

Fire Safety of Multi-Storey Wood Buildings

Performance Approach to Fire Safety

Montréal, 12 novembre 2014

Andrew Harmsworth, MEng, P Eng, PE, CP

GHL Consultants Ltd.

ah@ghl.ca

www.ghl.ca

Christian Dagenais, ing., M.Sc.

FPInnovations

christian.dagenais@fpinnovations.ca

Web: www.fpinnovations.ca

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

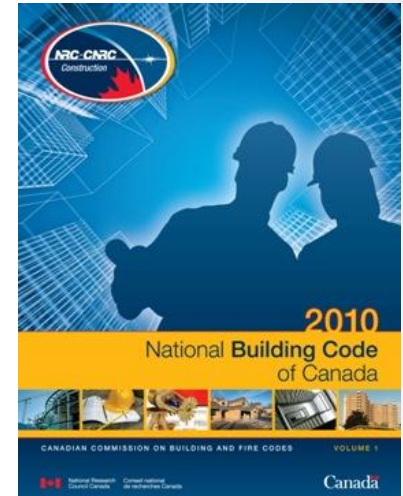
(Picture Courtesy of FPIinnovations)

National Building Code of Canada

All buildings are subject to risks:

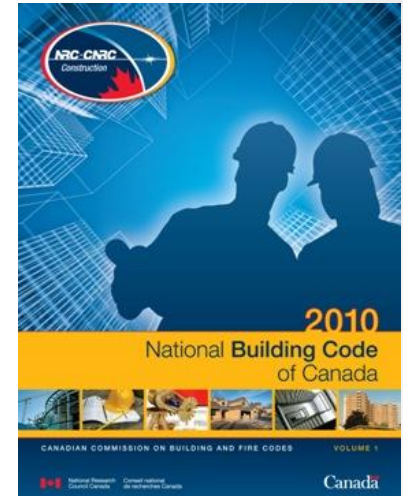
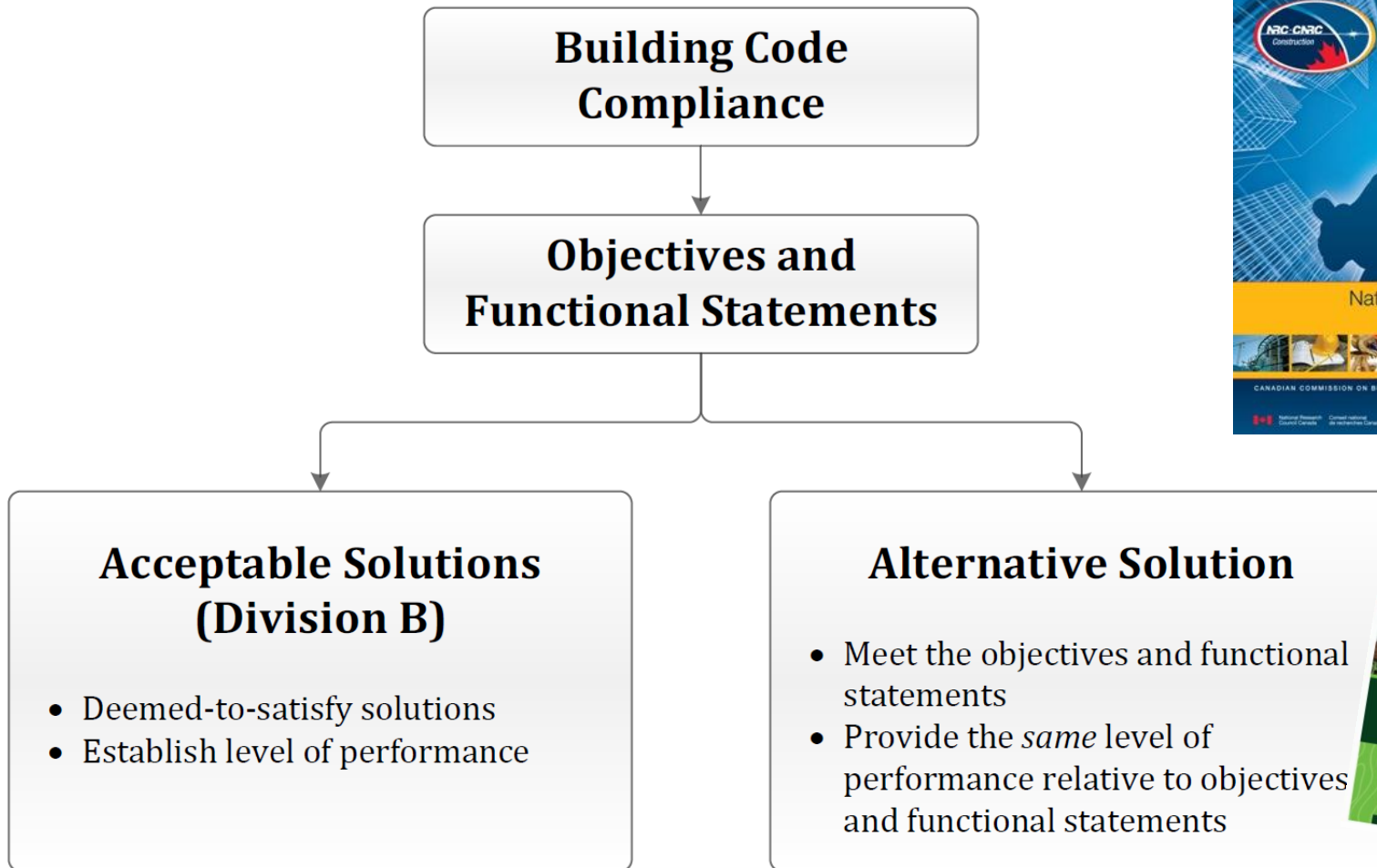
- Code compliance \neq no risk.
- Code compliance = risks at acceptable level.

