SFU RENEWABLE CITIES

SFU MORRIS J. WOSK CENTRE FOR DIALOGUE

ZGF

MARCH 2024

Design Solutions to Prefab Mass Timber Construction v2.0

Design Guidance for 7-12 Storey Mass Timber Buildings

Contents

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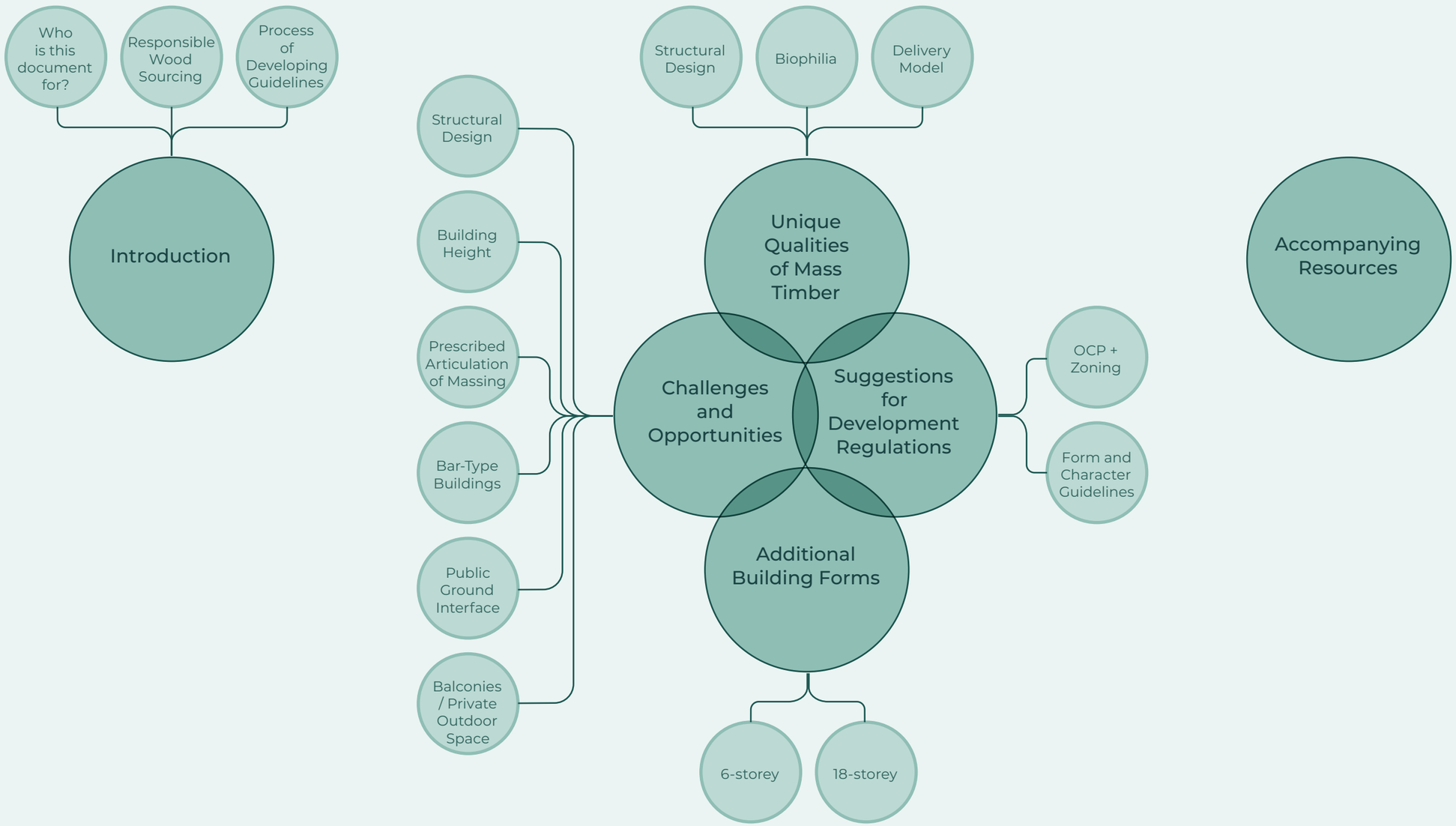


Introduction

This document provides guidance on how municipal form and character design guidelines can better accommodate 7-12 storey mass timber buildings in BC municipalities, any jurisdiction with regulatory control over planning and development including local governments, First Nations and regional districts. In addition, considerations for up to 18 storey projects will be outlined in anticipation of upcoming Building Code changes.

Who is this document for?

Municipal Staff

I want access to the resources I need

So that I can write design guidelines

Applicant / Designers
during design

I want to understand the challenges and opportunities of building with mass timber

So that I can design more effectively and inform my clients

Applicant / Designers
after application

I want to understand the rationale behind the design guidance

So that I can make informed decisions in responding to design guidance

General Community
general interest

I want to be informed about what's happening in my community

So that I can have and share informed opinions

Development Community
industry / environmental interest

I want to be informed about the latest information

So that I can propose progressive projects using mass timber

Decision Maker
council member, mayor, etc

I want to understand the background

So that I can make decisions that support mass timber projects and the many benefits that brings

Background

This document is the latest addition to the ongoing work led by SFU Renewable Cities to bring together an interdisciplinary project team of architects, planners, developers and building officials to work with communities and stakeholders to increase understanding of key land use and permitting opportunities to enable the construction of prefabricated and mid-rise mass timber projects. This document is an updated version intended to replace the previous Design Solutions to Prefab Mass Timber Construction. It compiles supporting information and resources to help municipalities develop a review process for applications they receive for mass timber projects within their jurisdiction.

Funders

This project is funded by Forestry Innovation Investment, BC Hydro and the Office of Mass timber Implementation in the BC Ministry of Jobs, Economic Recovery and Innovation.

Forestry Innovation Investment | BC Hydro | British Columbia | Office of Mass Timber Implementation

Contributors

This document was independently prepared by an interdisciplinary project team assembled by SFU Renewable Cities, involving ZGF Architects, Ecosse Development Corp, Gary Penway Consulting, Scius Advisory Services and Frank Ducote Urban Design. SFU Renewable Cities is a special initiative of the SFU Morris J. Wosk Centre for Dialogue.

Responsible Wood Sourcing

As mass timber and wood become increasingly popular from an embodied carbon reduction standpoint, sourcing wood fibre represents the next frontier to focus on to maximize positive environmental, economic, and social outcomes of using wood in our buildings.

Responsible wood sourcing can have a large impact on the economic health (regional sourcing), ecological health (sustainable and regenerative forestry practices), and planetary health (climate smart forestry). Similar to healthier materials and embodied carbon, wood supply chain transparency that discloses where our wood comes from opens the door to engaging these goals in a meaningful way.

Considerations for municipalities:

Regional Wood: Support your existing local wood industry where possible, create demand signal to support growth where it is slower. Encourage the use of locally and regionally sourced timber to reduce transportation-related environmental impacts. This also supports local economies and promotes the use of timber from sustainably managed forests.

Supply Chain Transparency: Cultivate transparency in the wood supply chain so we can better understand impacts of wood sourcing and make more informed procurement decisions. Consider requiring use of certified mass timber products and require a chain-of-custody documentation to trace the origin of the timber. This ensures that the timber used in construction meets specific environmental and social criteria.

Sustainably Managed Forests: Support wood products that come from sustainable and ecologically regenerative forest practices.

Climate Smart Forestry: Help mitigate climate change by sourcing wood from resilient forests that optimize carbon storage while producing wood products.

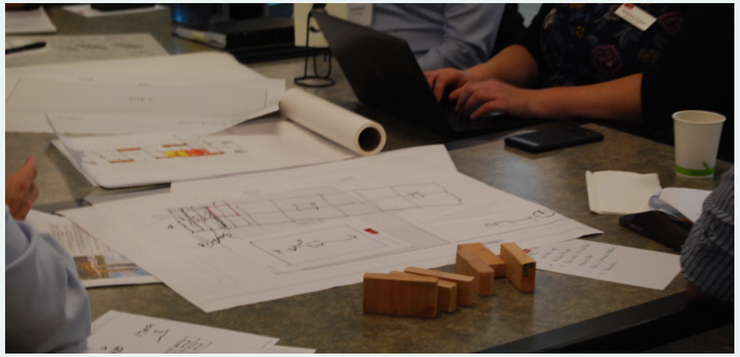
Process of Developing Guidelines

In October 2023, SFU Renewable Cities held a Prefab Mass Timber Design Charrette at the SFU Morris J. Wosk Centre for Dialogue. Facilitated by Frank Ducote, the full day Design Charrette brought together leading industry experts from across the construction and design sectors with local government officials to collaboratively pinpoint barriers, address issues, and propose solutions to advance prefabrication and mass timber construction for projects up to 12 storeys in British Columbia.

Participants were invited to discuss the design challenges and solutions identified in Design Solutions to Prefab Mass timber Construction. Key findings of the Design Charrette are published in the Design Charrette Report, and used in the current report to prepare an updated version of Design Solutions and Challenges in Challenges and Opportunities.

To support local authorities on providing guidelines and zoning that better accommodate prefab mass timber 7-12 storey constructions, the revisions to design solutions and challenges were reviewed in working groups with the Cities of Kelowna and Coquitlam. Working group collaborations resulted in the identification of two major focus areas to respond to City Staff needs related to mass timber construction:

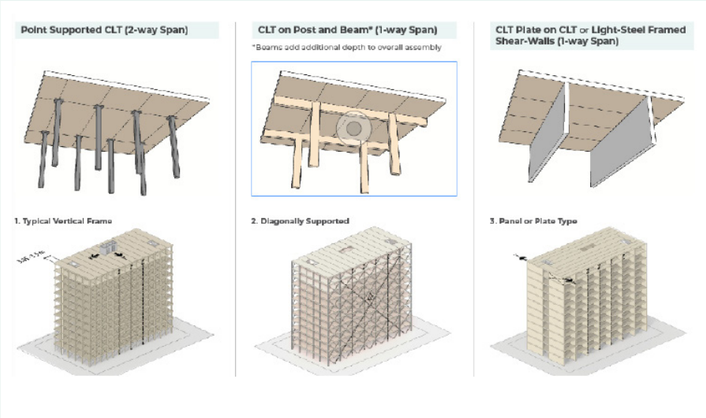
- Background knowledge about design and construction characteristics of prefab mass timber buildings. Areas that relate to unique qualities of the material has limited overlap with planning and zoning regulations but provide valuable information for staff while providing design guidelines or reviewing development applications.
- Guidance on how to improve overall alignment of municipal guidelines with prefab mass timber construction characteristics and considerations. Since both Kelowna and Coquitlam are in the process of updating municipal design guidelines, this report aims to provide recommendations for city staff to consider in future zoning bylaw and design guidelines updates.



A full day Design Charrette brought together leading industry experts from across the construction and design sectors with local government officials to collaboratively pinpoint barriers, address issues, and propose solutions to advance prefabrication and mass timber construction for projects up to 12 storeys in British Columbia

Unique Qualities of Mass Timber

The unique qualities of mass timber make it efficient to transport, handle, and erect on site, leading to reduced construction time and cost when compared with alternatives. The inherent fire resistance and biophilic qualities of the material combined with the potential for precise prefabrication create flexibility in application. These qualities also cause challenges in meeting common prescriptive form and character guidelines.

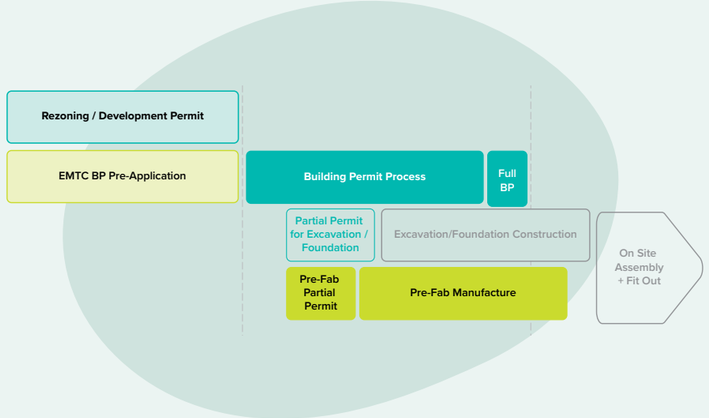


Structure and Design

Mass timber has unique structural considerations implied in its details, but often evident in the form of the building. Designs for a structure will be determined by many factors during its conception. Once set, a project's exterior appearance will have a highly integrated and direct relationship to the underlying structure.

