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BUILDING CAPACITY

LOCAL PREFAB MASS TIMBER SOLUTIONS

GET STARTED

Brock Commons Tallwood House -
Tall Wood Building progress.
Credit: Acton Ostry
(flickr.com)

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Get Started

This Guide aims to advance the construction of mass timber buildings in British Columbia. It is primarily directed towards local government and the development sector.

Click through the menu above and on the left to navigate to each section.

Who is this Guide For?

Local Government
Local Governments including those involved in land use policy and development approvals:

- Building officials
- Fire officials
- Planners

Local elected officials are a vital audience. As with any major course correction, they can play a pivotal role in facilitating policy and process innovations. Materials are being developed for elected officials.

Development Industry
Development Industry, specifically those working in the mid and high-rise sectors interested in mass timber construction:

- Developers
- Architects
- Engineers, e.g. structural, mechanical, specialists in codes and standards and building envelopes
- Planners

Mass Timber Industry Influencer and Advocates
This guide is useful to other audiences engaged in accelerating prefabricated, mass timber construction market transformation. This includes decision makers involved in building and fire code renewal, education and training support, energy and climate policy and industrial development across diverse sectors, including:

- Federal Government
- Provincial Government Senior Government Departments in building codes and standards, climate, energy and industrial development
- Post-Secondary Education
- Non-profits

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SUMMARY OF SOLUTIONS
For a quick-reference of solutions for all audiences. →

Who is this Guide For?

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Summary of Solutions

The following is a summary of solutions identified through this study. Please refer to the hyperlinked sections for more information.

Community Plans and Zoning

Long-Term Solutions

- Inform municipal councils, development planning staff and advisory bodies of the benefits, characteristics of, and challenges facing pre-fabricated mid-rise mass timber buildings.
- Create new 7-12 storey/3.5 -5.0 FSR land use categories to accommodate mid-rise mass timber.
- Modify existing zones to better accommodate 7-12 storey/3.5-5.0 FSR mass timber buildings.
- Adjust zoning height measurements to accommodate thicker mass timber floor assemblies.
- Conduct an internal review of existing regulations to identify potential barriers to mass timber buildings.

Project Driven Solutions

- During site specific applications, inform municipal councils, development planning staff and advisory bodies of the benefits, characteristics of, and challenges facing prefabricated mid-rise mass timber buildings.
- Expedite mass timber applications.
- Early planning, building and fire staff consultation with applicant teams.
- Support site specific zoning variances for mass timber buildings.
- Delegation of "minor" zoning variances (lot coverage, setbacks, etc.) to staff to simplify approvals.

Development Permit Design Guidelines

Long-Term Solutions

- Prepare design guidelines to complement new zones created to accommodate mid-rise mass timber buildings with reference to *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings*
- Modify existing design guidelines to accommodate the building forms associated with mid-rise mass timber buildings with reference to *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings*
- Adjust Design Guideline height measurements to accommodate thicker mass timber floor assemblies.

Project-Driven Solutions

- Early planning, building and fire staff consultation with applicant teams.
- Consider the design needs of mass timber buildings to achieve efficiencies, including:
  - Floor assembly thickness and overall building height.
  - Need for uniform floors and vertical stacking.
  - Methods to break up the massing of buildings other than the stepping of upper storeys.
  - Modified balcony treatments.
  - Combined outdoor common areas.

LONG-TERM SOLUTIONS

Actions local governments can take to tune policy and processes for the future.

PROJECT DRIVEN SOLUTIONS

Actions local governments can take for specific projects.

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Building Permit

Long-Term Solutions

- Education: Increase awareness of the benefits of and challenges facing premanufacturing and mass timber through continuing education of stakeholders including politicians, building officials, planners, engineers and others.
- Encourage and support further building and fire code changes.
- Enhance the building permit process overall to speed applications.

Project-Driven Solutions

- Engage with applicant teams well in advance of building permit applications.
- Provide for the unique off-site construction requirements associated with mass timber.
- Issue partial permits to enable the premanufacturing of mass timber components in advance of a full Building Permit.

Developer / Applicant Team

- Project teams need to commit to a mass timber method of construction at the outset of the project.
- Encourage project teams to engage a qualified professional team at the outset of the design process (rezoning/development permit) to ensure smooth municipal design and building permit approvals.
- Municipal planning, building, fire and engineering staff should be ready to engage with project teams as early as possible in the design process.

Provincial

- Increase the existing 12 storey mass timber BCBC height restriction.
- Pursue alternatives to mass timber encapsulation while still achieving life-safety standards.
- Identify, track and revise BCBC provisions that create challenges at the local level.
- Modernize the NBC/BCBC update process to allow for more frequent code changes.
- Track and share Alternative Solutions.
- Faster certification of building products.
- Create a green certified professional program to simplify approvals.
- Provide ongoing financial assistance to local governments to modernize building permit processes.
- Support the expansion of the mass timber manufacturing industry to kick start Mass Timber demand and increase investor confidence.

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Contributors and Credits

Many people across public, private and non-profit sectors generously shared their knowledge and experience to shape these solutions. Thank you!

Funders

This Guide was funded by BC Hydro, Forestry Innovation Investment (FII) and the Office of Mass Timber Implementation in the B.C. Ministry of Jobs, Economic Recovery and Innovation.

Project Team

This Guide was independently prepared by an interdisciplinary project team assembled by Renewable Cities with the MJ Wosk Centre for Dialogue, Simon Fraser University involving Gary Penway Consulting, ZGF Architects, Ecosse Development Corp, and Scius Advisory Services. Report Authors: Alex Boston, Norm Couttie (AIBC), Brad Doff (ENV SP, LEED Green Assoc), Helen Goodland (Arch), Gary Penway (RPP, MCIP), John de Ruiter (Building Inspector), Thomas Noussis (Arch), Daniel Wilson (Arch, AIBC, CPHD).

Contributers

The authors have relied upon extensive input from a host of building stakeholders comprised of developers, design consultants, builders, manufacturers, local government planners and building officials, among others.

Building Industry

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DIALOG
Ecosse
EllisDon
Evolution Building Science Ltd.
Fast + Epp
Gary Penway Consulting
GHL Consultants Ltd.
Glotman Simpson
Henriquez Partners Architects
Integra Architecture
Intelligent City Inc.
Kalesnikoff Inc.
Kindred Construction Ltd.
Kinsol Timber Ltd.
Ledcor Group
LWPAC Inc.
MA+HG Architects
Mackin + Associates
McFarland Marceau Architects Ltd
MCM Architects
Meiklejohn Architects Inc.
NOvation Architecture
PC Urban Properties Inc.
PCI Developments
Perkins & Will
Prock Ltd
RDH Building Science Inc.
RH Architects
ROV Engineering Consultants
Ryder Architecture
Scius Advisory
Scuka Construction
Seagate Mass Timber
StructureCraft Inc.
Urban One Builders Inc.
Ventana Construction
WHM Structural Engineers
ZGF Architects Inc.

Local and Senior Governments & Agencies

City of Abbotsford
BC Hydro
British Columbia Institute of Technology
City of Burnaby
City of Campbell River
City of Colwood
City of Coquitlam
City of Delta
Forestry Innovation Investment
City of Kelowna
City of Langford
City of Langley
Office of Mass Timber Implementation
City of Mission
Ministry of Jobs, Economic Recovery and Innovation
City of Nanaimo
City of New Westminster
City of North Vancouver
City of Port Moody
District of Squamish
The University of British Columbia
City of Vancouver
City of Victoria
District of West Vancouver

PAE Living Building - ZGF Architects
Photographer: Dan Bihn

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Context

This section provides an overview of the Local Prefab Mass Timber Solutions project, the stakeholders involved and the project approach. It provides a synopsis of major players involved in the transition to prefabricated and mass timber buildings in Canada, the building policy evolution and landscape and a strong rationale for building with mass timber 7-12 storey in B.C.

Click through the links on the left to navigate to each section.

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Project Overview

Mass timber can provide a competitive low carbon structural system for buildings between 6 storeys and towers that are 12 storeys and higher. However, there are planning and building policy gaps and conflicts that are currently hampering adoption.

This guide presents a conceptual Official Community Plan and Zoning regulations for high-density 7-12 storey building forms along with a set of corresponding design guidelines that local governments can use to develop their own "mass timber friendly" policies and regulations.

Simon Fraser University's (SFU) Renewable Cities assembled an interdisciplinary project team to engage B.C. municipalities, the development sector and related stakeholders to better understand and solve policyand regulatory impediments to the delivery of mid-rise 7-12 storey mass timber buildings.

The year-long project involved independent research and analysis that was complemented by engagement with over 230 developers, design consultants, builders, manufacturers, local government planners and building officials.

The scope of work included an investigation into existing British Columbia land use regulations that challenge 7-12 storey mass timber developments. This is because, in the continuum of urban form, there are well-established categories that range from single family dwellings (SFD) through 6 storey mid-rise, but then there is a gap between 6 storeys and towers. Currently, 7–12 storey building forms are rarely built in B.C. for market and policy reasons. If a building is permitted to be taller than 6 storeys, it is almost invariably greater than 12 and typically much taller. Further, the economics of 7–12 storey mass timber building normally require a larger footprint than the dominantly accepted high-rise "point tower" built in B.C. However, with communities looking to densify without having to make the leap to towers, the 7-12 storey format is being revisited from land use and urban planning perspectives.

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PURPOSE OF THIS GUIDE

- **Build awareness of key local mass timber solutions relating to land use policies (i.e. OCP, zoning, and design guidelines) and building permit processes.**
- **Build capacity for municipal policy makers to act on key solutions and to develop their own "mass timber friendly" policies and regulations.**

Recognizing that mass timber's advantages lie in modern methods of construction that require a shift to digitization and industrialization, the building permit application review and issuance processes were also analyzed for opportunities to accommodate prefabrication and digital project delivery. A suite of solutions was identified concerning the building permit process, including early engagement, collaboration, partial permits and electronic processing.

While the project focused on finding solutions at the local government level, there were other challenges and solutions pertaining to senior governments, notably provincial and the broader market transformation process discussed during stakeholder dialogues.

These are briefly documented in this Guide as Collaborative Action for consideration by public, private and non-profit stakeholders.

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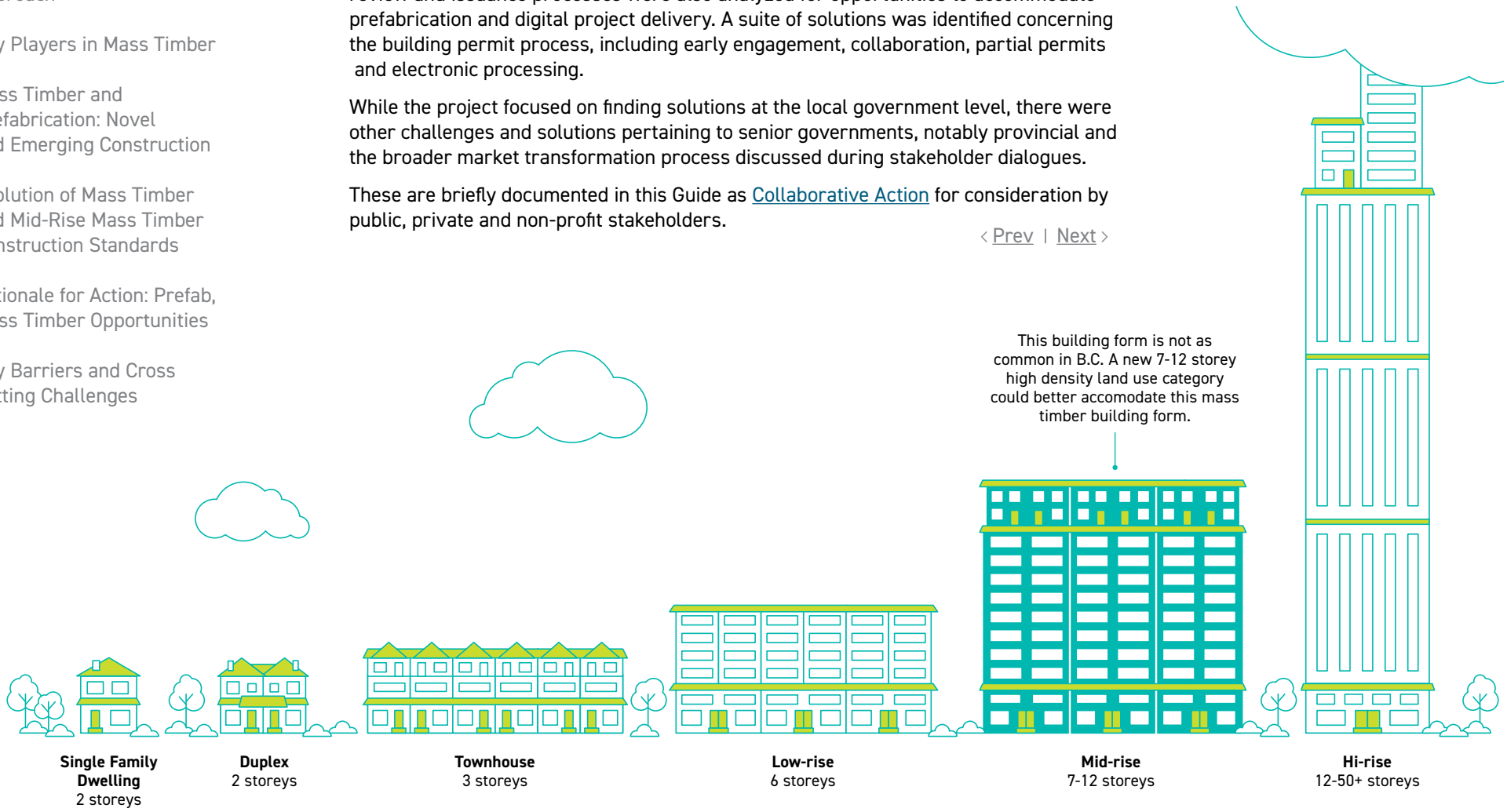