(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



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.*

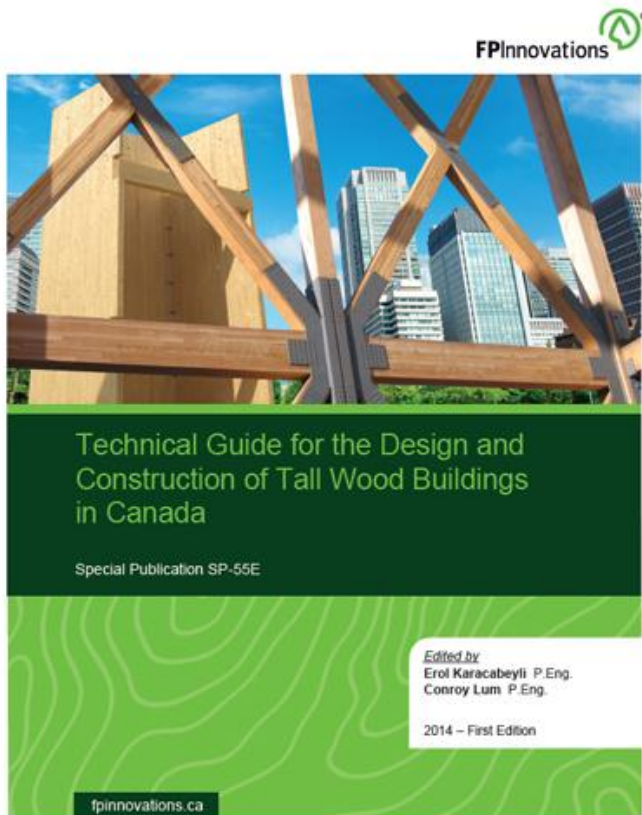
- Other *Provisions of the Acceptable Solutions* (Division B) are similarly worded.

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!!!