Biophilia

Biophilic architecture aims to enhance the well-being, productivity, and overall experience of occupants by fostering a stronger connection to nature within the built environment. Mass timber structures make an attractive option for architects, developers, and building owners looking to create environmentally friendly and visually striking buildings.



Delivery Model

While mass timber construction offers numerous advantages in terms of sustainable and efficient construction; navigating design, permitting, and construction schedule of mass timber projects requires careful planning, coordination, and consideration of various factors to ensure successful project delivery.

Structure and Design

A mass timber project's exterior appearance will have a highly integrated and direct relationship to the underlying structure.

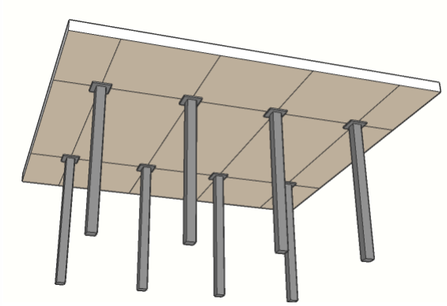
Mass timber has unique structural considerations implied in its details, and this is often evident in the form of the building. Designs for a structure will be determined by many factors during its conception. Once set, a project's exterior appearance will have a highly integrated and direct relationship to the underlying structure.

It is crucial for planners and urban designers to recognize the relative inflexibility of a mass timber project in later phases of design, as compared to cast-in-place concrete (CIPC) construction. Authors of new guidelines should consider what aspects of existing ones have been originated and conditioned by long-established construction methods and materials for buildings. Design guidelines for mass timber buildings should recognize and reflect the patterns and principles unique to the construction. The following summarizes three general patterns of structural strategy for a mass timber building, relating them to tendencies in the design of their outward appearance. These are not exhaustive nor strictly bound, the appearance of any future mass timber buildings will rely on appropriate combinations of proven designs, and the ingenious invention of new ones.

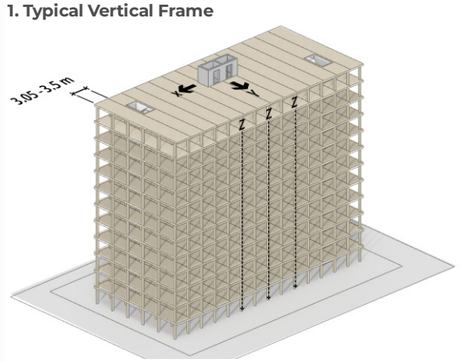
Considerations for municipalities

- Explore opportunities with design team to incorporate design guidance through means that do not disrupt structural design.
- Provide early guidance for setbacks, building facades, and stepbacks.
- Provide flexibility in massing review to accommodate complete structural bays.

Point Supported CLT (2-way Span)



1. Typical Vertical Frame



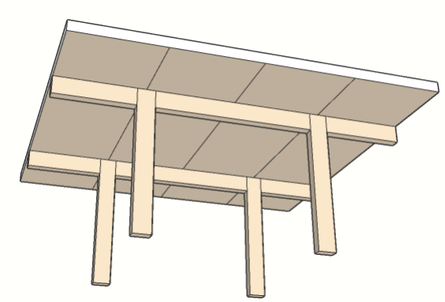
Vertical Load Resistance:
- Super imposed timber or steel columns,
- Point-supported 2-way spanning Cross Laminated Timber (CLT) floor structure
- Post and beam structure with 1 or 2-way mass timber floor

Lateral Load Resistance:
- CIPC cores
- Steel or mass timber braced frames

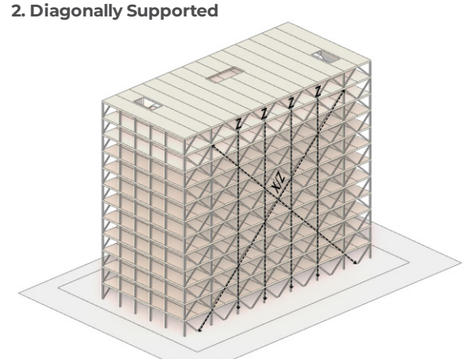
Common Design Implications
- Stacking
- Vertical alignment
- Expressed verticality
- "Classically" inspired, ordered compositions
- Expressed orthogonality
- Panelized construction

CLT on Post and Beam* (1-way Span)

*Beams add additional depth to overall assembly



2. Diagonally Supported

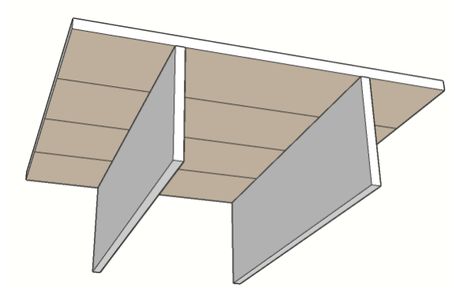


Vertical Load Resistance:
- Columns and perimeter frames
- Point-supported 2-way spanning CLT floor structure
- Post and beam structure with 1 or 2-way mass timber floor

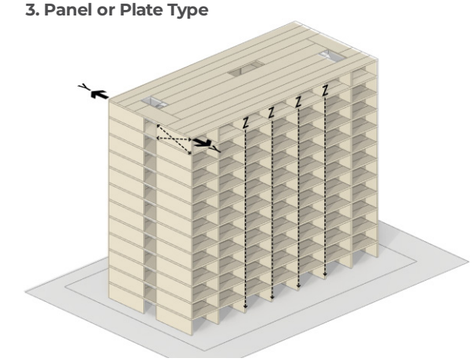
Lateral Load Resistance:
- Perimeter frames/diagrid

Common Design Implications
- Anti-stacking or diagonal-stacking
- A-B modules
- Textile-like or "woven"
- Expressed diagonals
- Layered diagonal structured with orthogonal
- Panelized construction

CLT Plate on CLT or Light-Steel Framed Shear-Walls (1-way Span)



3. Panel or Plate Type



Vertical Load Resistance:
- Vertical panels/walls as load-bearing walls
- 1 or 2-way mass timber floor

Lateral Load Resistance:
- Vertical panels/walls as shear-walls

Common Design Implications
- Aspects of both
- More possibility of cantilevering if vertical CLT is used to form plate or box structure
- Horizontal massing
- Possibility of alternating/contrasting differences between floor plates
- Volumetric podular or panelized tilt-up construction

Additional Design Considerations for 18 Storeys

As buildings grow taller (13-18 storeys and above), structural considerations come into play which are not as important in lower buildings, or must be addressed differently and often with hybrid structural systems. General design guidance should recognize and acknowledge underlying principles at work.

General tendencies of design

Existing 18+ storey examples of mass timber buildings have interrelated formal and structural tendencies. Although they are not strictly consistent, with some distinctive outliers, there are clearly observable pattens for structural approach and form which result in common features of design.

- Predominance of rectilinear, rectangular, and symmetrical forms where no external factors drive idiosyncratic building forms, for efficiency of plan, and symmetrical or cost-effective structures.
- Straight, superimposed floor plates with no variation or step-backs.
- With post and beam structures, greater freedom of glazing, potential for exposing or reinforcing building massing structured around lateral stabilizing features like eccentric cores or bracing.
- Prominent lateral stabilizing elements and frames.

Building massing and proportion

Contemplated BC Building Code changes allow for 18 storey residential buildings at the same maximum area as those of 12 storeys. Different tendencies in massing may arise in buildings designed within acceptable solutions of the building code. Proportions of buildings on suitable sites may be expected to narrow into more slender forms. A compact rectangular or square tower footprint will in turn introduce different considerations for structural and space planning and lateral systems.

Lateral stability and design elements

Lateral stability in a tall timber building, especially growing past 7-10 storeys becomes a very important factor in the design, more so than steel or concrete buildings due to timber's light weight. This problem grows as buildings get taller. How lateral stabilizing elements are worked into the design of any scale of building can have a large influence on their outward appearance. Different structural design strategies will require rather different approaches for integration with the envelope, and thus produce rather different architectural character. In many outstanding cases, lateral stabilizing elements become important design features to be exposed and celebrated outwardly.

Tower-podium forms

The ubiquitous 18+ storey tower building type in parts of BC is a cast-in-place concrete building, where a podium mass of some height transitions into a slender tower form. This design balances both urban design requirements with solar access and tower separation for neighboring properties in areas planned for high-density. Such a design is intrinsically more difficult to realize in mass timber construction.

There are numerous reasons for this—from a structural stand point it could be generally attributed to a few important features:

Transfer levels are more challenging in mass timber than in concrete

Where two different floor plates are super-imposed, differences in structural position and services routing are hard to reconcile. Vertical support elements in mass timber construction are tied precisely to panelized floor elements and must be superimposed. Transferring, or stepping the position of these supports (relatively simple in cast in place concrete) would require sizeable connections or over-sized beams, distruptive to space plans below the transfer level, or costly redundancy in vertical supports.

Central cores and varying tower foot-prints

In a tower design with two or more distinctive floor plates, a central core typically provides vertical circulation and egress, vertical service space, and lateral stability. The logistics of constructing this element is frequently staged independently and prior to of the remaining timber structure, diminishing the schedule efficiency of timber as a prefabricated construction method. The same type of structure is possible by using a prefabricated steel core, complimentary and concurrent to mass timber construction processes, but at great cost, and is less efficient with material than if steel stabilizing elements are used at a building's perimeter.

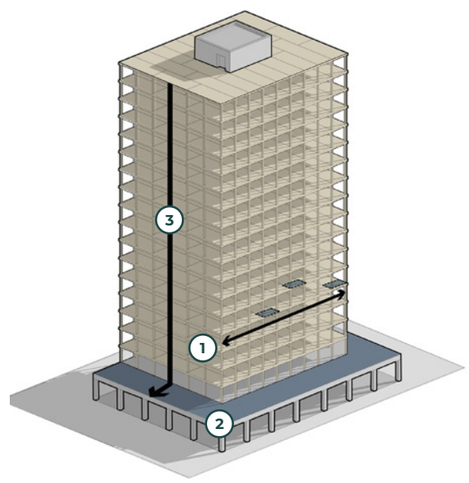
In practice, examples of tall timber tower designs which do incorporate a podium situate it within one or two storeys of the ground (rather than 5, 6, or even 8 storeys up). Near grade a logical inflection point exists, where structural system, mixed building use, methods of construction (ground-staged vs crane or tower-deck-staged), service cores and exits, can transition favorably.

Post and Beam or Superstructure Approaches / Tendencies

One general approach is to structure an 18 storey mass timber building with simple, regular grid of columns supporting a flat, panelized floor structure with a central core forming the lateral stabilizing element of the building. Frequently this type of building uses a concrete "podium" at or above ground level to transfer and rationalize the upper-storey grid to a parkade or street-level occupancy below. In many respects, their design is quite simple and comparable to lower buildings of the same general structure.

Another 18+ storey tendency, of which only a few examples exist in the world, with none built in British Columbia, is a superstructural approach, where braced or diagonally oriented structures in timber, steel, or hybrid construction provide the primary lateral stability for a building. Given their position—typically along the perimeter of a tower footprint, rather than perpendicular and interior as with shear walls or column grids—designers must integrate the configuration of these elements with both the interior space and the outward form. These structures will tend to span multiple storeys and may even support the load of interstitial storeys at progressive stages of the building's height.

