Fire Safety of Multi-Storey Wood Buildings

Performance Approach to Fire Safety

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- 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
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
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
9 Principals + staff (total 21)
Building Code Committee Work

- APEG Building Codes Committee (Khash Vorell / Andrew Harmsworth)

- BC Appeal Board (Frankie Victor)
Building Code Committee Work

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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.
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
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)
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.
National Building Code of Canada

Building Code Compliance

Objectives and Functional Statements

Acceptable Solutions (Division B)
- Deemed-to-satisfy solutions
- Establish level of performance

Alternative Solution
- Meet the objectives and functional statements
- Provide the same level of performance relative to objectives and functional statements
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.
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!!!*
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.
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.
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
  - Robert Gerard
  - George Hadjisophocleous
  - Angela Lai
  - Tim Ryce
  - Peter Senez
  - Joseph Su
  - Geoff Triggs
Achieving Fire Performance using Encapsulation

- Steel and concrete assemblies
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
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)
Achieving Fire Performance using Encapsulation

Encapsulating for Strength

Encapsulating for Combustibility

What is the difference?
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.
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”
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
Fire Resistance

- CSA O86-14 – Annex B
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)
Other Considerations

• Connections

2h Fire Rated Connection
The Landing, Vancouver
Other Considerations

• Firestopping
Other Considerations

• Protection of concealed spaces
Other Considerations

• Construction fire safety

Laminated 2x6 elevator shaft
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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Questions?
Thank You

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