Tall Wood

The Next 20 Years, The Next 20 Storeys

Andrew Harmsworth, MEng, P Eng, CP
Email: ah@ghl.ca
Web: www.ghl.ca

A copy of this presentation is available at:

http://www.ghl.ca/shared/Tall_Wood_Presentation (CoR Feb 2014).pdf

Copyrights and Limitations

GHL takes no responsibility for application of any concepts or interpretations in this presentation to specific projects unless specifically retained for that project.

This presentation is conceptual and intended to be presented by GHL.

These slides must not be considered complete or exhaustive.

This presentation is copyright GHL Consultants Ltd and others and all rights are reserved.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

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

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

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

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

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

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

8 Principals + staff (total 21)

David Graham, P Eng, CP Principal

Andrew Harmsworth, M Eng, P Eng, PE, CP Principal

Teddy Lai, Architect AIBC, MRAIC, CP Principal

Khash Vorell, M Eng, P Eng Associate Principal

Adam Nadem, AT.AIBC, AScT Associate Principal

Frankie Victor, AScT, BCQ Associate Principal

Jeffery Mitchell, M Eng, P Eng, CP Associate Principal

Wendy Morrison, AScT, BCQ Associate Principal

GHL CONSULTANTS LTD

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Building Code Committee Work

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

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

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.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