Post and Beam

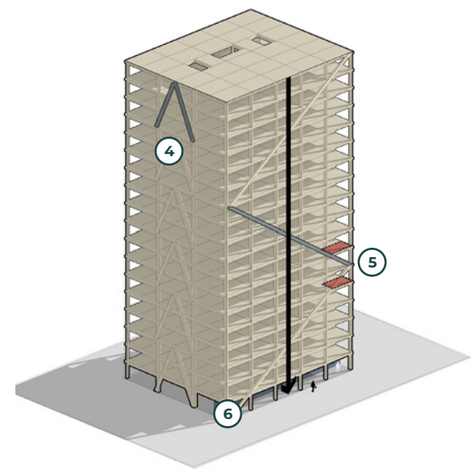


Lateral stability and design elements

- More freedom of glazing
- Relative freedom of balcony type, number and placement
- Freedom of articulation and programming at grade level and below grade

1. Perimeter un-encumbered by lateral stabilizing element
2. Podium at or near grade to transfer structures
3. Straight, superimposed floor plates with no variation or step-backs

Super Structure

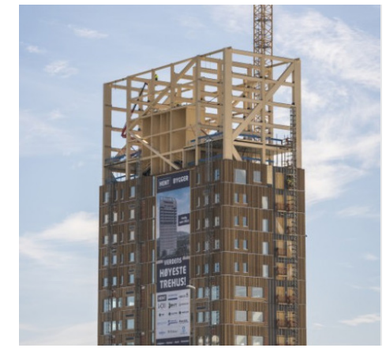


Lateral stability and design elements

- Some constraint of glazing or envelope treatment where diagonal structures exist
- Tendency for offest or projected balconies / cassette or clipped system
- Little flexibility for building articulation that does not follow precisely the form of the bracing structure
- More dynamic or uniqe forms which integrate diagonally orientated structures

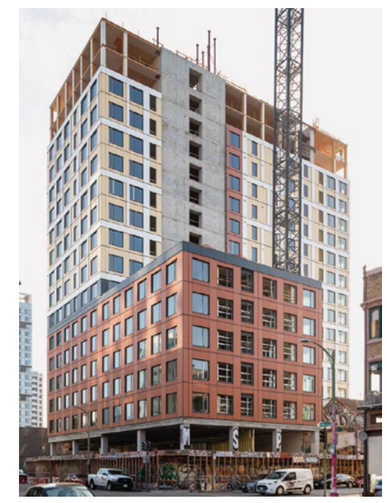
4. Design opportunities to highlight large multistorey bracing structures
5. Balcony integration and placement with diagonal bracing or perimeter bracing will be constrained
6. A need to land the superstructure directly at grade on a suitable foundation. (i.e. no ground floor insets or changes in massing between floors above and at grade)

Precedents



Mjøstårnet (Voll Arkitekter, Moelven)
Photo: Moelven

A tall timber tower with a prefabricated timber superstructure being erected.



1510 Webster (DCI Engineers)
Photo: Andrew nelson

A tall timber tower with a post and beam and central core being erected.

Biophilia

In architecture, biophilia refers to the concept of integrating elements of nature and natural processes into the design of built environments.

Biophilia is a term coined by biologist E.O. Wilson in the 1980s, which refers to the innate human tendency to seek connections with nature. In architecture, biophilia refers to the concept of integrating elements of nature and natural processes into the design of built environments. Biophilic architecture aims to enhance the well-being, productivity, and overall experience of occupants by fostering a stronger connection to nature within the built environment.

Use of exposed timber beams, columns, and ceilings brings the warmh, texture, and aesthetic qualities of natural wood into spaces, fostering a connection with nature. Mass timber can also be used to create natural patterns to help create visually stimulating environments that promote well-being and reduce stress. Therefore, mass timber structures make an attractive option for architects, developers, and building owners looking to create environmentally friendly and visually striking buildings.

Exposed wood elements often have to be larger when not encapsulated due to char layer and fire resistance requirements. This will result in thicker walls or columns which may be counted towards total floor area ratio (FAR) in some municipalities. Similarly, the increased height of wood colonnades or interior vaults might be included in the development area calculations. Providing flexibility on floor to area ratio calculations in mass timber buildings supports use of exposed wood and biophilic value of mass timber products.

Biophilia was added during the Design Charrette process to respond to the following pressing issues in addition to the 6 challenges identified in Design Solutions for Mass Timber Construction.

Considerations for municipalities

- Create incentives for biophilic design of mass timber elements including exposure of structural timber in occupied areas.

Photos courtesy of ZGF Architects

Delivery Model

Navigating the design, permitting, and construction schedules of mass timber projects requires careful planning, coordination, and consideration.

While mass timber construction offers numerous advantages in terms of sustainable and efficient construction; navigating design, permitting, and construction schedule of mass timber projects requires careful planning, coordination, and consideration of various factors to ensure successful project delivery.

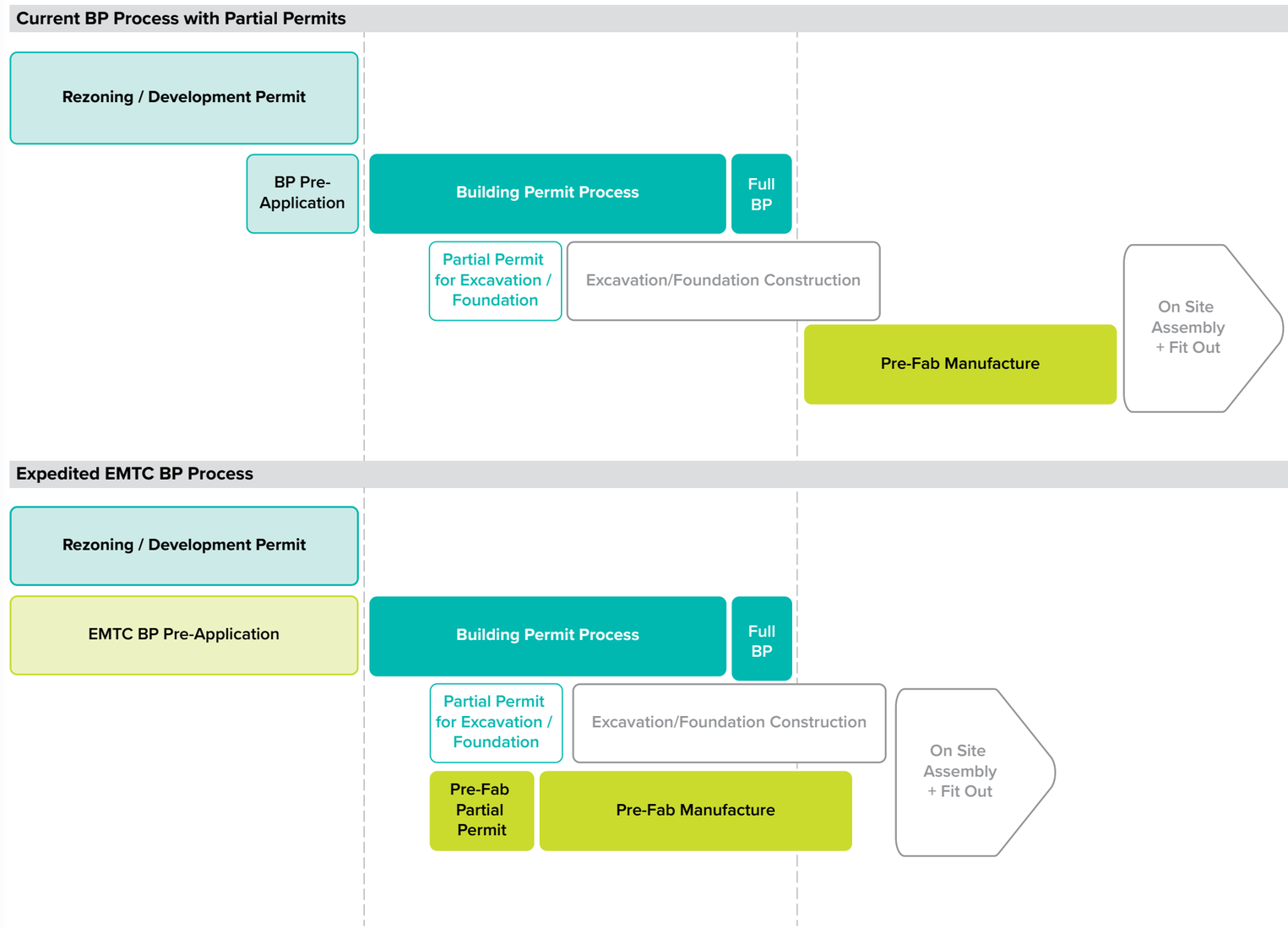
Material lead times: The procurement of mass timber materials, such as cross-laminated timber (CLT), will require longer lead times compared to materials like concrete and steel. It's essential to consider the availability and delivery schedules of mass timber components when planning the construction timeline.

Manufacturing and prefabrication: Mass timber components are typically prefabricated off site in controlled factory environments. The manufacturing and fabrication process for mass timber elements will take time, especially for custom-designed components or large-scale projects. Coordination with timber manufacturers and suppliers is essential to ensure timely production and delivery of materials.

Design and engineering complexity: The design and engineering of mass timber buildings can be complex, particularly for innovative or unique architectural designs. Detailed structural analysis, coordination of building systems, and compliance with building codes and standards will require additional time during the design phase, impacting the overall construction schedule.

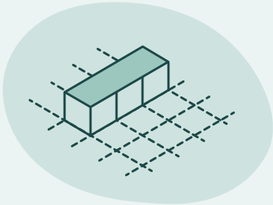
Considerations for municipalities

- Simplify review processes for mass timber projects and frontload Form of Development review and approval.
- Support accessible resources for staff, applicants, and public to illustrate opportunities for, and challenges to, local mass timber projects.
- Allow flexibility in review and approval process for mass timber projects to accommodate unique aspects of procurement and construction sequencing.
- Have building officials engage in the design process early (rezoning or DP) to identify any BC Building Code issues.
- Have building officials consider the issuance of partial permits early in the permit process to allow prefabication to begin early.



Challenges and Opportunities

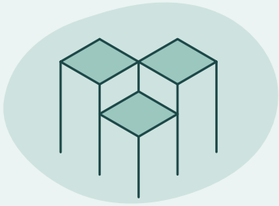
To effectively accommodate mid-rise mass timber buildings, Official Community Plan's (OCP's) and Development Permit Area Design Guidelines require adaptation. The following aims to identify and characterize the most significant challenges affecting mid-rise mass timber buildings and presents a range of design guidance and high-level solutions.



Mass Timber Structural Logic

The logic of a cost-competitive mass timber structure tends not to be as responsive as required by existing zoning bylaws.

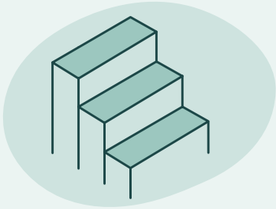
Pre-determined constraints or design expectations can erode the efficiency of structures conceived with repetitive, standard dimensions of engineered timber products.



Building Height

Mass timber floor assemblies are thicker than concrete, translating to comparatively taller buildings to achieve the same interior clearances.

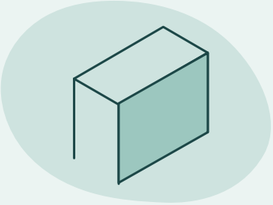
Thus, a mass timber project may not fit under the same height restrictions as an equivalent building in concrete.



Prescribed Articulation of Massing

Design guidelines and OCPs frequently request upper storey setbacks to provide massing relief and articulation of a base, middle and top of a building.

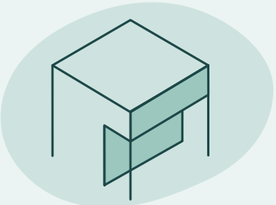
Such massing modulation can be difficult and costly to accommodate with a mass timber structure.



Bar-Type Buildings

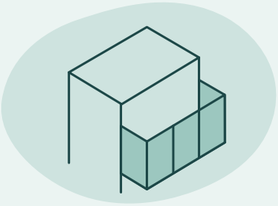
Bar-type buildings built on long lots with densities conducive to encapsulated mass timber construction (EMTC) often present an over-bearing, heavily shadowing building form.

These attributes may meet stiff public resistance.



Public / Ground Interface

Consideration for varied ground plane responses which embrace the inherent vertical lines and material logic of timber towards creating activated street interfaces.



Balconies / Private Outdoor Space

Multifamily residential buildings are often required to provide private outdoor space for family oriented units. Balconies can introduce significant complexity and cost on mass timber buildings.

Mass Timber Structural Logic

Challenges

Optimal Dimensions, Zoning Conflict and Design Recommendations

The logic of a cost-competitive mass timber structure tends not to be as responsive as required by existing zoning bylaws. Recommendations aimed at improving the "fit" of a building into an existing OCP framework may imply quite onerous/incompatible work to reconcile the overall form with the underlying structural system, which inherently follows different organizing principles to Cast-In-Place Concrete (CIPC) buildings.

The definition of building massing and spatial planning in a prefabricated mass timber building ought to be more "structure forward" than in a comparatively flexible concrete given the designer's adherence to strict modules derived from the manufacturing process for Cross-Laminated Timber (CLT). In order to make mass timber housing as affordable as possible, the building floor plate ought to be developed using the most-common-denominator CLT panel widths (~3m wide) available among manufacturers to allow the CLT bidding to remain as competitive as possible.

Opportunities

Discretionary Variance

Given the overall lot dimensions of some sites, it may be necessary to provide discretionary variances to yards, setbacks, site coverage, and building depth and length to optimize for the latter.