Approach

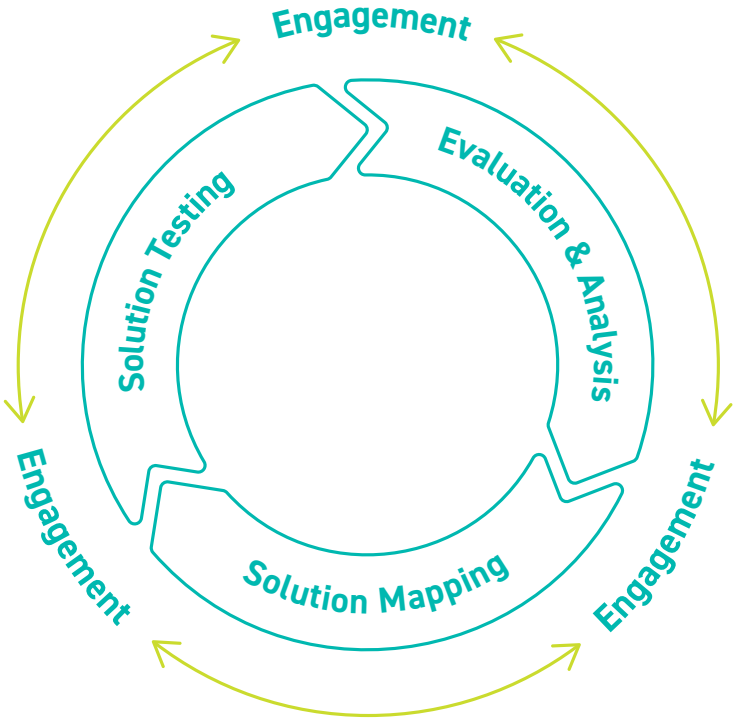
This Guide is the product of a year-long project to better understand and address policies and regulatory barriers to mass timber midrise construction at the local level.

A central part of the project was engagement with 250 local government, developer, manufacturer, provincial government and non-profit stakeholders with a particular emphasis on key professions interfacing with this novel construction approach and form, specifically: architects, building officials, code consultants, engineers and planners.

The project involved a double cycle of deep evaluation and analysis, followed by solution mapping and testing. Stakeholders were engaged over the course of the project with diverse approaches from semi-structured interviews to surveys. The solution testing phases involved large multi-stakeholder workshops.

This engagement was critical to strengthening solutions. The Guide is expected to evolve with a similar cycle during a broader knowledge mobilization and continuous improvement phase which will solicit further input to deepen and refine knowledge.

The Guide supports adoption of mass timber as set out in the B.C. Mass Timber Action Plan. Mass Timber offers a triple win to B.C .in the form of local jobs, low carbon buildings and a new market for B.C. forest products. Mass timber is part of a worldwide evolution in construction that is seeing a shift to prefabrication



and offsite construction. As such, the solutions in this guide are relevant to a wide range of prefabricated construction systems that are, or about to enter the market. Thus, we refer to prefabricated and mass timber buildings throughout.

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Community Plan and Zoning Solutions

Development Permit Design Guideline Solutions

Building Permitting Solutions

Key Players in Mass Timber

The transition to prefabricated and mass timber buildings in Canada involves many players. The role of local governments in advancing mass timber are set out below, along with those with whom local governments may need to collaborate with, such as the federal and provincial governments, developers/ applicant teams, and the mass timber supply chain (including specialist fabricators and installers).

Local Government

Local governments are established by and receive their authority and obligations through provincial legislation. The primary role of local governments in supporting prefabricated mass timber construction includes:

Land Use Regulations
- Official Community Plans and Zoning
- Development Permits

Construction Approvals
- Application of Building and Fire Code Standards
- Municipal Building Permit Issuance

Municipalities in B.C. must work with, but not supplement, the BCBC. The exception is the City of Vancouver which has the authority to augment and supplement the BCBC under the Vancouver Charter.

In 2019, B.C. implemented BCBC changes to allow for mid-rise mass timber buildings up to 12 storeys. That change did not apply province-wide, rather only to the 22 municipalities which chose to opt-in. It is expected that mid-rise mass timber BCBC standards will apply to all B.C. municipalities once the BCBC 2022 is released.

Opportunities for B.C. municipalities to further support mass timber are presented in Community Plan and Zoning Solutions, Development Permit Design Solutions and Building Permitting Solutions.

Federal and Provincial

The Canadian Constitution assigns responsibility for "local matters" to provincial governments. This includes land use regulations and construction standards. Provinces then delegate some of their authority and give responsibilities to municipalities. Despite this dominant provincial role, the Federal Government has a significant role in establishing construction standards for mass timber.

Since 1941, the Federal Government has a National Building Code (NBC) and a National Fire Code (NFC). These codes go through a rigorous process involving the National Research Council and the Canadian Board for Harmonized Construction Codes, among others. Both the NBC and NFC are updated approximately every 5 years. As a result of the Constitution, these national

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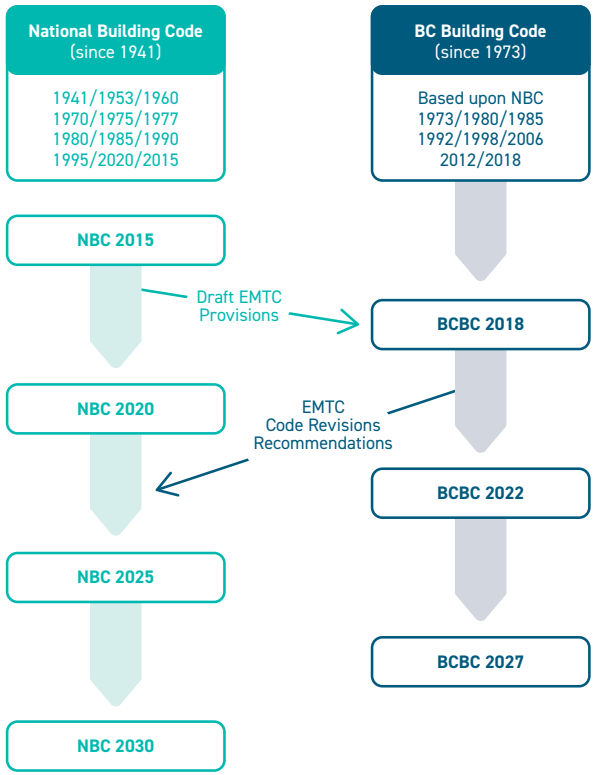
Evolution of Mass Timber and Mid-Rise Mass Timber Construction Standards

Provincial Solutions

codes only apply to federally regulated lands. They do not automatically apply to provinces.

The Province of British Columbia has had a B.C. Building Code (BCBC) since 1973. BCBC updates occur approximately 2 years after the NBC is updated (with limited variations). In this way the BCBC is heavily influenced by both national standards and NBC timing. This inter-related process is depicted on the below.



The Construction Codes Reconciliation Agreement effectively binds provinces to a nationwide agreement on new building code standards. This process can delay code changes due to the need to achieve a national consensus. Provinces do, however, still have the constitutional authority to create their own standards, which the Province of British Columbia has a history of doing to advance wood construction ahead of the NBC.

The resulting NBC/NFC and BCBC/BCFC standards have significant control over the technical requirements governing mass timber construction at the local level. The evolution of mass timber standards is explained in Evolution of Mass Timber and Mid-Rise Mass Timber Construction Standards. While this report focuses on solutions to mass timber at the local level, the role of senior governments cannot be ignored.

Suggestions for senior government actions to further support mass timber are presented in Provincial Solutions.

Developer/Applicant Team Roles

The private sector will construct the vast majority of mass timber buildings. As a result, the development sector is of utmost importance in the transition to mass timber construction. Provincial construction standards and municipal processes need to support, not constrain, private mass timber development if prefabricated mass timber buildings are to advance.

Development is a collaborative effort. Developers acquire sites and assemble consultant teams to

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Developer/Application Team Solutions

Collaborative Actions

achieve a successful development. Those teams include architects, engineers (structural, mechanical, electrical, building envelope, code specialists, drainage, etc.), energy specialists, environmental professionals, planners and more. The range of consultants required to design a project has expanded significantly as new concerns and standards have evolved.

How the developer/applicant team performs has an enormous impact on a project's success. A smooth and timely process and even financial viability are dependent upon an effective and coordinated project team. Suggestions for how developer teams can best contribute to successful mass timber projects are presented in Developer/Application Team Solutions.

Mass Timber Supplier Roles

Canada has the third most extensive forested area on Earth, meaning a significant supply of timber stock is available to meet growing demand for mass timber. In 2018, Canada was the greatest exporter of sawn wood, capturing 19.3% of global exports. The size of Canada's forestry and wood processing sectors creates an industrial base that could be retooled to meet a growing demand for mass timber.

B.C. is well positioned to supply the market with mass timber components that will help meet the growing demand for residential, commercial, industrial and institutional buildings. As of mid-2021, B.C.'s mass timber plants produced about a quarter of the leading types of mass timber in North America. According to the Mass Timber Action Plan, if B.C. continues to invest in expanding the sector, it could see the equivalent of 10 new mid-sized factories by 2035. That could translate to 2,400 plant jobs and an additional 2,000 construction and design positions. However, while the sector scales up, supply and demand are not aligned. There is a "chicken and egg" situation whereby developers are reluctant to proceed with mass timber buildings due to the lack of supply and cost. At the same time, manufacturers are reluctant to invest in mass timber manufacturing due to uncertain demand. Currently, supply is limited, and costs are high. The mass timber manufacturing sector needs to scale production to decrease costs and secure further supply.

Suggestions for how prefabrication of mass timber can be advanced are presented in Collaborative Action.

Construction, Fabrication and Project Delivery Roles

Similar to most countries, Canada's construction industry has struggled with stagnant productivity for the past 30 years. Under pressure to deliver projects faster, greener and more efficiently, construction companies are shifting to off-site and prefabricated construction methods. Enthusiasm for mass timber has boosted interest and investment in prefabrication in B.C. to realise the benefits of accelerated schedules, cleaner, quieter and safer sites and enhanced build quality.

Working with mass timber and prefabricated systems changes relationships, sequencing and scope of work for project teams. Prefabricated elements can be constructed offsite in parallel to the on-site work, which can improve overall delivery time.

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Mass Timber and Prefabrication: Novel and Emerging Construction

Mass timber is a type of prefabricated construction that uses specially manufactured wood products with very high structural strength.

This includes products such as glue-laminated (glulam) columns and beams, cross-laminated timber (CLT) panels, and dowel-laminated timber (DLT) panels, among others, that can be used in a wide range of building types. Mass timber elements, like all prefabricated materials, are manufactured off-site using advanced digital technologies, delivering a precise, high-quality, sustainable product that can reduce overall construction time, as well as construction-related noise and disruption. They are engineered for high strength ratings comparable to concrete and steel. Additionally, they can be one-fifth the weight of comparable concrete buildings while still meeting performance standards for safety, structural resilience and fire protection.

In Canada, traditional light wood frame construction is limited to a maximum height of 6 storeys due, in large part, to light wood-frame structural system limitations and concerns with combustibility beyond a 6 storey building height. Since mass timber has the structural integrity and fire resistance[2] to exceed 6 storeys, efforts have been underway over the past decade (or more) to allow mass timber buildings above this cap. As of 2019, encapsulated mass timber construction (EMTC) up to 12 storeys has been permitted in B.C. through an interim change to the B.C. Building Code (BCBC). Encapsulated mass timber construction is where the mass timber components are enclosed with fire-resistant materials like drywall to meet building and fire codes.

Prefabricated construction, in general, has many advantages over conventional construction. This building form is expected to grow significantly despite many present policy, supply chain and other barriers limiting its growth. Local government will need to anticipate these changes and tune permit and policy processes to accommodate this evolution.

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Key Barriers and Cross Cutting Challenges

[2] https://web.fpinnovations.ca/fire-performance-of-mass-timber-construction-continuous-testing-confirms-their-fire-safety-attributes

Evolution of Mass Timber and Mid-Rise Mass Timber Construction Standards

B.C. has been a leader in pioneering wood construction for several decades. Examples include BCBC changes allowing the transition from 3 storey wood frame buildings to 4 storeys in the 1990s and then to 6 storeys in 2009. More recently, the province shifted its attention to mass timber.

North America's first modern mid-rise mass timber buildings were built in B.C., including the 7 storey Wood Innovation and Design Centre in Prince George (2014), followed by the 18 storey Brock Commons Tallwood House at UBC (2017). At the time, Tallwood House was the tallest mass timber building in the world. Each of these projects was approved with a site-specific regulation that was created by B.C. Ministerial Order. They helped demonstrate that mass timber buildings over 6 storeys were viable.

Tallwood House was approved with a requirement that all mass timber elements be enclosed with a fire-rated material (typically a 2 hour fire-rated drywall assembly). This method is called Encapsulated Mass Timber Construction (EMTC). The Tallwood House EMTC standards set a significant precedent both domestically and internationally.

Following the success of Tallwood House, EMTC mid-rise buildings were introduced into the draft NBC 2020. Although Tallwood House was 18 storeys, the draft NBC 2020 standards limited the maximum building height to 12 storeys/42m (137.8 ft). While these NBC 2020 standards were still in draft form, B.C. proactively introduced the draft EMTC provisions into the BCBC 2018 as an interim change. These BCBC provisions were added in a way that did not automatically apply to all municipalities.

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Municipalities were given the ability to "opt-in" to the new 12 storey EMTC standards. Since 2019, the following 22 municipalities have passed Council resolutions to allow mass timber buildings up to 12 storeys.