FPIinnovations Tall Wood Guide



FPIinnovations 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

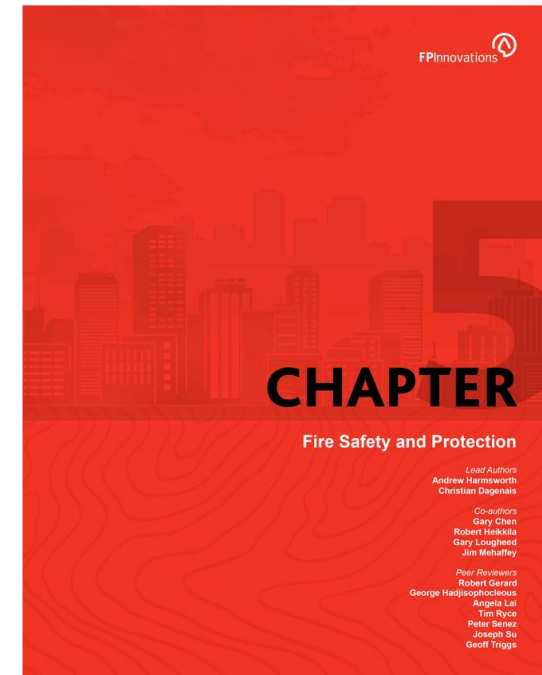
- *Andrew Harmsworth*
- *Christian Dagenais*

- Co-authors

- *Gary Chen*
- *Robert Heikkila*
- *Gary Loughheed*
- *Jim Mehaffey*

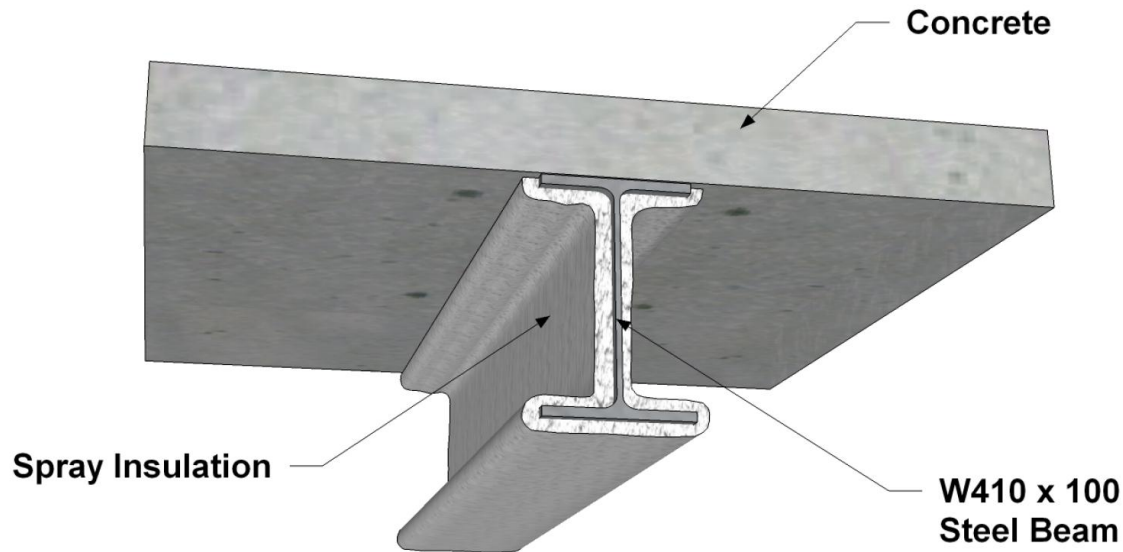
- Peer Reviewers

- *Robert Gerard*
- *George Hadjisophocleous*
- *Angela Lai*
- *Tim Ryce*
- *Peter Senez*
- *Joseph Su*
- *Geoff Triggs*



