Fire Safety of Multi-Storey Wood Buildings

Performance Approach to Fire Safety

Edmonton, AB
November 14, 2014

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A copy of this presentation is available at:
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Andrew Harmsworth, M Eng, P Eng, CP
Principal, **GHL** Consultants Ltd Email: ah@ghl.ca

- BASc, Queen's University at Kingston, Civil Engineering
- M Eng, UBC's short lived Fire Science program
- 25 years' experience in Equivalencies and Alternative Solutions

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GHL Consultants Ltd

- Founded 20 years ago
- Building Code Consultants
- Fire Engineers
- Code reviews – both assisting clients and as Authorities
- No system design – won't sell you things you don't need

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About GHL

- "Code Consulting" firm
- Prefer "Fire Engineering"
  - Focus on Part 3
  - Fire hazard analysis
  - Fire risk analysis
  - Structural fire resistance
  - Heat transfer
  - Smoke control design

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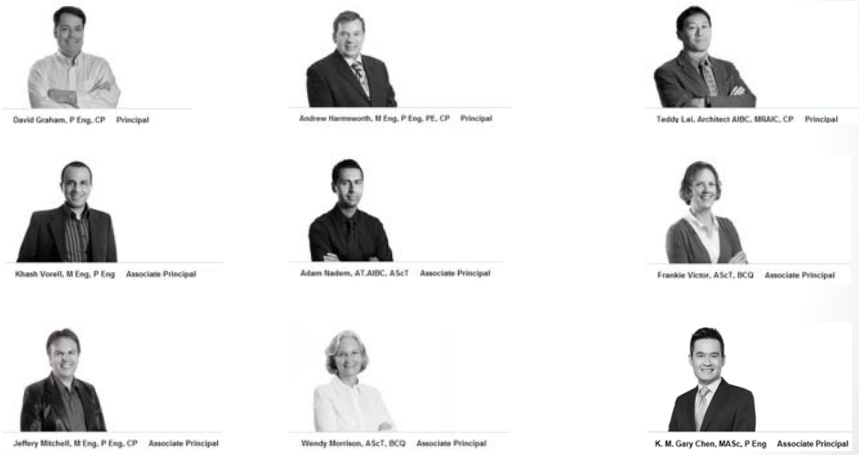
9 Principals + staff (total 21)



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Building Code Committee Work

- APEG Building Codes Committee (Khash Vorell / Andrew Harmsworth)
- BC Appeal Board (Frankie Victor)

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Research Work

- BC Wood First Advisory Committee to Forestry Investment Innovations
- CAN 086 Task Group on Fire (Andrew Harmsworth)
- NEWBuildS Research Network (Andrew Harmsworth, Board of Directors) – 40 Master's and PhD Students
- Fire Risk Assessment for Alternative Solutions (Gary Chen)
- Effectiveness of Sprinkler Systems after an Earthquake.

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Research Work

- 6 Storey Group C (Residential) – Code Change (Andrew Harmsworth / Gary Chen, 2009)
- Group D (Office) Studies – 6 Storey Frame and 8 Storey Heavy Timber (HT)
- MSc Studies on Effects of Fire as a Structural Load (Gary Chen) - Current
- Lead Author, Tall Wood Guide with FP Innovations

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It's Been Done Before…

- Objective is to show that it can still be done TODAY

Kelly Douglas Building, Vancouver
9-Storey Heavy Timber -1905

312 ft. (95 m) Sitka Spruce
Canada

(Picture Courtesy of FPInnovations)

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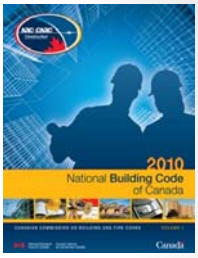
National Building Code of Canada

All buildings are subject to risks:



- Code compliance ≠ no risk.
- Code compliance = risks at acceptable level.

  (see "Objectives" in Preface of NBCC, Vol.1)

Entering a building is just like getting into a car…
…there is an acceptable level of risk.