City of Abbotsford

City of Campbell River

City of Colwood

City of Kelowna

City of Langford

Township of Langley

District of Mission

City of North Vancouver

City of Richmond

District of Saanich

City of Surrey

City of Victoria

The University of British Columbia

University Endowment Lands

City of Port Moody

City of Coquitlam

District of West Vancouver

District of North Vancouver

City of Delta

City of Prince George

City of New Westminster

The City of Vancouver did not need to opt-in due to its authority under the Vancouver Charter. It also permits mass timber buildings up to 12 storeys and currently has 2 projects at the detailed design stage that are over 12 storeys ("Prototype", 2015 Main Street—25 storeys (Westbank), LGBTQ Community Centre and residential tower—17 storeys (BC Housing) with more at the rezoning stage.

The new NBC 2020 (released in March 2020) includes 12 storey EMTC standards. Release of the BCBC 2022 is expected in 2023 and will allow 12 storey EMTC buildings in all municipalities. Since 2019, 1 EMTC building has been completed, 3 are under construction, 8 are at the building permit stage and 9 are in the rezoning enquiry and planning approval stage. By allowing these projects to proceed in advance of the release of the BCBC 2022, much experience has been gained and supply chains have started to gear up.

B.C. is now home to some of North America's leading experts in mass timber engineering, custom fabricators and specialist installers, many of whom are now sought after worldwide. B.C. has 321 mass timber projects (of all heights), totalling 12.2 million square feet of floor area as of the end of 2022. There are a further 99 projects comprising approximately 9 million square feet planned or under construction. Currently there are more mass timber projects in B.C. (by number and floor areas) than in the rest of Canada.

Elsewhere around the world, building code provisions for mid-rise and high-rise buildings are evolving differently. For example, the International Building Code 2021 (which primarily serves the US along with several central American and Caribbean countries) allows 18 storey EMTC buildings based largely on UBC's Tallwood building—several states, such as California and Wisconsin, have adopted this code. European countries, such as Austria, Switzerland and Norway, have all adopted regulatory approaches that would enable tall timber structures. The Australian Construction Code

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has also recently been amended to open the door for timber construction, whether lightweight frame or mass timber, to an effective height of 25 meters, approximately 8 or 9 storeys. While B.C. has been a leader in wood construction, including mass timber, the current limit of 12 storeys is less than many other jurisdictions. By February 2022, over 200 mass timber buildings were proposed, under construction or approved worldwide, with heights of up to 25 storeys.

Mass timber structures behave differently in fire to traditional light wood frame. The results from fire studies conducted by the National Research Council in Canada and others around the world have been very promising, which could result in more opportunities to use and expose mass timber building components in interior compartments of new timber buildings. Further research and testing will be provided by national and international agencies to increase the use of mass timber components in the built environment.

In summary, standards for mass timber buildings over 6 storeys are emerging worldwide, and B.C. has been a leader in this new construction method. The 12 storey NBC and BCBC height limit is less than the Tallwood House and other national standards. The next cycle for updating these codes is through the NBC 2025 and BCBC 2027. Changes to the maximum height, encapsulation and other requirements may be included. B.C. is currently considering code requirements for 18 storey mass timber buildings.

Suggestions for such further Building Code changes are included in Provincial Solutions.

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Brock Commons Tallwood House -
Photos courtesy of naturallywood.com
Photographer: Brudder
(flickr.com)

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Provincial Solutions

Rationale for Action: Prefab, Mass Timber Opportunities

There are diverse and compelling reasons to support prefabricated, mass timber, mid-rise construction. Different communities will be attracted to these technologies for different reasons. These reasons can be used to inform the rationale for creating a new OCP category, zoning bylaw or supporting other zoning or building permit process changes.

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Economic Development

- Creating industrial and community economic opportunities
- Enhancing productivity
- Mitigating supply chain risks

Liveable Communities

- Supporting attractive, transit-orientated scale
- Reducing constructions disruptions, waste and environmental impacts
- Increase affordable housing
- Enhancing worker safety

Climate Action

- Reducing greenhouse gas emissions

Economic Development

Industrial, Forest-Based and Indigenous Community Economic Development
Significant market growth is expected. Mass timber and prefabricated construction has the potential to strengthen the economies of forest-based and Indigenous communities with the production of high value-add products, creating secure, value-added jobs.

Advancing industrialization in the construction industry is an immense task but it could create significant opportunity in B.C. for domestic and international markets both in new construction and the renovation and retrofit markets. There is significant potential for communities of all sizes to benefit from prefabricated and mass timber construction. Their advantages include significantly lower land values, more abundant (often abandoned) industrial land, lower cost of living, and many transferrable skills. For rural and remote communities, prefabricated building solutions are already well established to deliver high quality projects within short construction seasons (e.g., Bella Bella Passive House project).

Labour Productivity, Mitigating Scarcity and Risk
B.C.'s long-term prosperity depends on dramatically improving labour productivity due to the steadily declining share of the workforce needed to support a large, aging demographic. Construction material availability and price volatility impacted by global supply chain issues increases the vulnerability of the construction sector.

Because of the significant efficiency potential, a high-performance, mass timber prefabricated construction sector could help B.C. transition to an economy with a work force unable to meet growing demand. Additionally, prefab plants are larger, with greater purchasing power than individual traditional trades. Some mass timber companies like Kalesnikoff have their own forest licenses, increasing the security of supply.

Liveable Communities

Walkable, Transit-Supportive, Missing-Middle Scale
The 7-12 storey height permitted for mass timber characterizes some of the world's most celebrated, socially and economically vibrant, walkable cities—Paris, Barcelona, Amsterdam—and some of Montreal and New York's most attractive neighbourhoods. The scale creates markets that allow local shops, transit ridership and revenue to thrive. The scale—almost non-existent in contemporary B.C.—requires thoughtful development of development permit area design guidelines.

Low Local Disruption and Environmental Impact
Like most prefabricated construction, mass timber buildings can be erected very quickly, causing less neighbourhood disruption and local environmental impact. Projects are at least 25% faster to build than conventional on-site construction and require 90% less construction traffic. Projects are unlikely to require work to occur outside permitted construction hours in contrast to concrete pours where exemptions are common. Sites are quieter, cleaner and more orderly than conventional on-site projects. Sites are also more resource efficient, requiring far fewer bins for waste, recycling and re-use. Mass timber construction does not impose the same run-off hazards on storm/sanitary infrastructure.

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Material Efficiency and Waste Reduction
Manufacturing buildings offsite with optimized factory conditions leads to material optimization, reduced errors and accidental damage and improved inventory control, reducing overall material inputs and overall waste generation. With good policy and planning, prefabrication supports adaptive building reuse, extending life or facilitating disassembly and material repurposing at end-of-life.

Affordable Housing
The cost control, efficiencies and replicability of assembly lines establish the potential for prefabricated construction to build multi-family housing projects at lower costs and in almost half the time relative to conventional methods. Hurdling the barriers outlined in this guide can help deliver on these cost reductions and supply opportunities.

Worker Safety
B.C. records its highest mortalities and injuries in the construction sector. Prefabricated building manufacturing plants have dramatically lower workplace injury and mortality rates compared to conventional construction sites. The more advanced the prefabrication, the lower the injury and mortality risk. Prefabricated construction project managers must remain vigilant during the final installation/assembly stage because, as within a traditional construction site process, this is where accidents are most likely to happen.

Climate Action

Efficient Buildings, Built Efficiently
Mass timber lends itself to highly efficient building construction and is driving investment in prefabrication generally. Due to labour and skill shortages compounded by the need to achieve high quality airtight building envelopes, it will become increasingly economically and technically challenging to meet very high energy standards with traditional on-site construction. To enable province-wide delivery at the top of the Step Code—Near Net Zero Energy—a significant share of new construction will need to migrate to the assembly line. These gains in energy efficiency will naturally drive GHG reductions.

Low Embodied Carbon
The carbon captured by mass timber can be significant, especially in a tall wood building. For example, UBC's eighteen-storey Brock Commons Tallwood House at the University of British Columbia (UBC) stores 1,753 tonnes of CO_2, while the total carbon benefit created by the tower's construction process is approximately 2,432 tonnes of CO_2—equivalent to taking 511 cars off the road for a year.

Concrete, steel and aluminum are responsible for 23 percent of total global emissions (most of this is used

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in the built environment) and are amongst the most hard-to-abate sectors. To effectively account for the carbon performance contribution and support a sustainable forest industry, it will be necessary to develop accounting methodologies that distinguish between old growth and second growth stands as well distinguish between different types of forestry practices, determinants with a profound impact on embodied carbon calculations.

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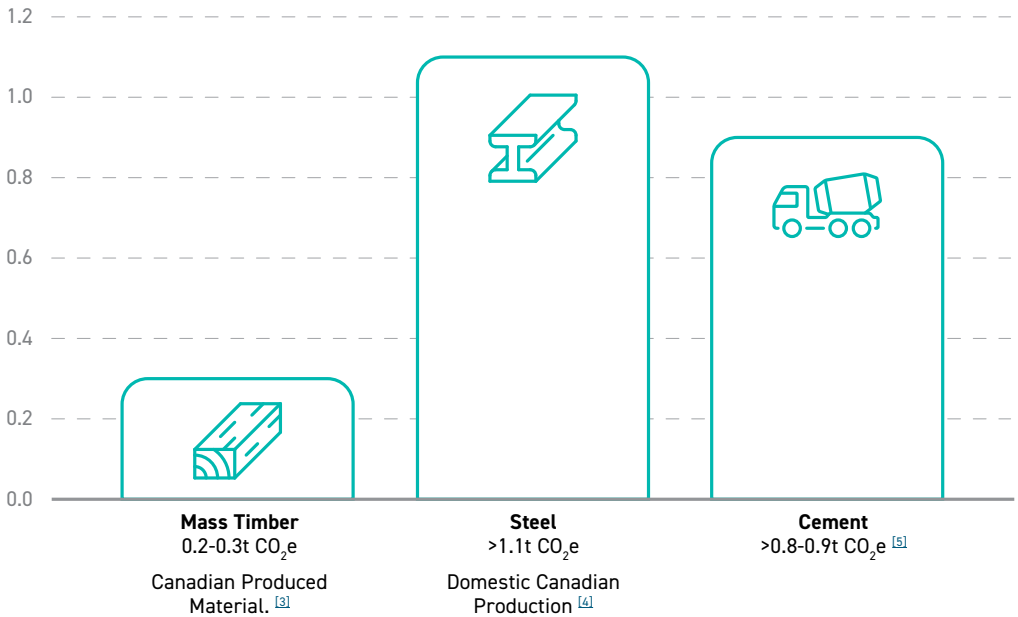
Average Production Emissions: CO_2e/tonne



[3] Carbon Leadership Forum. (2020, March 24). *The Embodied Carbon in Construction Calculator (EC3) Tool.*

[4] The Standing Senate Committee on Energy, and the Environment and Natural Resources. (2018). *Decarbonizing Heavy Industry: The Low-Carbon Transition of Canada's Emission-Intensive and Trade-Exposed Industries.* The Senate of Canada.

[5] Hassan, S. M. N. (2005). *Techno-Economic Study of CO2 Capture Process for Cement Plants.*

Key Barriers and Cross Cutting Challenges

Although prefabrication has played a small role in Canada's construction industry for many years, mass timber is a new technology and the transition to prefabrication requires construction policies and practices to modernize for it to be successful.

To support this new approach to construction there are a wide range of barriers that must be addressed, many of which are not only relevant to mass timber design but apply to a broader shift to prefabrication currently underway in B.C.'s construction sector and across the country.

Key Barriers

Human Resource Capacity

The prefabricated mass timber sector is still young in B.C. A significant knowledge gap exists among skilled labourers, architects, designers, engineers and building consultants. Further types of education, on-the-job training, re-skilling and subtrade engagement are required.

Demand/Supply Dynamics

A present dynamic exists whereby developers are reluctant to proceed with mass timber buildings due to the lack of supply, while manufacturers are reluctant to invest in mass timber manufacturing due to uncertain demand.

Provincial and Federal Policy

Provincial and federal level government policymakers and regulators hold the pen on code revisions and strongly influence parts of the approval process at the local level. Changes will have to be made, for example, by senior governments to revise the BCBC requirements that are currently presenting challenges to mass timber construction. See Provincial Solution for a brief overview of Senior government solutions.

Local Government Policy

Several local government challenges inadvertently hinder widespread adoption of prefabricated mass timber. While by no means the biggest, they are critical to support market transformation. They are overwhelmingly a function of policies and processes designed for traditional, in situ construction. This Guide focuses on solutions in land use policy and building permitting.

QUICK LINKS

Provincial Solutions

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Cross Cutting Barriers

There are a variety of inter-related, cross-cutting challenges critical for tackling these barriers and capitalizing on the priorities:

Prefabricated Construction Transition: Central to seizing the opportunities and overcoming the barriers is transitioning construction to the assembly line. Engineered wood is vital for structurally engineering mid and high-rise buildings. This industrial transition should not leave behind the broader building construction continuum: 90% of B.C. housing units are less than 6 storeys and don't require mass timber. As it has in leading jurisdictions, high performance panels and roofs are likely to play a critical role in B.C.'s deep energy and carbon retrofit strategy. The vast majority of this construction should be transitioning to manufacturing plants to maximize cost-effectiveness, labour force transition, industrial development potential and create a sustainable, net-zero, low-embodied carbon built-environment.