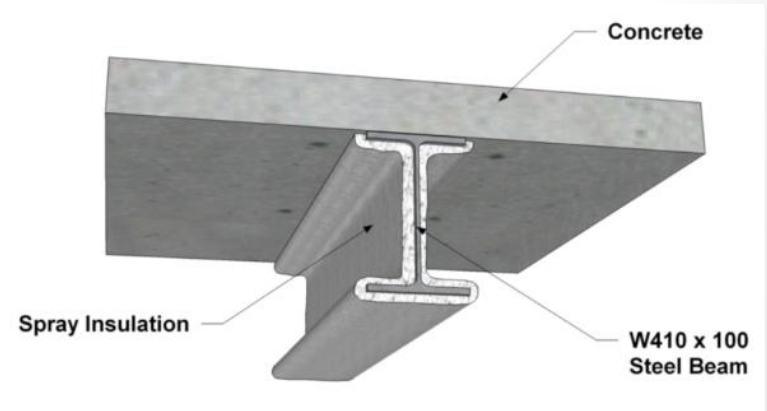
Achieving Fire Performance using Encapsulation

- Steel and concrete assemblies



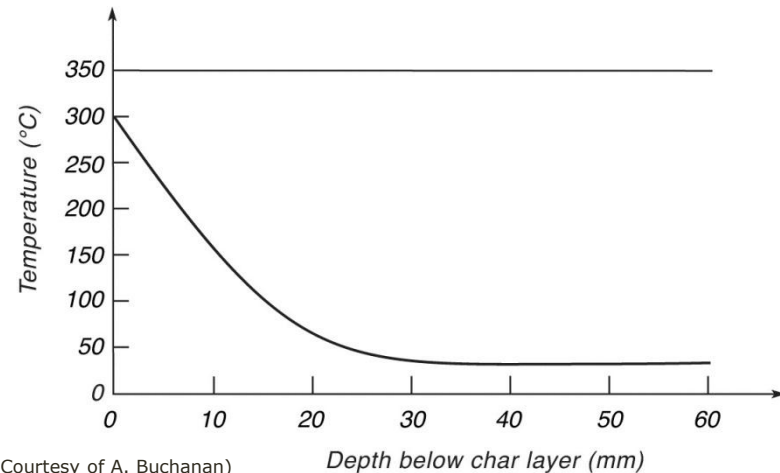
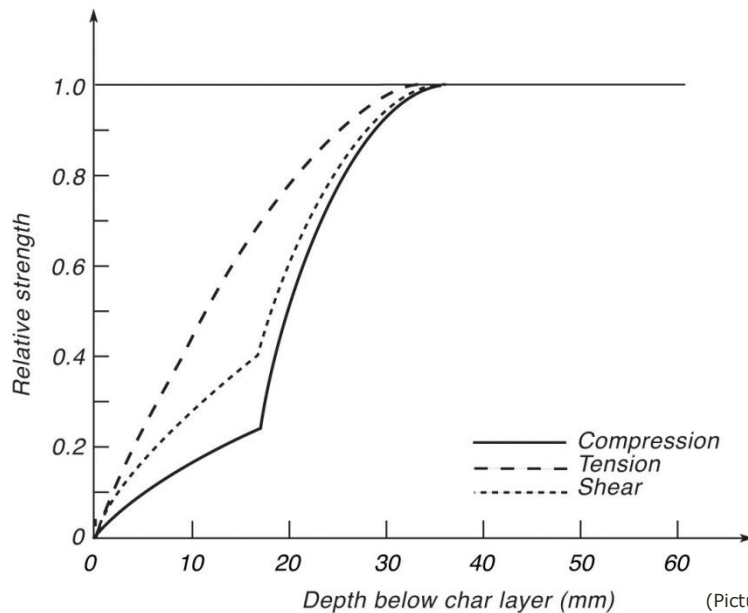
Achieving Fire Performance using Encapsulation

