADDS WARMTH TO INTERIOR ENVIRONMENTS AND CAN BE A DIFFERENTIATOR IN THE MARKET.

Introduction

BUILDING CODE EVOLUTION: MORE EXPOSED WOOD ALLOWED IN TYPE IV CONSTRUCTION

The 2021 and 2024 International Building Codes adopted significant changes to the mass timber construction types. Local jurisdictions are preemptively adopting some the changes for their 2021 code updates or allowing adoption through a project specific administrative code request. For residential projects, the most significant change in the 2024 IBC Type IV-B construction is that mass timber ceilings are permitted to be exposed up to 100% of the floor area (IBC 602.4.2.2.2).

While concealed spaces for soffits and chases still need to be fire protected, the remaining ceiling area can be exposed to fully express the beauty of the wood can be fully expressed in the interior spaces.

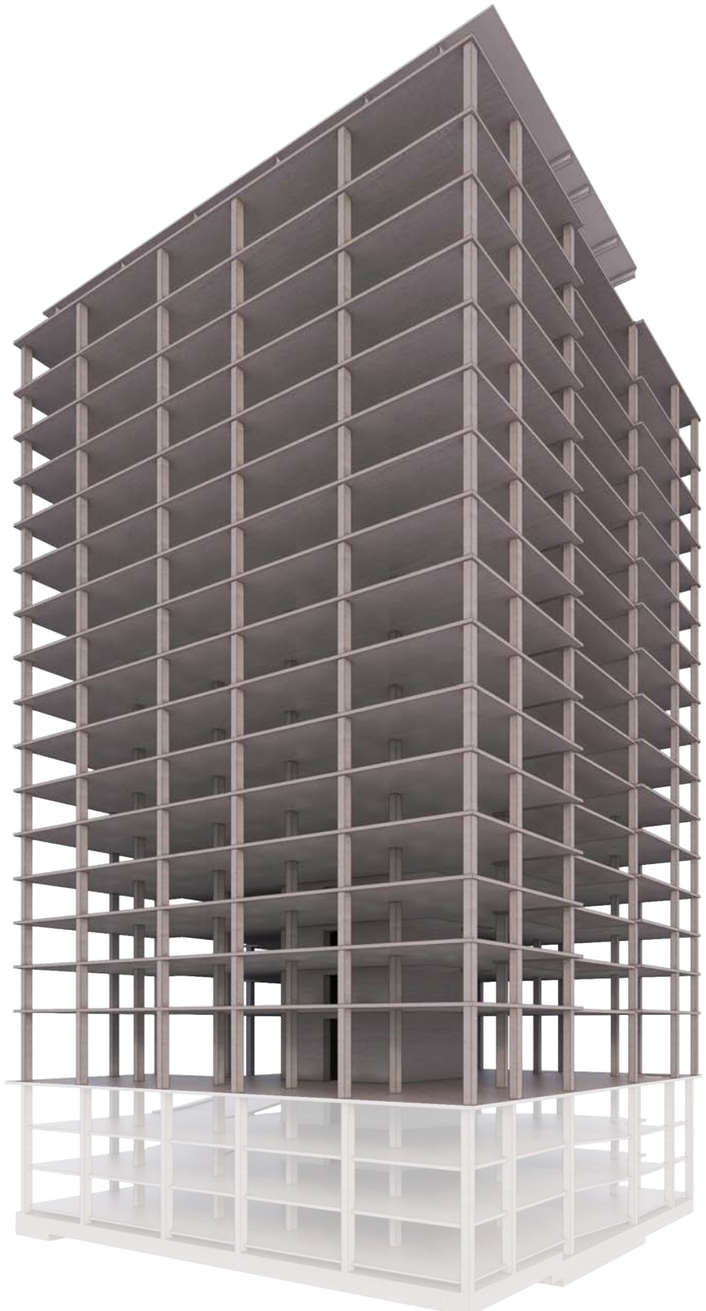


Introduction

SCOPING: WHAT WAS STUDIED AND WHY

At the onset of the study, the team recognized an opportunity to address development sites whose yield potential lent itself to a shorter high-rise less than 200 ft tall, a challenging height to make profitable. The cost of concrete construction and labor typically becomes more economical with increased height. In zones that allow for this height, developers often opt to build shorter, more profitable buildings, resulting in housing density left on the table.

Type IV-B construction allows 12 stories and up to 180’ of height. With residential floor to floor heights typically being in the 10’ range, twelve stories would leave significant development height unused. By leveraging the provisions of a podium structure with Type I-A concrete stories at the base, the resulting increased development potential aligns with a fully concrete tower. (Horizontal Building Separation Allowance (IBC 510.2). In addition, the concrete podium allows for load transfers to create more open amenity and retail spaces typically seen at lower levels with fewer columns.



POST-TENSIONED CONCRETE TOWER

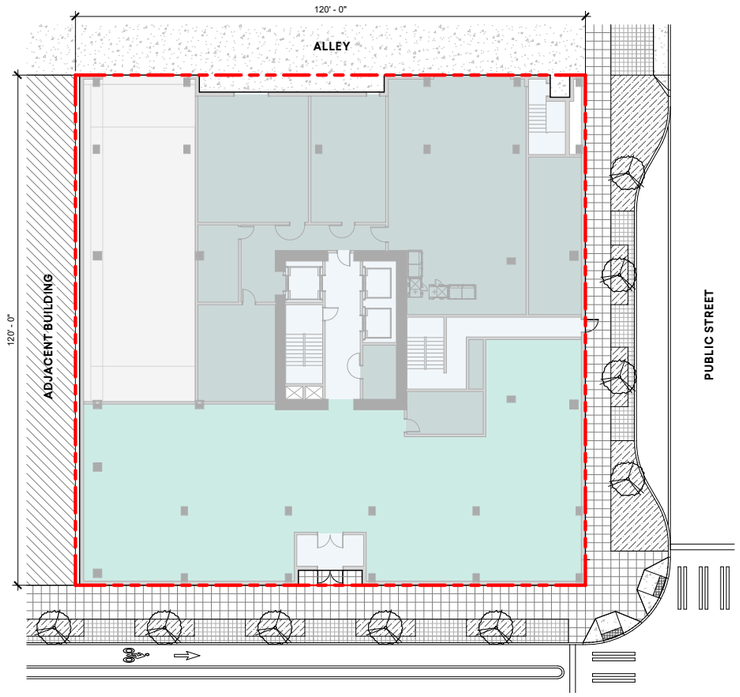
HYBRID MASS TIMBER TOWER

Methodology

PROCESS

The design team assumed a generic urban site, 120’ x 120’ with two street frontages and an alley, a commonly found medium scale site in the Seattle area. Similar to many mixed use towers in the region, a 16’ tall first floor will accommodate potential retail and building services with multiple levels of parking below grade. As with any residential design effort, the unit mix and floor plate efficiency are key design drivers. The team chose a range of unit sizes from open one bedroom units to two bedroom units reflective of typical market rate developments.

The team approached the study with the goal of identifying factors that would influence the economic competitiveness of mass timber and found that the prefabrication of mass timber could potentially shorten the construction schedule, by reducing on-site labor, increasing speed of follow-on trades, and shortening construction loan duration and construction leading to faster occupancy.



SITE PLAN

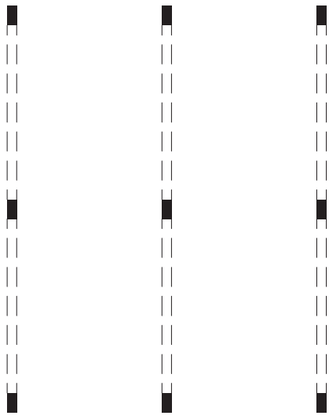
FRAMING APPROACH: POST AND BEAM VS. POST AND PLANK

Initially we discussed both a post and beam system (columns supporting beams that support the mass timber panels) and a post and plank system (point supported mass timber panels with only columns, no beams).

A post and plank system creates a clean ceiling plane, simplifying the routing of Mechanical, Electrical and Plumbing (MEP) systems and maximizing floor to ceiling height in the unit. However, it would require additional structural testing to be allowed by a jurisdiction, so a code compliant post and beam approach was chosen for the study.