Long Term, Sustainability Vision: Building an economically resilient prefabricated, mass timber manufacturing sector demands stable and secure fibre supply. The convergence of climate change and industrial forest management have driven an unprecedented series of intense wildfire and insect infestation events, eroding fibre security. A variety of efforts must re-build security: updating forest management practices, strengthening wood diversion from landfills, improving building adaptability, optimizing sustainably harvested wood for its highest and best use, embracing a wide array of low-embodied carbon materials in prefabricated construction such as recycled plastic cladding, diverse plant-based materials in insulation or panels from straw or perennial crops. Defensible life cycle analysis of this diversity of materials, including distinguishing second and old growth forest, is necessary to shape policy and inform the manufacturing process.

Policy and Governance Innovation and Coordination: Transitioning construction to the assembly line and ramping up mass timber manufacturing to address time sensitive priorities from climate action to labour force transition and seize the economic opportunities requires decisive leadership. Strategic public procurement can play an important role creating a predictable pipeline of projects that instills investor confidence in capitalizing high tech manufacturing plants. The potential to do this on strategically-located, underutilized public land could make this highly cost effective as it generates a real estate revenue stream. Aligning priorities horizontally across multiple departments, vertically between local and senior governments as well as non-profit and critically developer and manufacturer industries will be central to its success. BC is well positioned to steward this transition. There is a critical mass of innovation and aspiration across all these public, private and non-profit players. The creation of the Office of Mass Timber Implementation in the Ministry of Jobs, Economic Recovery and Innovation could provide a central coordinating role. The development of B.C.'s Energy Step Code, North America's most powerful market transformation building energy policy framework, provides some insight into the necessary leadership, collaborative governance and policy innovation.

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Local Solutions

The mid-rise mass timber building form provided for in the B.C. Building Code does not necessarily align well with existing local government regulations and procedures. As a result, there are planning and building policy gaps and/or conflicts that currently hamper 7-12 storey mass timber projects. This section presents opportunities for policy and process solutions that can be adopted by local governments as they develop their own "mass timber friendly" policies and regulations.

Click through the links on the left to navigate to each section.

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Interactive Guide

The Interactive Guide provides an overview of key long-term and project driven solutions that occur at various points in the municipal building approval process.

Click through the guide below to navigate to each section.

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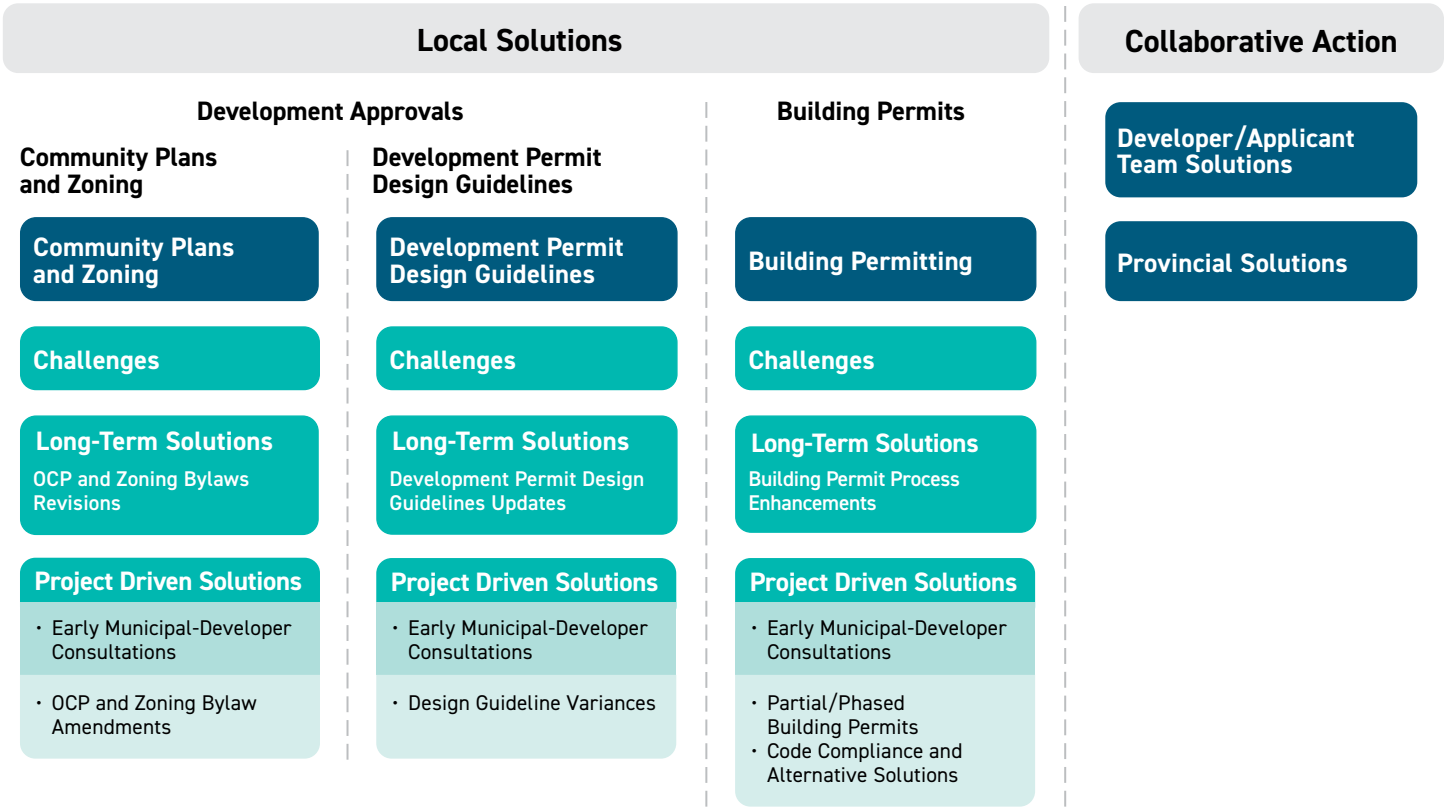

LONG-TERM SOLUTIONS

Actions local governments can take to tune policy and processes for the future.

PROJECT DRIVEN SOLUTIONS

Actions local governments can take for specific projects.

Community Plans and Zoning

Municipal land use regulations determine land use, density, height and other standards. Historically, the BCBC has had a significant influence on these regulations.

For example, before the 1990s, the BCBC limited the height of wood frame buildings to 3 storeys. Municipalities matched this with 3 storey medium-density apartment regulations. While it would have been possible to build apartment buildings over 3 storeys using non-combustible materials (usually concrete), such materials were more expensive and were generally not considered financially viable. The next step in density was non-combustible (mostly concrete) high-rise buildings in a point tower form. The financial viability of non-combustible construction meant that high-density buildings were 12 or more storeys. In this way, the BCBC and market forces have a history of influencing Official Community Plans and zoning bylaws.

In the 1990s, the BCBC was revised to allow 4 storey wood frame buildings. These were financially viable, and most municipalities accommodated 4 storey heights in their medium-density land use regulations. From a land use planning perspective, 4 storey buildings easily fit within existing 3 storey, medium-density zoned areas.

In 2009, B.C. made a further change to the BCBC to allow 6 storey wood frame buildings. 6 storey buildings are noticeably larger than 4 storey ones and accommodate higher densities (approximately up to 3.5 FSR). This scale of 6 storey wood frame buildings raised concerns in some communities, with upper floors sometimes required to be stepped back. However, 6 storey wood frame buildings are now well established as a very efficient building form that is the first choice for delivering more affordable multi-family housing. Since 2009, this building form has been accommodated in most municipalities. The evolution of municipal land use regulation changes in response to BCBC provisions for higher wood frame buildings is described in more detail in the next section on Challenges.

The BCBC 2019 change to allow 12 storey mass timber buildings creates a new opportunity for developers and municipalities to consider. Previously, this mid-rise building form was not common in B.C. Unlike earlier BCBC changes to 4 and 6 storey buildings, this 12 storey building form does not easily fit into existing municipal land use categories.

The challenge of incorporating mid-rise mass timber into municipal regulations is explored in the next section.

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Challenges

The most significant land use regulation challenges for mass timber relate to residential buildings. That is, therefore, the focus of Community Plans and Zoning and Development Permit Design Guidelines. Existing regulations for commercial and industrial buildings are more likely to accommodate mass timber designs.

Since high-density, 12 storey mid-rise residential buildings are not common in B.C., most municipalities will not have OCP categories, zoning or design guidelines to address the scale of prefabricated mid-rise mass timber buildings. Councils, staff and advisory design panels will have little, if any, experience with them. This creates challenges for mid-rise mass timber building approvals, as discussed in Community Plans and Zoning and Development Permit Design Guidelines.

For mid-rise 7-12 storey mass timber buildings to become commonplace, they must fit into municipal land use regulations. This potential fit has been examined as part of this study.

The development potential of 12 storey mass timber buildings has been assessed on lots ranging from 14,000 sq. ft (100 x 140 ft) to 42,000 sq. ft. (300 x 140 ft.). A sample of this examination is shown on the following page. Further studies were conducted as contained in Resources Section. The examination applied zoning setback and lot coverage standards. 1-building and 2-building scenarios were considered on larger lots.

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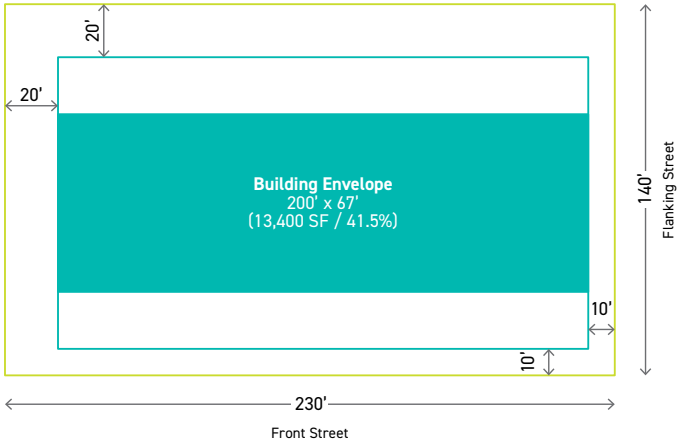
Brock Commons Tallwood House - Tall Wood Building progress. Credit: naturallywood.com Photographer: KK Law (flickr.com) /(flickr.com)

Scenario B-1: 1-Building



FSR: 3.5 and 5.0
Lot Size: 230' x 140'
(32,200 SF)
Exterior Lot

@ all FSR = 67' x 200' footprint
(13,400 SF/41.5%)
@ 3.5 FSR = 8.4 Storeys
@ 5.0 FSR = 12 Storeys

RMT Zone

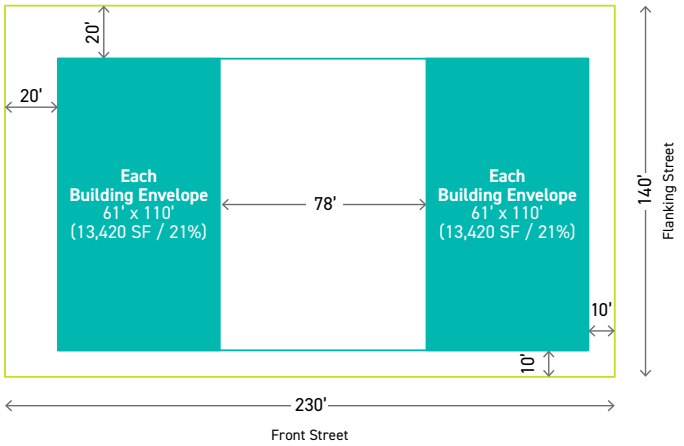
Height:
12 Storey (120 ft)

Max. Lot Coverage:
40%: 12,800 SF
45%: 14,500 SF
50%: 16,100 SF

Setbacks:
Front: 10ft
Rear: 20ft
Ext Side: 10ft
Interior: 20ft

Max GFA:
3.5 FSR: 112,700 SF (9,390 SF plate)
4.0 FSR: 128,800 SF (10,735 SF plate)
4.5 FSR: 144,900 SF (12,075 SF plate)
5.0 FSR: 161,000 SF (13,415 SF plate)

Scenario B-2: 2-Buildings



FSR: 5.0
Lot Size: 230' x 140'
(32,200 SF)
Exterior Lot

@ 5.0 FSR and 42% = 12flrs
@ 5.0 FSR = 2 x 61' x 110' footprint
(13,400 SF / 41.5%)
@ 2 x 61' x 110' = 78' spacing

RMT Zone

Height:
12 Storey (120 ft)

Max. Lot Coverage:
40%: 12,800 SF
45%: 14,500 SF
50%: 16,100 SF

Setbacks:
Front: 10ft
Rear: 20ft
Ext Side: 10ft
Interior: 20ft

Max GFA:
3.5 FSR: 112,700 SF (9,390 SF plate)
4.0 FSR: 128,800 SF (10,735 SF plate)
4.5 FSR: 144,900 SF (12,075 SF plate)
5.0 FSR: 161,000 SF (13,415 SF plate)

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The study revealed that mid-rise (7-12 storey) mass timber buildings could be expected to have a relatively large building footprint. It appears that densities up to 5.0 FSR could be accommodated. Examples of this type of mass timber building are shown on the right.

From a market perspective, 6 storey wood frame buildings are now well established with densities up to 3.5 FSR. These use conventional wood frame construction and are likely to continue to dominate that market segment. At 6 storeys/3.5 FSR, builders could use mass timber which would fit into existing municipal regulations for 6 storey buildings.

The "sweet spot" for mid-rise (7-12 storey) mass timber buildings will be at densities of 3.5 FSR to 5.0 FSR. Under current municipal land use regulations, high-density zones provide for point towers with higher heights and smaller footprints. Therefore, 12 storey mass timber buildings up to 5.0 FSR are unlikely to fit into existing zones without variances. In addition, the higher heights (and potentially higher densities) allowed in high-rise zones will place the 12 storey mass timber buildings at a competitive disadvantage since developers will pay more for the site for those higher heights and densities (using concrete construction). As a result, it will be difficult for 12 storey mass timber buildings to secure sites under current municipal land use regulations and market forces.

