With the advent of modern mass timber products and systems, a renaissance in construction of tall wood buildings is underway. Some of the earliest multi-story buildings that were built during the move to urbanization were timber. Some of these heavy timber structures, which can still be found today in the urban cores of cities that were established more than 100 years ago, have been repurposed from their original light industrial applications to multi-residential units or offices. As the world’s population grows and becomes even more concentrated in urban areas, there is going to be greater demand for larger buildings – both to provide services, as well as to house people – and building with materials that have minimal impact to the environment would be preferred. This desire for construction using sustainably produced materials that are engineered specifically for building construction has triggered initiatives both in Canada and the U.S. to support demonstration projects showcasing mass timber technology and tall wood buildings.

This guide is part of the Canadian tall wood building initiative. It is intended to be used by design and construction teams as a resource that provides the concepts and background to respond to questions that would arise when designing beyond the height and area limits prescribed by the acceptable solutions in the National Building Code of Canada (NBCC).

This multi-disciplinary guide is organized under nine chapters.

The chapter, Building as a System, takes the architect’s view of the conceptual design process and applies this to tall wood buildings. Thoughts on the integration of all building systems, the building envelope, performance detailing, architectural form and function, and flexibility from the outset of the design process are discussed. This chapter presents principles and potential solutions to help designers, owners, and construction teams navigate through this integration process. As tall wood buildings fall outside the specified
acceptable solutions in the NBCC, a general discussion on code compliance following the “alternative solutions” path is also included. In addition, this chapter includes information to assist the Authority Having Jurisdiction in establishing a process to evaluate a tall wood building project that adopts an alternative solution.

The chapter, Sustainability, covers a range of sustainability considerations and provides guidance on how to measure the environmental performance of tall wood buildings. Emphasis is placed on the science-based life cycle assessment (LCA) methodology, followed by a discussion of the various green building certification systems and other tools applicable to tall wood structures.

The chapter, Structural and Serviceability, reflects the structural engineer’s view as structural calculations are necessary for both strength and serviceability design. This chapter follows performance-based principles. It covers topics that span the entire structural design process and is intended to give the engineer direction in finding and refining the structural solution. In the Considerations for Conceptual Design section, several existing (historical and modern) and proposed tall mass timber and timber-hybrid buildings are presented.

The sections Design Considerations and Input Parameters for Connections and Assemblies, and Advanced Analysis and Testing of Systems for Design, may be used together to obtain basic performance data from testing materials and components for use in computer models to assess the performance of innovative building systems under gravity and lateral loads. For gravity structural systems, progressive and partial collapse is discussed. For the design of structural systems for earthquake loads, force modification factors for all-wood and hybrid lateral load resisting systems (wood/steel or reinforced concrete) are discussed.

Sound and vibration mitigation are important design considerations for multi-family or multi-party occupancies. The guide provides general direction to the designer on methods that might be employed to reduce or eliminate the issue as detraction from the occupants’ standpoint. It also recommends the best practices for implementation of the design solutions to achieve the design goals and to ensure the end users’ satisfaction.

The chapter, Fire Safety and Protection, covers all pertinent topics related to fire safety and fire protection. Currently, available acceptable solutions for addressing fire safety are often impediments to the use of advanced wood design solutions in buildings. This chapter presents guidelines for developing an alternative solution and demonstrating that a tall mass timber building can meet—or even surpass—the level of fire performance currently stipulated in the NBCC’s acceptable solutions for tall buildings of non-combustible construction. In order to limit the severity of a fire, it may be demonstrated that “complete encapsulation” of all mass timber elements with fire resistant membranes can result in an equal or better level of fire performance than that provided by buildings of noncombustible construction. A lesser level of encapsulation as well as exposure of certain mass timber elements may be demonstrated to provide an equivalent level of safety when compared to that of noncombustible construction. The pros and cons of three levels of encapsulation are considered: complete, limited, and no encapsulation (fully exposed). The potential for using enhanced fire protection systems, including enhanced sprinkler systems and smoke control systems to compensate for the additional risk of exposed timber, is also explored. This chapter addresses other concerns, such as flame spread in mass timber construction, the impact of combustible construction on building exposure and spatial separation, performance concerns during a fire following an earthquake, the treatment of void spaces, and fire during construction.