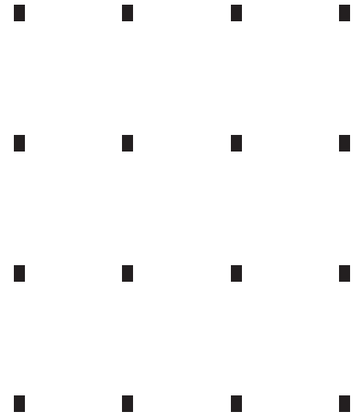
POST AND BEAM

(9 COLUMNS, 6 BEAMS, 3 CLT PANELS)



POST AND PLANK (POINT SUPPORTED)

(16 COLUMNS, 3 CLT PANELS)



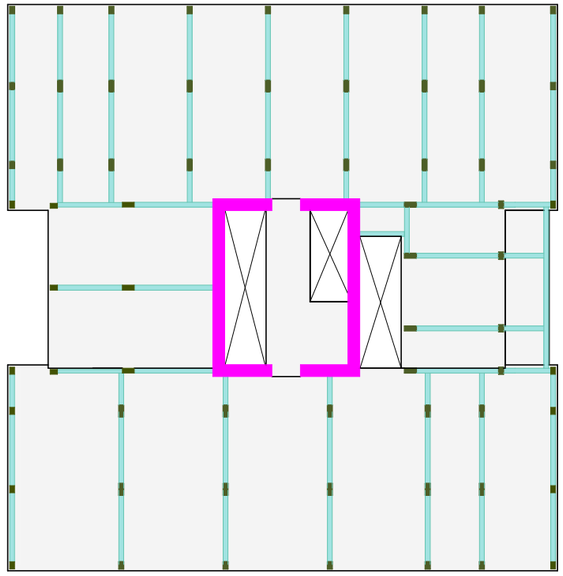
Methodology

LATERAL DESIGN: TWO APPROACHES AND MULTIPLE SUPPLIERS

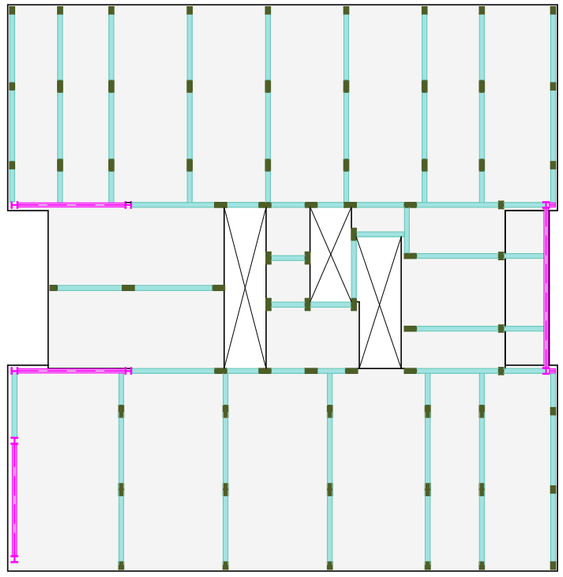
Two different approaches for the lateral system were examined. A traditional concrete core that consolidates lateral forces and transfers them to the foundation vs. a steel brace frame approach that uses Buckling Restrained Brace Frames (BRBFs) distributed throughout the floor plan with a transfer to concrete columns and shear walls in the podium structure.

In general, consolidating forces to discreet locations like the concrete core allows for more flexibility but increases the work the floor plate structure must perform to transfer these forces. This usually results in increased cost. Both systems were initially evaluated in regard to construction time, labor force and material costs with a final check on the comparative embodied carbon impacts of each system.

Pricing was solicited from three different mass timber suppliers for both Cross Laminated Timber (CLT) panels and glulam beams and columns. The team engaged with two regional suppliers and one European supplier. The goal was to get a range of pricing similar to a typical bidding phase on a project, with a focus only on the structural frame, lateral systems and associated fire protection.



TRADITIONAL CONCRETE CORE AND SHEAR WALL APPROACH



STEEL BRACE FRAME APPROACH (BRBF)

Methodology

ASSUMPTIONS

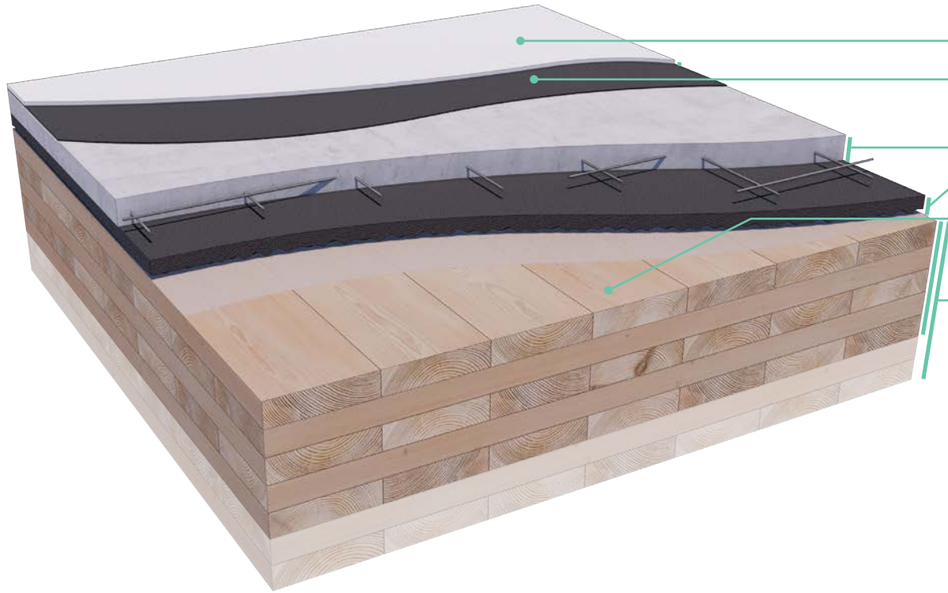
Mass Timber. The team focused on glue laminated columns and beams with CLT floor panels due to the larger quantity of suppliers and the high quality appearance of the panels.

Fire Ratings. A Type IV-B mass timber structure requires a 2-hour fire protection rating. Consequently, the mass timber design includes concealed steel connections protected during a fire by the char of the mass timber around them. Char is the sacrificial layer of wood that can burn at a slow, predictable rate providing protection without affecting the necessary structural capacity of the member. Portions of the lateral system (the steel BRBFs) require fire protection by enclosing them with framed walls with 2 layers of gypsum sheathing on each side or with intumescent paint.

Acoustics. Code requires that floor assemblies separating dwelling units have a sound transmission class rating (STC) of at least 50 for airborne sound and an impact insulation class rating (IIC) of at least 50 for structure borne sound. Market driven expectations point to a minimum 55 STC rating and 52+ for IIC. A base assumption included an acoustic membrane above the structural deck and below the finished flooring. The pricing comparison reflects minor assembly differences between the mass timber and concrete tower options.

EXCLUSIONS

The primary objective was to evaluate the structural and lateral system options. To simplify the effort, the team excluded the envelope system, roofing, interior finishes, non-rated interior walls and MEPF systems as any differences between the two buildings would be negligible. Fire protection needed to encapsulate the steel lateral system and the required non-combustible concrete topping on the CLT panels was included.



Component Thicknesses

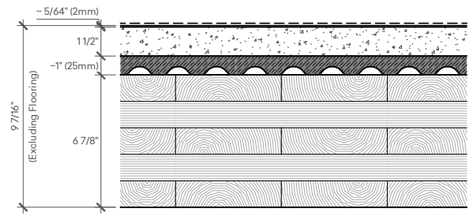
Finish Flooring:	Varies
Pliteq GenieMat RST02:	1/8”
Concrete Topping:	1 1/2”
Pliteq GenieMat FF25:	1”
Temporary install WRB:	0”
5-Ply CLT:	5 1/2” - 7”
7-Ply CLT:	7 1/2” - 11”

Total Assembly Thicknesses

5-Ply CLT:	8 1/8” - 11 5/8”
7-Ply CLT:	10 1/8” - 13 5/8”

Assembly Properties

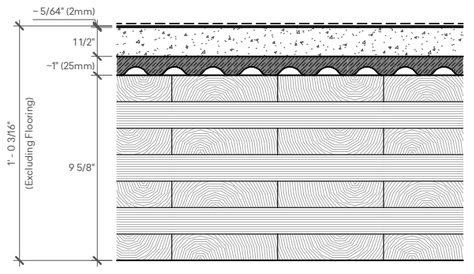
Fire Rating:	2-Hour
Acoustics:	STC 58 / IIC 52



1. *LVT Flooring*
2. *Pliteq GenieMat RST02*
3. *Concrete Topping*
4. *Pliteq GenieMat FF25*
5. *5-Ply CLT*

STC 58
2-Hour Fire Rating

1 5-PLY CLT



1. *LVT Flooring*
2. *Pliteq GenieMat RST02*
3. *Concrete Topping*
4. *Pliteq GenieMat FF25*
5. *7-Ply CLT*

STC 58?
2-Hour Fire Rating

2 7-PLY CLT

Study Results

There are several decision making points that significantly influence the pricing of the mass timber structural system.

WOOD FIBER VOLUME VS. PIECE COUNT

Initial approaches in the industry have been to focus on reducing the amount of wood fiber in the structure to lower overall costs; and this does make an impact on the material cost's bottom line. However, in digging deeper, the costs of time and labor to fabricate and install the structure need to be considered and are often more impactful. Typically, there is one crane on a construction site for a project of this size, so crane time is a finite resource. The more pieces of mass timber needed to be picked by the crane, the longer the construction duration. Reducing the crane time yields significant project savings overall with a shorter schedule and reduced holding costs.

