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CANADIAN DESIGN GUIDE TO TALL WOOD BUILDINGS

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NEWBuildS Tall Wood Building Design Presentation

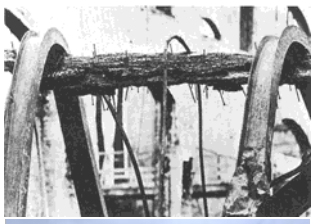
November 14th, 2014 Edmonton, AB

Issues with Wood Construction

Fire:

After fire, wood beam supporting
Twisted steel beams

Courtesy: Forest Products Laboratory



Durability:

Horyuji Temple & five-storey Pagoda
(Temple of the Flourishing Law 法隆寺金堂)
Ikaruga, Japan
Built in 607AD

Courtesy: Wikimedia Commons

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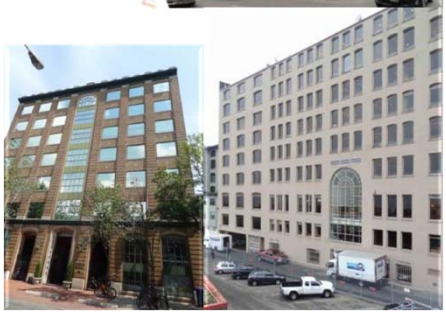
Inspiring >100 Year Old Tall Wood Buildings in Canada

- Adaptive re-use of the industrial old brick & timber buildings from 1850's into unique work or living environments
- Up to 8 storeys (≈100 ft or 31 m high)
- Up to 326,759 ft^2 (≈ 32,500 m^2)
- Built from 1859 to 1940
- Factories, warehouses and manufacturing plants - during the industrial era
- All across Canada
- Tenant – high tech companies



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Brick & Beam Buildings

- Toronto - 129 buildings
  - 43 buildings = 5 storeys +
  - 19 buildings = 7 to 8 storeys
  - Toronto Carpet Factory
  - Floor space = 190,000 ft^2 (single building)
- Vancouver – 50 buildings
  - Historical Buildings
  - The Landing
  - The Leckie

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Brick & Beam Buildings

Unfortunately…

- Construction of such buildings stopped mainly due to the introduction of modern building codes (NBCC 1941)
- Limits on wooden building height & areas were introduced (i.e., combustible vs. non-combustible construction concepts)

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National Building Code of Canada

1941 NBCC: Combustible Construction
Occupancy, Maximum Building Height, # Storeys:

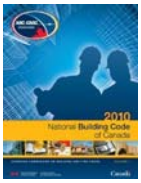
- Heavy Timber:
  Office & Low Hazard Industrial: 75 feet (23.4 m), Not specified
  Apartments & Hotels: 55 feet (17.2 m), 4 storeys
  One & two family dwellings: 55 feet (17.2 m), 4 storeys
- Wood Frame:
  Office & Low Hazard Industrial: 35 feet (10.9 m), 2 storeys
  Apartments & Hotels: 35 feet (10.9 m), 2 storeys
  One & two family dwellings: 40 feet (12.5 m), 3 storeys

Carleton UNIVERSITY
Source: NEWBuildS Master's Thesis - Michael Kruszelnicki

2010 NBCC:
4 Storeys for combustible construction

2009 BC Building Code:

2015 Ontario Building Code:



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Recent Trends

Recently, strong interest to re-specify wood in non-res. & mid and high rise buildings

- Several factors have contributed to this:
  - Availability of new generation of innovative EWP, connection systems & design tools
  - Recent changes to building codes
  - Development of CLT
  - Environmental concerns (i.e., climatic changes)

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Expanding Wood Use in Mid and High-rise Buildings

Over the last 15 years, significant efforts by federal & provincial governments and industry to expand wood use in the **non-res. and mid & high rise** construction market

- Examples include NRCan's support to R&D:
  - FPInnovations (TT Next Generation Building Systems and Products)
  - Universities (NEWBuildS – Investment in the Forest Sector)
  - Industry associations (NRC/CWC/FPI mid-rise project)
- 2010 & 2013 NRCan's Mid-rise and Tall Wood Demo Buildings Initiatives

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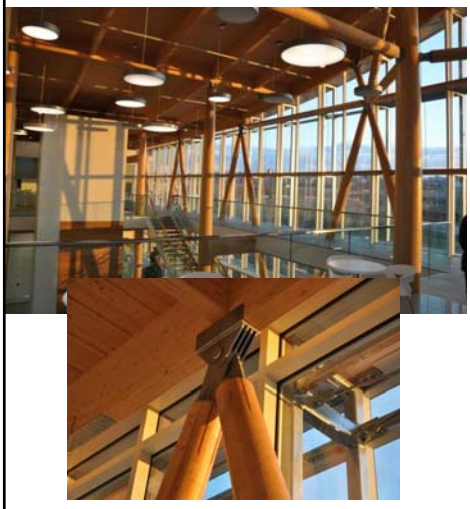
2010 NRCan's Mid-rise Wood Demo Bldgs Initiative: Examples