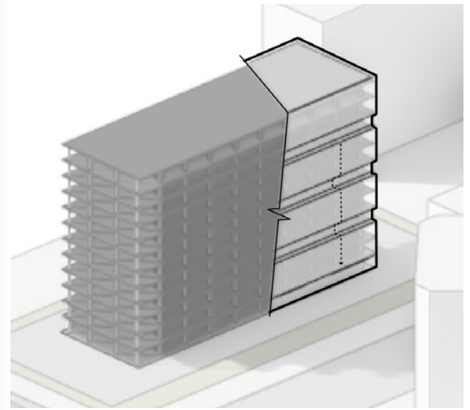
Attune Massing Guidance to Structure

Provide material or textural sub-scale design articulation for breaking up larger masses - this could be achieved through varied cladding colours, interplay of solid vs transparent, and exploration of multi-storey grouping of elements - *emphasize vertical expression over linear horizontality.* A repetitive massing break congruent with established structural module could be encouraged under broad massing moves.

18 Storey Considerations

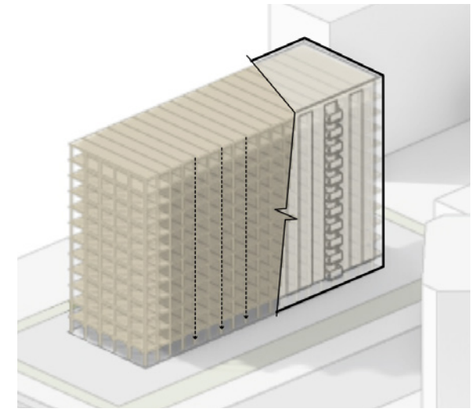
18 Storey buildings have similar underlying constraints to 7-12 storeys, and additional structural considerations around lateral stability, and the practicality of their general structural strategy at this higher scale. See Additional Building Forms for more detail.

Concrete Structure

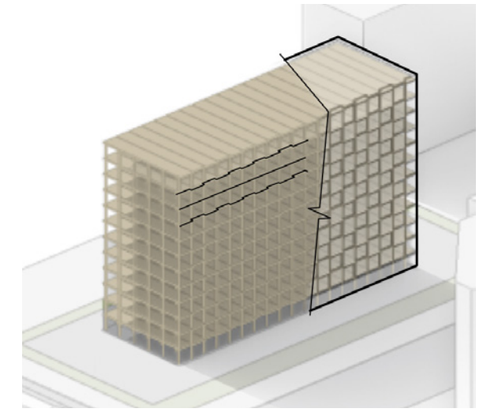


Concrete structure with horizontal massing
The need to cantilever concrete floors past supports and the formal freedom of the material lends itself to many horizontal breaks in the building.

Attune Massing Guidance to Structure

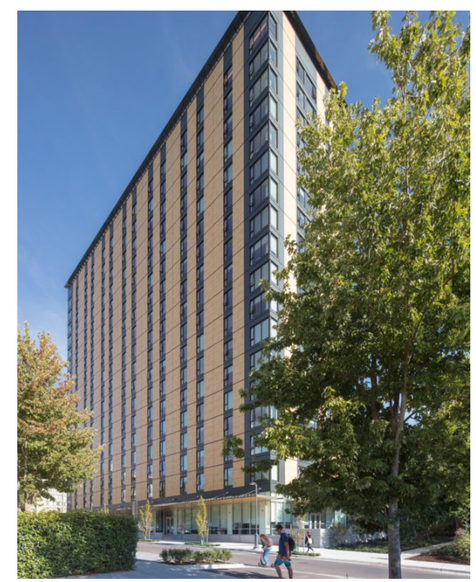


Timber structure with consistent vertical massing
The direct transfer of vertical loads and the limitations on cantilevering timber floors, demands consistent vertical massing from top to bottom.

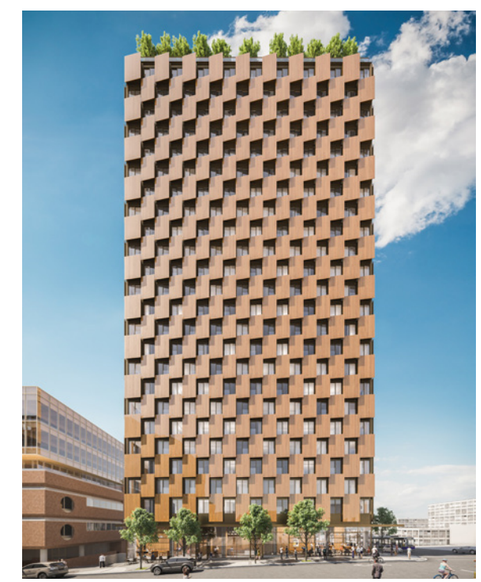


Sub-scale massing modulation through repetition
The modularity inherent to the prefabrication of mass timber structural elements and building envelopes can be used to coordinate repeated, gradual or subtle differences in massing.

UBC Lot 11 (ZGF Architects)
Photo: Geoff Lister



Brock Commons (Acton Ostry Architects)
Photo: Michael Elkan



M5 Concept (Henriquez Partners Architects)

Building Height

Challenges

Required floor-to-floor heights

Mass timber floor assemblies are thicker than concrete which inherently translates to an increase in required floor-to-floor heights, creating comparatively taller buildings. In conventional concrete residential construction, building services such as electrical conduit and exhaust duct work can be buried within the slab without significantly impacting structural strength. In Cross-Laminated Timber (CLT) construction, such services must be suspended below the wood slab and then concealed with ceiling construction. This also effectively increases the thickness of the floor-ceiling assembly.

Opportunities

Discretionary height variance

Allow for a discretionary height variance (per storey) for buildings meeting the zoning definition of a mass timber building above 7 storeys, where height provisions are stipulated in certain district schedules.

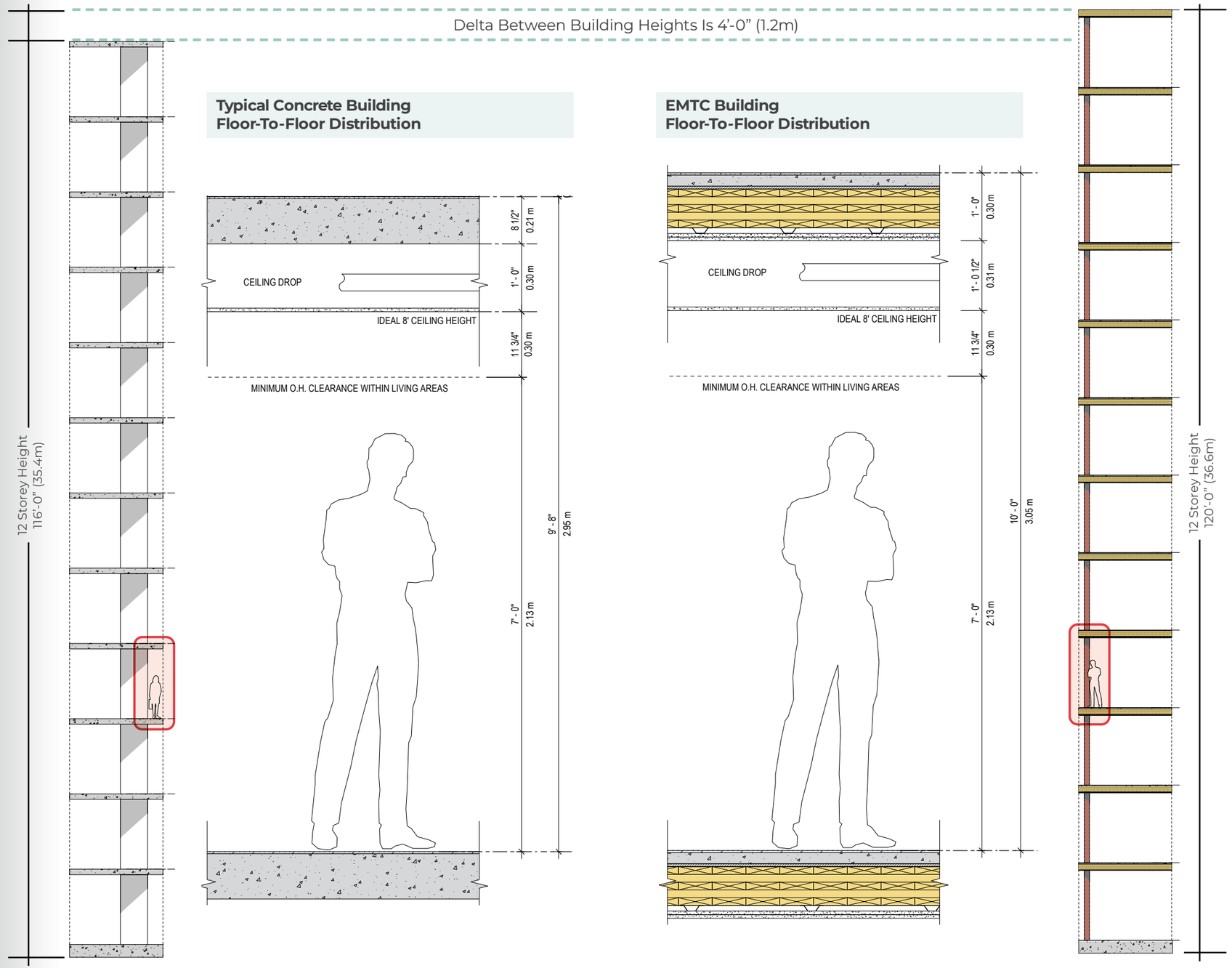
Additional height requirements will vary by the particular structural system selected. In the example illustrated, where a flat, two-way CLT floor plate can be point supported on steel or engineered timber columns, the increase in thickness between a typical EMTC floor assembly and equivalent concrete assembly is 4".

So, to achieve the same interior clearance in a point supported EMTC building, a variance of 4'-0" (1.2m) for a 12 storey building is required, at minimum.

This differential would be even greater if a post and beam structure were used.

18 Storey Considerations

Same considerations apply where similar structural systems are used. Taller buildings, especially those employing a super-structural approach, may have additional drivers for extra height, depending on the particulars of their structural designs. See Additional Building Forms for more detail.



Prescribed Articulation of Massing

Challenges

Set-Backs and Proscriptive Massing

OCP's frequently request upper storey setbacks to provide massing relief and building articulation towards defining a base, middle and top of a building.

Such step-backs and massing modulation can be difficult and costly to accommodate with a mass timber structure that relies on repetitive stacking of its structural elements.

Similarly, step-backs designed to continue consistent building lines and street walls, while reducing the shading and massing effects of tower elements, may demand multiple step-back locations, starting at a relatively low point in a 7-12 storey building. These proscriptions are difficult to reconcile with a consistent tower foot-print conducive to mass timber construction.

Opportunities

Reformulate Massing Guidance

Allow for discretionary design flexibility for mass timber buildings 7 storeys and higher to relax massing articulation requirements, as well as yards, set-backs, site coverage, building depth, and external design. Creating flexibility to reduce or remove building step-backs (where appropriate), will simplify mass timber construction and make the typology more cost competitive.

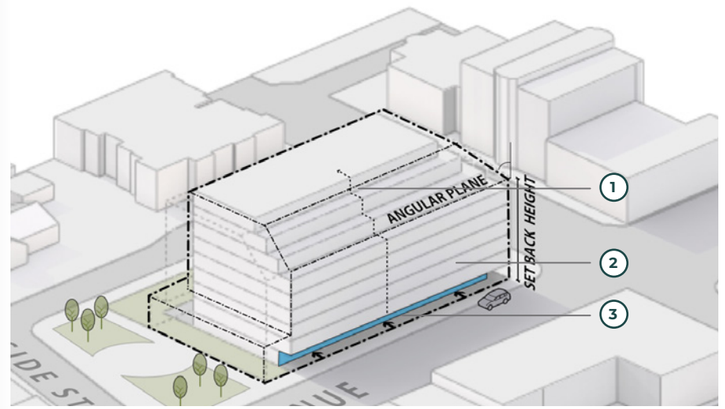
Podium Massing

Where the scales are appropriately balanced, consider allowing for a "podium" massing which fits into the existing street wall and scale of an urban location at a lower elevation than the maximum proscribed, and a tower foot-print set-back which continues up with a step-back.

18 Storey Considerations

Similar guidance as above is applicable to 18 storeys-with some variation. The 18 storey building is a de facto tower form. Any constraints or proscriptions for set-backs or multiple types of super-imposed floor plates are especially difficult to reconcile as buildings get higher in mass timber construction. See Additional Building Forms for more detail.