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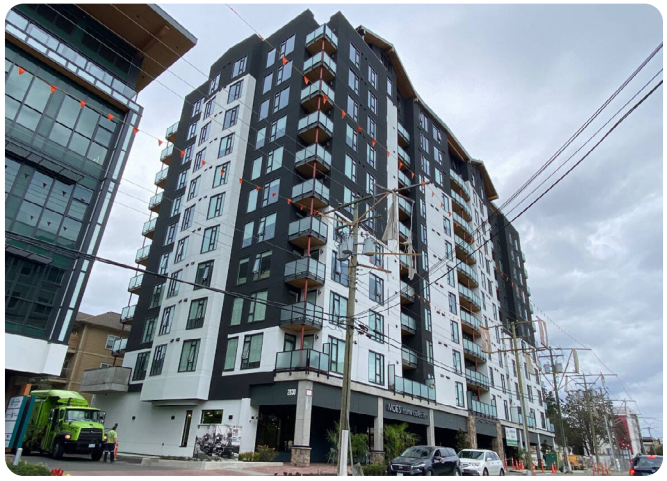
Capstone, Society of Hope - NOvation Architecture Ltd. (flickr.com)



Tallwood 1 at District 56 - Jack James Architect and Design Build Services

Monad Granville - Image courtesy Intelligent City and LWPAC

Just as the 6 storey building form was accommodated by most municipalities previously, an opportunity now exists to explore a new 7-12 storey mid-rise mass timber building form. This is depicted below. Without some type of accommodation, either new land use categories or site-specific zoning amendments, developers will find it difficult to find sites on which to build mid-rise mass timber buildings.

Possible solutions to this situation are presented in the Long Term Solutions and Project Driven Solutions, respectively. Design considerations related to mid-rise mass timber building designs are discussed in Development Permit Design Guidelines.

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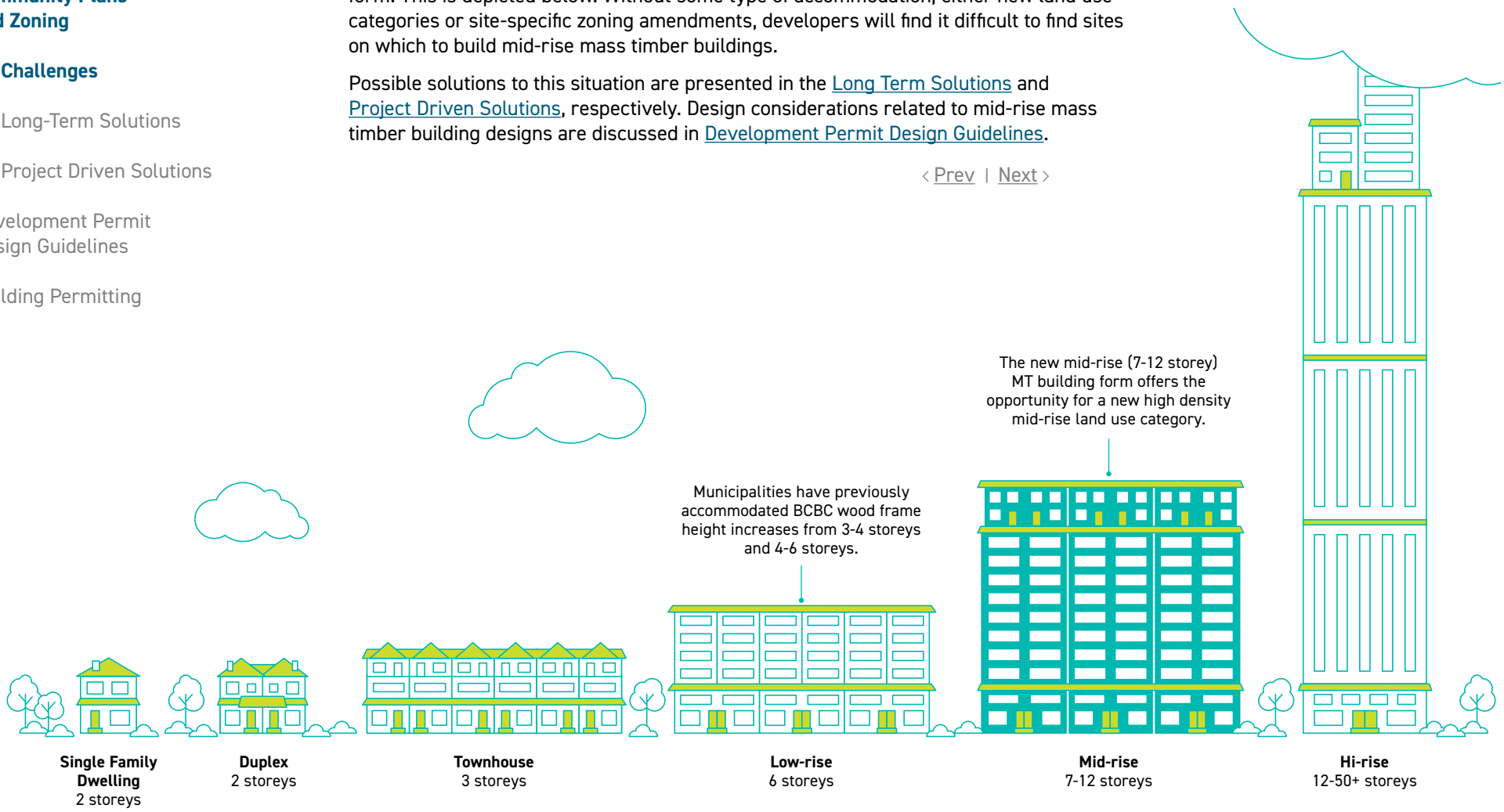

Long-Term Solution

OCP and Zoning Bylaws Revisions

The delivery of mid-rise (7-12 storey) mass timber buildings will begin with having sufficient lands appropriately zoned for them to be built on. The following long-term solutions are presented for municipal consideration.

1. **Inform municipal councils, development planning staff and advisory bodies of the benefits, characteristics of, and challenges facing pre-fabricated mid-rise mass timber buildings.**
   The challenges currently constraining the advancement of mid-rise mass timber buildings will only be addressed if decision-makers are aware of those barriers and the ways to address them.

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PAE Living Building - ZGF Architects
Photographer: Dan Bihn

PAE Living Building - ZGF Architects
Photographer: Jamie Goodwick, Goodwick Creative Services

2. Create new 7-12 storey/3.5 FSR - 5.0 FSR land use categories to accommodate mid-rise mass timber.
Land use categories that specifically accommodate mid-rise mass timber buildings are ideal since they would allow this building form to compete in the marketplace as the "highest and best use". To expedite the approval process, lands could be pre-zoned. Sample OCP and Zoning standards are shown below for consideration.

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Conceptual OCP and Zones for Mass Timber Buildings.
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).

OFFICIAL COMMUNITY PLAN			ZONING BYLAW								
OCP Designation	Storeys	FSR	Zone	FSR	Max Height (storeys)	Max Building Length (ft)	Coverage (podium)	Max Coverage (above podium)	Setbacks (above podium, ft)		
									Front	Int. Side	Ext. Side	Right
Residential												
High Density Mid-Rise Residential	12	3.5	R 3.5	3.5	12	150-250?	n/a	40% - 50%	10	20	10	20
High Density Mid-Rise Residential	12	4.0	R 4	4.0	12	150-250?	n/a	40% - 50%	10	20	10	20
High Density Mid-Rise Residential	12	4.5	R 4.5	4.5	12	150-250?	n/a	40% - 50%	10	20	10	20
High Density Mid-Rise Residential	12	5.0	R5	5.0	12	150-250?	n/a	40% - 50%	10	20	10	20
Mixed Use												
Mixed Use / High Density Mid-Rise	12	3.5	Mixed 3.5	3.5	12	150-250?	90%	40% - 50%	0	0	0	20
Mixed Use / High Density Mid-Rise	12	4.0	Mixed 4	4.0	12	150-250?	90%	40% - 50%	0	0	0	20
Mixed Use / High Density Mid-Rise	12	1.5	Mixed 4.5	3.5	12	150-250?	90%	40% - 50%	0	0	0	20
Mixed Use / High Density Mid-Rise	12	5.0	Mixed 5	4.0	12	150-250?	90%	40% - 50%	0	0	0	20
Commercial												
Retail/ Office	12		Comm-1	3.5-5.0	12	n/a	90%	90%	0	0	0	20

3. **Modify existing zones to better accommodate 7-12 storey/3.5-5.0 FSR mid-rise mass timber buildings.**
   In addition to, or instead of new zoning land use categories, municipalities could amend existing zones to better accommodate mid-rise mass timber buildings. This could include standards like those shown in the Table on the previous page related to:

   - Increased lot coverage
   - Reduced setback
   - Increased maximum building length
   - Height

   It would be possible to establish a set of standards unique to a 12 storey mass timber building form within an existing high-density zone. How these work within specific zones will be different for each municipality.

   This type of solution will be most effective if the mass timber building form coincides with the highest and best use. If not, the higher densities/heights would favour conventional concrete towers. That is because the taller/larger concrete buildings would command a higher value when sites went on the market.

4. **Adjust zoning height measurements to accommodate thicker mass timber floor assemblies.**
   As identified and described in more detail in Development Permit Design Guidelines, mass timber floor assemblies are typically thicker than most concrete floor assemblies. The difference ranges from 4 to 7 inches. Unless this difference is provided for through a height exception, mass timber buildings could be at a significant disadvantage compared to concrete construction. Over 12 floors, the difference could be 4 to 7 feet. Depending upon the maximum height allowed, this could result in an entire storey being lost and only an 11 storey building being constructed, potentially destroying the financial viability of the project.

   The City of Vancouver has responded to this concern by allowing staff to vary height to account for floor assembly differences. The Vancouver staff report is available in Resources.

5. **Conduct an internal review of existing regulations to identify potential barriers to mass timber buildings.**
   This study has provided a generic assessment of potential land use challenges. Every municipality has unique bylaws, policies and processes. Reviewing those with a mass timber lens may reveal other matters to address.

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Project Driven Solutions

While long-term changes to OCPs and zoning bylaws might have the greatest impact on making sites available for mid-rise mass timber, development planning often occurs in a more incremental manner, a project at a time.

For this reason, it is worth considering how the processing of individual applications might better accommodate this building form.

Since most land use regulations and design guidelines were not written with such a building form in mind, departures should be expected. If these are anticipated and understood, it is much more likely that such applications will be successful.

Mass timber building can be supported on a project-driven basis by the following:

Early Municipal-Developer Consultations
Early consultation between applicant teams and municipal planning/building/fire/engineering staff.

The unique characteristics of mass timber construction need to be identified at the outset of the development process. Early identification of issues will help lead to solutions and avoid subsequent problems, including at the building permit stage.

OCP and Zoning Bylaw Amendments

1. **During site specific applications, inform municipal councils, development planning staff and advisory bodies of the benefits, characteristics of, and challenges facing prefabricated mid-rise mass timber buildings.**
   The challenges currently constraining the advancement of mid-rise mass timber buildings will only be addressed if decision-makers are aware of those challenges and the ways to address them.
2. **Expedite mass timber applications.**
   Staff could be instructed to give priority to mass timber projects.
3. **Early planning and building consultation with applicants.**
   If applicants are going to proceed with a mid-rise mass timber building, they must decide this at the project's outset. Therefore, they must cultivate an early understanding of what will be supported in the way of variances from existing policies to accommodate this different building form.

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4. **Support site specific zoning variances for mass timber buildings.**
   Variances should be expected and accommodated whenever possible. This could be achieved through site-specific rezonings (use/density/lot coverage, setbacks), Development Variance Permits (lot coverage, setbacks, etc.) and Development Permits (with lot coverage, setback variances). Variances to be expected include:

   - Lot coverage
   - Siting/Setbacks
   - Building length
   - Height
   - Combined amenity spaces
   - Others

5. **Delegation of "minor" zoning variances (lot coverage, setbacks, etc.) to staff to simplify approvals.**
   The authority to delegate such variances was recently provided to municipalities through changes to the Local Government Act.

   Municipalities could choose to combine options or apply them as best suited to different neighbourhoods.

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Brock Commons Tallwood House
Credit: naturallywood.com
Photographer: KK Law
(flickr.com)

Development Permit Design Guidelines

Municipalities have the authority to regulate design through development permits under the Local Government Act.

Buildings must comply with development permit area guidelines or OCPs that are approved by council. Building designs can also be scrutinized through any other type of application that requires council approval. That includes rezonings or development variance permits. Since councils have absolute discretion over these types of approval, building design is often taken into consideration. Some municipalities have design guidelines for such processes, in lieu of a formal development permit process.

Many municipalities have established advisory planning commissions and advisory design panels to assist with building and landscape design approvals. Such advisory bodies do not have approval authority but function in an advisory capacity.

Since high-density, 12 storey mid-rise buildings are not common in B.C., most municipalities will not have design guidelines to address the characteristics and needs of prefabricated mid-rise mass timber buildings. Councils, staff and advisory bodies will have little, if any, experience with them. This creates challenges for mid-rise mass timber building approvals, as discussed next.

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PAE Living Building - ZGF Architects
Photographer: Dan Bihn

Challenges

The design challenges connected to mid-rise mass timber relate to:

- The massing of the 12 storey high-density (3.5-5.0 FSR) building form
- The design constraints associated with prefabricated construction

Since many existing design guidelines and policies will not be compatible with mid-rise mass timber building forms, an analysis was undertaken to identify design issues and propose solutions. The results of this analysis are presented in the companion document *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings*, this document is not intended to be fully comprehensive, nor prescriptive. Rather, it identifies design issues and practical solutions for consideration. Designers and municipalities are encouraged to draw from and expand these suggestions as best fits their specific community or site.

