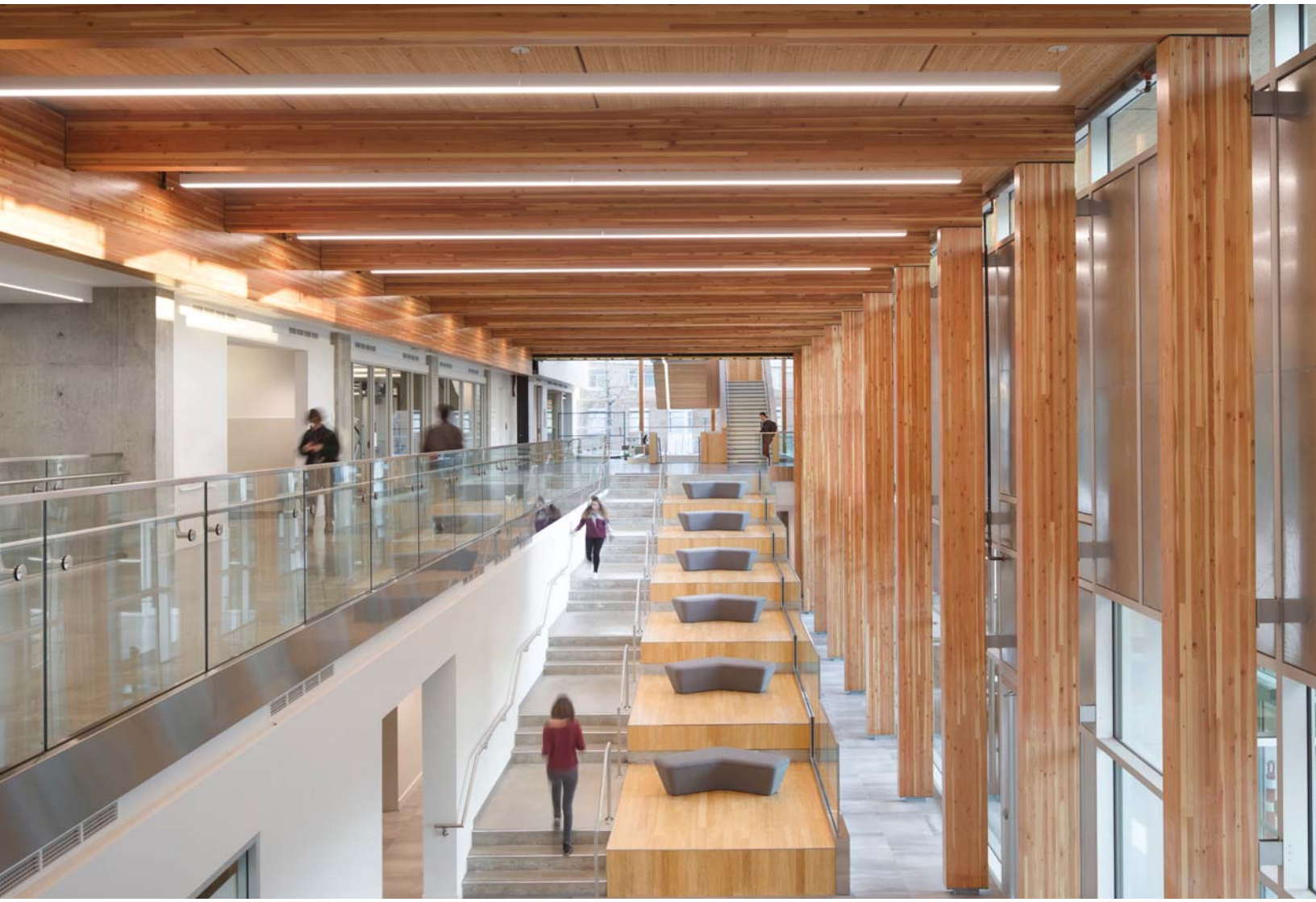
MASS TIMBER INFLUENCERS

Understanding mass timber perceptions among key industry influencers



PERKINS+WILL

Forestry Innovation Investment

08 AUGUST 2018

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We extend a special thank you to the event panelists for sharing their expertise and enriching the conversation on a sustainable, low-carbon future.

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Cover Image: Orchard Commons, Vancouver BC, Perkins+Will. (Photo: Michael Elkan)

MASS TIMBER INFLUENCERS /

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SECTION 01. INTRODUCTION

Earth Sciences Building, Vancouver BC, Perkins+Will. (Photo: Martin Tessler)

SUMMARY

Mass timber is gaining momentum in BC and beyond—how do we encourage a systemic shift towards a sustainable, low-carbon future?

We are experiencing a renaissance in the use of wood driven by technology and a desire to live in a more healthy, sustainable environment.