Concrete Massing Approach



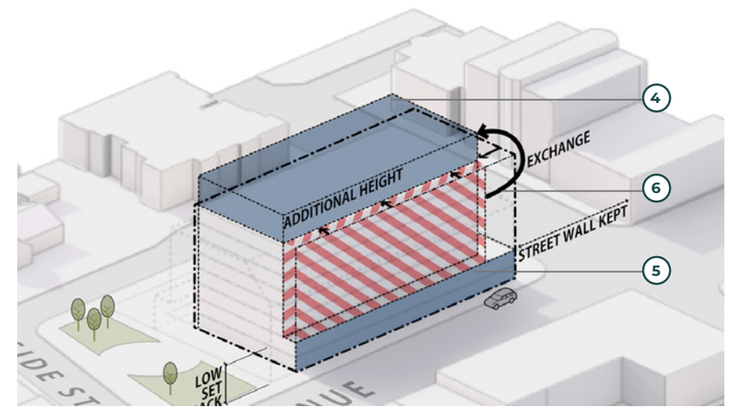
Mid-rise concrete framed building approach to zoning envelope.

1. Terracing/step-backs beginning at angular plane are easily accommodated by varying suspended slabs/transferring of CIPC.
2. Building maxed out to zoning envelope.
3. Possible inset at grade for pedestrian right-of-way can be accommodated with simple cantilever/transfer logic of suspended concrete floors.

Duke Condos (BDPQuadrangle Architects)
Photo: Thomas Noussis

Duke Condos is a 7-Storey, concrete-framed residential building with retail along avenue at grade. The structure allows for distinct, horizontal massing transitions with a variety of terraces, step-backs, and over-hangs breaking up the form and adhering to neighbourhood zoning and planning requirements.

Mass Timber Massing Approach



A comparable approach made feasible in mass timber.

4. Discretionary allowance for viable "single" tower massing (no multiple "set-backs") can approach intent of set-back requirements and street-facing height limits. In this case, a feasible timber system may encroach on a maximum developable volume.
5. A lower, initial set-back can maintain street-wall/integrate with existing low rise context, while providing some relief and street level solar access from "tower massing" above.
6. A slimmer tower with a larger site footprint may represent "un-used" allowable volume in a zoning envelope, compensated by exceeding the height limitations of the envelope, with a consistent floor plate. This could allow for a compromise between development goals and urban design/planning goals.

Arbora Apartments (LeMay, CHA, Provencher-Roi Architects)
Photo: Adrien Williams

Arbora Apartments combines a 3-storey concrete podium with 5 storeys of CLT/Glulam Framed apartments above. Note the distinct, sheltered transition between pedestrian level uses provided by concrete frame below, and the regularity of the timber-framed floor plate of the apartments above.

Challenges

Finishing the Tower

Certain design language and elements at the crown of a building may be prescribed by neighbourhood character guidelines to avoid the "harsh" and continuous break at the roof-line of a modern parapet or flat roof.

These design elements may or may not work well with practicalities of the construction method.

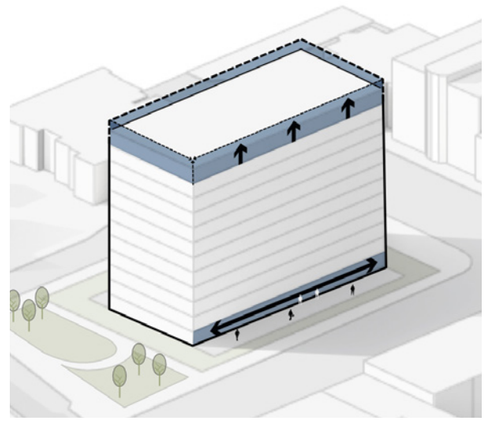
Opportunities

Massing of Crown/Softening Bar Massing

There are several other design approaches that can be explored to achieve similar desired outcomes that do not include a step-back:

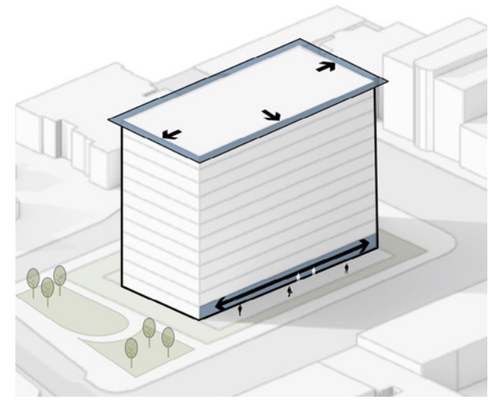
1. Switch the scale of the building expression at the upper storeys. Can also create a well defined building "top."
2. Provide a protruding architectural element or unique expression at the parapet, like a cornice or "crowning element."
3. Where practical, likely in lower 7-8 storey buildings, a gabled roof framed in heavy-timber construction may bring more positive formal associations in keeping with a BC municipality's general design guidelines and more acceptable in character than a modern flat roof.

1 Grow Upper



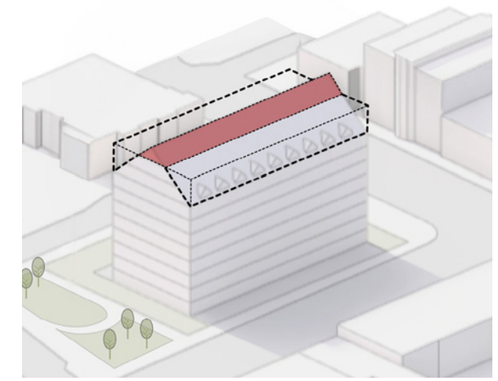
Sandy Pine Proposal (Lever Architects)

2 Cornice Parapet



Brock Commons (Acton Ostry Architects)
Photo: Michael Elkan

3 Gabled Roof



Strandparken Hus B, Sweden (Windgardhs Architects)
Photo: Tord-Rickard Söderström

Bar-Type Buildings

Challenges

Overbearing/Shadowing Form

As identified in FAR studies, bar-type buildings built on long lots with densities conducive to mass timber present an over-bearing, heavily shadowing building form. Long, slab-type building forms identified as workable in the pre-study tend to evoke unsuccessful examples of urbanism, forming very long street walls. Such proposals may meet public resistance for their impact on existing neighbourhoods.

Addressing issues of solar-access is highly site-specific, but the details of a building's design can anywhere influence the sense of scale.

Opportunities

1 Inflect Mass with Grid

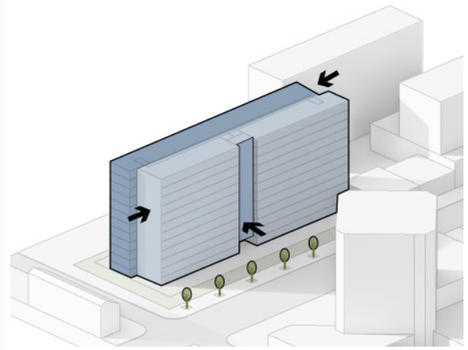
Guidelines should allow designers to confine massing articulation to large scale, singular or rational moves that fall along the logic of timber structural grids. This may still result in large faces, but there are simple "tricks" to start breaking up a timber mass which are conducive to structural alignment.

2 Bent Bar

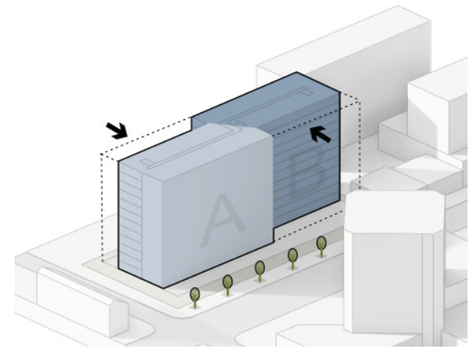
Without sacrificing the efficiencies of the "bar" when executed in mass timber construction, one possible variation may be a "bendy", "trapezoidal" or "knuckled" bar which features an inflection point to articulate the bar into sections. Allowing for more oblique approaches to lot-boundaries, angled forms will present a dynamic form in the urban context. Context-depending, they may offer some advantage in terms of over-shadowing and self shading.

This strategy may work best in places where development is occurring on large, unencumbered green or brownfield sites, rather than as infill projects on constrained urban sites.

1 Inflect Mass with Structural Grid

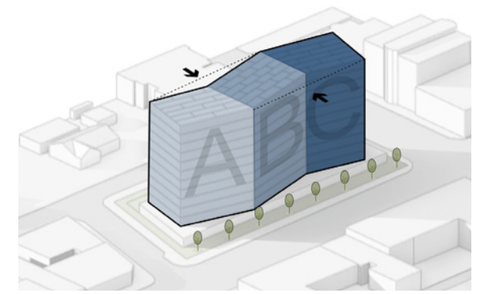


Shifted bar along major axis.



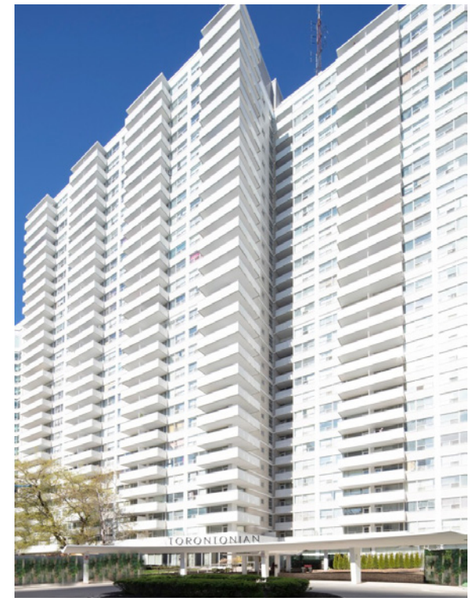
Slipped or pinwheeled bars hinging on central cores.

2 Bent Bar



Inflection points to articulate the bar into sections.

Ascent by Architects Korb and Associates
Photo: Naim Olker



Torontonian Apartments (Northgrave Architect)
Photo Courtesy of Shiplake Properties

The form of this very long building is attenuated by conjoining two smaller bars with a central core at their corners. The highly regular grid of the building would also lend itself to a contemporary mass timber building.

Pukkoka Housing Block (OOPEAA)
Photo: Mikko Auerniitty

Pukkoka Housing complex is a trio of gabled bar buildings responding to an irregular site. The design inflects rectangular CLT 'wings' at a central atrium, resulting in a dynamic form with a plan much like a conventional bar.

Opportunities

3 Materials and Colour

Where residential typology permits only limited glazed area, and limited exposed timber due to stricter code provisions of use type, encourage façade treatment with natural, or colourful materials.

Lighter, reflective materials will also have a positive impact in reflecting more indirect sunlight where the building would otherwise block direct exposure.

Where timber elements have been used as structural members of balconies, encourage visibility of soffit with its direct line-of-sight to public realm (with appropriate provisions against moisture and fire).

18 Storey Considerations

18 storey building designs may tend towards different forms and aspect ratios than 7–12 storey ones, but with a tendency towards more elongated forms than other towers. See Additional Building Forms for more detail.

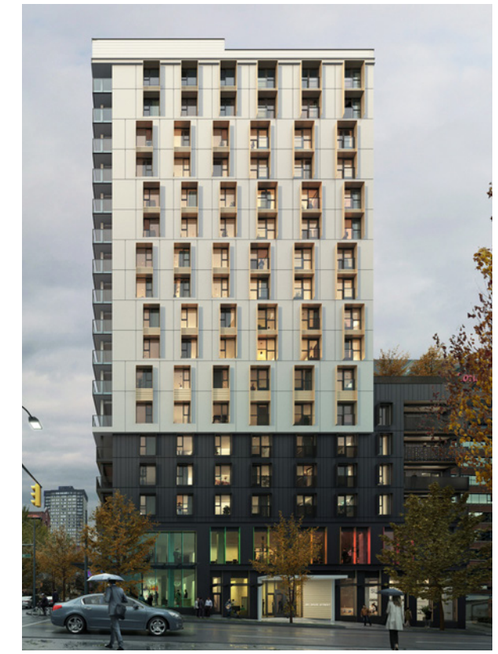
3 Materials and Colour Examples

Mac (MA+HG Architects | EDR)

Colour and panel modulation can animate another highly regular, flat façade.

Forte Building, Melbourne (Nielsen/Lend Lease)
Photo: Emma Cross

White cladding provides large area to reflect direct sunlight indirectly, exposed CLT structure at balcony soffit, creates a direct visual connection to wood from pedestrian at street level.



VAHA Burrard (ZGF Architects)

Modulation of window elements, addition of bright colour adds vibrancy to an otherwise flat façade designed to contain a regular CLT floor plate in an energy efficient envelope.

Public / Ground Interface

Challenges

Massing and Urban Design

Consistent vertical lines/massing required by structural logic of timber may not sit well with requirements for more dynamic/activated street interface required in urban design guidelines, nor with ground-level right-of-way set-backs.