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

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

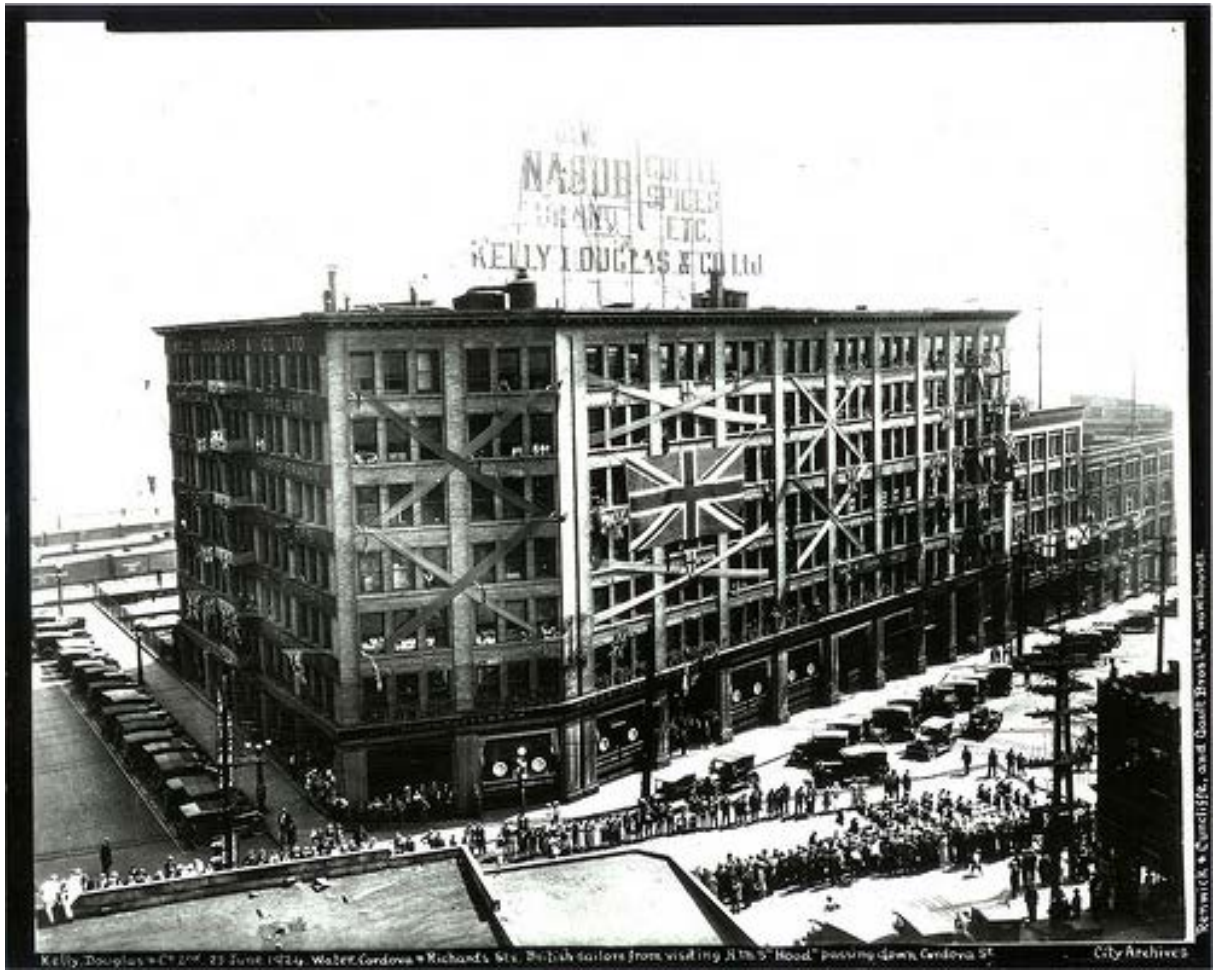
6 Storey Wood - 1871

Wikipedia

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

9 Storey Heavy Timber - 1905



GHL CONSULTANTS LTD

GHL CONSULTANTS LTD

Kelly Douglas Building, Vancouver

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Today

Wikipedia

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

What Happened

- Greater concern with fire safety.
- National Building Code of 1941.
- Initially prefaces with the idea that it was a ‘Guide’.
- Over time it became a restrictive document.

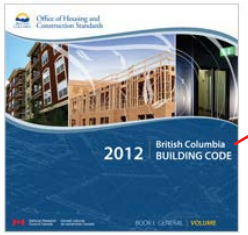
© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

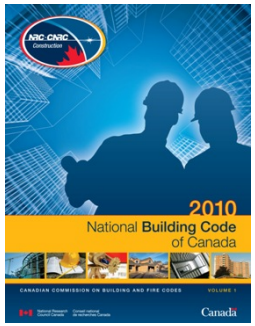
The Building Code System

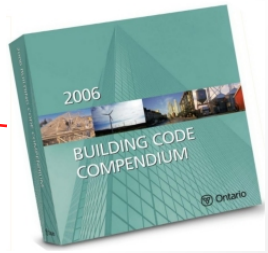
National Building Code is a **model code**

It is a consensus document:

- It regulates construction of buildings.
- Traditionally written by NRCC (Constitution).
- The Province adopts it on the public's behalf.
- Code measures are public interest decisions.



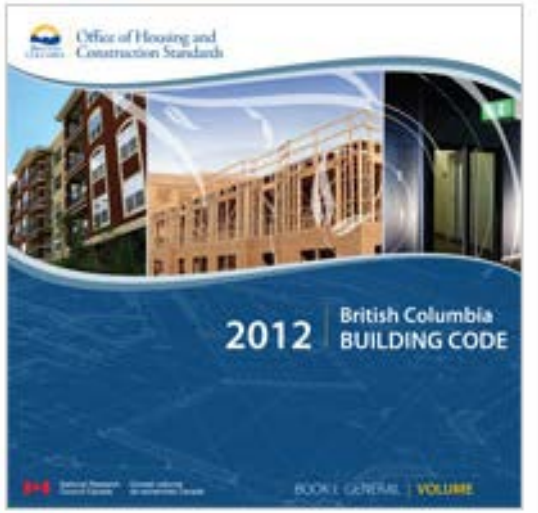




GHL CONSULTANTS LTD

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only



Buildings are subject to risks:

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

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

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Codes and Mass Timber

Vancouver

Québec City

Building Code Compliance

- **Acceptable Solutions**
- **Alternative Solutions**

GHL CONSULTANTS LTD

GHL CONSULTANTS LTD

Courtesy FPInnovations

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

History and Background

Use of Combustible Construction

- Up to early 1900's
  - Regulated by insurance industry
  - 5 and 6 storey wood frame was common
  - 8 and 9 storey HT common
- NBCC 1941, introduced height and area limits
- NBCC 1965, 3 storey height limit
- BCBC 1973 (NBCC 1970), 3 storey
- BCBC 1992 (NBCC 1990), 4 storey
- BCBC 2006 (April 4, 2009), 6 storey height limit

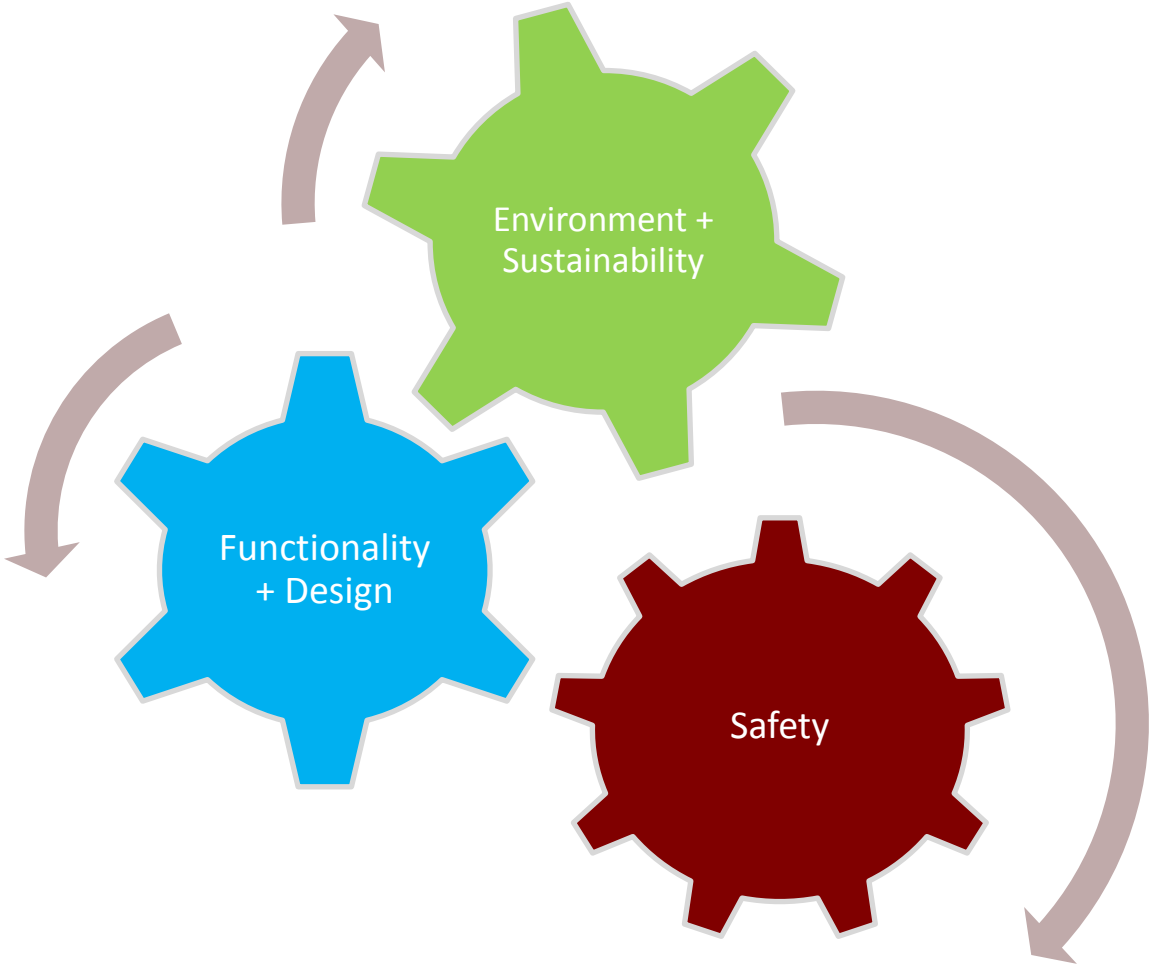
© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Thoughts on Codes