The growing field of mass timber challenges conventional concrete and steel building systems. BC is home to a number of precedent-setting mass timber projects that demonstrate the viability of a sustainable, low-carbon approach.

However, broader acceptance of mass timber requires concerted industry-wide efforts to share knowledge with all project stakeholders, including key 'influencer' industries (i.e. leasing/ marketing, financing/lending, and insurance), who have a significant impact on building design and construction decisions.

As key influencers of a project's decision-making process, it is critical for leasing, financing and insurance partners to have a clear understanding of mass timber compared to conventional concrete and steel approaches from pre-design through post-occupancy.

This document aims to reframe the conversation around mass timber by engaging these key influencer industries to understand their current perceptions, as well as next steps needed to clarify the design and construction process and accelerate the adoption of innovative wood systems in BC.

The following pages provide:

- An overview of mass timber and its relevance to contemporary design and construction;
- Findings from a preliminary perception survey and panel session with key industry influencers;
- Key benefits and barriers for adoption of mass timber, including areas for further research; and
- Recommendations and next steps to accelerate adoption of mass timber in BC.

Cross-Laminated Timber (CLT)

Glue-Laminated Timber (Glulam or GLT)

Dowel-Laminated Timber (DLT)

Nail Laminated Timber (NLT)

Laminated Veneer Lumber (LVL)

Mass Ply Panel (MPP)

Laminated Strand Lumber (LSL)

Parallel Strand Lumber (PSL)

Photo: Perkins+Will

WHAT IS MASS TIMBER?

BUILDING WITH WOOD

Wood is one of the oldest construction materials known to us, yet we are still discovering new applications through material research and sophisticated engineering approaches.

Some of the most cherished heritage buildings in Vancouver and around the world were built in the early 20th century using solid sawn lumber, i.e. heavy timber[1]. These historic buildings still continue to thrive as modern working and living spaces. The Horyu-ji Temple located in Nara, Japan, built over 1400 years ago, is the oldest surviving wood building, and is a testament to the capability of wood structures to endure seismic and wet climate environments for centuries.

LIGHT WOOD FRAME VS MASS TIMBER

Light wood frame structures are comprised of dimensional lumber, which are mechanically fastened to create a frame, and then enclosed for fire and weather protection.

Unlike light wood frame, mass timber structures are comprised of engineered wood products (such as CLT, LVL, Glulam, and LSL—see previous page) which are assembled with sophisticated connectors to create a panelized or post-and-beam system.

Mass timber structures incorporate minimal steel and concrete elements (typically as engineered connectors and toppings respectively) to create a light-weight, durable, low-carbon structural system with load capacities similar to concrete and steel structural systems. Some of the key characteristics of mass timber buildings include:

Material characteristics

- Lighter weight material that meets the same load capacities as concrete structures.
- Predictable fire-resistance performance.
- Better thermal resistance, resulting in lower heat loss.
- Wood is a renewable resource.

Design characteristics

- Greater quality control through prefabrication and integration of services in a factory-setting.
- Structural wood products that could double as interior finishes.

Construction characteristics

- Faster construction of superstructure.
- Use of local wood species to create mass timber products that are consistent in strength and performance.
- Composite/hybrid construction potential using concrete and steel.
- Quiet and safer construction sites.

Experiential characteristics

- Potential to leverage the warmth of wood to create biophilic experiences for end users.

MATERIAL

- Light-weight
- Predictable fire-resistance
- Better thermal resistance
- Renewable

DESIGN

- Pre-fabrication potential
- Integrated services potential
- Structural product as interior finish

CONSTRUCTION

- Regional variance
- Composite / hybrid potential
- Quiet / safer construction

EXPERIENCE

- Biophilic experience
- Warm interiors

Orchard Commons, Vancouver BC, Perkins+Will. (Photo: Michael Elkan)

CONSTRUCTION TRENDS AND WOOD

With increasing pressure to reduce our carbon footprint, it is critical to identify key drivers for greater adoption of renewable resources.

We have reached a global tipping point in terms of climate change. The building sector is the single largest contributor to global greenhouse gas (GHG) emissions[2].

We are also experiencing rapid migration to urban centres. More than half the world's population (54%) currently live in cities, and this will change to 66% by 2050[3]. This means 2 out 3 people in the world will be living in cities in the near future and will need meaningful and sustainable spaces to live and work.

We have an incomprehensibly large and unmet demand for high-performance buildings in increasingly complex, urban infill sites.

Conventional methods of construction are challenged to meet these growing pressures in a meaningful way.

Mass timber offers a fundamental shift in construction that is sustainable, renewable, fast, light, and durable. Mass timber offers a 'do more good' framework.