GSK bldg , Quebec City, Qc

Complan bldg, Qc
(CLT-glulam top storey on existing 4 storey concrete)

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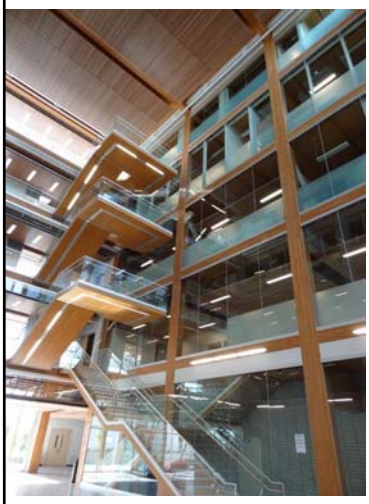
2010 NRCan's Mid-rise Wood Demo Bldgs Initiative: Examples



New ESB at UBC, Vancouver, BC
(Hybrid, wood-steel-concrete bldg with HBV shear connector from Germany)

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Modern Tall Wood Bldgs in Europe & Australia

9-Storey buildings, London, UK
1st storey concrete, 8 storeys CLT

2 @ 8 storeys CLT buildings, Oslo, Norway

4 CLT residential buildings/social housing @ 9 storeys, Milan, Italy

10 storeys CLT tower in Melbourne, Australia
"World Tallest Wood Building"

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Modern Tall Wood Buildings (TWB)

Wood Innovation and Design Center, Prince George, BC
Height: 28 m

8 storeys office high-rise, Austria
Uses of innovative hybrid wood-concrete system (CREE). One storey/day!

14 storeys Wood Building, Norway (under construction)

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Modern Tall Wood Bldgs: Design Concepts

30 storeys wood high-rise
(Source: Tall Wood Building: mgb ARCHITECTURE + DESIGN)

42 storeys wood high-rise
(Source: Skidome, Owings & merrill, LLP)

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Developing Design Guidelines
CLT Handbooks

CLT Handbooks facilitate use of CLT under **Alternative Solutions**

Sponsored by NRCan, BSLC and other partners

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NRCan's Tall Wood Demo Buildings Initiative (2013)

- Modern TWB in Europe triggered interest from NRCan
- NRCan launched TWB Demo projects initative
- In May 2013 a request for EOI issued for design teams to use innovative design and build high-rise wood demo projects
- Objective is to showcase the benefits of using innovative wood-based structural solutions in real TWB projects
- To support the initiative, FPInnovations developed this *Technical Guide for the Design and Construction of Tall Buildings in Canada* was developed by

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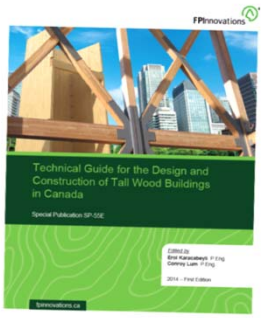
FPInnovations' Technical Guide for the Design & Construction of TWB in Canada

- Prepared by a group of more than 85 experts
- Guide designed to assist designers, code consultants, developers, building owners, and AHJ in understanding the key technical issues and challenges associated with the design and construction of tall wood buildings
- Written to be consistent with the design objectives in the 2010 NBCC
- Guide is multi-disciplinary and peer reviewed document
- Guide published in April 2014
- Funded by NRCan



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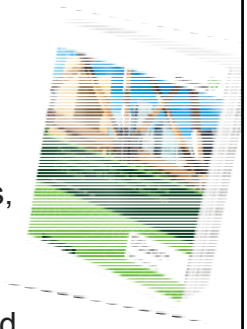
About the Guide ….

Tall Wood Building Guide



- TWBs covered by the Guide are beyond the height and area limits found in the NBCC
- With the use of modern mass timber products such as glulam, CLT and SCL, TWB is a goal that assembled team of experienced architects, engineers, cost consultants, contractors, and researchers believe is achievable
- Intended to be used by experienced design and construction teams; it provides the concepts and background

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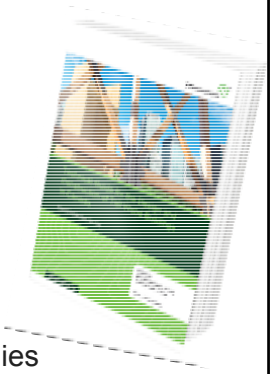
Guide Content/Layout

Tall Wood Building Guide



Nine Chapters in Total

1. Introduction
2. The Building as a System
3. Sustainability
4. Structural & Serviceability
5. Fire Safety & Protection
6. Building Enclosure Design
7. Prefabrication & Inspection of Assemblies
8. Project & Construction Cost Considerations
9. Monitoring & Maintenance