5-PLY VS 7-PLY

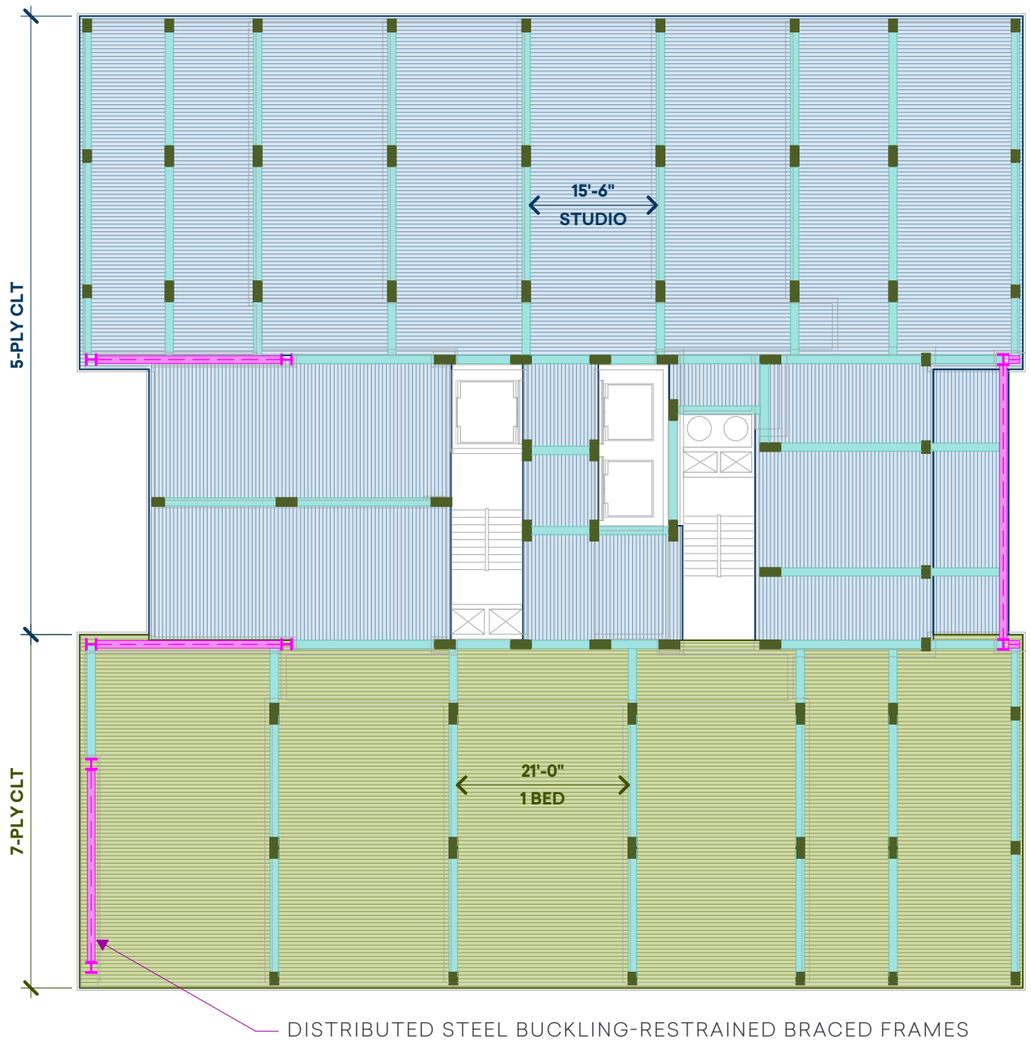
Deeper analysis revealed that utilizing a 7-ply CLT panel at the one bedroom units would allow a free span between demising walls and eliminate the need for additional bearing lines and columns. While this increased the wood fiber in the floor panel, it reduced the number of columns and beams leading to a better residential plan and valuable time savings in construction.

Additionally, the fabrication costs associated with glulam elements are typically higher than CLT panels, so not all fiber has the same volumetric cost. An increase in CLT fiber can be slightly offset by the reduction in fabrication costs of the more expensive glulams and connection hardware.

MASS TIMBER RESIDENTIAL STUDY – FRAMING OPTIONS COST EXERCISE

MASS TIMBER SUPPLY			
Scope (per typical floor)	**Option #1**	**Option #2**	**Option #3**
CLT Panels Type	5-PLY V2	5-PLY E1	7-PLY V2
CLT Panels (EA)	15	15	15
Glulam Columns (EA)	51	41	30
Glulam Beams (EA)	53	45	27
Total Glulam (EA)	104	86	57
Total Supply Cost (Average)	$260,069.33	$239,407.33	$251,606.00
MASS TIMBER INSTALL			
CLT INSTALL	CLT installation cost will be the same for all 3 options (Same # of CLT panels)		
GLULAM INSTALL	Option #3 is preferred in terms of piece count efficiency. Half as many pieces as Option #1.		

TYPICAL TIMBER FRAMING PLAN



Study Results

CHALLENGES OF A HYBRID MASS TIMBER TOWER: CONSIDERATIONS WITH THE LATERAL SYSTEM

Ultimately, the team focused on a steel lateral system above the podium. Updates to the 2021 concrete code will increase the amount of concrete and reinforcement needed for shear in structures of this height. Concrete cores and shear walls in a mass timber building cause out-of-sequence work as the concrete elements need to be formed, poured and cured before the next floor of mass timber can be placed. By utilizing a site-built steel frame lateral system, the team reduced the crane time and the overall construction schedule by five weeks, resulting in substantial savings.

The steel brace frames aren't without their challenges. Typically the steel and wood scopes of work in a construction project are handled by two different subcontractors. Navigating two different crews on a tight site can cause access conflicts that could result in additional delays. A key decision is to have the steel and mass timber installed by the same subcontractor. The prefabricated nature of mass timber is similar to structural steel framing in that the parts and pieces arrive on-site ready to be connected with little on-site fabrication. Rather than a weld, the mass timber needs bolts or screws, well within the capabilities of a steel erector.

A distributed braced frame system can be a challenge when transitioning to a parking garage. This requires careful initial planning and design work to limit significant space plan impacts.

Steel needs to be fire rated to match the 2-hour protection of the construction type. It can be coated on-site with an intumescent paint or over-framed and covered in gypsum sheathing. The team included the additional cost for the framed gypsum protection in the comparative cost analysis.

Finally, construction tolerances of steel vs. concrete construction are an important consideration with mass timber. The precision of the modeling and CNC machines used to fabricate glulam beams and CLT panels yield tolerances within 1/16". Steel fabrication tolerances are closer to timber than concrete and can reduce costly on-site labor needed to align structural connections.

MASS TIMBER VS. CONCRETE SCHEDULE ASSUMPTIONS

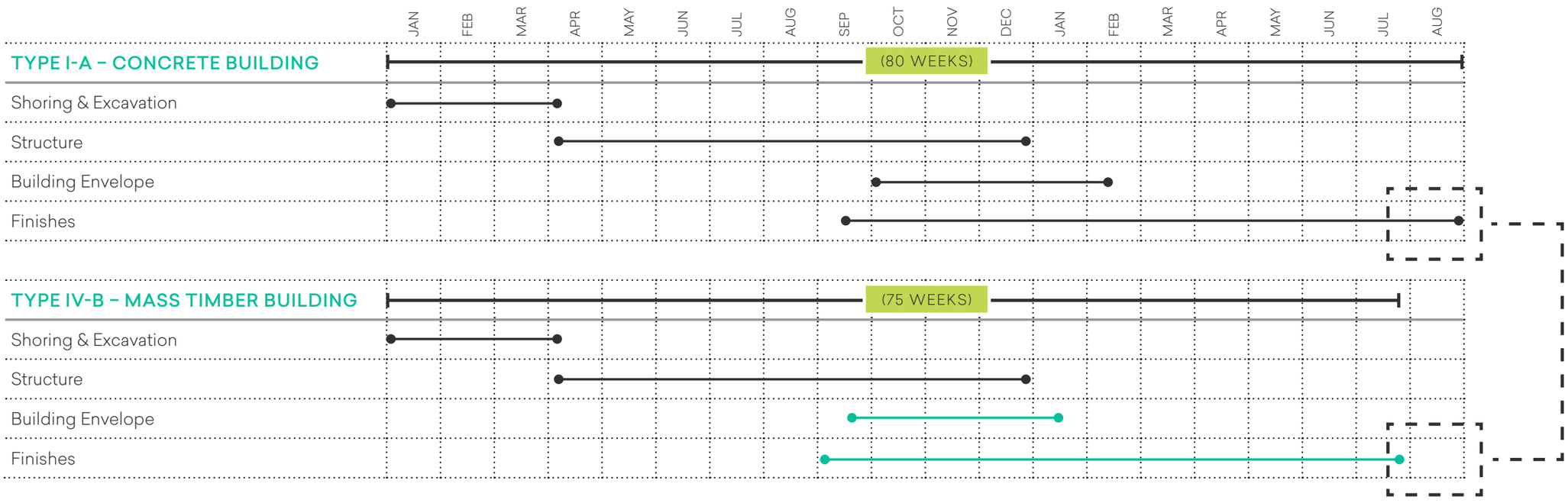
Mass Timber

- Concrete parking garages are mild reinforced concrete (not Post Tensioned (PT))
- Rated concealed steel timber connections
- Late CLT floor panel placement for crane blockouts

Concrete

- Pad footings, not mat foundation
- Premanufactured formwork system up to level 1
- Table formwork level 2 and above
- Slab pour backs for crane blockouts

Concrete VS Mass Timber Schedule Savings



BY UTILIZING A SITE BUILT STEEL FRAME LATERAL SYSTEM, THE TEAM REDUCED THE CRANE TIME AND THE OVERALL CONSTRUCTION SCHEDULE BY FIVE WEEKS, RESULTING IN SUBSTANTIAL SAVINGS.