- 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

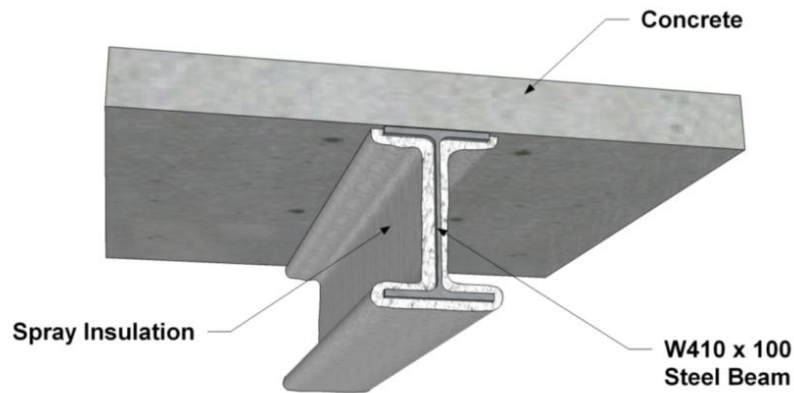


(Pictures Courtesy of A. Buchanan)

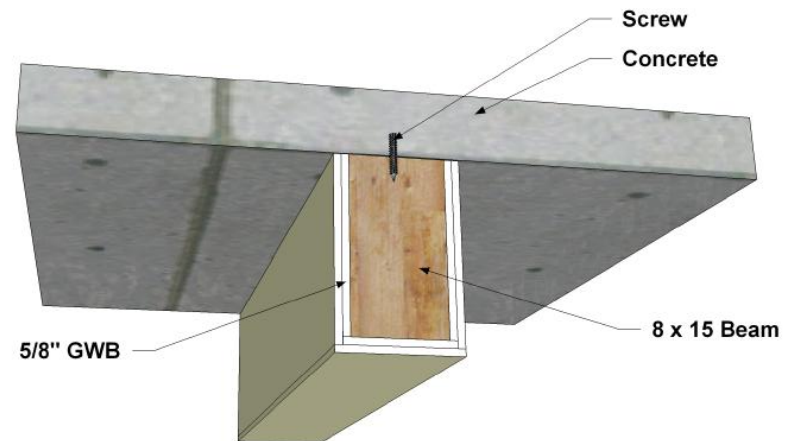
Achieving Fire Performance using Encapsulation



What is the difference?



Encapsulating
for Strength



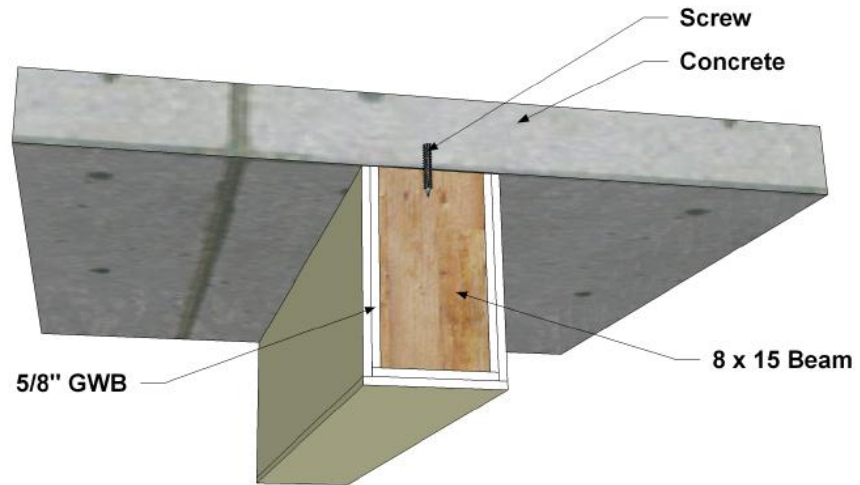
Encapsulating for
Combustibility

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.