The following pages include summary extracts from this companion document.

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Barriers and Design Guidance to Mass Timber Construction

To effectively accommodate mid-rise EMTC buildings (7-12 storey), OCPs and Development Permit Area Design Guidelines require adaptation. The following aims to identify and characterize the most significant barriers affecting mid-rise EMTC buildings and presents a range of design guidance and high-level solutions.

Building Height
Mass timber floor assemblies are thicker than concrete, translating to comparatively taller buildings to achieve the same interior clearances. Thus, a Timber project may not fit under the same height restrictions as an equivalent building in concrete.

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
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.

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.

Massive Bar
Bar-type buildings built on long lots with densities conducive to encapsulated mass timber construction 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.

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Municipal height restrictions need to accommodate the thicker floor assemblies typically required for mass timber construction.

Mass timber buildings require a thicker floor assembly than concrete construction. This assembly can range from 4 to 7 inches per floor, depending on the construction type and ventilation method. As a result, a 12 storey mass timber building could be 4 to 7 feet taller than a comparable concrete building.

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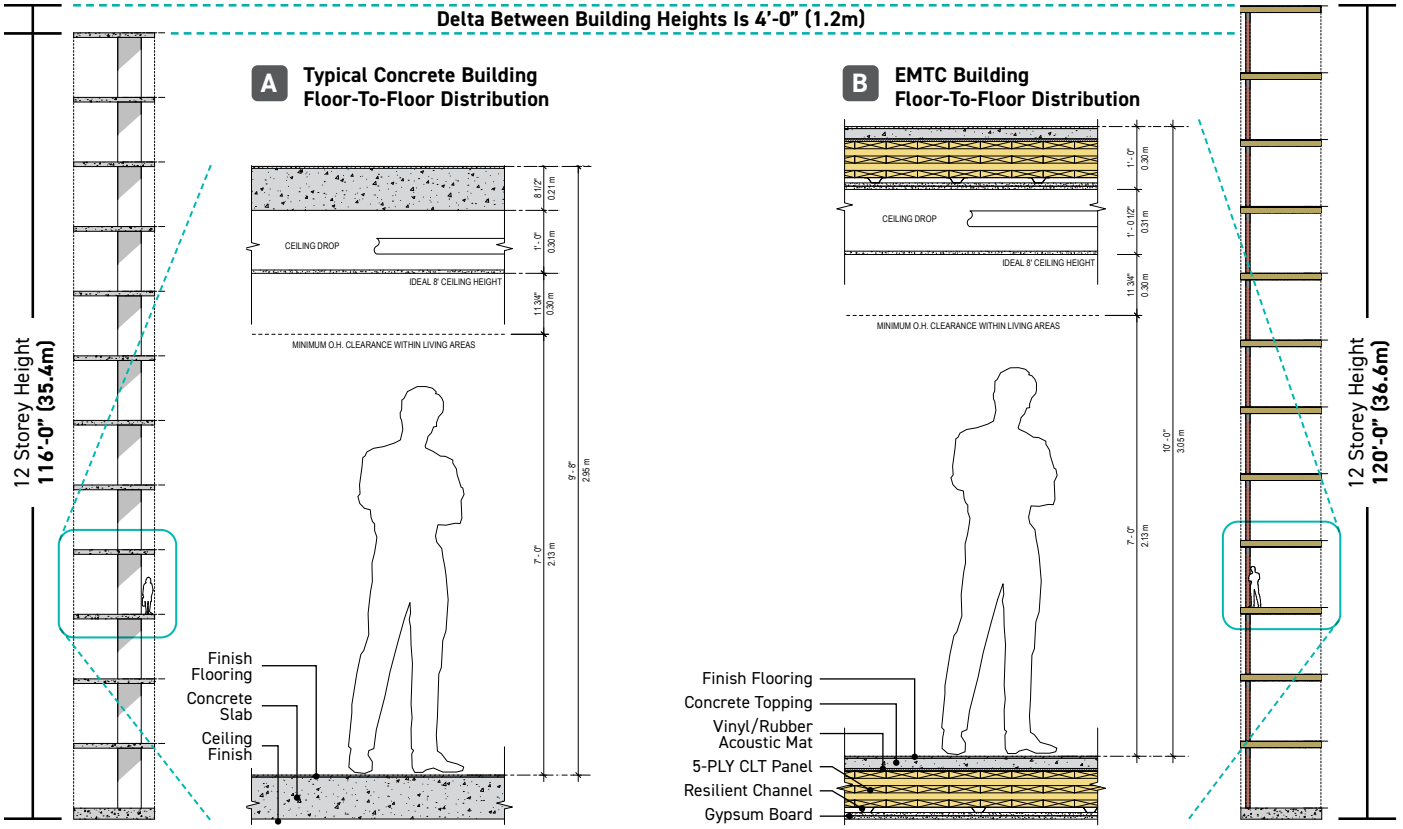

Efficient and cost competitive mass timber buildings require a repetitive floor plan with design features that are practical to pre-manufacture and assemble.
Prefabricated mass timber buildings need to be more "structure forward" than a comparatively flexible concrete building. Rigorous structural modules which are derived from the manufacturing process of CLT are the primary drivers/constraints which inform building form and interior space planning.

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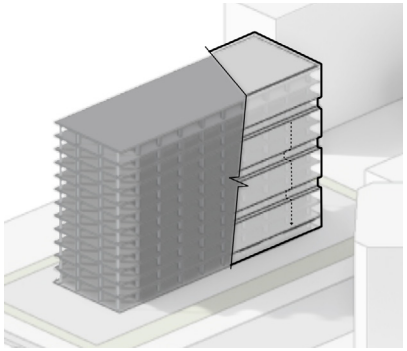
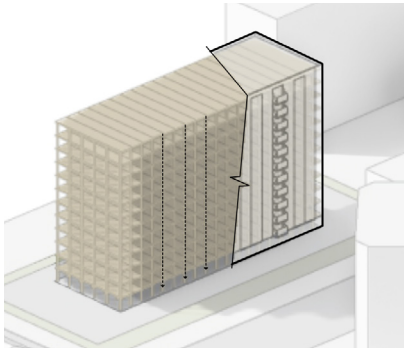
A **Concrete Structure**

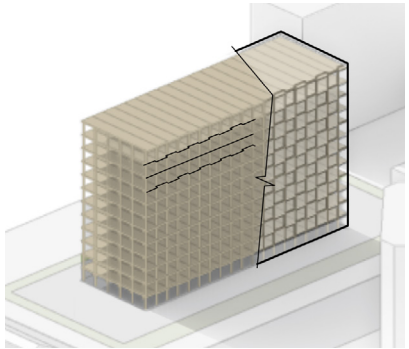


Concrete structure with horizontal massing

B **Attune Massing Guidance to Structure**



Timber structure with consistent vertical massing



Sub-scale massing modulation through repetition

High-density mass timber buildings limited to 12 storeys will require special design considerations to address building articulation.

Bar-type buildings built on long lots with densities conducive to mass timber construction often present an over-bearing, heavily shadowing building form. *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings* offers some examples of ways to avoid an overly massive appearance.

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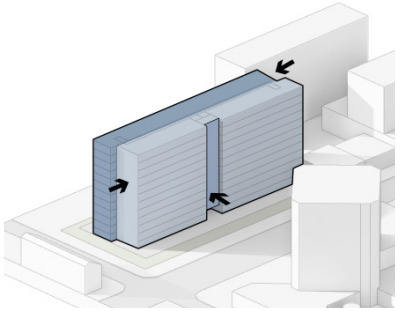
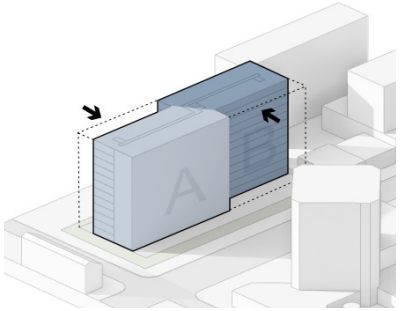
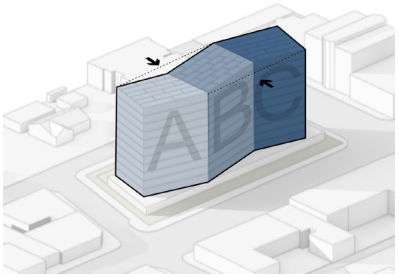


Shifted bar along major axis.



Slipped or pinwheeled bars hinging on central cores.



Inflection points to articulate the bar into sections.

Combined amenity and open spaces, rather than individual balconies, may be most cost effective for mass timber buildings.

Multifamily residential buildings often require private outdoor space for (at minimum) 2 and 3 bedroom units. Balconies introduce significant complexity and cost to high-performance mass timber buildings.

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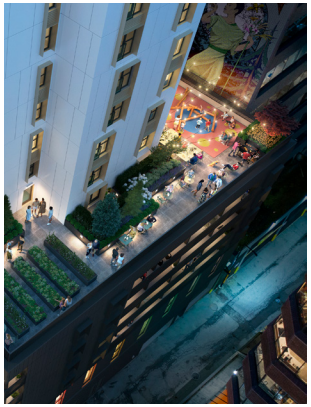
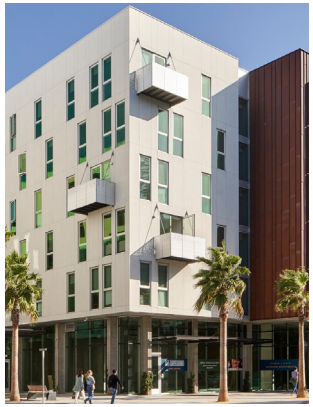
Combined Outdoor Spaces

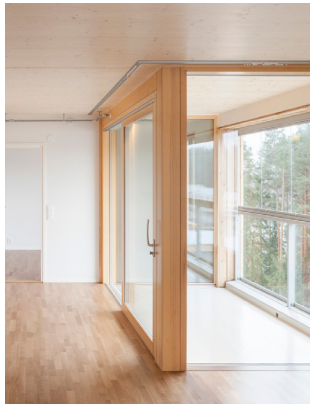


1190 Burrard Proposal -
ZGF Architects

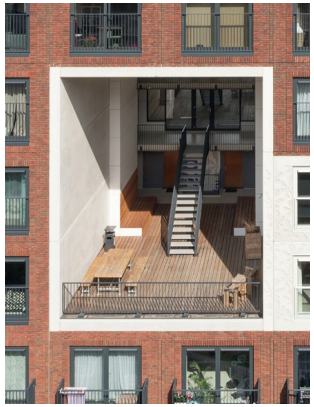
Reduced Balcony Requirements



355 Brannan - 'Hung' Balconies.
David Baker Architects
Photographer: Bruce Damonte



Puukuokka Housing Complex -
OOPEAA
Photographer: Mikko Auerniitty



Villa Mokum, Amsterdam -
Kampman Architecten
Photgrapher: Ossip van Duivenbode

Long-Term Solutions

Development Permit Design Guidelines Updates

The following proposed solutions are for consideration by municipalities to make their design approval regulations more compatible with mid-rise mass timber buildings:

1. **Prepare design guidelines to complement new zones created to accommodate mid-rise mass timber buildings with reference to** *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings.*
   Community Plans and Zoning suggests that new OCP categories and zones be created for 7-12 storey high density development to accommodate mid-rise mass timber buildings. New development permit area guidelines could then be implemented to shape that development. Those guidelines should allow for the design characteristics of mass timber.
2. **Modify existing design guidelines to accommodate the building forms associated with mid-rise mass timber buildings with reference to** *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings.*
   In areas where design guidelines already exist, they could be modified to allow for the characteristics of mid-rise mass timber.
3. **Adjust design guideline building height measurements to accommodate thicker mass timber floor assemblies.**
   An allowance of 4 to 7 inches per floor should be granted to mass timber buildings to account for thicker floor assemblies. This could be done through an amendment to the definition of height. The City of Vancouver has implemented such a relaxation, as shown in the Resources section.
4. **Adjust building height measurements to accommodate shared roof top amenity space.**
   Common roof top amenity space can be very beneficial for residents. If such spaces are to be provided (partly in lieu of individual balconies on mass timber buildings), they will need to be provided for in both zoning and design guidelines.

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Project Driven Solutions

To accommodate the unique characteristics of mass timber construction, site-specific development applications should incorporate:

Early Municipal-Developer Consultations
Early consultation between applicant teams and municipal planning/building/fire/engineering staff.

The unique characteristics of mass timber construction need to be identified at the outset of the development process. Early identification of issues will help lead to solutions and avoid subsequent problems, including at the building permit stage.

Design Guideline Variances

1. **Early planning, building and fire staff consultation with applicant teams.**
   The unique characteristics of mass timber need to be identified at the outset of the design and planning process. Early identification of issues will help lead to solutions.
2. **Consider the needs of prefabricated buildings to achieve efficiencies. Such as:**
   - Floor assembly thickness and overall building height
   - Need for uniform floors and vertical stacking
   - Methods to break up the massing of buildings other than the stepping of upper storeys
   - Modified balcony treatments
   - Combined outdoor common areas

   These are explained in *Design Solutions to Prefab Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings.*

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Building Permitting Solutions

Following zoning and development permit approval, projects move into the building permit stage. Applicants and municipalities pursue compliance with the BCBC, BCFC and other codes/bylaws through this process.

Fire departments are involved in applying the BCFC with regards to mass timber. Notably, the issuance of a building permit constitutes compliance with these codes and virtually all relevant municipal regulations and procedures. As a result, the building permit process includes referral to multiple departments. Matters such as building finish materials, affordable housing, drainage, landscaping, road works, utility works, amenities and more must all be addressed before the issuance of a final building permit.