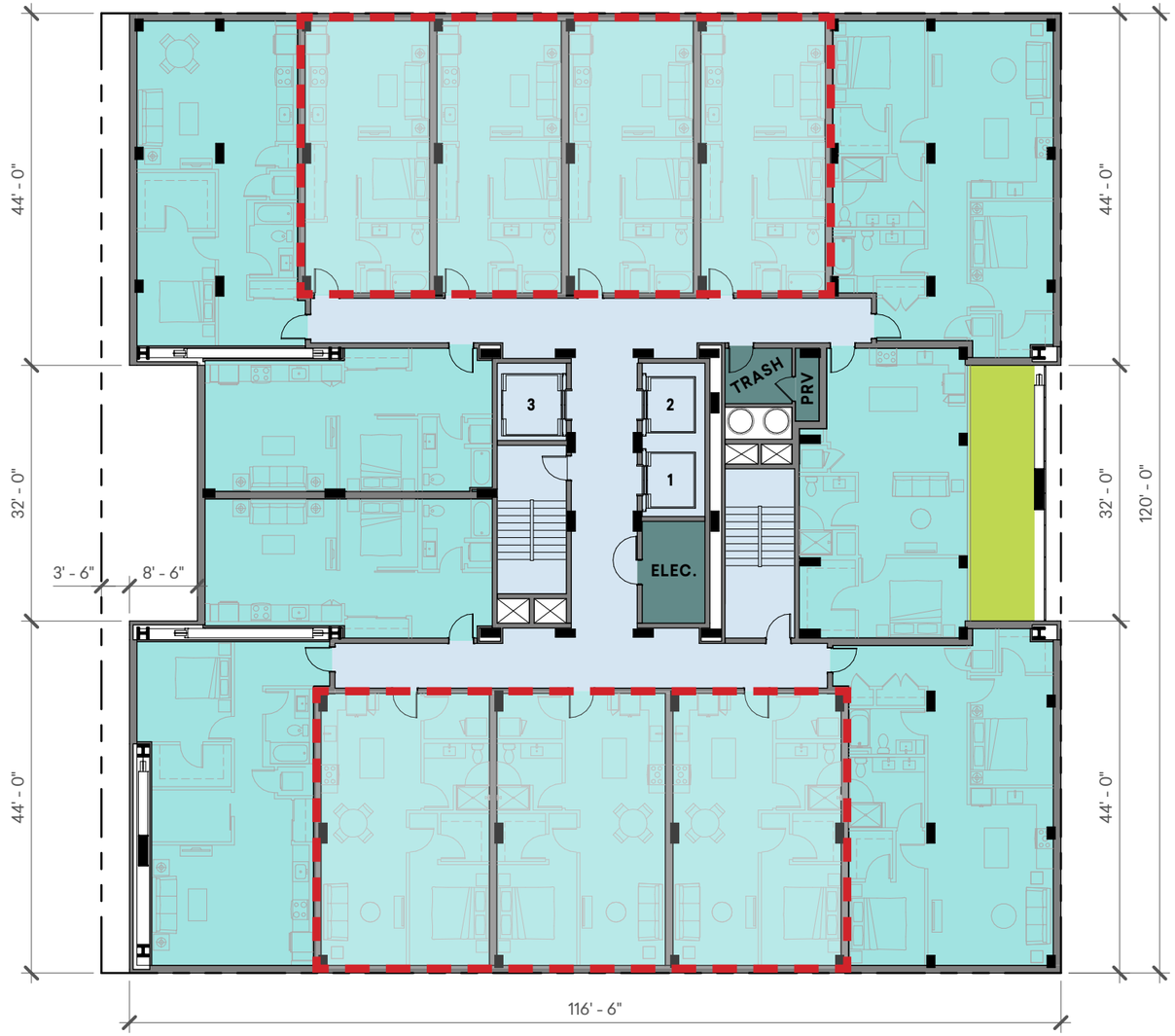
Study Results

RESIDENTIAL UNIT CONSIDERATIONS

Most high-rise residential developments seek a unit mix that reflects the local market needs. In a typical concrete residential tower, there is some flexibility with column location that allows for blending unit types along the facades and adjusting the unit mix distribution vertically within the tower.

In a mass timber tower, it is important to rationalize the timber grid to optimize the use of the timber elements. Not all glulam beam and CLT panel spans align with traditional unit demising dimensions. Great care needs to be taken to coordinate with interior unit elements or upsize the timber to better marry with the demising wall locations. We chose to group the unit types together so that efficiencies of CLT spans and the timber grid could be realized. This allowed us to fine tune the structural design more holistically across the facade. We also assumed that all unit types stack vertically to be efficient with distribution systems and reduce the acoustic impacts of dissimilar uses vertically through the building.

This approach has an impact to the unit mix, sacrificing diversity for efficiency. A longer facade will give you more flexibility in adjusting the grid to accommodate for a more diverse mix of unit types, but there are limits for a small site like the proposed tower.



TYPICAL RESIDENTIAL FLOOR

Pricing Model

Cost Comparison

Once the tower design was developed, pricing was solicited from three different mass timber suppliers for both CLT panels and glulam beams and columns. We engaged with two regional suppliers and one European supplier. The goal was to get a range of pricing similar to what a typical project would see during a bidding phase.

For the concrete scope, PCL provided pricing based on their self-performed historical cost metrics from recently completed high rise projects. Local subcontractors were solicited for pricing the remaining structural steel scope for both test fits.

PRICING COMPARISON REQUIRES A DEEP REVIEW

The pricing comparison on the right shows the pricing range from the three mass timber suppliers. It is important to note that there are many factors to consider when selecting a mass timber supplier in addition to pricing (i.e. lead time of material, material escalation, scope inclusions/exclusions, allowances provided, distance between supplier and project site, etc.). Getting multiple bids from manufacturers helps to provide competitive pricing, illustrated by the range of pricing we recieved in the chart on the right.

TYPE IV-B HYBRID MASS TIMBER BUILDING – SUPPLIER PRICING

MASS TIMBER SUPPLY	Regional Supplier #1	International Supplier	Regional Supplier #2
GLULAM COLUMNS			
GLULAM BEAMS			
CLT PANELS			
HARDWARE (GLULAM + CLT)			
FREIGHT			
SEALER FOR GLULAM			
SHOP APPLIED TEMP ROOF PREMIUM (ROOF CLT ONLY)			
TOTAL	**$8,105,400.00**	**$7,379,000.00**	**$6,558,227.59**

Pricing Model

Cost Comparison

The cost comparison between a post-tensioned concrete tower and the hybrid mass timber tower is presented to the right. An average cost was carried for the mass timber supply scope from the overall cost comparison given the range in pricing between the three suppliers in a specific moment in time (Q2, 2023).

As noted previously, there is a five week schedule reduction in the mass timber structure option which will result in indirect cost savings for the project. PCL included the projected indirect cost savings resulting from this reduced schedule for reference in the mass timber option. This schedule savings resulted in just under a $2/sf indirect cost reduction and helps reduce the direct cost premium for the mass timber structure.

POTENTIAL OTHER EXCLUSIONS TO SCOPE:

1. **Ceiling finishes:** Sealing CLT panels isn't required vs. a skim coat is typically required for exposed concrete ceilings in residential units.
2. **MEP scopes:** A shorter duration site installation due to a quicker structure erection schedule and early modelling coordination will likely result in further cost savings from MEP trades familiar with mass timber work.
3. **Type IV-B construction:** Typically requires gypsum protection for any concealed spaces; this was not included in the pricing for the mass timber option as MEP and soffits weren't part of the comparative scope of work for either option.