Opportunities

1 Hybrid Structural Solution

Concrete podia constructed up to level 2 are likely required in any case as part of transfer structures to below grade structures and foundations. These can serve to modulate an over-bearing massing above, by providing relief in the form of canopy projections, overhangs, façade-insets, breaks in pattern, greater transparency, etc., relying on the greater flexibility of concrete structure for these breaks.

2 Timber Structural Solution

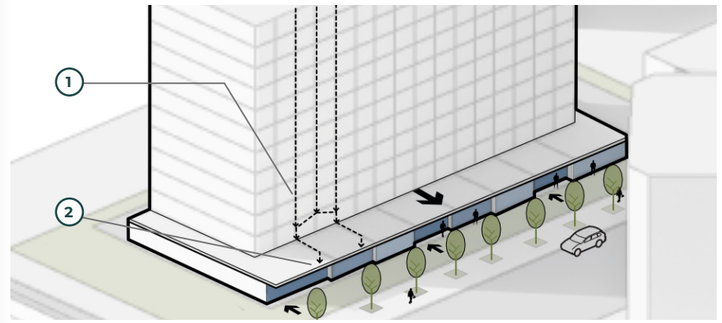
Where it is desirable to continue a timber structure to grade, complex urban interfaces may be encouraged by more subtle means, less formally intensive and more material or texturally driven, or by better integrating landscaping elements.

Partially exposed timber is intrinsic to a mass timber building, encouraging the use of exposed timber elements at grade for canopy supports/enclosed or exposed arcades, can provide both formal interest and add material vibrancy to the urban experience at grade.

18 Storey Considerations

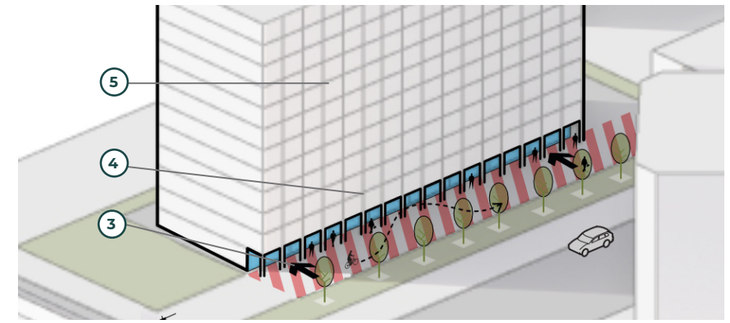
Similar considerations apply for hybrid structural solutions, which occur in similar configurations at this building scale. Other variations of timber and hybrid structural solutions (super-structural frames) which are largely only contemplated at this height or higher—will introduce unique considerations to 18+ storeys. See Additional Building Forms for more detail.

1 Hybrid Structural Solution

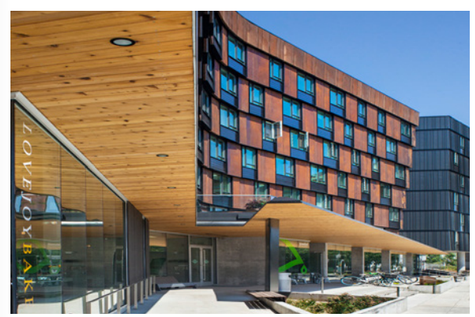


1. A concrete transfer structure can reconcile differences in dimensions of structure and program above with mixed-used program below.
2. Highly variable/cantilevering structure can accommodate many detailed requests/multiple competing demands for resolution of building where it meets the ground.

2 Timber Structural Solution

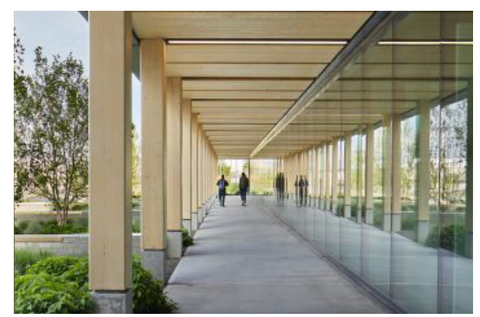


3. Pedestrian right-of-way requirements may limit the most direct use of mass timber structures in maximizing an urban zoning envelope above.
4. Residential grid dimensions and typical commercial or parking grid dimension do not match-up well for most building programmes.
5. Permitting some flexibility in how a mass timber structure can carry directly to ground level while still allowing pedestrian passage, and permitting some flexibility in mixed-use programing allows for one continuous, tight grid.



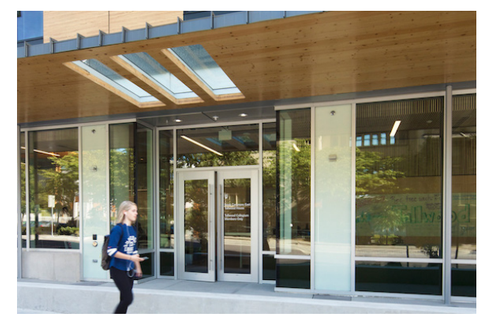
The Emery (ZGF Architects)
Photo: Pete Eckert

Wood-Construction Above a Concrete Base
The above is a 6-storey light-framed wood apartment over a mixed-used concrete base. The building cantilevers an inflected floor plate over a commercial street frontage. Its successful integration with the street relies on a well articulated ground level, without complicating the design of the apartments above. Similar principles can be applied to a taller structure in mass timber construction.



Catalyst Building, WA (Michael Green Architects)
Photo: Benjamin Benschneider

Timber Structure to Grade Forming a Covered Arcade
Permitting the extension of a timber structure above to ground level can provide a human scaled covered area while allowing for the functional requirements of passage along a pedestrian right-of-way.



Brock Commons (Acton Ostry Architects)
Photo: Michael Elkan

CLT Entrance Canopy
Mass timber elements can be used to form an appealing, sheltered, and distinct interface between the building and the street without the need to inflect the building envelope.

Private Outdoor Space

Challenges

Private Outdoor Space Requirements

Multifamily residential buildings are often required to provide private outdoor space for, at minimum, 2 and 3 bedroom units. Balconies introduce significant complexity and cost on mass timber buildings.

Opportunities

1 Combined Outdoor Spaces

Allow for discretionary design flexibility for mass timber buildings 7 storeys and higher to relax design requirements for individual private outdoor patio/ balcony spaces, and instead provide for more meaningful shared indoor/outdoor building amenities.

Giving freedom for designers to imagine alternative ways of connecting apartment spaces to the outside can result in as much amenity or more than private, projected balconies, while supporting the design of an envelope in keeping with practicalities of mass timber construction.

With a particular focus on affordable housing solutions, this flexibility could dramatically simplify mass timber construction and drive down project cost.

2 Reduced Balcony Requirements

If balconies are to be included, it is preferable to minimize size requirements to improve viability of structural support from timber elements, which are comparatively weaker than concrete or steel ones. Reducing the number and types of units required to be served by a balcony can ease their configuration into a residential plan. Consider alternatives to projected balconies which can reclaim usable indoor-space while providing a good connection to the exterior through appropriate design.

18 Storey Considerations

Similar technical considerations apply in 18 storeys. Many designs for balconies will be nearly exactly alike as related to underlying structural systems. However, the taller building form and greater potential to realize superstructural strategies—both for overall building and balcony structures—will introduce unique considerations. See Additional Building Forms for more detail.

1 Combined Outdoor Spaces

1190 Burrard Proposal (ZGF Architects)

Shared Spaces on a Roof
Gathering outdoor spaces in central rooftop locations allows greater possibility of activities, better solar access, and fosters community within a building. As a substitute for balconies, this can focus design efforts on a part of the building where tricky problems of envelope and structure are addressed as a matter of course, while simplifying the overall form of the building.

Villa Mokum (Kampfman Architecten)
Photo: Ossip van Duivenbode

Alternatives to Balconies
The above is an 8 storey, concrete-framed apartment building with a prefabricated envelope. In-lieu of singular projected balconies, the complex integrates expansive juliette balconies in most suites, and incorporates several large covered loggias as communal outdoor spaces.

2 Reduced Balcony Requirements

Pukkoka Housing Complex (OPPEA)
Photo: Mikko Auerniitty

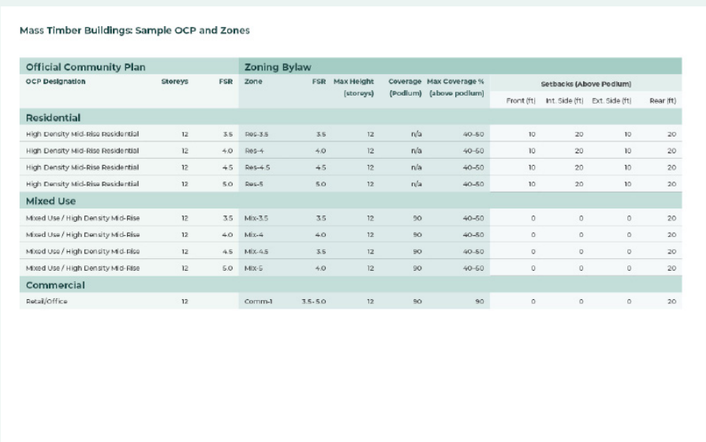
Semi-Enclosed Balconies
The above is a semi-enclosed balcony in the world's first 8 storey, volumetric mass timber housing project. Allowing for partial sheltering and finishing within a prefabricated unit could improve the viability of balconies in timber buildings by mitigating risk of moisture-related issues inherent to projected balconies, and by simplifying structural integration.

355 Branan (David Baker Architect)
Photo: Bruce Damonte

Modest Balconies
Simply reducing expected sizes for balconies can diminish the size and complexity of their connections to the buildings' structure and envelope. The above example shows partly prefabricated balcony units, feasibly hung onto a hybrid-light-wood frame.

Suggestions for Development Regulations

The ability to construct a mass timber buidling begins with acquiring a site. Official Community Plans and Zoning Bylaws establish the highest and best use and therefore significantly influence land values.

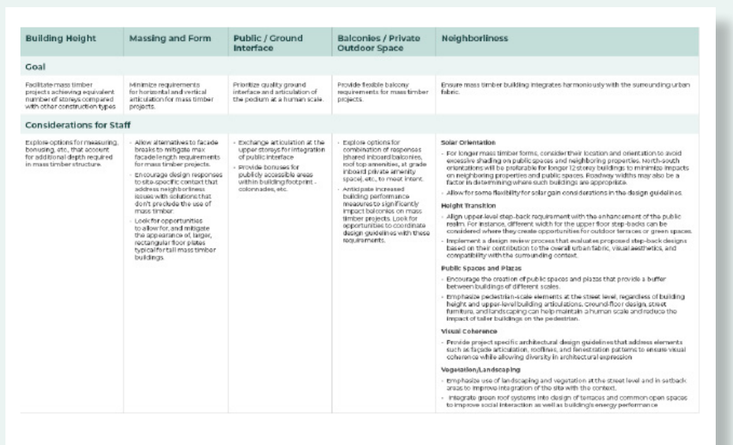


Mass Timber Buildings: Sample OCP and Zones

Official Community Plan			Zoning Bylaw									
OCP Designation	Storeys	FSR	Zone	FSR	Max Height (storeys)	Coverage (Podium)	Max Coverage % (above podium)	Setbacks (Above Podium)			
								Front (ft)	Int. Side (ft)	Ext. Side (ft)	Rear (ft)
Residential											
High Density Mid-Rise Residential	12	3.5	Res-3.5	3.5	12	n/a	40-60	10	20	10	20
High Density Mid-Rise Residential	12	4.0	Res-4	4.0	12	n/a	40-60	10	20	10	20
High Density Mid-Rise Residential	12	4.5	Res-4.5	4.5	12	n/a	40-60	10	20	10	20
High Density Mid-Rise Residential	12	5.0	Res-5	5.0	12	n/a	40-60	10	20	10	20
Mixed Use											
Mixed Use / High Density Mid-Rise	12	3.5	Mix-3.5	3.5	12	90	40-60	0	0	0	20
Mixed Use / High Density Mid-Rise	12	4.0	Mix-4	4.0	12	90	40-60	0	0	0	20
Mixed Use / High Density Mid-Rise	12	4.5	Mix-4.5	3.5	12	90	40-60	0	0	0	20
Mixed Use / High Density Mid-Rise	12	5.0	Mix-5	4.0	12	90	40-60	0	0	0	20
Commercial											
Retail/Office	12		Comm-3	3.5-5.0	12	90	90	0	0	0	20

OCP and Zoning Bylaw

Consideration needs to be given to how mid-rise (7-12 storey) mass timber buildings align with existing municipal land use regulations (Official Community Plans and Zoning Bylaws). Changes are likely required to best accommodate mid-rise mass timber building forms.