Fire and structural safety generally generate the most questions when wood is proposed for tall building construction. Other topics deemed to be as important for the success of tall wood buildings are also covered in the guide. Building Enclosure Design focuses on developing an understanding of the control functions and the critical barriers which form the layers that make up a building enclosure. Details of selected assemblies that might be used in a tall wood building are presented in the guide. Prefabrication and Inspection of Assemblies seeks to establish best practices and standards, which can provide confidence that what is designed in accordance with the intent of relevant building codes, can in fact be built to high standards of quality. Project and Construction Cost Considerations provides guidelines for consultants tasked with estimating costs associated with tall wood buildings higher than six stories. Monitoring and Maintenance includes recommendations for performance testing and monitoring and provides guidance on building maintenance to help building owners avoid unexpected high repair and replacement costs during operation.

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A working group comprised of Erol Karacabeyli of FPInnovations, Michael Green of MGA, Eric Karsh of Equilibrium, Andrew Harnsworth of GHL, Dave Ricketts of RDH, Joe Rekab of BTY, Kevin D. Below of Douglas Consultants, Cameron McCartney of NRC, and Helen Griffin of CWC has overseen the development of the guide. The contributions of more than 80 experts, who devoted much time to the development of the guide, are also greatly acknowledged.

The complete guide is available at www.fpinnovations.ca
Common Lessons from 10 Tall Wood Buildings Highlighted in New Survey

Rebecca Holt

Why not tall wood in North America? This is a question that many architects, developers and other building professionals have been asking themselves and the industry in recent years. While there has been an increase in interest for the use of wood in taller buildings in North America, stronger regulatory support and greater market acceptance for renewable materials in Europe and other parts of the world make the practice more common outside of North America.

A recently released report by Forestry Innovation Investment (FII) and the Binational Softwood Lumber Council (BSLC) aims to highlight the lessons learned from 10 completed projects around the world that demonstrate successful applications of mass timber technologies in buildings of five stories or higher. As interest in building tall with wood grows in North America, the value of learning from stakeholders with applied experience cannot be overstated.

The Survey of International Tall Wood Buildings gathered insights from the experiences of four key stakeholder groups involved in the projects, including developer/owners, design teams, authorities having jurisdiction, and construction teams. The goal of the survey is ultimately to increase the adoption of wood systems in tall building construction by presenting relevant stakeholders with information necessary to help simplify their processes and lower perceived risks of designing tall wood structures.

The survey includes design and construction best practices that address structure, lateral stability, fire protection, acoustics and vibration, system integration, moisture protection and durability concerns. Common lessons learned and trends across projects are also presented.

Strong collaboration between all involved stakeholders is often noted as the critical element for achieving success. Additional lessons and considerations include:

Commitment: All stakeholders agreed that the importance of committing to a timber solution at the start of the project is imperative. Innovation inevitably presents challenges and strong focus is required in order to achieve satisfactory results.

Planning: The importance of investing significant effort early in the design process to identify and subsequently resolve potential design and construction related issues was consistently emphasized by all stakeholders. Early planning is also essential to identify and anticipate additional effort associated with research and testing, and engaging with and obtaining approvals from the authority.

Collaboration: All stakeholder groups reported strong collaborative ties with research institutions, timber fabricators and each other. In general, the project construction timeline was potentially shortened by maximizing prefabrication of major structural elements according to those surveyed. Additionally, engaging early with the authority having jurisdiction and directly involving them in the design development process was key to a successful approvals process in almost all cases.

Holistic Innovation: Most stakeholders emphasized the need to approach mass timber/tall wood projects as wholly inno-
ulative, rather than with a focus on a single application, component or system that is related to wood elements. Project success was based on innovation in process, not just design strategies or material considerations. For instance, it was noted as highly beneficial to engage the construction team early in the process to align design concepts, regulatory requirements and construction realities, in an attempt to identify critical issues related to site, material selection, fabrication constraints and construction coordination. Similarly, for the authorities having jurisdiction, the approval process was expedited by the presentation of detailed research and well-developed design details that clearly achieved or exceeded building safety standards.

While perceived challenges remain for designing tall wood buildings, and design and construction solutions continue to be refined, the survey results confirm that wood is a viable option for attaining safe, cost-equivalent, high-performance tall buildings. Furthermore, it reveals critical details about project approach and process that will certainly inform the next generation of tall wood projects in North America and around the world.

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