TYPE IV-B HYBRID – MASS TIMBER BUILDING

	TYPE IV-B – MASS TIMBER BUILDING		TYPE I – CONCRETE BUILDING	
SCOPE OF WORK	**$**	**$/SF**	**$**	**$/SF**
MASS TIMBER SUPPLY + INSTALL	$8,365,954.63	$30.81	N/A	$-
STRUCTURAL STEEL (COLUMNS & BRB FRAMING)	$2,178,000.00	$8.02	N/A	$-
L1-L5 CONCRETE LEVELS	$6,422,372.00	$23.66	$15,830,336.00	$58.31
P3-P1 CONCRETE & REBAR	$3,002,444.00	$11.06	$3,311,023.00	$12.20
TOPPING SLAB & ACOUSTIC MAT AT CLT	$712,647.00	$2.62	$160,185.00	$0.59
TOTAL DIRECT COSTS	**$20,681,417.63**	**$76.17**	**$19,301,544.00**	**$71.09**
INDIRECT COSTS - SAVINGS FROM FASTER SCHEDULE	$(467,512.29)	$(1.72)		
-PROJECT STAFF				
-GENERAL EXPENSES				
-PROJECT OVERHEAD				
-BONDS/PERMITS/INSURANCE/FEE				
TOTAL COST	**$20,213,905.34**	**$74.45**	**$19,301,544.00**	**$71.09**

What if we didn't have a concrete podium?

Cost Comparison

PRICING ANALYSIS

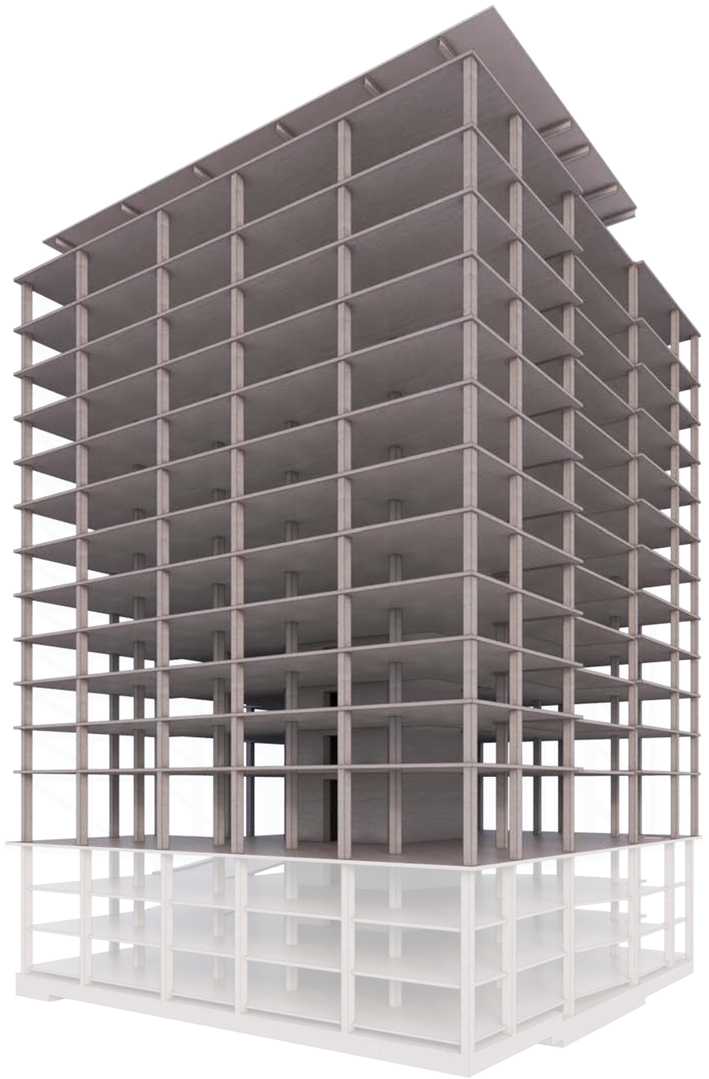
The team started this analysis with a goal to demonstrate whether mass timber is an optimal choice for a building of 180'. During the study it became clear that the amount of concrete needed for the multi-story podium to maximize the developable area created a hybrid structural system. The mass timber option became a hybrid mass timber and concrete structure which muddied the pricing comparison between the two structural systems.

This led us to a quick look at pricing for a 12-story mass timber vs. a 12-story concrete structure option.

PRICING RESULTS

- 12 story mass timber with steel brace frames: $78.04/sf
- 12 story concrete with concrete shear core: $76.87/sf
- The mass timber structure was five weeks faster to construct which also reduced construction costs/sf

In addition, the global warming potential (GWP) reduction for the mass timber option is significant; see the following pages for more detail.



CONCRETE TOWER

MASS TIMBER TOWER

Looking Forward

Additional & Future Opportunities

Post and plank assemblies hold the biggest potential gains in mass timber design and construction for a residential program. By eliminating beams, not only is the crane time shortened, but likely the total fiber count and materials cost will likely drop. In addition, the clear ceiling area makes it much simpler to accommodate MEP systems while maintaining maximum ceiling height.

Sustainability

GLOBAL WARMING POTENTIAL (GWP) | KEY FINDINGS

STRUCTURAL ELEMENTS

The floors and lateral system comprised the largest portion of impacts for all categories across all structural system options.

The mass timber floor system demonstrated 33% less GWP than the concrete floor system.

The steel BRBF lateral system demonstrated 40% less GWP than the concrete shear wall lateral system.

MATERIALS

Concrete and reinforcing steel comprised the largest portion of impacts for all categories across all structural system options.

Due to the lighter floor system in comparison to the concrete option, the 18-story mass timber BRBF option saved 220 yd^3 of concrete and 30 tons of rebar; the 18-story mass timber shear wall option saved 345 yd^3 of concrete and 33 tons of rebar at the foundations.

For the 12-story scenario, the mass timber options saved 253 yd^3 of concrete and 32 tons of rebar at the foundations due to the lighter floor system in comparison to the concrete option.

OVERALL

The below-grade parking levels contributed 30-33% of the overall GWP associated with the 18-story options and 34-41% of the overall GWP associated 12-story options.

The 18-story mass timber framing option with concrete shear walls demonstrated a 10% GWP reduction compared to the concrete framing option. Utilizing the steel BRBF lateral system in lieu of concrete shear walls on the upper floors of the mass timber option yielded an additional 10% GWP reduction for a **total 20% GWP reduction.**

The 12-story mass timber framing option demonstrated a 25% reduction in GWP compared to the concrete option.

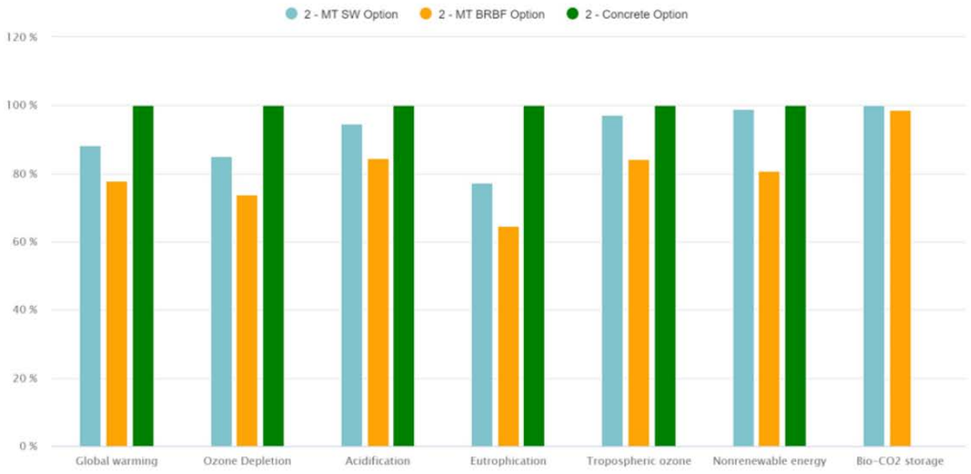
SUMMARY

For the 18-story scenario, the mass timber shear wall option saved approximately 617 metric tons of Carbon Dioxide Equivalent or CO2e and the mass timber BRBF option saved approximately 1,160 metric tons of CO2e compared to the concrete option. For the 12-story scenario, the mass timber BRBF option saved approximately 1,311 metric tons of CO2e compared to the concrete option.

In addition to the avoided carbon described above, the mass timber framing options also include bio-based materials that inherently store carbon throughout the life of the building. The mass timber framing options are anticipated to store an average of 3,350 metric tons of CO2e throughout the building's useful life.

This is equivalent to the carbon sequestered by 4,000 acres of U.S. forests in one year or eliminating 745 gasoline-powered passenger vehicles from the road for a year. (See Figures 3 & 4 below for additional information.)

When comparing the environmental impact reductions associated with the concrete and mass timber options, GWP and two of the other five environmental impact categories decreased by at least 10%, which puts this project in a good position to attain three (3) LEED v4.1 points for the Building Life Cycle Impact Reduction credit when this analysis incorporates the enclosure.