- Code should not care what material you use.
- All materials and design methods should be required to meet the same performance level.
- Code should be based on science, not emotion.
- Designers and Owners should be able to choose the best material for the job.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Safety Needs to Balance Other Goals



GHL
CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Code Evolution

- NBC up to 1995
- Many Codes around the world

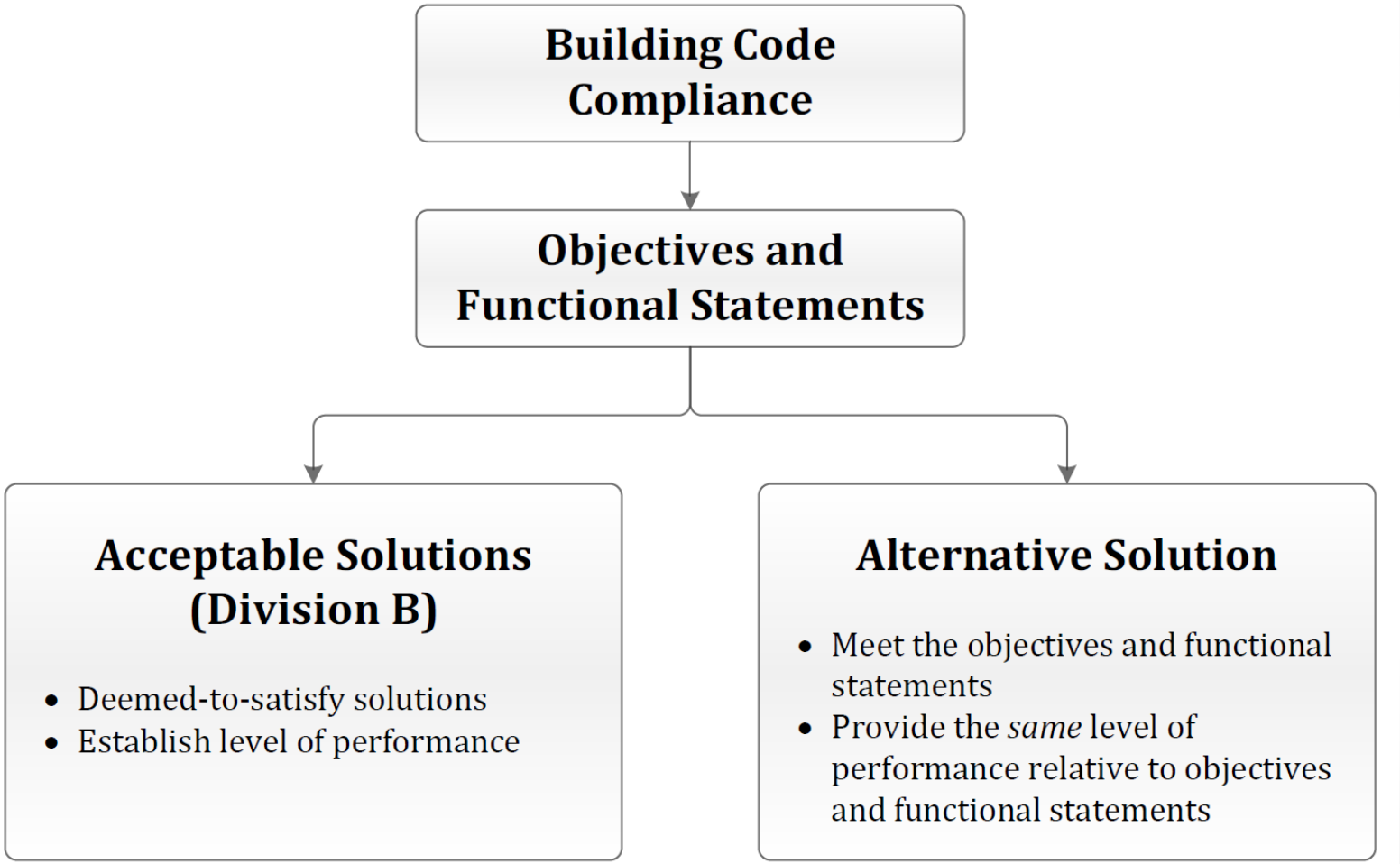
- NBC since 2005

- UK, Australian & New Zealand codes

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Objective-based Code Framework



© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Why Non-combustible

Objective OS1 Fire Safety from 3.2.2

- Intent 1:
- 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 ~~Requirements~~ *Provisions of the Acceptable Solutions* are similarly worded.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

I Hope to Demonstrate to You

That we can design a building of mass timber that:

- is equivalent or better in the overall level of safety for occupants and emergency responders to a noncombustible building:

  - **during the time required to achieve occupant safety and for emergency responders to perform their duties.**

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Facts

Population of 7 to 9 Billion needs housing.

We are resolving most problems.

http://www.gapminder.org/videos/dont-panic-the-facts-about-population/

EXCEPT - Global Warming.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

One Square Meter of Floor

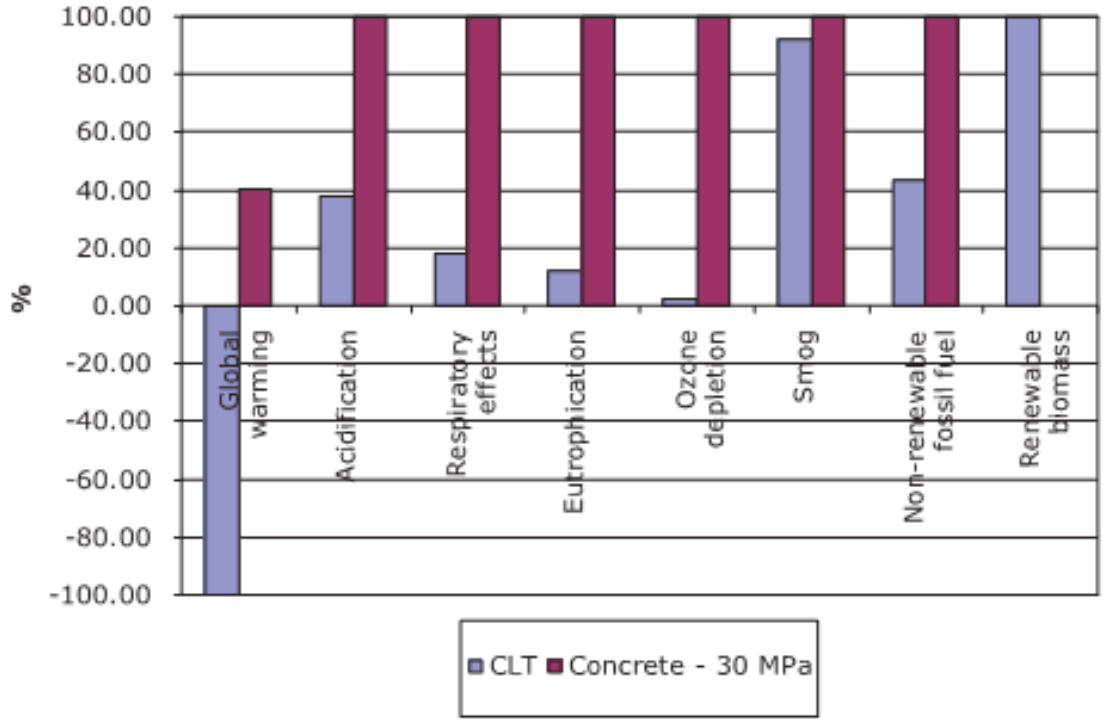


Figure 6

Comparative LCA between 1 square meter of CLT and concrete floor structure

Note: This Figure graphs the data shown in Table 1 on a percentage basis, with the baseline set at the highest number in each environmental performance category. For example, in fossil fuel consumption, the concrete system had the highest number and was set to 100%, with the CLT number shown as 43% of the fossil fuel use of concrete.