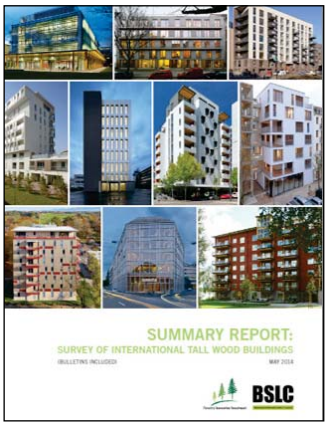
Through the use of engineered wood, we now have the ability to create light-weight, prefabricated structures that can be rapidly assembled on site that offer the same or higher level of performance compared to concrete and steel structures. Mass timber utilizes the least amount of energy to fabricate and contributes lower greenhouse gas emissions when compared with other structural materials[4].

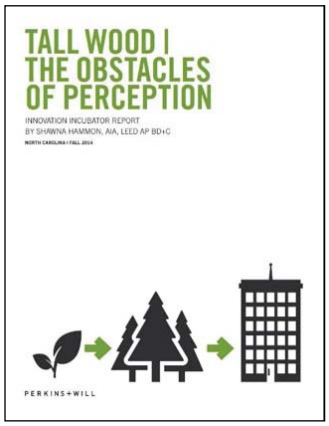
BC is home to a number of demonstration mass timber buildings that have become valuable precedents for future projects. As more project stakeholders explore mass timber for economic, environmental and other reasons, we need to identify key drivers that will shift mass timber from demonstration applications to a commonly accepted solution.

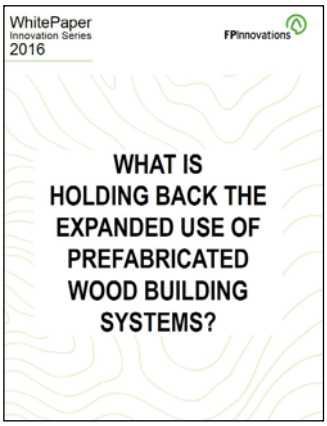
SECTION 02. BACKGROUND

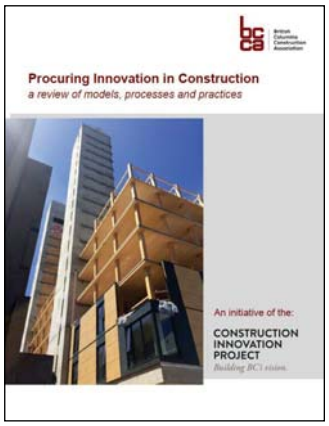
Centre for Interactive Research on Sustainability (CIRS), Vancouver BC, Perkins+Will. (Photo: Michael Elkan)

EXISTING STUDIES









KEY RELEVANT STUDIES

Key reports that capture local and global market trends and perceptions are highlighted here for reference. These reports engage a number of key project stakeholders, including design and engineering professionals, Authorities Having Jurisdiction (AHJ), contractors, and developer/owners.

This report follows in the footsteps of these and other similar initiatives in an attempt to understand perceptions of 'influencer' industries, i.e. those in leasing/marketing, lending, and insurance, towards mass timber construction in British Columbia.

Survey of International Tall Wood Buildings

Forestry Innovation Investment + Binational Softwood Lumber Council + Perkins+Will 2014

This report documents an in-depth survey of key project stakeholders involved in the successful completion of 10 tall wood buildings in several countries around the world, and summarizes their insights and lessons learned.

Tall Wood | Obstacles of Perception

Perkins+Will
2016

This document summarizes the findings from an online survey of public perceptions of engineered wood, and identifies key trends and barriers of adoption for tall wood buildings. Survey responses were received from all across the United States, with greater responses from Eastern US.

What is holding back the expanded use of prefabricated wood building systems?

FPInnovations 2016

This white paper summarizes findings from interviews with key project stakeholders around the world to understand opportunities and barriers for adoption of prefabricated elements in wood buildings in BC and across Canada.

Procuring Innovation in Construction: A review of models, processes, and practices

British Columbia Construction Association 2017

This report uses mass timber as a case study to identify opportunities for accommodating and encouraging innovative processes and new technologies in the construction industry.

*Refer to **Section 05. Appendix: Resources** for additional references on mass timber.*

Dalston Lane
London, UK
10 Stories
2013

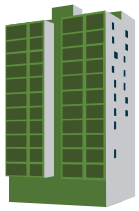
Contralaminada
Lleida, Spain
8 Stories
2014

Wood Innovation & Design Centre
British Columbia, Canada
8 Stories
2014

Strandparken
Stockholm, Sweden
8 Stories
2014

Puukuokka
Jyväskylä, Finland
8 Stories
2015

Banyan Wharf
London, UK
10 Stories
2015

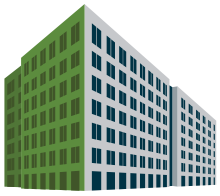


TREET
Bergen, Norway
14 Stories
2015

19 TALL WOOD BUILDINGS
(7 STORIES OR TALLER)
ARE
UNDERWAY OR HAVE BEEN BUILT
IN THE PAST
5 YEARS

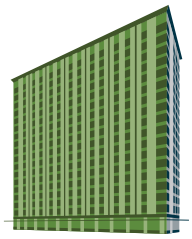
Moholt 50/50
Trondheim, Norway
9 Stories
2016