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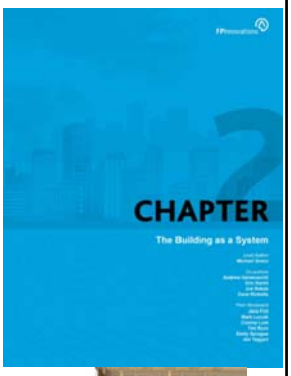
The Building as a System

Tall Wood Building Guide

- Presents the "**Architect's View**" of the conceptual design process and how it is applied to TWB
- Thoughts on the integration of all building systems, its principles & potential solutions
- Discussion on code compliance following the "*alternative solutions*" path
- Chapter includes information to assist AHJ in establishing a process to evaluate a TWB project under alternative solution



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Sustainability

Tall Wood Building Guide

- Factors that contribute to the overall sustainability of TWB (e.g., sequestering of carbon & reduction of embodied energy).
- Information on re-use and recycling of wood components
- How to evaluate the environmental impacts of the building over its lifespan
- A special emphasis on the life cycle assessment (LCA) and discussion of the various green building certification systems

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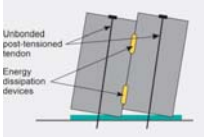
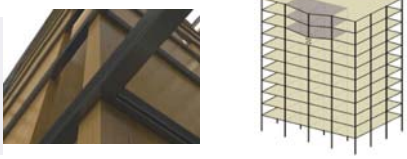
Structural & Serviceability

Tall Wood Building Guide

- Reflects the "***Structural Engineer View***"
- Recommendations for conceptual design
- Design considerations & input parameters for connections and assemblies
- Advanced analysis and testing of systems for design for wind and seismic
- Building sound insulation and floor vibration control (including hybrid floors)





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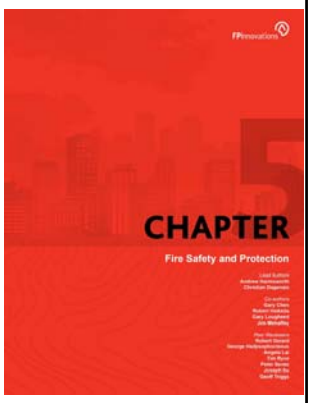
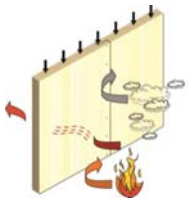
Fire Safety and Protection

Tall Wood Building Guide

BUILDING TALL WITH WOOD IS FIRE SAFE

- Technical information as to how TWB can "*MEET*" or even "*EXCEED*" the level of fire performance currently provided by the NBCC's acceptable solutions for tall buildings of noncombustible construction (i.e., concrete or steel building, 2h FRR & sprinklered)





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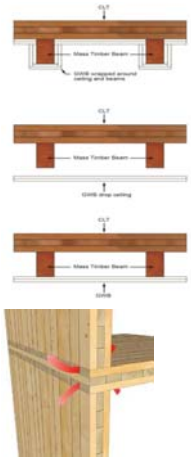
Fire Safety and Protection

Tall Wood Building Guide

Guide covers all pertinent issues associated with the fire safety and fire protection such as:

- Full encapsulation
- Flame spread
- Fire during construction
- Enhanced fire protection
- Development of alternative solutions
- Guide also addresses issues of safety of firefighters and other emergency responders



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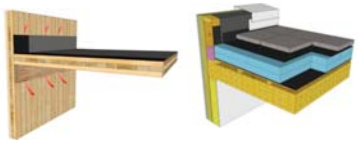
Building Enclosure Design

Tall Wood Building Guide

- Addresses design considerations for the building enclosure and durability of TWB
- Control of heat, air & moisture transfer through the building enclosure and cumulative vertical wood movement
- Five wood-based structural systems and associated wall assemblies are presented: platform, post-and-beam with wood-frame infill, mass timber, etc.)



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Prefabrication and Inspection of Assemblies

Tall Wood Building Guide

- Best practices and standards (i.e., what is designed can in fact be built to a high quality level)
- Tall wood construction incorporates a large degree of prefabrication similar to steel and precast concrete buildings
- Chapter covers key issues associated with quality assurance, qualification of personal, fabrication, executing and inspection of records

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Monitoring and Maintenance

Tall Wood Building Guide

- Recommendations for performance testing and monitoring and guidance on building maintenance
- Covers short and long term measurements to test and monitor the bldgs
  (Examples: airtightness, vibration, sound insulation, floor and building vibrations, energy efficiency, etc.)
- Planning and costing for testing & monitoring

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Future Edition of the Guide

This is just the first edition…

Future editions of the Guide will take into consideration the experience of NRCan's Demonstration Project design teams and others utilizing concepts found in the first edition

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Price = $ 225 paper / pdf (non members)
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