Courtesy F I CLT Handbook 2013

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Table 1

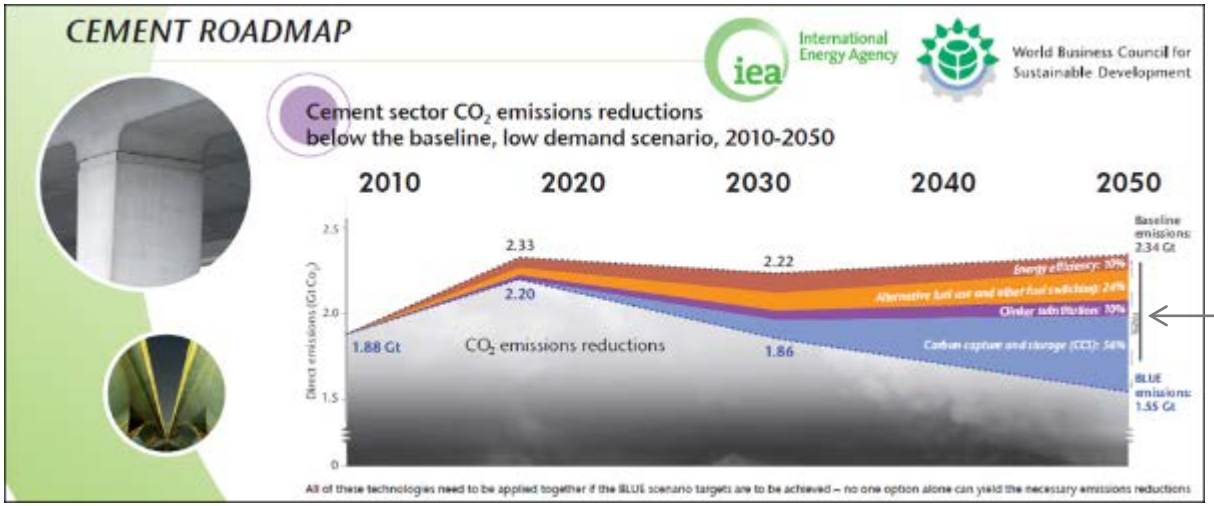
Comparative LCA results for CLT and concrete produced and used in Vancouver – absolute values

Impact Category	Unit	CLT 1m² of Floor	Concrete 1m² of Floor
Global warming	kg CO_2 eq.	-222.55*	90.12
Acidification	H+ moles eq.	8.77	23.00
Respiratory effects	kg PM2.5 eq.	0.010	0.058
Eutrophication	kg N eq.	0.014	0.115
Ozone depletion	kg CFC-11 eq.	7.15E-09	2.65E-07
Smog	kg NOx eq.	0.21	0.23
Non-renewable fossil fuel	MJ eq.	274.30	633.54

Note: *Net emissions, when taking into account forest carbon sequestration (248 kg CO_2 eq.) and reduction in carbon emissions from substituting wood residues for natural gas (21.8 kg CO_2 eq.).

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Carbon Capture and Storage



CCS

IEA.org Cement Industry Roadmap

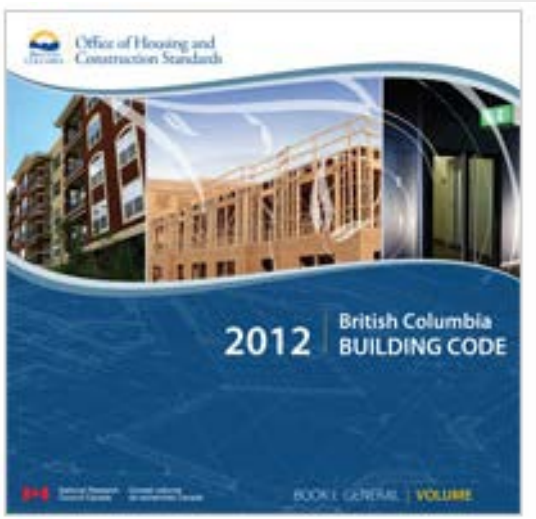
No financially viable operating CCS of any size?