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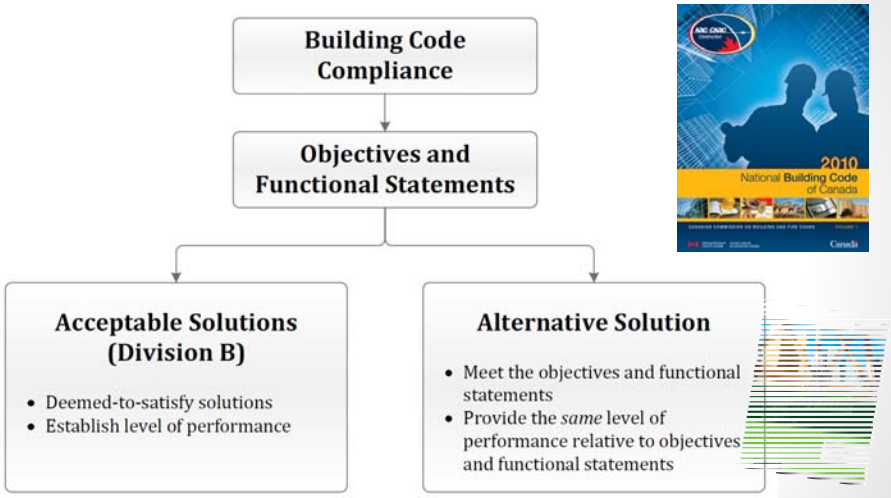
National Building Code of Canada



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National Building Code of Canada

Objective OS1 "Fire Safety"

- Intent:

  To limit the probability that combustible construction materials within a storey of a building will be involved in a fire, which could lead to the growth of fire, which could lead to the spread of fire within the storey ***during the time required to achieve occupant safety and for emergency responders to perform their duties,*** *which could lead to harm to persons.*

- Other *Provisions of the Acceptable Solutions* (Division B) are similarly worded.

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National Building Code of Canada

- Design and Evaluation of alternative solutions should be based on science not emotion
- Level of safety need to balance risks

Emotion prevails but let's apply science!!!

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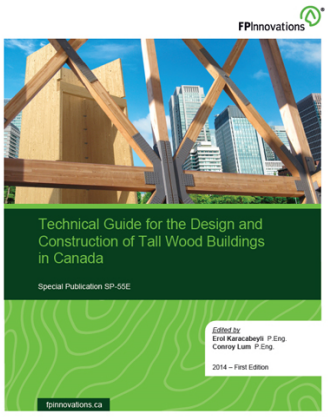
FPInnovations Tall Wood Guide



FPInnovations project funded by Natural Resources Canada (Federal Agency)

- 400 pages → 70 on fire safety
- Fire chapter is the first to provide comprehensive review of fire issues in tall wood buildings.

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FPInnovations Tall Wood Guide

- A guide to an alternative solution
- Intent was to demonstrate that it CAN BE DONE.
- Nationally acceptable risk tolerance.
- Took a conservative approach.

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FPInnovations Tall Wood Guide

- First to map out an alternative solution for Tall Wood on a national basis
- Chapter 5 of the Tall Wood Guide is on Fire Safety and Protection.
- Peer Reviewed
  - Lead Authors
    - *Andrew Harmsworth*
    - *Christian Dagenais*
  - Co-authors
    - *Gary Chen*
    - *Robert Heikkila*
    - *Gary Lougheed*
    - *Jim Mehaffey*
  - Peer Reviewers
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    - *Peter Senez*
    - *Joseph Su*
    - *Geoff Triggs*

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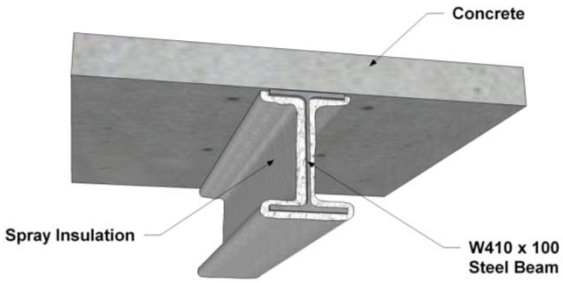
Achieving Fire Performance using Encapsulation

- Steel and concrete assemblies



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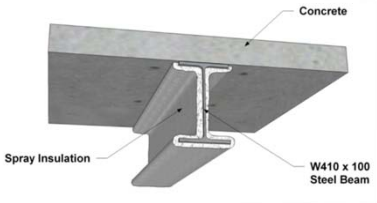
Achieving Fire Performance using Encapsulation