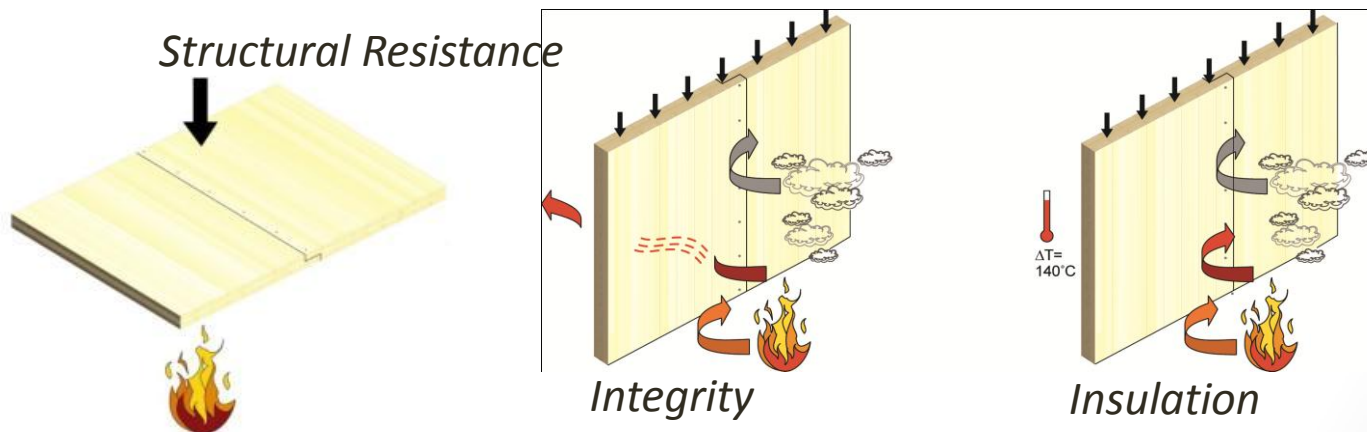
Limited Encapsulation

- 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”



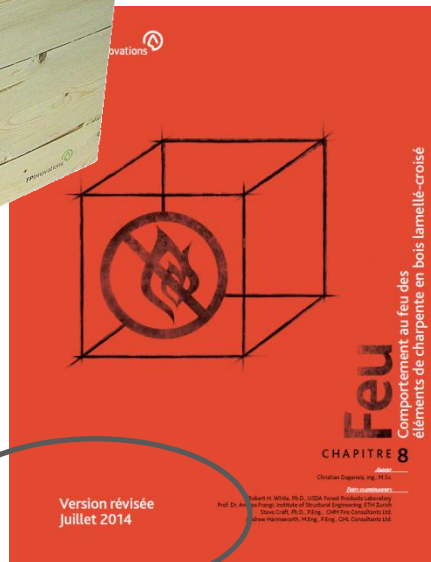
Fire Resistance

- 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

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



© 2014 CSA Group

Engineering design in wood

Annex B (informative)

Fire resistance of large cross-section wood elements

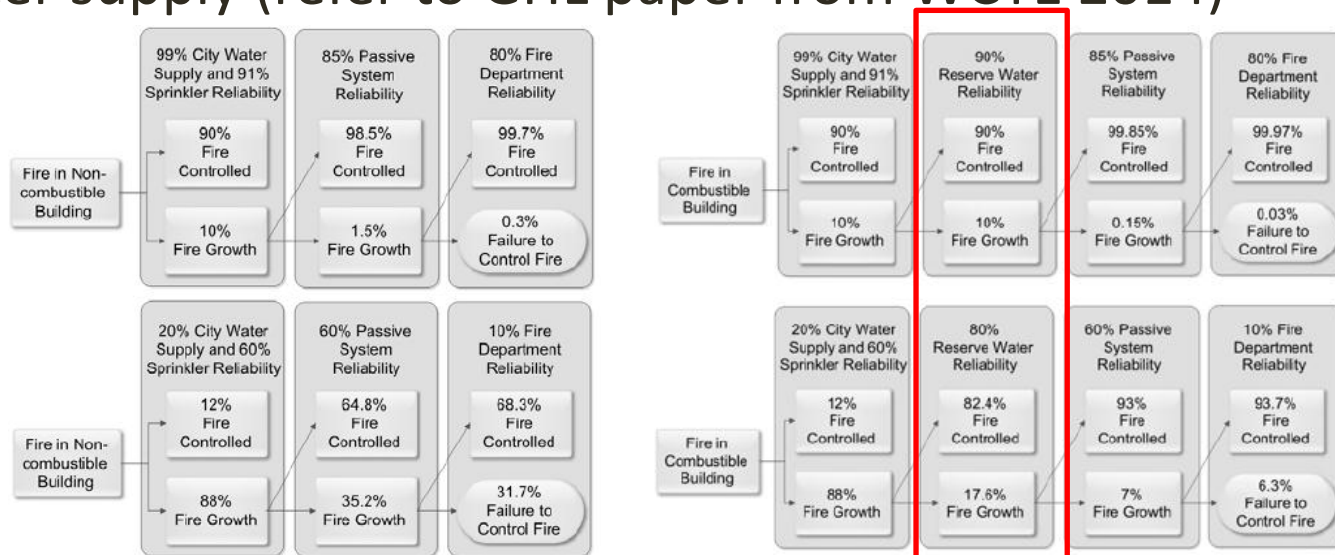
Notes:

- (1) This informative (non-mandatory) Annex has been written in no where users of the Standard or regulatory authorities wish to ac Standard.
- (2) When this informational (non-mandatory) Annex is not otherv as additional requirements to this Standard, the methodology users of the Standard in the development of a proposal for an National Building Code of Canada (NBCC).



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

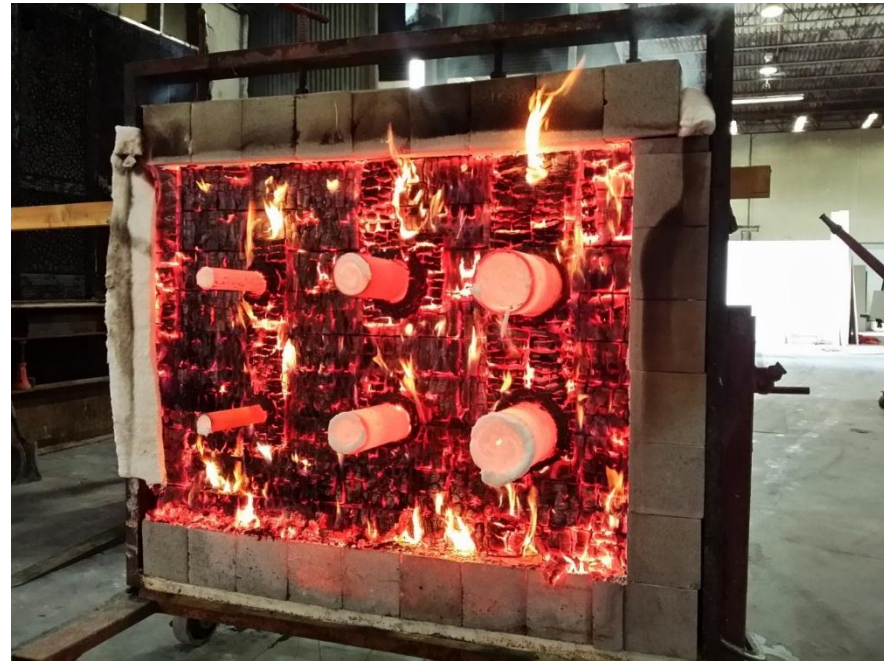


2h Fire Rated Connection
The Landing, Vancouver



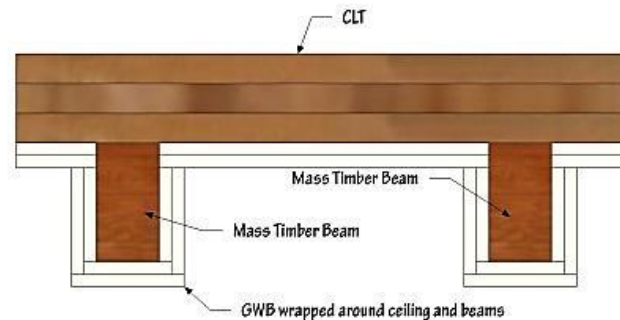
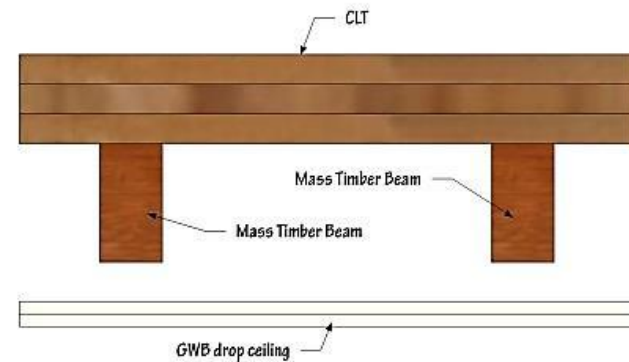
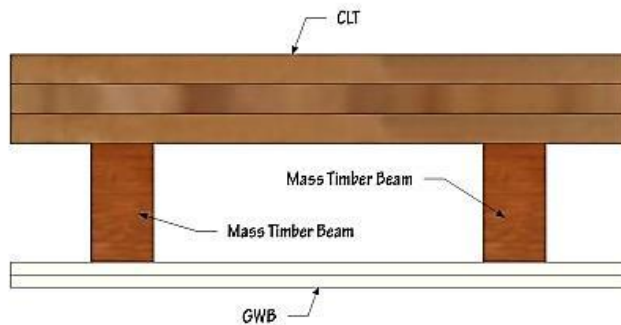