Building Height	Massing and Form	Public / Ground Interface	Balconies / Private Outdoor Space	Neighborliness
Goal				
Facilitate mass timber projects achieving equivalent number of storeys compared with other construction types	Minimize requirements for horizontal and vertical articulation for mass timber projects.	Prioritize quality ground interface and articulation of the podium at a human scale.	Provide flexible balcony requirements for mass timber projects.	Ensure mass timber building integrates harmoniously with the surrounding urban fabric.
Considerations for Staff				
Explore options for measuring, bonusing, etc. that account for additional depth required in mass timber structure.	• Allow alternatives to facade breaks to mitigate max facade length requirements for mass timber projects. • Encourage design responses to site-specific context that address neighborliness issues with solutions that don't preclude the use of mass timber. • Look for opportunities to allow for, and mitigate the appearance of, larger, rectangular floor plates typical for tall mass timber buildings.	• Exchange articulation at the upper storeys for integration of public interface • Provide bonuses for publicly accessible areas within building footprint - colonnades, etc.	• Explore options for combination of responses (shared inboard balconies, roof top amenities, at grade inboard private amenity space), etc., to meet intent. • Anticipate increased building performance measures to significantly impact balconies on mass timber projects. Look for opportunities to coordinate design guidelines with these requirements.	**Solar Orientation** • For longer mass timber forms, consider their location and orientation to avoid excessive shading on public spaces and neighboring properties. North-south orientations will be preferable for longer 12 storey buildings to minimize impacts on neighboring properties and public spaces. Roadway widths may also be a factor in determining where such buildings are appropriate. • Allow for some flexibility for solar gain considerations in the design guidelines. **Height Transition** • Align upper level step-back requirement with the enhancement of the public realm. For instance, different width for the upper floor step-backs can be considered where they create opportunities for outdoor terraces or green spaces. • Implement a design review process that evaluates proposed step-back designs based on their contribution to the overall urban fabric, visual aesthetics, and compatibility with the surrounding context. **Public Spaces and Plazas** • Encourage the creation of public spaces and plazas that provide a buffer between buildings of different scales. • Emphasize pedestrian-scale elements at the street level, regardless of building height and upper-level building articulations. Ground-floor design, street furniture, and landscaping can help maintain a human scale and reduce the impact of taller buildings on the pedestrian. **Visual Coherence** • Provide project specific architectural design guidelines that address elements such as façade articulation, rooflines, and fenestration patterns to ensure visual coherence while allowing diversity in architectural expression **Vegetation/Landscaping** • Emphasize use of landscaping and vegetation at the street level and in setback areas to improve integration of the site with the context. • Integrate green roof systems into design of terraces and common open spaces to improve social interaction as well as building's energy performance

Form and Character Guidelines

Development Permit and other design guidelines need to be reviewed to better accommodate the characteristics of mass timber as desribed in this document.

Background

In most communities, 7-12 storey building forms are not very common since 6 storey wood frame buildings are very efficient and, above that, towers of 18 or more storeys become the norm. This means that many OCP's and Zoning Bylaws will not have categories for 7-12 storey buildings at higher densities. Without such categories, it will be difficult for mass timber projects to proceed without an OCP or Zoning change, which present significant barriers. Sites that allow for taller or higher density than can be accommodated in mass timber will be difficult to acquire since they will be outbid by those higherbuilding proponents. OCP's and Zoning Bylaws should be reviewed to determine if they are in support of mid-rise mass timber as outlined in this section.

OCP and Zoning Bylaw

For mass timber buildings at 7–12 storeys to evolve as a common building form, they will need to be more readily accommodated in municipal land use regulations. Municipalities are therefore encouraged to consider the following changes:

Create new 3.5–5.0 FSR OCP/ Zoning categories for 7–12 storey buildings

The benefits of this option is that it would accommodate mass timber as the "highest and best use." Sample OCP and Zoning standards are shown on the following page in the table *Mass timber Buildings: Sample OCP & Zones*. These conceptual zones have been evaluated based upon lot sizes ranging from 14,000 sq. ft (100 x 140 ft) to 42,000 sq.ft (300x140 ft). Municipalities will need to evaluate their own lot size standards and regulations to determine optimal regulations.

Modify existing high rise zones to better accommodate mass timber buildings at up to 5.0 FSR/12 storeys

This might include adding distinct lot coverage and setback standards for a 12 storey building form. While better accommodating mass timber, market forces are likely to result in conventional concrete towers above 12 storeys being built. That is because the taller building would offer more views and likely be considered the "highest and best use." However, such a change would make mass timber possible without variances being required.

Support mass timber applications through site specific applications

A site specific rezoning offers flexibility to accommodate mass timber designs. While this has advantages, a rezoning process comes with a political process and uncertainty. Removing barriers from existing zoning regulations and design guidelines will reduce such uncertainty. Delegating design and minor zoning variances to staff will also help remove uncertainty. Due to the added front-end cost of mass timber design, applicants need to start the process with as much certainty as possible.

Accommodate 18 storey mass timber buildings

Having led the country by allowing 12 storey mass timber buildings in its Building Code, the Province of British Columbia is once again leading the nation by introducing 18 storey mass timber buildings into the BC Building Code in 2024. This study has focused on a 12 storey height limit. The move to an 18 storey mass timber height limit will allow for taller buildings with a smaller footprint. 18 storey mass timber buildings will be easier to accommodate within existing OCP categories and zones. Though not the focus of this study, municipalities should consider how 18 storey mass timber buildings will fit within their existing regulations.

Amend height definitions to accommodate the thicker floor assemblies required for mass timber

As noted previously, mass timber assemblies are thicker than concrete. This difference of approximately 6 inches per floor can result in a 6 ft height difference on a 12 storey building. Depending on the height allowed in the zone, this could prevent the 12th storey from being achieved on a mass timber building. To avoid this barrier, municipalities should provide for additional height to accommodate the difference. The City of Vancouver recently amended its regulations to provide a 10% height increase for mass timber buildings. Another approach would be to add a 6 inch per floor height exception for mass timber buildings.

Provide incentives for mass timber buildings

Municipalities may consider incentives to encourage mass timber buildings. For example, the City of Vancouver recently adopted the following height and density incentives:

- 2 additional storeys for 8-11 storeys buildings
- 3 additional storeys for 12+ storey buildings

Consideration needs to be given to how mid-rise (7-12 storey) mass timber buildings align with existing municipal land use regulations (Official Community Plans and Zoning Bylaws). Changes are likely to be required to best accommodate mid-rise mass timber building forms.

6 storey wood frame residential buildings are well established in the development industry and accommodate densities of approximately 3.0 FSR to 3.5 FSR. Many, if not most, municipalities now accommodate such buildings.

The "sweet spot" for mid-rise mass timber buildings will therefore be between 3.5 and 5.0 FSR. At these densities, mass timber buildings with a maximum height of 12 storeys will have a large footprint, similar to a 6 storey building. Above 6 storeys, most existing municipal regulations provide for a point tower with setbacks, lot coverage and other standards accommodating a corresponding small "footprint". As a result, 12 storey mass timber buildings will not fit within most existing higher density/height zones.

Mass Timber Buildings: Sample OCP and Zones

Official Community Plan			Zoning Bylaw								
OCP Designation	Storeys	FSR	Zone	FSR	Max Height (storeys)	Coverage % (Podium)	Max Coverage % (above podium)	Setbacks (Above Podium)			
								Front (ft)	Int. Side (ft)	Ext. Side (ft)	Rear (ft)
Residential											
High Density Mid-Rise Residential	12	3.5	Res-3.5	3.5	12	n/a	40–50	10	20	10	20
High Density Mid-Rise Residential	12	4.0	Res-4	4.0	12	n/a	40–50	10	20	10	20
High Density Mid-Rise Residential	12	4.5	Res-4.5	4.5	12	n/a	40–50	10	20	10	20
High Density Mid-Rise Residential	12	5.0	Res-5	5.0	12	n/a	40–50	10	20	10	20
Mixed Use											
Mixed Use / High Density Mid-Rise	12	3.5	Mix-3.5	3.5	12	90	40–50	0	0	0	20
Mixed Use / High Density Mid-Rise	12	4.0	Mix-4	4.0	12	90	40–50	0	0	0	20
Mixed Use / High Density Mid-Rise	12	4.5	Mix-4.5	3.5	12	90	40–50	0	0	0	20
Mixed Use / High Density Mid-Rise	12	5.0	Mix-5	4.0	12	90	40–50	0	0	0	20
Commercial											
Retail / Office	12		Comm-1	3.5- 5.0	12	90	90	0	0	0	20

Building Height	Massing and Form	Public / Ground Interface	Balconies / Private Outdoor Space	Neighbourliness
Goal				
Facilitate mass timber projects achieving equivalent number of storeys compared with other construction types	Minimize requirements for horizontal and vertical articulation for mass timber projects	Prioritize quality ground interface and articulation of the podium at a human scale	Provide flexible balcony requirements for mass timber projects	Ensure mass timber building integrates harmoniously with the surrounding urban fabric
Considerations for Staff				
Provide a height exception for mass timber floor assemblies of 6 inches/floor or 10%	• Allow alternatives to facade breaks to mitigate max facade length requirements for mass timber projects • Encourage design responses to site-specific context that address neighbourliness issues with solutions that don't preclude the use of mass timber • Look for opportunities to allow for, and mitigate the appearance of, larger, rectangular floor plates typical for tall mass timber buildings	• Exchange articulation at the upper storeys for integration of public interface • Exclude covered publicly accessible areas, such as colonnades, from floor area calculations	• Explore options for combination of responses (shared inboard balconies, roof top amenities, at grade inboard private amenity spacs, etc.) to meet intent • Anticipate increased building performance measures to significantly impact balconies on mass timber projects. Look for opportunities to coordinate design guidelines with these requirements	**Solar Orientation** • For longer mass timber forms, consider their location and orientation to avoid excessive shading on public spaces and neighboring properties. North-south orientations will be preferable for longer 12 storey buildings. Roadway widths may also be a factor in determining where such buildings are appropriate • Allow for some flexibility for solar gain considerations in the design guidelines **Height Transition** • Align upper-level step-back requirement with the enhancement of the public realm. For instance, different width for the upper floor step-backs can be considered where they create opportunities for outdoor terraces or green spaces. • Implement a design review process that evaluates proposed step-back designs based on their contribution to the overall urban fabric, visual aesthetics, and compatibility with the surrounding context **Public Spaces and Plazas** • Encourage the creation of public spaces and plazas that provide a buffer between buildings of different scales • Emphasize pedestrian-scale elements at the street level, regardless of building height and upper-level building articulations. Ground-floor design, street furniture, and landscaping can help maintain a human scale and reduce the impact of taller buildings on the pedestrian **Visual Coherence** • Provide architectural design guidelines that address elements such as façade articulation, rooflines, and fenestration patterns to ensure visual coherence while allowing diversity in architectural expression **Vegetation/Landscaping** • Emphasize use of landscaping and vegetation at the street level and in setback areas to improve integration of the site with the context • Integrate green roof systems into design of terraces and common open spaces to improve social interaction as well as building's energy performance

Additional Building Forms

Mass timber construction has gained popularity and acceptance across various building types due to its sustainability, versatility, and aesthetic appeal. Where building code allows, mass timber products can be used in hospitality, commercial, industrial, institutional and transportation hubs. This sections covers key considerations for 6 and 18 storey buildings.

6 Storey Mass Timber Construction

6 storey mass timber projects would fill a niche where $/M2 construction costs are not the primary driver on a project, for tight sites with limited access, for sites where speed is of the essence, and for clients that are striving to build with mass timber. If light-frame wood construction is an option, under current market conditions, it is a significantly less expensive option.

In the case where on-site construction time, the biophilic qualities of mass timber, or other desirable traits unique to the material justify the increased price most of the considerations for other scales of mass timber projects would apply to up 6 storey projects.

Inherent to these projects are fewer typical floors, which will also drive up the cost of the material while requiring similar coordination during construction.

Prospective Changes to BC Building Code and EMTC

Prospective changes to the BC Building Code for mass timber construction would significantly alter height and occupancy. In the future, buildings of this size would be permitted to be constructed with little to no encapsulation. The ability to expose more timber, while providing the code-required fire-resistance for floor and wall assemblies, will have interesting outcomes where this type of construction would otherwise compete with light-wood frame construction.

Untested Hybrid Structural Types and Methods

Going further, with current code-restrictions eased, new combinations of mass timber structural elements and more conventional ones may be explored and 'fine-tuned' by designers in search of structural schemes with the maximum efficiency and cost-benefit. For instance, even now there are schemes which seek to use mass timber mainly where it is desirable and useful to expose, while employing less expensive or simpler types of structural elements to form the remainder of a building—especially where these are inherently concealed.