- Steel is encapsulated for thermal protection
  - Performance criteria: limit steel temperature to 538°C (ULC S101)
- Reinforced concrete uses encapsulation to protect steel
  - Code provides minimum cover to protect reinforcement
  - Performance criteria: limit steel temperature to 593°C (ULC S101)
- Complete encapsulation would allow maintaining 100% strength



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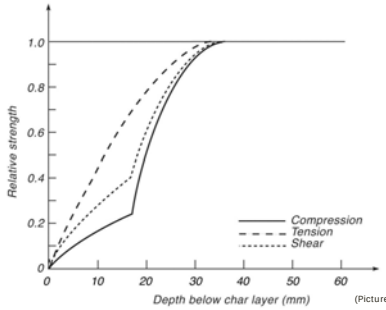
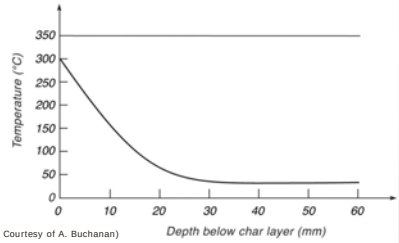
Achieving Fire Performance using Encapsulation

- Mass timber
  - Charring can provide inherent fire rating
  - Zero loss of strength below char layer
  - Wood is combustible





(Pictures Courtesy of A. Buchanan)

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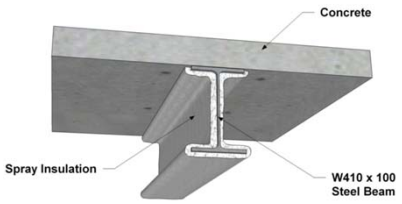
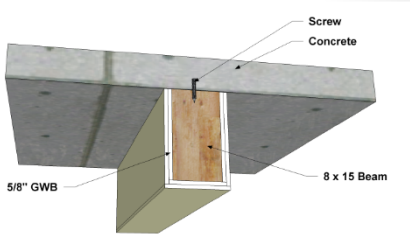
Achieving Fire Performance using Encapsulation

What is the difference?



Encapsulating for Strength



Encapsulating for Combustibility

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Complete Encapsulation

- Wood not affected by the fire for expected duration (2h).
- Wood does not contribute to the fire for expected duration.
- 3 or 4 layers of Type X gypsum board.
- Makes the point that it CAN BE DONE.

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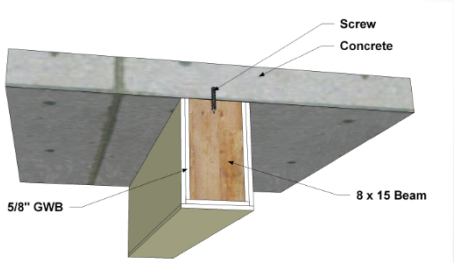
Limited Encapsulation

- Prevent wood from contributing to fire severity for "*time to achieve evacuation and FF response*"
- 1 to 2 layers of Type X gypsum board
- Prevent possibility of "re-flashover"



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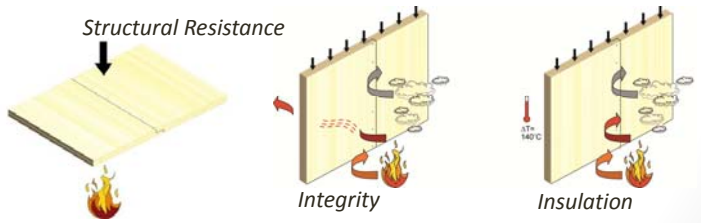
Fire Resistance

- We can start with full encapsulation and peel off layers
- Code indicates some exposed wood panelling is acceptable
- “Burnout with all systems failed” is not appropriate
- Continued charring is acceptable, Re-flashover is not