Arbora
Montréal, Canada
8 Stories
2016

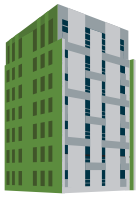


T3
Minnesota, United States
7 Stories
2016

Origine Condos
Quebec City, Canada
13 Stories
2017

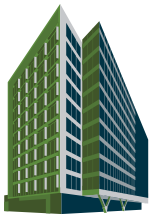


Brock Commons Tallwood House
Vancouver, Canada
18 Stories
2017

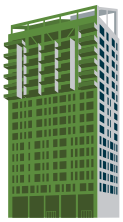


Sanctuary
Scotland
7 Stories
2018

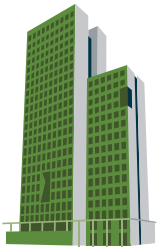
Carbon 12
Portland, United States
8 Stories
2018



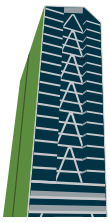
5 King
Australia
10 Stories
Under Construction
2018



Mjøstårnet
Norway
18 Stories
Under Construction
2018

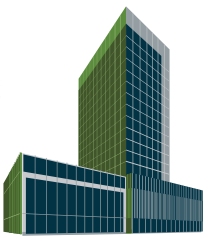


HoHo Vienna
Vienna, Austria
24 Stories
Under Construction
2018



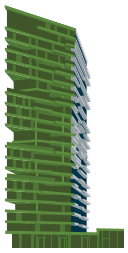
Silva
Bordeaux, France
18 Stories
Under Construction
2020

T3 West Midtown
Atlanta, United States
7 Stories
Under Construction



Sida Vid Sida
Skellefteå, Sweden
19 Stories
Announced
2019

Hypérion
Bordeaux, France
18 Stories
Proposed
2020



Haut
Amsterdam, Netherlands
Proposed
21 Stories

Tall Wood Buildings Around the World (Source: ThinkWood[5])

SURVEY AND PANEL SESSION: OVERVIEW

Two approaches were taken to identify key perceptions towards mass timber within the influencer industries—an online survey and a panel session.

SURVEY OVERVIEW

An online survey was designed to collect data from leaders in leasing/marketing, financing/lending, and insurance industries (influencers).

Participants for the survey were identified by contacting industry influencers directly, and by encouraging owner/developers to share the survey with their network of influencers. The survey was comprised of 12 questions that were broken down into 6 key sections:

- Demographic information (i.e. participant's industry / area of expertise)
- Familiarity with mass timber
- Marketability + leasing factors
- Fire + water risk factors
- Cost factors
- Maintenance + performance factors

Response Rate

The survey was shared with 118 stakeholders in BC (predominantly in Metro Vancouver), including developer/owners, between April 24-May 17, 2018. A total of 38 responses were received (32% response rate), of which 30 respondents completed the full survey. Percentage of responses noted in the following pages are based on total number of responses received for each question. Demographic breakdown, as self-identified by participants, are as follows:

- Developer/Owner – 26% (10)
- Insurance – 8% (7)
- Lending/financing – 16% (6)
- Leasing – 8% (3)
- Other (includes design professionals, Authorities Having Jurisdiction, etc.) – 32% (12).

The survey response rate is reflective of the limited number of players in these industries in Metro Vancouver. We recommend greater in-depth engagement through one-on-one discussions or focused surveys to further refine key perceptions.