While the focus of this study is on compliance of the building with the BCBC, it is useful to understand the nature of the building permit process and the various forces (and delays) at play. This section, therefore, addresses 2 aspects of construction approvals:

- Building/Fire Code Compliance
- Building Permit Process

The building permit process is typically led by building officials who are members of the Building Officials Association of B.C. (BOABC). These officials use their best judgement to ensure compliance with the BCBC, other codes, municipal bylaws and BOABC professional standards. Since 2015, municipalities have been unable to create regulations for construction requirements also contained in the BCBC, as per the B.C. Building Act. While there is a desire for consistent standards across the province, applying construction codes involves a degree of interpretation.

The work of building officials is guided by municipal building and construction bylaws, which vary considerably between municipalities. This is particularly true of inspections. It is not practical for municipalities to inspect all aspects of a building. The responsibility for complying with the BCBC rests with the property owner. However, registered professionals and trades working for the developer are expected to construct in accordance with approved standards. Municipal inspections are considered more of a "spot check" that may occur. Some municipalities have even opted out of inspections when a registered professional oversees a project.

Applicant consultant teams are a crucial part of the building permit process. These include, but are not limited to, architects, engineers (structural, electrical, mechanical, envelope specialists and building code specialists), landscape architects, trades, and more. Due to the technical nature of mass timber construction, the role of these consultants is heightened.

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The NBC and BCBC provide a comprehensive prescriptive pathway to achieving building code compliance for the new mid-rise mass timber buildings. The challenge for designers is in achieving compliance for building elements or systems that fall outside these predefined technical solutions. Unapproved systems no longer need to be equivalent; they only need to show that they achieve the same level of performance. This was not available in the prescriptive codes before the 2005 NBC objective code was introduced. It should also be noted that the fire science industry has evolved significantly in recent years and has, in some ways, replaced the testing that was normally required at the national level which could be years in the making.

There are several ways that departures from compliance with the prescriptive requirements in the BCBC can be addressed:

- **Interpretation of the BCBC 2018**
  Building officials have important but limited discretion to interpret the BCBC. This can sometimes address designs that are not exactly as presented in the BCBC.
- **Alternative Solutions**
  The BCBC provides designers with the option to achieve compliance through the Alternative Solution process, where it can demonstrate that the minimum level of performance in the areas defined by the code can be achieved. While some may see the Alternative Solutions process as time consuming and expensive, it offers design teams the opportunity for creativity and innovation. It falls within the principles of the current objective or performance-based codes, allowing for increased flexibility towards achieving compliance.
- **Site Specific Regulation Process**
  A process is provided in the B.C. Building Act to address situations where innovative buildings might not comply with the BCBC. This process involves the Building and Safety Standards Branch (BSSB) and resulted in the first mid-rise mass timber buildings in B.C. Although quite involved, it does offer a process to depart from the BCBC on a site-specific basis. The BSSB must be willing to apply this process to a project, and to do so, it must be considered innovative.
- **Certification of New Construction Products**
  There is a national process for building products to be certified as meeting code standards. Once completed, those products can be readily accepted by building officials. A more robust accelerated certification program for new building products could help reduce existing code issues currently requiring an Alternative Solution.

The next section identifies issues being faced by applicants and building officials for prefabricated mass timber buildings.

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Challenges

Building/Fire Code Compliance

Full compliance with the prescriptive requirements of the BCBC has proven difficult for mid-rise mass timber projects since 2019. Alternative Solutions prepared by a registered professional (i.e., building code consultant) have been necessary. The most common requests are listed in the following table:

MID-RISE MASS TIMBER COMMON BUILDING/FIRE CODE ISSUES	COMMENT
Increased exposed timber beyond limits prescribed in BCBC - VBBL EMTC provisions (BCBC 2018) Note: This is not unique to EMTC buildings. Many exceptions are provided, but when exceeded are either outright rejected or may seek approval through the Alternative Solutions process. This applies to all areas of the building including public areas and exit stairs.	This is a very common request. Reasons include: • Desire to reveal the beauty of the wood • A large amount of drywall diminishes the environmental benefits of mass timber • The impracticality of encapsulating timber for fire protection during construction • Need to contain costs related to EMTC • Future code change request could address this while still addressing life safety concerns.
Firestopping (BCBC 2018) Note: Until very recently, there have not been approved firestop listings that meet the required 2018 BCBC CAN/ULC- S115 "Fire Test of Fire Stop Systems" that penetrate EMTC systems. Projects have had to rely on the Alternative Solution approach for penetrations in EMTC systems. These proprietary systems have just recently been approved which will simplify Building Permit applications.	Theses proprietary systems are developed by the private sector and must be tested and approved by a recognized testing agency which can take many months. The recent approval of fire stop systems will support faster processing of EMTC applications. Faster approval of proprietary fire stop systems would help eliminate the need for regular Alternative Solutions.
Mass timber Exterior Walls (BCBC 2018) Note: Mass timber walls are not considered non-combustible construction and, as a result, if clearances to lot lines are reduced below permitted minimum distances (min. 1.5 metres) then compliance can only be achieved through the Alternative Solutions process. Currently only non-combustible walls are permitted to be constructed less than 1.5 meters from lot lines.	Future code change request could provide for this.

MID-RISE MASS TIMBER COMMON BUILDING/FIRE CODE ISSUES	COMMENT
Omissions of Sprinklers at Balconies (BCBC 2018) Note: Buildings over 4 storeys are subject to the NFPA 13 sprinkler standards. The 2018 BCBC Rev 2 Sentence 3.2.5.12 (8) requires sprinklers when the balcony depth exceeds 610mm. EMTC buildings are subject to more stringent standards than non-combustible buildings of this height. Alternative Solution requests to omit sprinklers are likely to be rejected by local fire departments. NFPA 13's built-in equivalency compliance pathway is inadequately appreciated solution that should be considered.	Given the history of balcony fires, code changes are not likely to be supported by provincial or local regulatory authorities.
Combustible Windows (BCBC 2018) Note: Combustible window frames and sashes are permitted to be installed in the exterior walls of EMTC buildings subject to conditions such as limited aggregate areas and distances between each other. Installation that cannot meet these conditions can apply to seek approval through the Alternative Solutions Process.	Future code change requests could be made for Alternative Solutions commonly applied for and approved.
Protection of Adjacent Buildings (BC Fire Code 2018) Note: Through the 2018 Fire Code, EMTC buildings with neighbouring buildings are subject to significant restrictive protective requirements related to the disposal/storage of materials, temporary access for firefighters, standpipe installations, and encapsulation during course of construction. These measures must form part of the site's Fire Safety Plan which must be approved the Fire Department. Review of these requirements and proposed alternative approaches by fire consultants should be considered given the difficulty in achieving the Fire Code requirements.	Future code change could provide for this.

Building Permit Processes

As buildings become more complex and more factors are added for regulatory consideration (e.g., energy efficiency, moisture and thermal performance), the permitting process for Part 3 buildings becomes cumbersome. Though commonly run by building officials, many departments are now involved with different responsibilities and priorities, which can lead to silos that are difficult to coordinate and measure performance. The process also often lacks council direction on service expectations which makes setting timelines and decision-making difficult. Building permit systems are often antiquated (or sometimes non-existent), and lack the ability to receive, review and issue permits electronically.

Emerging building permit software can move processes online, automate and coordinate workflows across the organization. A suite of available applications can guide users through the process and provide local governments with the intake, tracking and reporting capabilities needed to manage it successfully. Technology has now aligned with both industry and local government best-practices. When implemented effectively, it can significantly improve regulatory compliance and processing timelines. These improvements and the flexibility to the process they provide are key to the successful advancement of mass timber buildings.

The building permit process is currently very paper-intensive. Prefabricated mass timber design lends itself to digital systems such as Building Information Modelling (BIM) and electronic plan submissions, as the offsite prefabrication process for MT buildings typically ensures that a highly accurate 'digital twin' of the building is developed. In addition to the core building permit processing software, these systems provide further processing enhancements by allowing projects to be submitted and reviewed digitally, including in a 3D format, which continues to foster the collaboration and information exchange approach across the entire project team.

The transition to municipal electronic plan submission is desirable for all significant building permit applications, but particularly for mass timber. Electronic plan submissions and digital municipal processing greatly assist the building permit process. However, introducing new building permit systems capable of handling BIM and achieving paperless processing is a major challenge for municipalities. Hardware, software, and training costs are significant. There is also a need to integrate the new system into other core municipal business systems. Some B.C. municipalities have introduced an all-digital permit system with BIM potential only after years of effort.

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Alignment with off-site construction schedules
Many communities are pressured to deliver housing and civic infrastructure as quickly as possible. Prefabricated construction systems, such as mass timber, can significantly improve on-site schedules but the regulatory processes must be aligned to do so. If a prefabricated project must wait for a full building permit issuance, the benefits of parallel construction, on and off site, could be lost.

The major differences between traditional and prefabricated projects from the regulatory standpoint are:

- Inspections or other certification of off-site elements may need to happen at the plant.
- The prefabricated elements need to be locked down early in the design process before other aspects of the project are resolved.
- Building officials may need to be familiar with different standards for the mass timber components and the prefabrication process.

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Mass Timber Manufacturing Facility in West Kootenays - (flickr.com)

Mass Timber Manufacturing Facility in West Kootenays - (flickr.com)

Long-Term Solutions

Building Permit Process Enhancements

1. **Increase Education.**
   Enhance awareness of the benefits of and challenges facing premanufacturing and mass timber through continuing education of stakeholders including politicians, building officials, planners, engineers and others.

2. **Encourage and support further building and fire code changes.**
   Code revisions offer the potential to streamline mid-rise mass timber building permit applications. Since these are beyond local government authority, such changes will have to be made by senior governments. To contribute to federal and provincial changes, municipalities could:

   - Encourage senior governments to revise the BCBC to remove or revise requirements that are currently presenting challenges to mass timber.
   - Encourage the expedited certification of building products to resolve existing code issues.

   These and other suggestions for provincial action are contained in Project Driven Solutions.

Brock Commons Tallwood House - Tall Wood Building progress. Credit: naturallywood.com Photographer: KK Law (flickr.com)

Brock Commons Tallwood House - Steel Connectors. Credit: Acton Ostry Architects (flickr.com)

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3. **Enhance the building permit process overall to speed applications.**
   The efficiency of the building permit process varies considerably between municipalities. More efficient processes would be of benefit to all building types, including mass timber. Although it is beyond the scope of this study to recommend specific improvements to municipal building permit processes, there are certain principles that should be considered. These guiding principles are summarized below and expanded upon in the *Building Permit Process Enhancements: Guiding Principles.*

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BUILDING PERMIT PROCESS ENHANCEMENT: GUIDING PRINCIPLES

- Develop Excellence and Transparency in Building Permit Process
- Seek Council's Direction on Roles and Responsibilities
- Create Corporate/Department Business and Strategic Plans
- Create a Comprehensive Building Permit Intake/Review/Issuance Business Process
- Upgrade Permitting Software and Technology
- Encourage Pre-permit Application Meetings
- Accelerate Review/Approval Process (including partial permits for pre-manufacturing)
- Client/Applicant Streamline the Building Permit Processes
- Local Governments Streamline the Permit Approval Process
- Encourage Solutions from Outside Approving Agencies

Project Driven Solutions

There are a variety of options to enhance the processing of mass timber building permit applications. While municipal staff play a significant role, applicants have perhaps the greatest impact on achieving an efficient and successful permit process. Developer/Applicant Team Solutions are presented in the following section.

For municipalities, the following solutions should be considered to enhance the processing of mass timber:

Early Municipal-Developer Consultations
Early consultation between applicant teams and municipal planning/building/fire/engineering staff.

The unique needs of mass timber construction should be identified at the outset of the development process. Early identification of issues will help lead to solutions and avoid subsequent problems, including at the building permit stage. Building staff should engage with the applicants at the rezoning and/or DP stage. Such efforts will smooth the transition from zoning/design approval to building permit.

Partial/Phased Building Permits and Code Compliance and Alternative Solutions

1. **Provide for the unique off-site construction requirements associated with mass timber.** Activities associated with mass timber construction can be quite different than conventional construction. This may result in different requirements for street occupancy, deliveries, etc. Municipalities should recognize these unique needs and accommodate them as much as possible.
2. **Issue partial permits to enable the premanufacturing of mass timber components in advance of a full BP.** An essential benefit to mass timber construction is the speed with which buildings can be constructed. This is achieved through pre-fabrication off-site followed by swift assembly on-site. If pre-manufacturing must await the issuance of a full building permit, construction is delayed. The result can be no significant time saving over conventional concrete construction.

   A remedy to this would be introduce a form of "partial" building permit to authorize the pre-manufacture of building components. Partial permits are currently used by many, but not all, municipalities to assist with construction scheduling. Typically, this includes partial permits for excavation and foundation construction, as per the diagram on the following page.

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Through early pre-building permit application consultation (as recommended above), it may be possible to resolve Building Code issues well in advance of a building permit application. Such early collaboration might then allow Building Officials to issue a partial permit for the manufacturing of prefabricated components nearer the time of application. This would likely be for the structural "shell" of the building. Such a process might look as shown below in green.

Expediting the building permit process with partial permits could greatly assist with the timing and cost of mass timber projects. If municipal building permit processes are fast enough, partial permits might not be considered necessary. However, this seems unlikely for many municipalities.