What about the forest?

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

BC 6 Storey Residential



GHL prepared the risk analysis.

Essentially an 'Alternative Solution' that was incorporated in the Code.

GHL argued that risks were equivalent to existing allowable building areas and heights if appropriate provisions were made.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

Where Are We Now?

BC Code allows 6 Storey Residential, limited area.

Quebec interim changes.

NBC 2015 proposed changes to allow 6 storey wood frame published for comment.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Construction Fires

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Laminated 2x6 elevator shaft

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Mass Timber Terminology

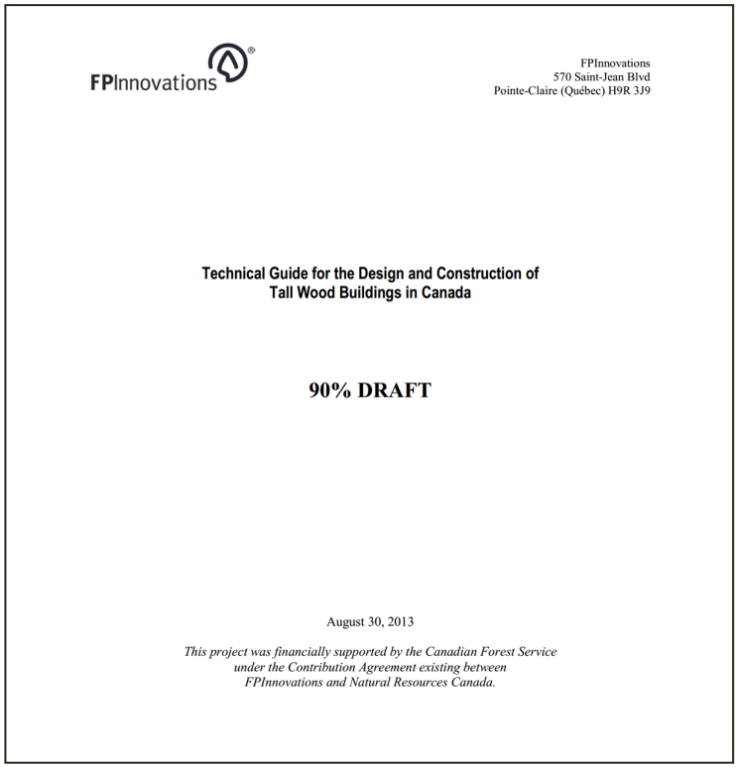
Consensus is developing to use the term Mass Timber.

(Massive lost out – too late)

Avoids confusion with the specified sizes for Heavy Timber in Division B.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

FPInnovations Tall Wood Guide



FPInnovations

FPInnovations
570 Saint-Jean Blvd
Pointe-Claire (Québec) H9R 3J9

Technical Guide for the Design and Construction of Tall Wood Buildings in Canada

90% DRAFT

August 30, 2013

This project was financially supported by the Canadian Forest Service under the Contribution Agreement existing between FPInnovations and Natural Resources Canada.

FPInnovations project funded by NRCan

- 400 pages.
- 70 pages on fire.
- Fire Section first to provide comprehensive review of fire issues in tall wood buildings.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Approach Chosen

- Intent was to demonstrate that it CAN BE DONE.
- Nationally acceptable risk tolerance.
- Took a conservative approach.
- Recommends an approach of encapsulation of combustibles.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Possible Approaches -

- Full performance based assessment
  - Lack of performance criteria/ inconsistent benchmarks
  - Time consuming

- Extend permitted combustible construction based on comparative risk analysis:
  - WIDC
  - BC 6 Storey

- Equivalent component performance
  - Protect components for equivalent performance