PANEL SESSION OVERVIEW

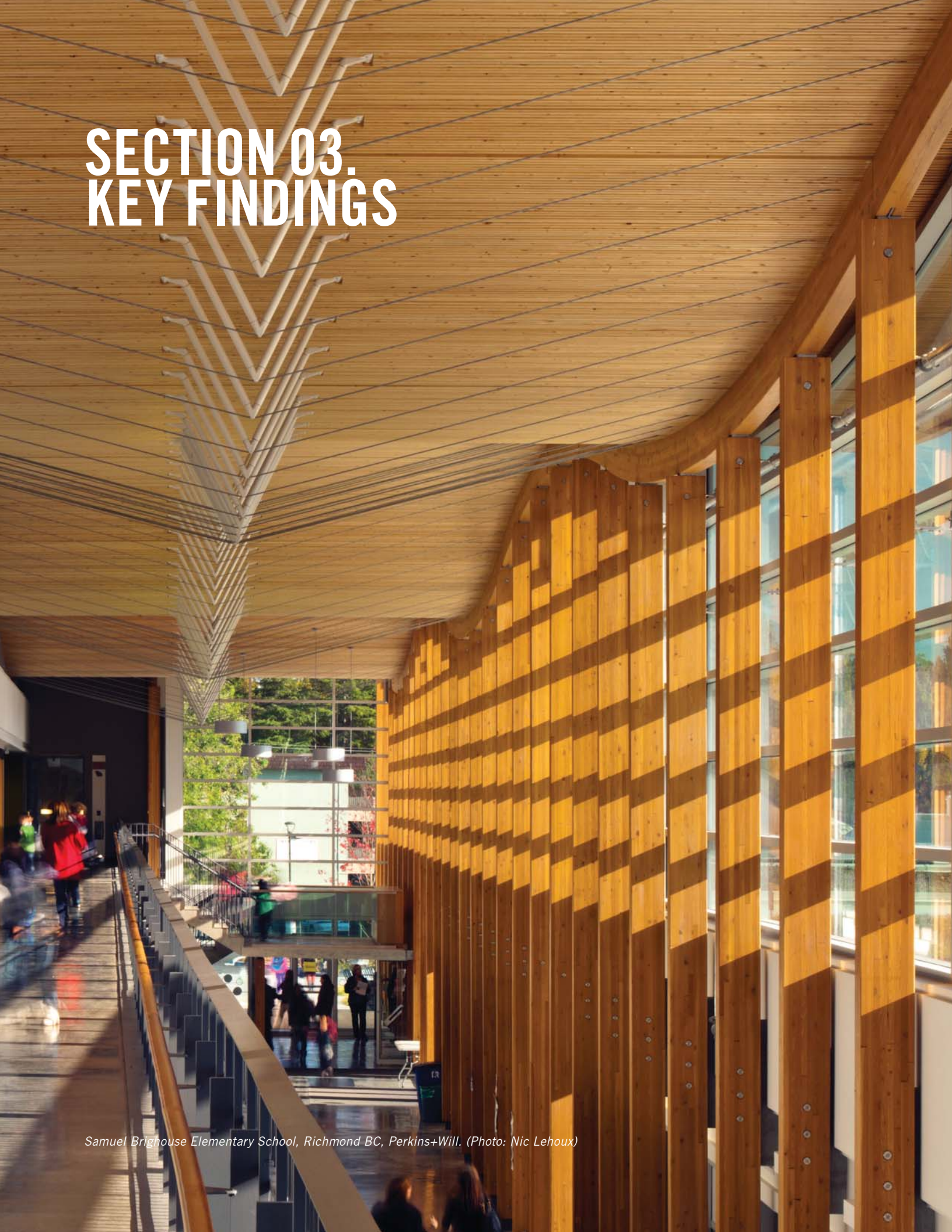
The survey responses provided a cursory overview of industry perceptions towards mass timber, and offered context for discussion at the Mass Timber Influencers panel event that was held at the Perkins+Will Vancouver office on May 24, 2018.

The panel session kicked off with an introductory presentation by Perkins+Will and FII who provided an overview of mass timber, current trends, and preliminary survey results.

The moderated panel discussion included experts from the insurance industry (Jeff McLellan, BFL Canada), owner/client (John Metras, UBC), local municipality (Sean Pander, City of Vancouver), developer industry (Rocky Sethi, Adera Development), and marketing industry (Greg Zayadi, Rennie Marketing Systems).

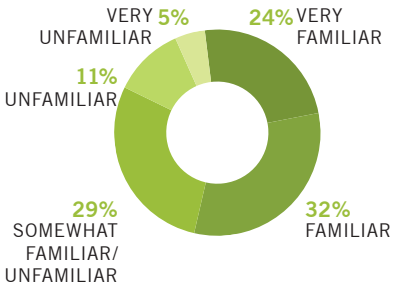
Topics for the panel discussion were framed around key trends from the survey responses. Panelists' commentaries are noted along with key trends in the following pages.

SECTION 03.
KEY FINDINGS

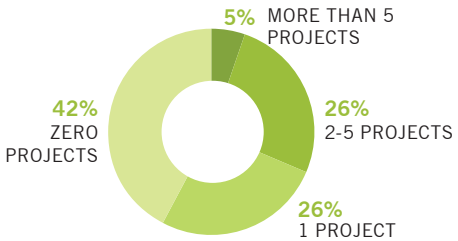


Samuel Brighouse Elementary School, Richmond BC, Perkins+Will. (Photo: Nic Lehoux)

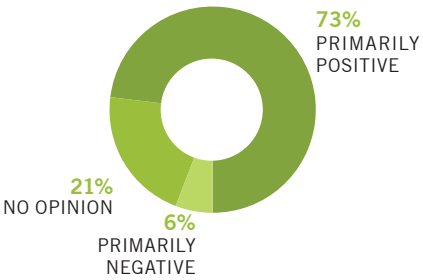
OVERALL FAMILIARITY



HOW FAMILIAR ARE YOU WITH MASS TIMBER AS A STRUCTURAL SYSTEM?