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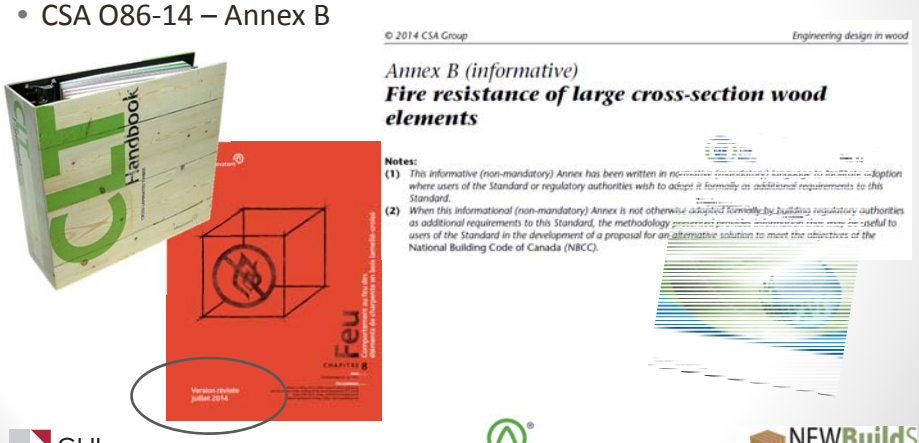
Fire Resistance

- CLT Handbook – Chapter 8 (2014 Edition)
- CSA O86-14 – Annex B



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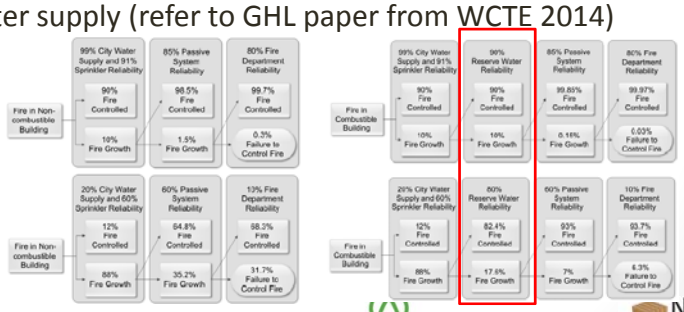
Fire Resistance

- Analysis shows that at least one wall can be exposed
- Two basic approaches
  - Complete encapsulation with city water supply
  - Limited encapsulation with some walls exposed with backup water supply (refer to GHL paper from WCTE 2014)



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Other Considerations

- Connections

2h Fire Rated Connection
The Landing, Vancouver

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Other Considerations

- Firestopping

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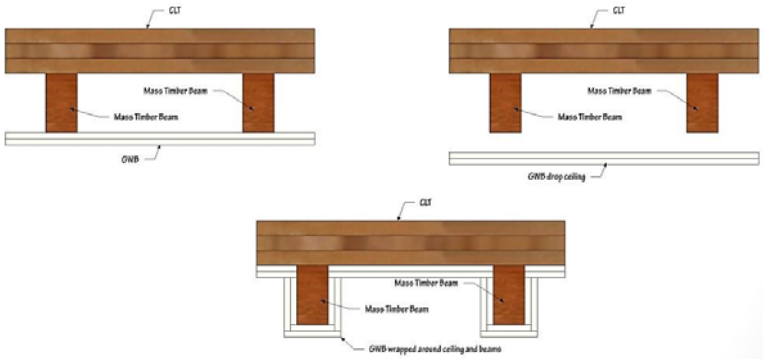
Other Considerations

- Protection of concealed spaces



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Other Considerations

- Construction fire safety

Laminated 2x6 elevator shaft

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Future Editions

- First edition needed to capture all the issues.
- Next edition needs to:
  - Edit out some issues
  - Look more at the solutions
  - Consider newer materials
  - Look at where appropriately protected light timber may be acceptable…
    …provided it is fully encapsulated (thus does not need to be mass timber)
  - Address quality control
  - Firefighting assumptions

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Acknowledgments

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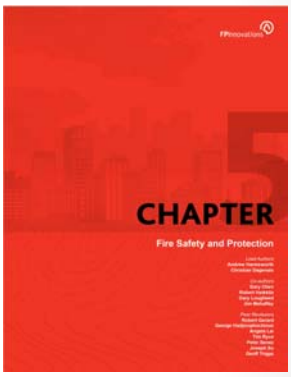

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Questions?

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Thank You

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