	Reduction	
	MT SW Option	MT BRBF Option
Global Warming	12%	22%
Ozone depletion	15%	26%
Acidification	5%	16%
Eutrophication	23%	35%
Tropospheric ozone	3%	16%
Nonrenewable energy	1%	19%

Figure 3

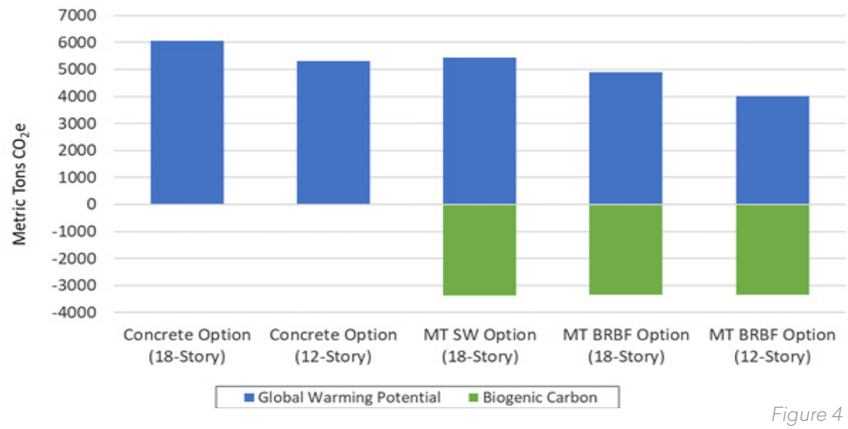


Figure 4

Conclusion

Future Code Development

Building and zoning codes are evolving to be more supportive of mass timber use. The recent code adoptions to allow CLT as a structural diaphragm and to increase wood exposure at the ceiling for mass timber elements are significant.

With the exponential increase in information about acoustic and vibrational testing and ratings for CLT assemblies, mass timber will only become more widely adopted for different project types.

The team is excited to see future adoption of CLT shear walls making even lower carbon structures possible. Point supported structural systems (post and plank) and updated char values will likely increase allowable CLT spans. This will further decrease the total amount of wood fiber, leading to even more sustainable construction assemblies while maximizing the efficiency of wood as a building material.

Our takeaways

An integrated team from the start is key. Multi-tiered information that can optimize construction costs is best gathered by a team of contractors, engineers and architects working together closely through initial schematic design and pricing.

Some discoveries found through this approach:

•Piece count, lateral system choice and crane time are equally as important as total wood fiber volume in optimizing construction costs.

•Being flexible with unit mix and layout early in the process allows the team to take advantage of the most cost effective timber grid.

•A hybrid timber and steel structure facilitates significant reductions in onsite labor and schedule duration if all of these elements are erected by the same crew.

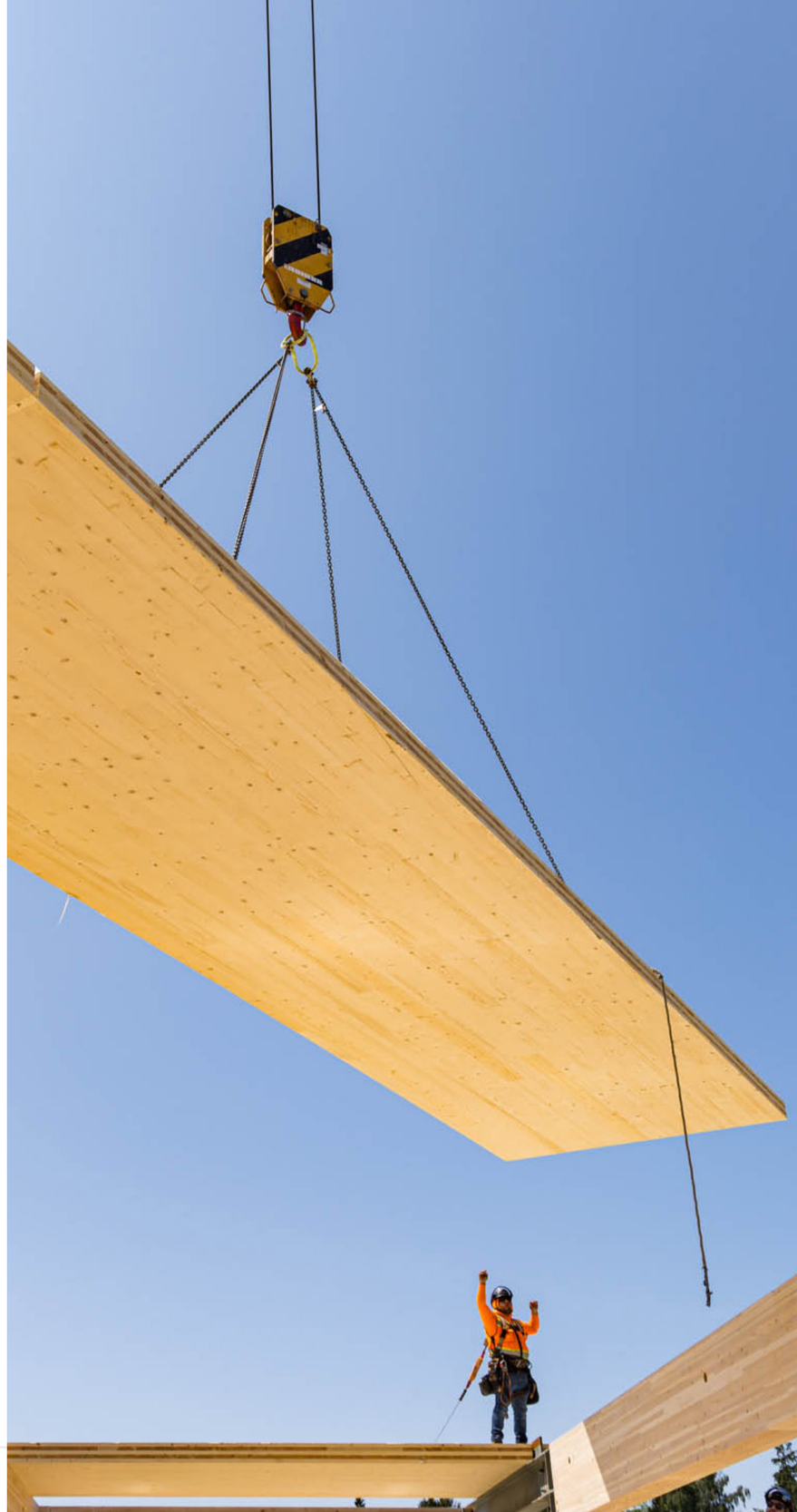
Low carbon construction is being legislated with everything from carbon taxes to outright requirements to reduce embodied carbon in new construction. As more local and state governments enact these laws, mass timber offers up the most promising approach for many building types to meet these impactful goals.

With unmet housing needs in most cities, this study shows one way to maximize housing density for urban sites in the intermediate tower height zones. These are the zones which are so often under-built due to an unfortunate intersection of construction cost and code requirements.

Summary

A combination of market forces is creating a more robust supply chain resulting in more competitive pricing and design options. At the same time, recent code changes have secured a viable place for mass timber alongside concrete and steel structural systems. A final layer of incentive is found in the health and wellbeing benefits embodied in the use of a natural material such as wood.

With these changes the market for mass timber buildings is becoming much broader and more achievable to housing developers. The future is bright!



Study Authors

WEBER THOMPSON

WEBER THOMPSON is an award-winning, majority women-owned architecture, interior design, and landscape architecture firm. Our dynamic, integrated design practice is led by curious people who challenge conventional wisdom, lead with integrity, and design with guts.

Our deep experience with high-performance mass timber construction and high-rise housing gives us insight on the challenges of successfully delivering a tall mass timber tower.

With mass timber, the details matter. To celebrate the warmth and texture of timber, you need to make smart decisions at the onset of a project to set yourself up for success at completion. Weber Thompson has a reputation for collaborating with consultants, contractors and fabricators to deliver high quality mass timber projects. Understanding timber species, sourcing and manufacturers allows us to design for a competitive marketplace and make sure we are creating both a beautiful and performative project.

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DCI ENGINEERS

DCI ENGINEERS has provided client-focused wood and mass timber services for over three decades. Our extensive mass timber portfolio includes several milestone projects: The Bullitt Center in Seattle; 1 De Haro in San Francisco; Northlake Commons in Seattle; and San Francisco's 1510 Webster, the first point supported MPP building in the world and tallest mass timber building in a high seismic zone. DCI's services include cost-effective solutions for fire-rated member design and connection detailing, composite wood and concrete systems, among other types of hybrid structural systems. DCI has been working with manufacturers, research universities, and industry leaders over the years, bringing successful and exciting wood and mass timber solutions to market for owners, developers, architects and contractors. Having a trusted and experienced partner is critical to project success and DCI Engineers looks forward to collaborating on your next mass timber milestone.