HOW MANY MASS TIMBER PROJECTS HAVE YOU WORKED ON?



WHAT IS YOUR CURRENT PERCEPTION OF MASS TIMBER AS A STRUCTURAL SYSTEM?

FAMILIARITY

The survey found that the majority of respondents were familiar with mass timber as a structural system to some degree, even though half of them have not worked on a mass timber project.

In spite of the limited experience on built projects, there is a primarily positive perception of mass timber.

In fact, most respondents (88%) were able to distinguish mass timber and light wood frame as two different structural systems.

The overall positive perception and familiarity with mass timber, combined with the lack of project experience, confirm a critical need to identify key drivers that will help participants—and the larger design and construction industry—to engage in mass timber projects.

WHAT ARE THE TOP 3 DRIVERS THAT YOU NEED TO ADVOCATE FOR A MASS TIMBER BUILDING?

All influencers who attended the panel session were asked to answer the above question in an effort to identify critical factors that drive their decision-making process. Broad trends emerged in their responses—listed below in order of priority:

- Cost (22%)
- Process/Capability + Supply Chain (22%)
- Durability (9%)
- Sustainability (9%)
- Flexibility (8%)
- Marketability (8%)
- Policy (7%)
- Building Code Approvals (7%)
- Insurance (4%)
- Construction Training + Awareness (4%)

Cost, process/capability and supply chain emerged as leading factors that drive Influencers decision-making processes. This aligns with the following key points raised in the panel discussion:

- **Cost competitiveness:** Mass timber is often perceived to not be cost-competitive. This may partly be driven by current models of early design that are limited to structural material costs, and are not able to take on a holistic approach to costing that includes schedule impacts, speed of construction etc.
- **Construction benefits:** Process/capability benefits of mass timber construction are perceived as strengths. This includes speed of construction, ability to work in a short construction season, factory-based quality control, improved safety, improved construction tolerance etc.
- **Fabrication capacity:** Expanding mass timber manufacturing/fabrication capacity is necessary to generate cost-competitive bids.

FACTOR		% OF RESPONSE	AGREE OR STRONGLY AGREE THAT...
DURABILITY		69%	MASS TIMBER BUILDINGS ARE ABOUT THE SAME OR BETTER IN DURABILITY COMPARED TO CONCRETE AND STEEL BUILDINGS
SEISMIC		91%	MASS TIMBER BUILDINGS PERFORM ABOUT THE SAME OR BETTER IN EARTHQUAKES COMPARED TO CONCRETE AND STEEL BUILDINGS
SUSTAINABILITY		81%	MASS TIMBER BUILDINGS ARE MORE SUSTAINABLE COMPARED TO CONCRETE AND STEEL BUILDINGS
SCHEDULE		81%	MASS TIMBER BUILDINGS DO NOT TAKE LONGER TO BUILD COMPARED TO CONCRETE AND STEEL BUILDINGS
STRENGTH		57%	MASS TIMBER STRUCTURES ARE AS STRONG AS CONCRETE AND STEEL STRUCTURES

BENEFITS AND OPPORTUNITIES

Based on the survey results and discussions at the Influencers Event, the following key trends on benefits / opportunities of mass timber emerged:

DURABILITY / STRENGTH

- Prefabrication potential, factory-based quality control, and use of building information modeling (BIM) are some of the underlying aspects that contribute to the overall strength and durability of mass timber.
- Example: Brock Commons was able to achieve +/- 2mm tolerance[6] through assembly in a controlled factory setting, which is nearly impossible to achieve in conventional concrete and steel construction.

SEISMIC PERFORMANCE

- Given that the value of using a light-weight structure to deal with seismic activity appears to be well-understood among survey participants, further research is recommended to understand if this perception has any impact on determining insurance costs.

SUSTAINABILITY

- Recent changes in the BC Energy Step Code and the City of Vancouver's Zero Emissions Building Plan target reductions in operational energy in an effort to begin reducing building GHG emissions. As buildings reduce operational energy, the relative importance of embodied energy rises quickly. As a low-carbon material, mass timber has significant potential to reduce the overall GHG emissions of the building sector.
- Some existing policies (such as the City of Vancouver's Zero Emissions Building Plan) actively seek data on embodied energy through LCA (Life Cycle Analysis). Future policy mandates would need to be in place to encourage the use of low-carbon materials in construction.
- Rising land values and growing pressure to densify urban centres in Metro Vancouver has led to the deconstruction of older building stock. Mass timber has the potential to be reused or repurposed in the event of disassembly at end of the project's life, thus allowing for longer carbon sequestration and reuse of construction materials.

