DESIGN AND CONSTRUCTION OF TALL WOOD BUILDINGS: A GUIDE FOR BUILDING ENCLOSURE DESIGN

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EXTENDED ABSTRACT:

A technical guide for the design and construction of tall wood buildings in Canada has been published by a working group of industry experts with support from Natural Resources Canada. Tall wood buildings are defined as high-rise wood structures of 10 to 20 stories in height and will be the next generation of wood-based buildings beyond current 4 to 6 storey wood-frame buildings. The purpose of the guide is to assist practitioners with tall wood building designs and to help facilitate the acceptance of tall wood buildings by the Authority Having Jurisdiction in Canada. The guide covers many aspects unique to tall wood buildings and has separate chapters dedicated to building systems, sustainability, structural and serviceability, acoustics, fire safety and protection, building enclosure, prefabrication, costing, monitoring, and maintenance.

This abstract provides an overview of the Building Enclosure (Envelope) chapter of the guide, with specific guidance to practitioners undertaking the building enclosure design and construction of tall wood buildings. The guide covers an overview of the fundamentals of building enclosure design is provided, with a focus on the unique or different aspects for a tall wood building versus other taller structures constructed of concrete or steel.

The building enclosure system physically separates the exterior environment from the interior environment(s). The focus of the guide is on the control of heat, air, and moisture transfer through the building enclosure. Noise and fire control is also discussed. Together with the heating, cooling and ventilation systems, the building enclosure maintains comfortable and healthy indoor spaces. It is also a key passive design element for an energy efficient building and is one of the most important systems in ensuring the durability of all other systems within a tall wood building.

Elements of the building enclosure include: roofs, above and below-grade walls, windows, doors, skylights, exposed floors, the basement/slab on grade floor and all of the interfaces and details between. As the focus of this guide is specific to tall wood buildings, the unique considerations for the wood-based above-grade wall and roof assemblies which are different than other high-rise structures are addressed.

The structural system utilized in the tall wood building has a significant impact on the location of thermal insulation, as well as the details. This guide therefore addresses five wood-based structural systems and associated wall assemblies:

- platform (and balloon) framing,
- post-and-beam with wood-frame infill,
- mass timber (CLT),
- curtain-wall with mass timber, and
- wood-frame infill within a poured-in-place concrete frame.

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Roof assemblies considered include both conventional and protected membrane systems on mass timber roof structures.

The environmental loads (primarily wind, rain, temperature differentials) and structural loads (primarily wind and seismic and related lateral movements) act on the building enclosure of tall wood buildings. These loads will be the same as those acting on other tall buildings constructed of steel or concrete. The structural loads will generally be greater for tall wood buildings than those experienced by low-rise wood-frame buildings. Design considerations such as cumulative wood shrinkage of the structure are potentially emphasized in taller wood-frame building and need to be accommodated by the building enclosure.

The guide provides an overview of the building code and energy efficiency requirements for tall wood buildings in Canada including a summary of the National Energy Code for Buildings (NECB 2011) and ASHRAE Standard 90.1 (various versions). Effective thermal resistance (R-values) targets for tall wood buildings are covered within the guide.

WALLS

The high rain exposure conditions associated with tall wood buildings dictate that a rainscreen water penetration control strategy be utilized for all wall assemblies. In addition, the energy efficiency requirements combined with the structure types considered lead to a requirement for exterior insulated wall assemblies. Insulation could also be used within stud spaces for some structure types. Exterior insulated rainscreen wall assemblies effectively manage exterior moisture sources and keep the wood structure warm and dry.

Various air barrier strategies can be considered, however an exterior liquid applied or vapour permeable membrane air barrier is the easiest to implement with exterior insulated rainscreen wall assemblies. The use of vapour permeable membranes and vapour permeable interior finishes will allow for initial drying of the wood wall assemblies. Vapour permeable insulation such as mineral wool is recommended because it similarly facilitates drying of moisture from within the exterior wall cavity and is non-combustible.

ROOFS

Tall buildings tend to have low slope roof assemblies, and either conventional roofs or protected membrane roof assemblies are acceptable. In either case a durable membrane system such as a 2-ply modified bituminous membrane is recommended because the wood substrate and structure is more susceptible to moisture damage than other substrates. In addition, pre-site protection of the wood substrate by use of pre-applied roofing or adhered roof vapour barrier membrane on CLT roof panels and other exposed heavy timber roof components is suggested, with joints immediately addressed upon installation. Where torch-on roofing membranes are used against wood a protection board (mechanically attached asphalt underlay or gypsum protection board) is required to protect the wood from burning during application of the roof membrane.

DETAILING

Continuity of the critical control layers is key to all of the interface detailing between elements of the building enclosure (water shedding surface, water resistive barrier, air barrier). To assist with detailing, the concept of control layer functions and critical barriers are introduced and utilized throughout to assist in wall and roof assembly and detailing.

WOOD DURABILITY

Wood has proven long-lasting performance in properly designed and constructed buildings in climate zones across Canada. The key to achieving durability is to prevent excessive moisture accumulation and to allow wood to dry should it get wet during construction and in-service. A greater need for protection from wetting during construction exists in tall wood buildings as heavy timber elements can easily get wet during erection and can take a long time to dry out. The immediate protection of wood components by use of temporary or permanent measures is critical.