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PCL CONSTRUCTION

PCL's network of qualified construction professionals located across North America is ready to help bring your mass timber project to life. Involving PCL early in the preconstruction process allows us to help determine the most effective erection sequence, considerations for early trade coordination, and opportunities to maximize prefabrication to help realize schedule and cost savings. Additionally, PCL's ability to self-perform mass timber erection, historical productivities database, and ownership of the unique tools and equipment related to mass timber allow for more competitive pricing. We take a comprehensive approach to pricing mass timber projects and understand where complementary cost savings can be achieved allowing mass timber to be cost-competitive when compared to other structure types. To learn more about our experience and what our team can offer: pcl.com/us/en/sectors/buildings/mass-timber

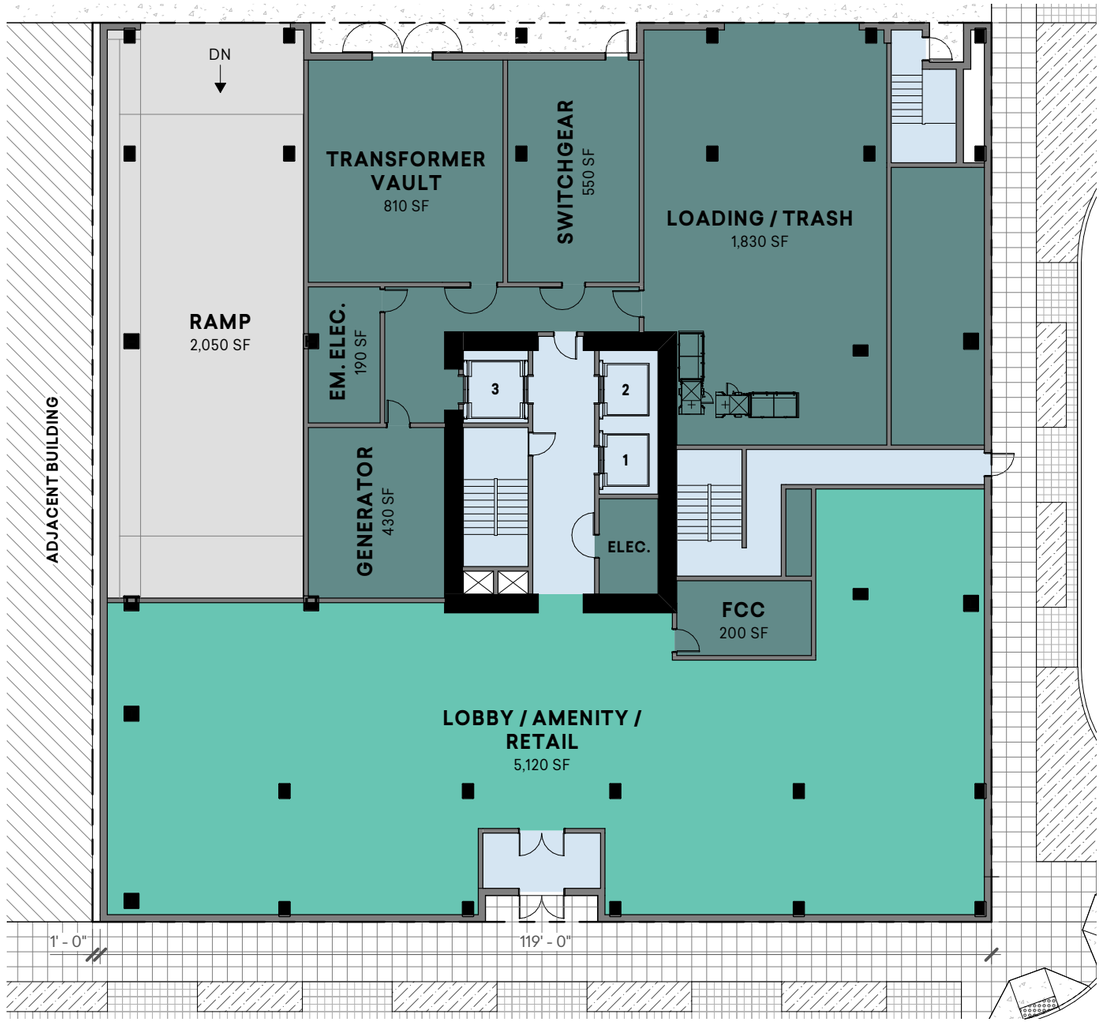
MATT GLASSMAN
DESIGN MANAGER

GARRETT DEROOY
SENIOR ESTIMATOR/PM

Appendix

Floor Plans

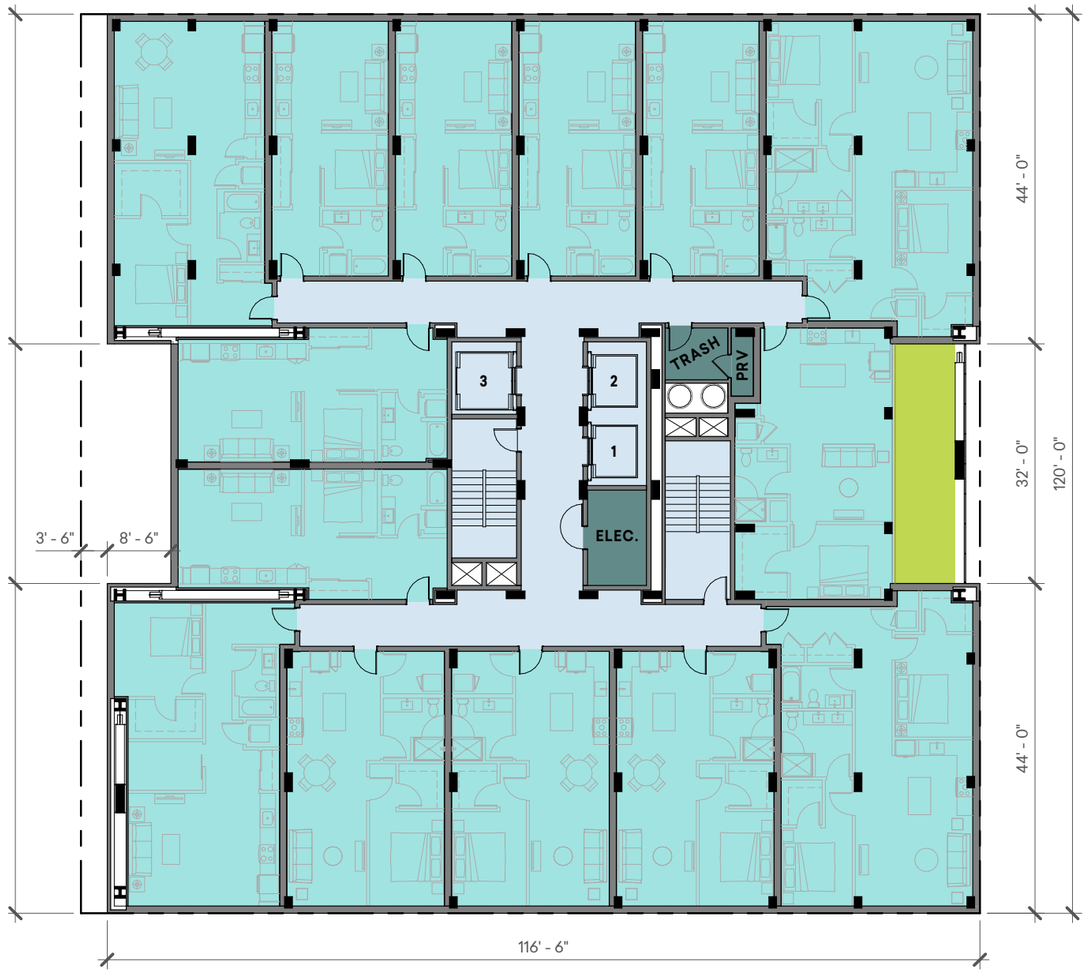
TYPICAL BELOW-GRADE GARAGE LEVEL



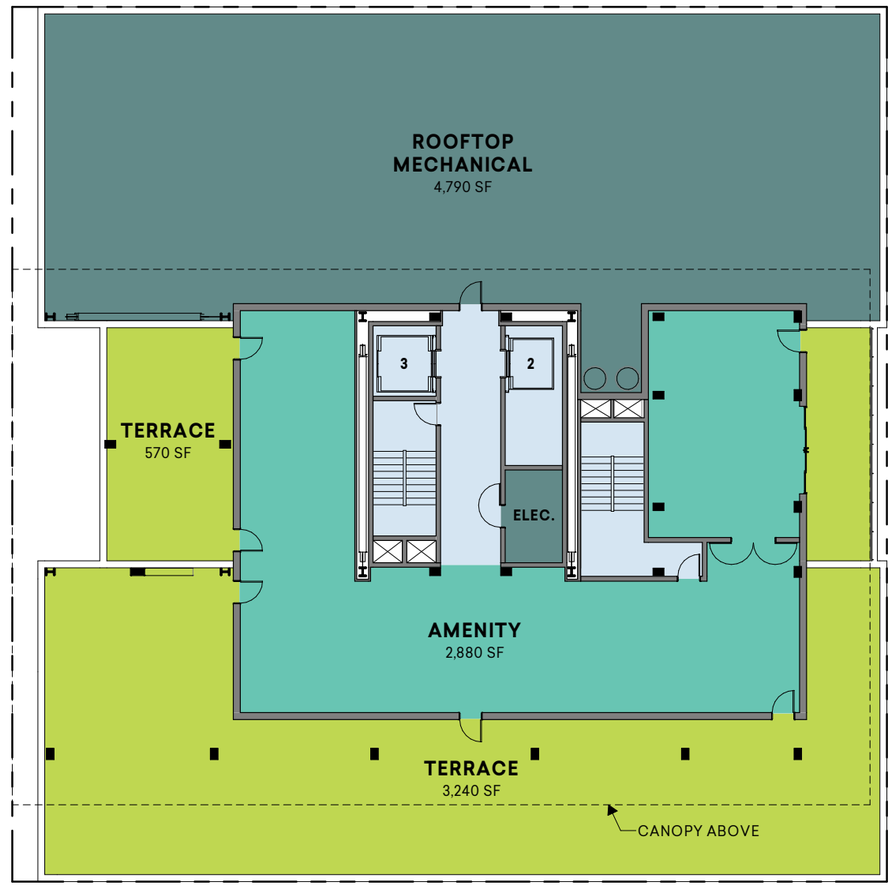
GROUND LEVEL

Appendix

Floor Plans



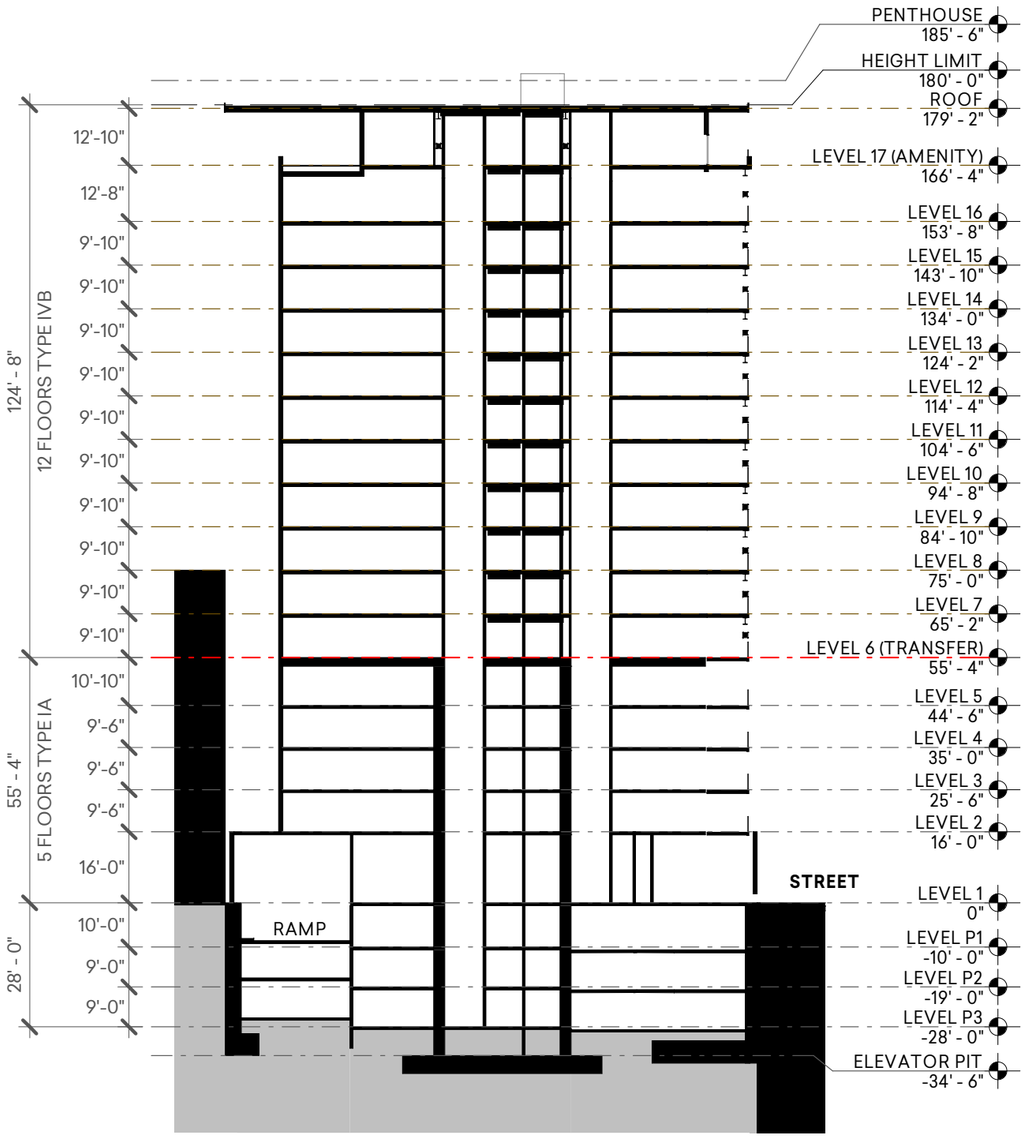
TYPICAL RESIDENTIAL LEVEL



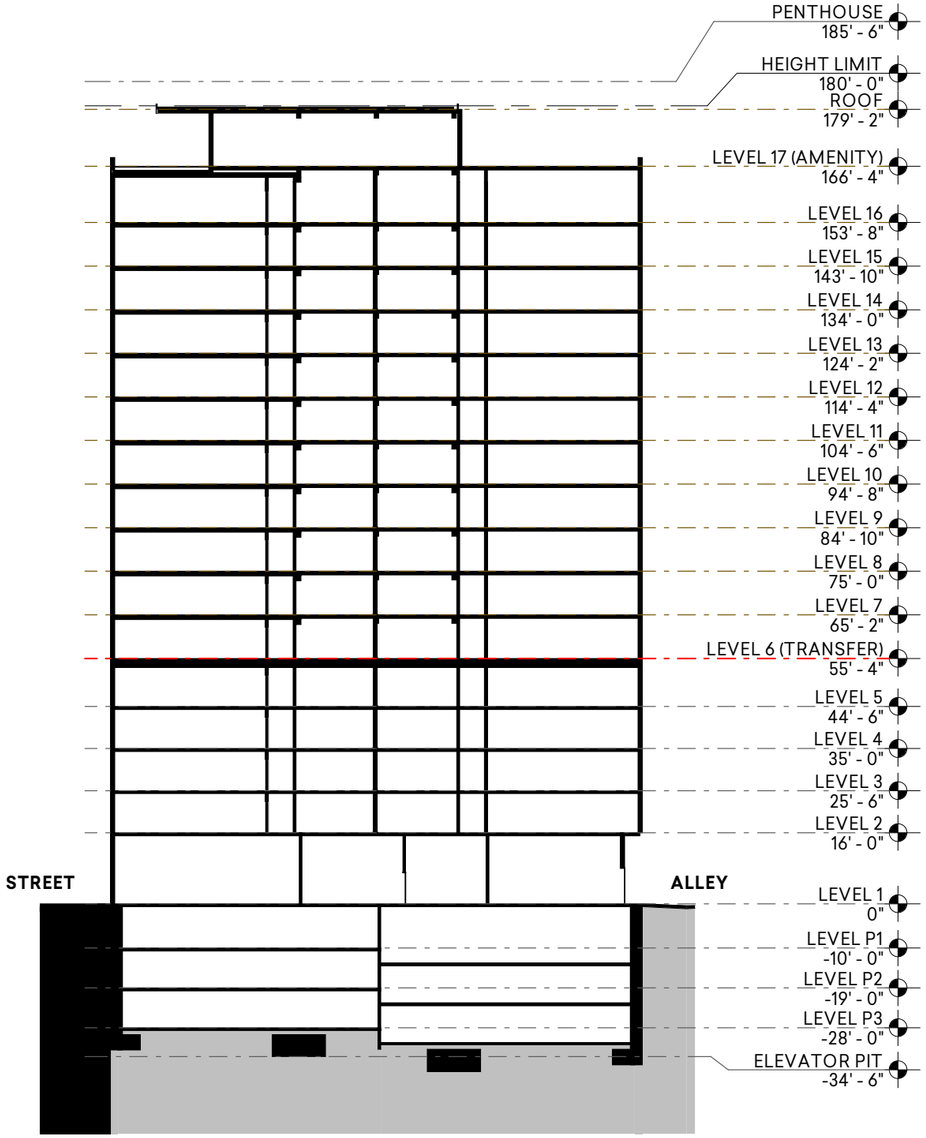
ROOFTOP

Appendix

Sections



1 **E-W SECTION**



2 **N-S SECTION**

SCALE: 1/32" = 1'-0"