SCHEDULE

- The ability to build quickly within tight infill sites, and off-site fabrication and assembly, are some of the underlying aspects that contribute to the overall construction schedule benefits of mass timber.
- While there are perceived construction schedule benefits, trades need to catch up to the speed of mass timber erection, in order to fully leverage the schedule benefits of building with mass timber.

FACTOR	% OF RESPONSE	AGREE OR STRONGLY AGREE THAT...
WATER DAMAGE POTENTIAL-CONSTRUCTION 	63%	MASS TIMBER BUILDINGS HAVE WORSE WATER DAMAGE POTENTIAL DURING CONSTRUCTION THAN CONCRETE AND STEEL BUILDINGS
WATER DAMAGE POTENTIAL-POST CONSTRUCTION 	56%	MASS TIMBER BUILDINGS HAVE WORSE WATER DAMAGE POTENTIAL POST CONSTRUCTION THAN CONCRETE AND STEEL BUILDINGS
FIRE PROTECTION-CONSTRUCTION 	61%	MASS TIMBER BUILDINGS HAVE WORSE FIRE-PROTECTION PERFORMANCE DURING CONSTRUCTION THAN CONCRETE AND STEEL BUILDINGS

BARRIERS AND PERCEIVED RISKS

Based on the survey results and discussions at the Influencers Event, the following key trends on barriers/ perceived risks of mass timber emerged:

WATER DAMAGE

- Water-related damage is the largest source of claims for homeowners in Canada, surpassing fire and theft[7]. As a result, water damage potential, both during and post-construction, are perceived as significant risks for mass timber adoption.
- Encouraging insurance influencers to view/understand studies such as submersion tests is critical to shift perceptions.

Construction

- Several measures can be taken during the construction process to avoid or limit exposure to water, such as temporary roofing, and funnels for water drainage. However, these concepts are not well understood by all project stakeholders.

Post-construction

- Management of post-construction water damage risk can also be addressed through simple design strategies such as providing floor drains, and leak detection systems, and maintenance and repair awareness. However, these concepts are not well understood by all project stakeholders.

FIRE PROTECTION

- Limited awareness among insurers and underwriters of mass timber's fire performance capabilities, as well as regulatory building code barriers were cited as some of the key underlying obstacles in regards to fire protection.
- Encouraging insurance influencers to view/understand studies such as field fire-tests is critical to shift perceptions.

Construction

- Several measures can be undertaken to improve fire safety during construction including provision of fire suppression, improved understanding of inherent fire-resistance of mass timber, and limited need for on-site welding work. However, these measures are not well understood by all project stakeholders.
- As a result, fire protection strategies during construction are still discussed on a project-by-project basis with local building authorities through Alternative Solutions.

Post-construction

- The Canadian building code categorizes mass timber and light wood frame together as combustible construction. The allowable height for combustible construction is based on historic fire fighting capabilities[8] from the turn of the century, and not on current technological advances in construction, fire fighting and fire protection strategies.
- As a result, post-construction fire strategies are still discussed on a project-by-project basis with local building authorities through Alternative Solutions.

FACTOR		% OF RESPONSE	NEITHER AGREE/DISAGREE OR DON'T KNOW...
CONSTRUCTION INSURANCE COSTS		45%	MASS TIMBER BUILDINGS HAVE HIGHER CONSTRUCTION INSURANCE COSTS COMPARED TO STEEL AND CONCRETE BUILDINGS
POST-CONSTRUCTION INSURANCE COSTS		52%	POST-CONSTRUCTION INSURANCE: MASS TIMBER BUILDINGS HAVE HIGHER POST-CONSTRUCTION INSURANCE COSTS COMPARED TO STEEL AND CONCRETE BUILDINGS
LEASING/ MARKETING		45%	EXPOSED MASS TIMBER STRUCTURES OFFER A LEASING ADVANTAGE COMPARED TO CONCRETE AND STEEL STRUCTURES
MAINTENANCE/ PERFORMANCE		57%	MASS TIMBER BUILDINGS REQUIRE GREATER ONGOING MAINTENANCE AS COMPARED TO CONCRETE AND STEEL BUILDINGS.

AREAS FOR FURTHER INVESTIGATION

The survey results and discussions at the Influencers Event were wide spread in perception indicating a lack of consensus on the following topics:

INSURANCE COSTS

- Even though mass timber has been in use for several decades as primary structural elements, it has yet to be fully recognized in the insurance industry as a unique approach that is comparable to concrete and steel systems.
- General perception within the insurance industry is that "wood is wood", i.e. mass timber and light wood frame can be grouped under the same classification in terms of insurance evaluations.
- Ongoing efforts by insurance industry leaders to classify mass timber as a separate structural category needs greater support in order to result in broad industry-wide re-evaluations.
- Ongoing efforts by insurance industry leaders need greater support to leverage knowledge and lessons learned from their European counterparts where mass timber has broader acceptance.