18 Storey Mass Timber Construction

There are now numerous examples of 18+ storey mass timber buildings built in North America and around the world. Future amendments to national and provincial building codes are on track to confirm their acceptability and allow for proposals to become more viable and commonplace. Their design involves many similar considerations to 7-12 mass timber storey buildings, with additional nuances due to their increased height.

Challenges

Tower form and super-imposition of loads

No different than in 7-12 storey construction, the need to super-impose vertical loads continuously from top to bottom of a mass-timber tower's structure makes it difficult to incorporate prominent shifts in massing over a building's height. For a super-structural approach where massive elements carrying lateral and vertical loads are positioned near a building's exterior walls, inflections of façade or significant changes in any point of the building's height may be irreconcilable.

Opportunities

Attune massing guidance to structure

Guidance should recognize that the footprint and form of a mass timber tower will tend to be most economical and viable when it is made as simple as possible, and in many cases necessitates a continuous or near continuous massing from top to bottom of the tower. Provide consideration for approaches where a super-structure or main building structure meets the ground, perhaps independent or outboard of where a ground level building envelope is positioned in relation to upper-storeys (i.e. though the structural elements must continue un-interrupted to grade, this is not strictly true for the whole form of the building).

Building Height

Similar framing systems are employed at both 12 storey and 18 storey construction. The same considerations apply for both where similar structural systems are used. Naturally the additional storeys only compound this issue. Buildings designed with a super-structural approach will have additional drivers for extra height, depending on the particulars of their structural designs.

Challenges

Required floor-to-floor heights

Mass timber floor assemblies are thicker than concrete which inherently translates to an increase in required floor-to-floor heights. In super-structural approaches, unusually large structural elements may contribute to additional height, depending on the particulars of how they are reconciled into a design.

Opportunities

Discretionary height variance

Allow for a discretionary height variance (per storey, or averaged out over the height of the building) for buildings meeting the zoning definition of a mass timber building above 7 storeys, where height provisions are stipulated in certain district schedules.

Prescribed Articulation of Massing

The increase in height from 7-12, to 18 storeys may imply different suitable sites for these taller buildings, falling under different conditions of height form, articulation and massing proscribed by OCP's or larger municipal planning framework.

Different structural tendencies and allowed sizes of floorplates will have a reciprocal relation to overall form and proportion. Other considerations in a tall tower, especially a superstructural approach will apply, and must be recognized implicitly in design guidance or they may be precluded as viable building.

Challenges

Building articulation and step-backs

In the case of an 18 storey tower, a continuous and regular set-back is generally precluded by the desired overall height of the building. As in 7-12 storey buildings, transferring and providing steps for terracing and roofing build-ups more complex, and are best to limit to one or two locations in the building (instead of over several floors in a mid-rise). This intrinsic constraint may limit economical forms to "pure" towers with the same footprint grade to peak, or tower-podium schemes with a limited, short podium, and a consistent tower floor-plate above.

Opportunities

Reformulate massing guidance

At 18 storeys, apart from the tower, unique building forms may be developed in response to other structural constraints. Responsiveness by design guidelines for these types will improve viability of these schemes and experiments by designers in the market to find more efficient schemes.

Podium massing

Realizing a tower podium-form, where two types of floor plate must be reconciled with super-imposed loads, is inherently difficult in mass timber construction. Perhaps because of this challenge, built examples of this type rarely integrate a significant difference in podium and tower massing or size.

Design guidelines might accept that a ground level or 2nd storey podium forms the base or mixed use and service space in such a building, with a consistent, vertical tower rising above for nearly the 18 storey height of the building.

Softening bar massing

Recognize the opportunities for different forms and aspect ratio of tower sizes, for instance elongated tower forms may arise (i.e. forms of a long bar-building and a narrow tower, which balance the strengths and weaknesses of each other from an urban and building design standpoint).

Bar-Type Buildings

Due to building area limitations, and efficiencies of space and structural planning common to other types of towers, 18 storey building designs may tend towards different forms and aspect ratios than 7-12 storey ones. Some built examples follow the same tendency toward elongated bars. More height only increases the potential for objectionable building forms.

Challenges

Overbearing / shadowing form

Overshadowing effects of a bar-type building will only be more prominent and problematic as a building becomes higher. Narrower or more compact floor plates may negate or balance this challenge, but proscriptions around size and area of tower-floor plates may also reduce viability for tower desings.

Opportunities

Inflect mass with grid

The strategy for inflecting the mass with grids or providing a bent-bar suggested for 7-12 storey building may be adjusted in this building type. For instance, a narrower floor plate will be conducive to a more slender tower form. Breaking such a narrow form into smaller masses proportioned to accentuate their verticality, or one simple volume, is an appropriate design strategy for a tower.

Angled form

Though there is a strong tendency towards rectilinearity for economy of material in timber buildings, it may still be possible to realize an efficient scheme with angular perimeter geometry, to make the visual perception of a tower form, and its cast shadows more discrete from many vantage points.

Ho-Ho Wien, Vienna (RLP RÜdiger Lainer + Partner)
Photo: Michael Baumgartner

This 24 storey tower combines aspects of a bar building, while presenting as a bundle of three towers. The building houses a mix of office, hotel and residential uses, alternating with the changing floor-plate up its height.

This complex form was achieved with an innovative hybrid-precast concrete and timber system for both structure and envelope, assembled on site as a true 'kit-of-parts'. Pre-manufacture of all components implies a careful pre-planning and integration of all structure and services.

Materials and colour

Same as 7-12 storey considerations. Note: above 12 storeys combustible cladding is strictly prohibited.

Tower-bar

Shorter, hybrid forms of a long bar and a tower form may reconcile the strengths and weaknesses of a tower and a bar building regarding overshadowing and efficiency of floor plates.

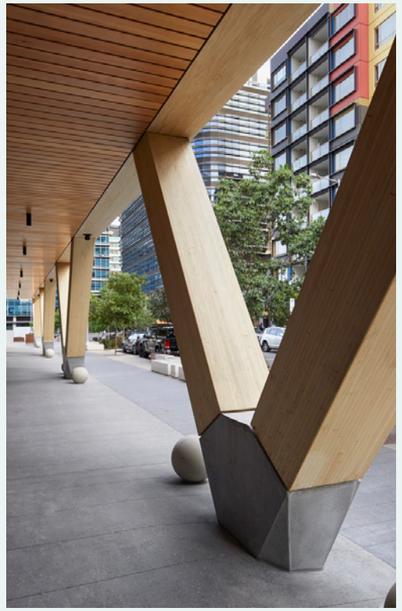
Public/Ground Interface

An 18 storey building has similar considerations to a 12 storey one, however these may change slightly or be more or less restrictive depending on the context of a building's site. If potential sites for 18 storey buildings are of a different nature and location, (e.g. urban intersections, dense infill locations with little to no limitation on height, transit nodes etc.) differences in spatial constraints between upper and grade-level storeys may have drastic implications on selection and viability of different structural approaches.

Challenges

Superstructures at grade

Superstructural approaches, described elsewhere in this document, require direct and consistent alignment of massive structural elements from the top of a tower into foundations. Street-level set-back or right-of-way requirements might preclude this strategy in many circumstances, especially constrained urban ones. Inhibiting structures from landing directly at the ground level will reduce flexibility and viability for otherwise practicable structural approaches.



25 King, Brisbane (Bates Smart)
Photo: Tom Roe

25 King is a 10-storey commercial office building with a post-and-beam structure. Its design cleverly grounds the lateral and vertical supports into 'chevrons', which frame a shaded colonnade for ground-level retail and lobby entrances. Similar approaches to exposing large structures and creating space at grade can be achieved in taller buildings.

Transfering and span changes

No different from 7-12 storey buildings, consistent vertical lines / massing required by structural logic of timber may not sit well with requirements for more dynamic/activated street interface required in urban design guidelines, nor with ground-level right-of-way set-backs.

Opportunities

Hybrid Structural Solution

Allowing for a more freely arranged concrete structure to form the ground-level interface in an urban site is a flexible strategy for a timber tower to interface with the ground

Super structural solution

The limitations and benefits of the superstructure present new opportunities for encompassing nominally public space, but within the building's structure. As in an arcaded building, in lieu of street level set-backs, accessible public space could be created between the lateral elements and the building enclosure, where normally this would be required as open, unencumbred space. Easement for, or consideration of this strategy, will open greater flexibilty for designers to propose such structures.

Other urban effects

Alternatively, such a timber structure, when landed directly at grade and/or set behind generous glazing, is an opportunity for the pedestrian to have near direct visual and tactile exposure to timber itself, especially at night time, a phenomenon unique to timber construction in general.

Sara Cultural Centre, Skellefteå (White Arkitektur)
Photo: Åke Eson Lindman

Sara Cultural Centre super-imposes a 20-storey hotel structure, over assembly spaces near grade, all structured in timber. Interior timber structures are exposed to pedestrians through generous glazing.

Private Outdoor Space

Almost all technical considerations for the integration of private balconies apply similarly for 12 to 18 storey buildings in timber construction. There are additional opportunities and constraints that may arise in this building form.

Economy of scale

The larger height of an 18 storey tower over 7-12 storey buildings presents different opportunities for integrating balconies in the overall economy and budget of a project. The possibility of increased economies of scale may ease the more difficult technical and manufacturing considerations.

Challenges

Superstructural approaches

The significance of a superstructure-type mass timber building may preclude more typical arrangements of balconies in a residential building. Locations of junctions of massive structural elements at the corners of a tower floor plate, are also common locations for family-sized units and corner balconies, and the two features may be difficult or impossible to reconcile in the same position.

Opportunities

Combined outdoor spaces

A different building form (like a tower-podium) may hold other opportunities to distribute communal/ larger outdoor spaces-on building podium roof-tops for instance, than in a 7-12 Storey scheme, where large podiums may be absent in lieu of minor, or private terraces and set-backs.

Structurally specific or reduced balcony requirements

Attune balcony requirements, sizing, and placement appropriately to the approaches unique to the building particular timber structural system.

For example, it may be possible to leverage the massive elements along a building's perimeter for structurally efficient schemes where stacks of multiple external balconies can be loaded from a super-structure or overhead structure at the top of a building.

Decoupling the balcony structure from the internal structure may produce more flexibility than in other, lower types of mass timber structures.

Mjøstårnet
Photo: Moelven

The significance of a superstructure-type mass timber building may preclude more typical arrangements of balconies in a residential building. Locations of junctions of massive structural elements at the corners of a tower floor plate, are also common locations.

M5 Proposal (Henriquez and Partners)
Photo: Henriquez and Partners

The 25-storey M5 proposal has contentiously negotiated a compromise to provide communal balconies rather than private ones, located strategically up its eccentrically placed core.

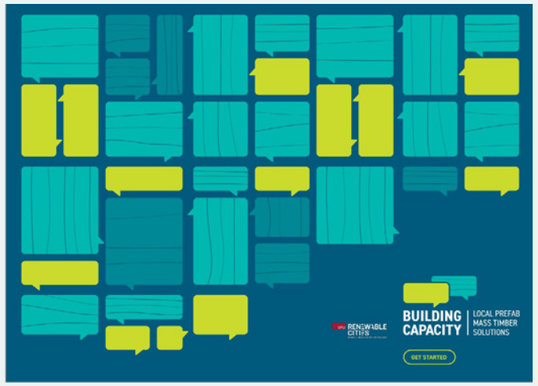
This preserves a carefully established and efficient structural scheme. The remainder of the building provides juliette balconies integrated with the buiding's facade, dispensing with costly and moisture sensitive projecting structures.

Haut, Netherlands (Team Ten, ARuP)
Photo: Jannes Linders

The 21-storey 'HAUT' building in the etherlands achieves an impressive variation in cantilevered balcony structures through innovative steel-timber-concrete construction. This is only possible through a systematic use of deep perimeter-beams around each floor, directly creating the architectural character of the whole building.

Accompanying Resources

This document is accompanied by other resources on local prefab mass timber solutions prepared by SFU Renewable Cities. Collectively, these publications aim to provide knowledge support for local governments in making informed decisions and developing regulations that facilitate mass timber constructions in BC.



Building Capacity – Local Prefab Mass Timber Solutions

Mass timber solutions for senior government officials, the development industry and local governments. Released in February 2023.

Local Government Quick Reference Handbook

A guide for elected officials and local government staff interested in implementing mass timber solutions in their community. Released in April 2023.

Design Solutions to Prefab Mass Timber Construction

A design guide aimed at those with planning or architecture backgrounds. Released in September 2023.

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