Other Considerations

- 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

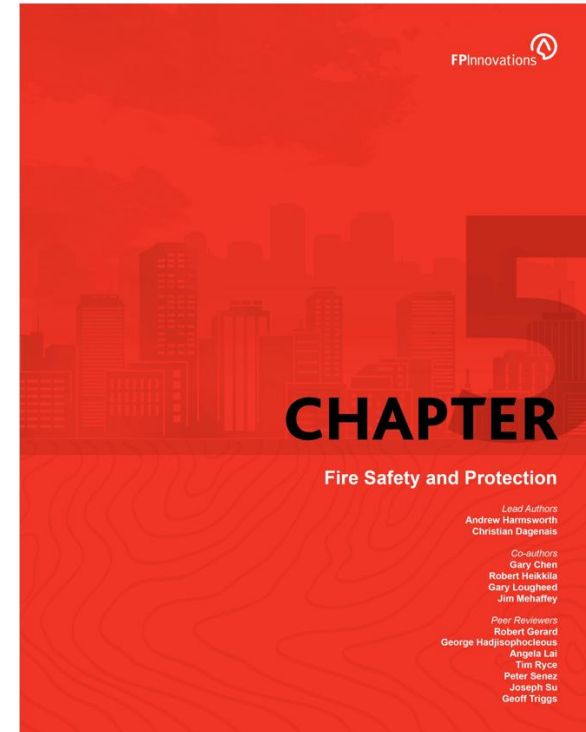
Acknowledgments

Natural Resources Canada

National Research Council Canada

FPIinnovations

- Lead Authors
 - *Andrew Harmsworth*
 - *Christian Dagenais*
- Co-authors
 - *Gary Chen*
 - *Robert Heikkila*
 - *Gary Loughheed*
 - *Jim Mehaffey*
- Peer Reviewers
 - *Robert Gerard*
 - *George Hadjisophocleous*
 - *Angela Lai*
 - *Tim Ryce*
 - *Peter Senez*
 - *Joseph Su*
 - *Geoff Triggs*



Thank You

GHL Consultants Ltd
Suite 950 – 409 Granville Street
Vancouver, BC V6C 1T2

P 604.689.4449 | ah@ghl.ca | www.ghl.ca

Questions?