LEASING/MARKETING

- General perception within the leasing/marketing industry is similar to that of their insurance counterparts as "wood is wood", i.e. mass timber and light wood frame are perceived to be similar structural systems.
- Owner/end user confidence is further clouded by a general lack of understanding of the hybrid nature of typical mass timber systems (i.e. the use of concrete and steel elements along with mass timber panels).
- While survey results indicated a general appreciation of health/wellness benefits of exposed mass timber structures, these were not perceived as beneficial from a leasing/marketing perspective.
- Higher quality and durability of construction achieved through prefabrication and integration of services in a factory-based setting were perceived as positive aspects that could be leveraged as a leasing/marketing advantage, especially for early adopters.

OPERATIONS/MAINTENANCE

- Lack of general understanding of ongoing operations/maintenance requirements of mass timber buildings, combined with a general perception of post-construction risk of water damage, further limits owner/end user confidence.

SECTION 04.
LOOKING FORWARD

Nexen CNOOC Ltd. Housing Module Prototype, Dilly Creek BC, Perkins+Will. (Photo: Perkins+Will)

CONCLUSIONS AND NEXT STEPS

The following recommendations and next steps are based on key questions that emerged in the survey and at the Influencers Event. Further engagement of leaders in each influencer industry is recommended to refine these findings and accelerate the adoption of mass timber in BC.

01/ AWARENESS AND EDUCATION

- Improve awareness among influencers and general public to distinguish between light wood frame and mass timber
- Increase awareness among influencers and general public on the equivalent performance of mass timber compared to concrete and steel structural systems.
- Improve communication of quality, durability, sustainability, aesthetic appeal as well as tangible health, and wellness benefits of mass timber to early adopters.

02/ CONSTRUCTION BEST PRACTICES TO MITIGATE RISK

- Understand history of construction insurance claims for mass timber buildings (compared to concrete and steel buildings).
- Collaborate with insurance industry leaders (including underwriters) to identify best design and construction practices that would mitigate key construction risk factors for mass timber buildings.

03/ OPERATIONAL BEST PRACTICES TO MITIGATE RISK

- Understand history of post-construction insurance claims for mass timber buildings (compared to concrete and steel buildings).
- Collaborate with insurance industry leaders (including underwriters) as well as owners/ facility managers/ end users to identify best design and operational management practices that would mitigate post-construction risk factors for mass timber buildings.

04/ CONSTRUCTION COST BEST PRACTICES

- Collaborate with key stakeholders such as cost consultants, quantity surveyors, design and engineering professionals, and contractors to identify construction cost best practices that account for broader cost benefits and impacts of mass timber on the overall design and construction of a project.

05/ POLICY MANDATES

- Strengthen existing policy mandates on reducing GHG emissions of buildings by support/ incentivize low-carbon structures with low embodied energy.
- Support/incentivize demonstration mass timber projects that are repeatable, and encourage greater adoption of low-carbon structures.

SECTION 05. APPENDIX

Cross Roads, Vancouver BC, Perkins+Will. (Photo: Latreille Delage Photography)

SELECTED RESOURCES

For further reading, selected references on mass timber that are relevant to the various influencer industries are listed below. Additional resources can be found through research databases of key research and advocacy organizations such as:

- Canadian Wood Council (www.cwc.ca),
- FPInnovations (www.fpinnovations.ca)
- Naturally:wood (www.naturallywood.com)
- Think Wood and Think Wood Research Library (www.thinkwood.com, www.research.thinkwood.com)
- WoodWorks! (www.wood-works.ca)

Market Trends and Perceptions

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Technical Resources

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12. Fell, D., and Augustin, S (2015). **Wood as a Restorative Material in Healthcare Environments.** FPInnovations.
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15. Wang, J (2018). **Wetting and Drying Performance related to on-site Moisture Protection of Cross-Laminated Timber.** FPInnovations.

ENDNOTES

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2 United Nations Environment Programme (2016). The 10YFP Programme on Sustainable Buildings and Construction, available at: http://www.oneplanetnetwork.org/sites/default/files/10yfp-sbc-brochure-en.pdf

3 United Nations, (2014). World's population increasingly urban with more than half living in urban areas, available at: http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html.

4 BC Ministry of the Environmental and Climate Change Strategy (2017). LEED v4 and Low Carbon Building Materials: A Comprehensive Guide.

5 Think Wood (2018). Looking Up: Tall Wood Buildings Around the World, available at: https://www.thinkwood.com/wp-content/uploads/2018/02/Think-Wood_Looking-Up-Tall-Wood-Buildings-2018.pdf

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7 KPMG, (2014). Water Damage Risk and Canadian Property Insurance Pricing, Canadian Institute of Actuaries.

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Pitt River Middle School, Coquitlam BC, Perkins+Will. (Photo: Latreille Delage Photography)

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