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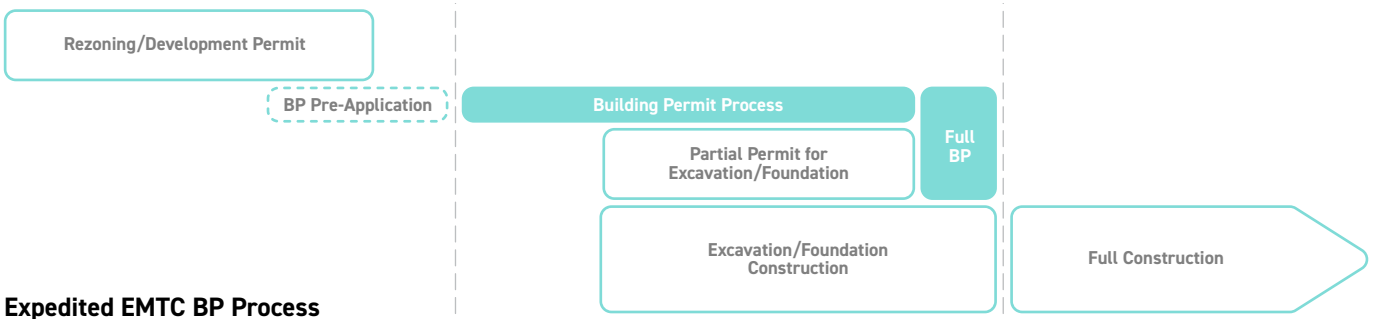
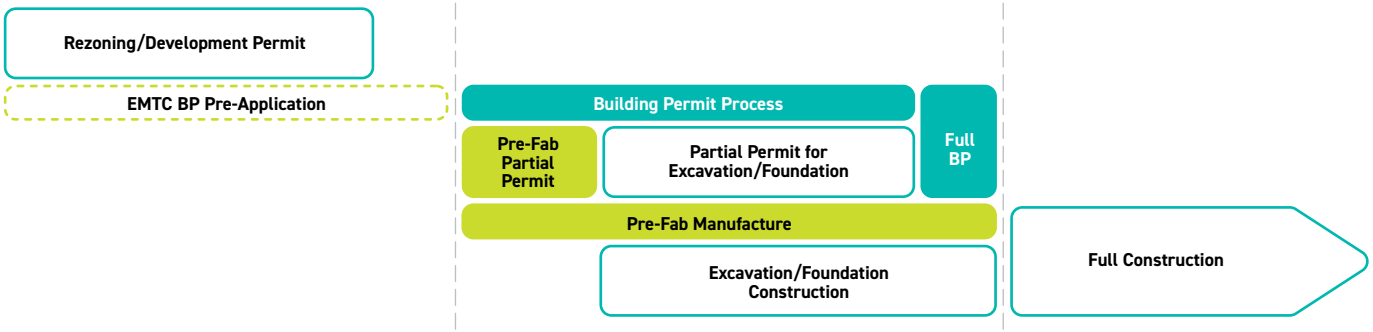
Current BP Process with Partial Permits



Expedited EMTC BP Process



One example is 330 Goldstream which was a prefabricated 6 storey LWF ESC Step 4 / Passive House performance affordable housing project in Colwood, B.C. The city of Colwood established a collaborative review process and integrated "review panels" with all the city departments working on the project in parallel so the builder could get the panels into the assembly line.

The Development Permit process took 9 months. However, the process's collaborative nature meant the city allowed the 2 applications to overlap with the building permit submission made 3 months prior to formal development permit approval. Overall, the permit approval process took 14 months from development permit application in October 2017 to issuing the building permit in December 2019. Colwood achieved this while experiencing unprecedented staff pressure.

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330 Goldstream Ave -
Photo credit: James Jones Photography, courtesy Cascadia Architects

Collaborative Action

This study has examined how mid-rise mass timber buildings might fit within existing municipal land use and building permit processes. During the engagement process, several other general solutions outside of the purview of local government were identified that apply to complementary key players, such as the development community, mass timber manufacturers and provincial and federal government.

Click through the links on the left to navigate to each section.

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Developer/Applicant Team Solutions

Development is a collaborative effort. Developers acquire sites and assemble teams to achieve a successful development.

How that applicant team performs has an enormous impact on the success of the project. This team works with municipal planning, building, engineering, environmental and other staff.

Suggestions for how developers can contribute to successful mass timber projects include:

1. **Commit to a mass timber method of construction at the outset of the project.**
   Mass timber buildings have unique characteristics. Buildings need to be designed with these characteristics in mind from the outset. Attempting to change from a concrete method of construction to mass timber at the building permit stage can result in a multitude of conflicts.
2. **Engage a qualified professional team at the outset of the design process (rezoning/Development Permit) to ensure smooth municipal design and building permit approvals.**
   Qualified consultants can identify building code concerns and solutions early in the design process. Leaving them out can result in conflicts at the building permit stage.
3. **Engage with municipal planning, building and engineering staff as early as possible in the design process.**
   Informing (and sometimes educating) and working with staff early can help build support for the project. Conflicts identified early can be either avoided or otherwise be addressed.

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Provincial Solutions

Advancing innovation in building construction and industrial development is a collaborative process involving diverse public, private and social sector players, of which the provincial government is central. B.C. has commendably driven important building code changes that are supporting this process of innovation, notably the Energy Step Code and the EMTC 7-12 storey code.

To meet the diverse socio-economic and environmental imperatives underpinning prefabricated, mass timber construction, stepped up policy making, collaborative action and capacity building are essential.

The following recommendations have emerged engaging with development and manufacturing industries, local governments and diverse professions.

Building and Fire Code Revisions

1. **Update codes to accommodate common alternative solutions for 7-12 storey buildings, reducing time and cost barriers.** Local governments, developers, manufacturers and notably professionals identified a number of alternative solutions frequently accepted by building officials and advanced by code consultants to address common building and fire code restrictions. These Alternative Solutions provide a basis for informing code revisions, reducing time, cost and administrative barriers and uncertainty, specifically:
   - **Remove or reduce encapsulation requirements,** prohibited under BCBC 2018, acknowledging mass timber's ability to meet life safety standards. Exposing the timber structure is beneficial for the occupant health and well-being, design attributes, cost management, operational carbon and resource efficiency.
   - **Increase mass timber exterior wall permissibility,** prohibited under BCBC 2018, acknowledging their tested fire resistance performance, reducing time and cost, and strengthening design potential.
   - **Adopt accepted proprietary firestopping systems,** prohibited under BCBC 2018, but now approved by a recognized testing agency to have met the required 2018 BCBC CAN/ULC-S115 "Fire Test of Fire Stop Systems." Streamlining the integration of approved fire stop systems into the BCBC would reduce demands on the Alternative Solutions process.
   - **Reduce combustible window installation limitations** under BCBC 2018. Common alternative solutions have permitted wider installation of combustible windows, acknowledging wood in these applications does not materially influence the growth or spread of fire.

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- **Reduce unduly restrictive adjacent building construction limitations** under BC Fire Code 2018, including standpipe installation and encapsulation during course of construction. Alternative Solutions developed by Fire Consultants and approved by Fire Departments should inform part of site Fire Safety Plans.

2. **Increasing height, accommodating high rise mass timber buildings.** The BCBC 2018 12 storey height limitation reduces site options for mass timber construction. The resulting 12 storey, 3.5 to 5.0 FSR, large footprint building forms are very uncommon in most of B.C. requiring atypical OCP and/or zoning amendments. While this building form can make an important contribution to many B.C. communities, e.g. a non-tower form that supports neighbourhood business viability and cost effective transit delivery, protracted regulatory reform constrains mass timber construction starts. As part of the 2021 International Building Code, the International Code Council adopted provisions to permit up to 18 storeys in mass timber. A number of jurisdictions are enacting the provisions, including a growing number of U.S. states and cities, e.g. California, Georgia, Idaho, Oregon, Utah, Virginia, Washington and City of Denver. An 18 storey building height—or more—has immense potential to grow mass timber construction and manufacturing.

Multi-Level, Multi-Sectoral Capacity Building

3. **Establish a central clearing house of information on mass timber and prefabricated construction** to support all levels of government, industry, professions and trades to support knowledge sharing and facilitate market transformation with several key components:

- **Tracking Alternative Solutions** generated across the province would permit industry, code consultants and building and fire officials to readily access accepted Alternative Solutions to adopt and/or build on. It would permits key B.C. Government bodies (e.g. Housing and Construction Standards, OMTI in Jobs, Economic Development and Industry and Energy, Mines & Low Carbon Innovation) apprised of innovations that can readily strengthen fire and safety codes, advance carbon performance and support economic development.
- **House diverse knowledge sharing materials** such as best practice guides, case studies, embodied carbon accounting methodologies, relevant peer reviewed literature, and possibly even major events generated by diverse organizations.

It would be prudent to reflect on the optimal scope of such a clearing house. While this project heard a pressing need for mass timber market transformation knowledge sharing, it may be appropriate to have a broader perspective given the diverse needs of key user groups. It would prudent, for example, to track all Alternative Solutions versus only those related to mass timber. Many of the permitting solutions laid out in this guide, e.g. digital processing and phased permitting, are relevant to all prefabricated construction and advance the very same objectives, e.g. value-add, economic development, climate action and labour force transition. The exercise could be phased, e.g. starting

Developer/Applicant Team Solutions

Provincial Solutions

with mass timber and then expand. It may initially be hosted in the private or social sector and migrate to government. The Environmental Protection Agency hosts a number of actively used clearing houses across a diversity of topics.

4. **Build local government building permitting capacity,** mobilizing knowledge and advancing novel practices that address the evolving state, complexity and standards of contemporary construction and address acute budgetary and labour force constraints, notably supporting the transition to digital processing which may include diverse types of financial support.

5. **Evaluate the need for certification of a code and standard professional to expedite and simplify approvals.** As expectations for sustainable and resilient construction and technological innovations evolve, so do new building requirements. These new requirements may not always be life-safety in nature, but still require some form of scrutiny and approval. A form of code and standard professional could address these matters including energy, stormwater, wildfire, LEED and other sustainable/resilient standards. This could remove the burden of this review from municipal officials and expedite the process.

Provincial Code and Standard Modernization

6. **Modernize the code update process to accommodate more frequent code changes.** Industry innovation in mass timber is eclipsing current building and fire code requirements. Professionals are generating Alternative Solutions, as per above, that can be used to support iterative updates. The current lag time in code updates results in permitting delays, administrative burden and additional industry and municipal costs. In the USA, code changes occur more frequently. More frequent code changes in Canada would help advance the mass timber industry.

7. **Accelerate building product certification and code integration.** The national process to certify products necessary for mass timber and prefabricated construction lags behind code updates. This results in Alternative Solutions being routinely requested. There is a need to both accelerate product certification and iteratively update codes to accommodate product certification, driven by code changes.

Value Added Manufacturing Capacity

8. **Simultaneously growing new prefabricated, MT construction starts (demand) and supporting expansion of prefabricated, MT manufacturing capacity (supply) is essential to grow this sector.** Transitioning to a prefabricated and mass timber construction will require a sustained and reliable supply of materials and components (panels, beams, connectors, etc.). The existing "chicken and egg" problem is hampering supply and needs to be addressed to remove uncertainty, reduce costs and foremostly drive investor confidence in manufacturing sector expansion. Provincial action can include guaranteed loans for manufacturing equipment, guaranteeing purchase contracts and capitalizing on the hundreds of strategically-located underutilized public land parcels to build affordable housing and other complementary uses.

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Brock Commons Tallwood House -
Tall Wood Building progress.
Credit: naturallywood.com
Photographer: KK Law
(flickr.com)

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Acronyms & Abbreviations

AHJ	Authorities Having Jurisdiction
BOABC	Building Officers Association of BC
BCBC	British Columbia Building Code
BCFC	British Columbia Fire Code
BCIT	British Columbia Institute of Technology
BIM	Building Information Modelling
BMC	BIM-based Model Checking
BP	Building Permit
BSSB	Building and Safety Standards Branch, Office of Housing and Construction Standards B.C.
CLT	Cross Laminated Timber
DP	Development Permit
DLT	Dowel Laminated Timber
ESC	Energy Step Code
EMTC	Encapsulated Mass Timber Construction
FSR	Floor Space Ratio
GHG	Greenhouse Gas
Glulam	Glue Laminated Timber
LWF	Light Wood Frame
MT	Mass Timber
NBC	National Building Code
NFC	National Fire Code
OCP	Official Community Plan
Prefab	Prefabricated
SFU	Simon Fraser University
UBC	University of British Columbia

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Resources

Context

Reports and Guides:

Mass Timber and Affordable Housing

B.C. Mass Timber Action Plan

The State of Mass Timber in Canada (2021)

Summary of CWC Fire Test

The Local Government Guide - Policies, Programs, and Incentives to reduce Embodied Emissions in the Built Environment

Websites

What is mass timber?

The CLT Handbook (2019 edition) includes a full discussion about the sustainability of mass timber

The Tall Wood Design Guide (2022)

Fire testing of rooms with exposed wood surfaces in encapsulated mass timber construction

Fire performance of mass-timber encapsulation methods and the effect of encapsulation on char rate of cross-laminated timber Fire Safety of CLT Buildings in Canada

Local Solutions Guide

Community Plans and Zoning

Mid-rise Mass Timber Zoning and Lot Size Analysis

Policies, Programs and Incentives to Reduce Embodied Emissions in the Built Environment

Development Permit Design Guidelines

Design Barriers to Mass Timber Construction: Providing Design Guidance for Mid-Rise Mass Timber Buildings

What is Holding Back the Expanded Use of Prefabricated Wood Building Systems

City of Vancouver Zoning and Development By-law Amendments for Mass Timber Construction

Building Permitting

Building Permit Process Enhancement: Guiding Principles

Report and Guides

CLT Handbook 2019 edition – FP Innovations

Technical Guide for Tall Wood Buildings 2022 edition – FP Innovations

AIBC / EGBC Encapsulated Mass Timber Guide up to 12 storeys

Websites

Naturally:wood

Canadian Wood Council

Amercian Wood Council

BC WoodWORKS!

Mass Timber Factsheet

Collaborative Action

B.C.'s Mass Timber Action Plan

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