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Mass Timber Fire Resistance

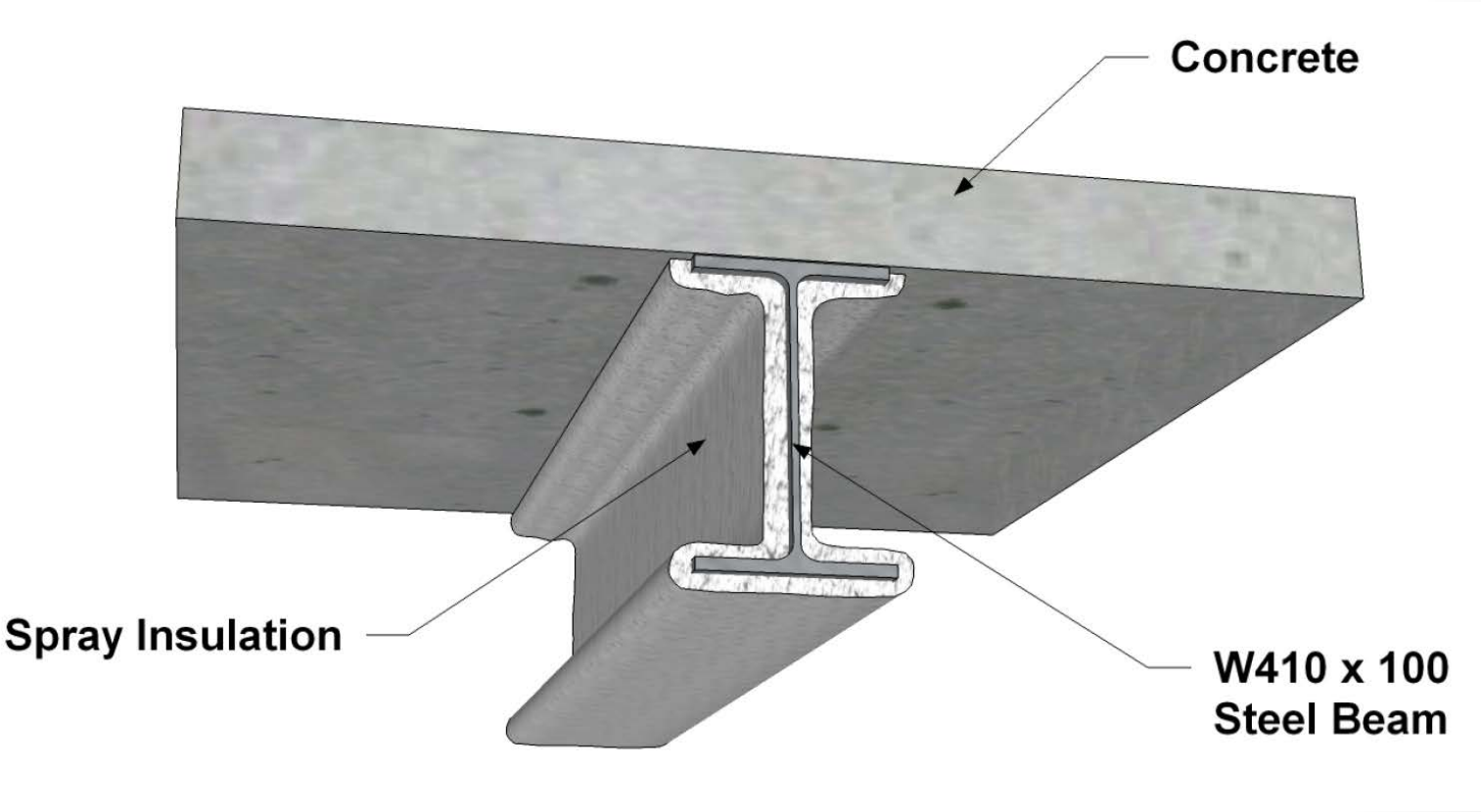
Two methods:

- Encapsulation
- Char

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

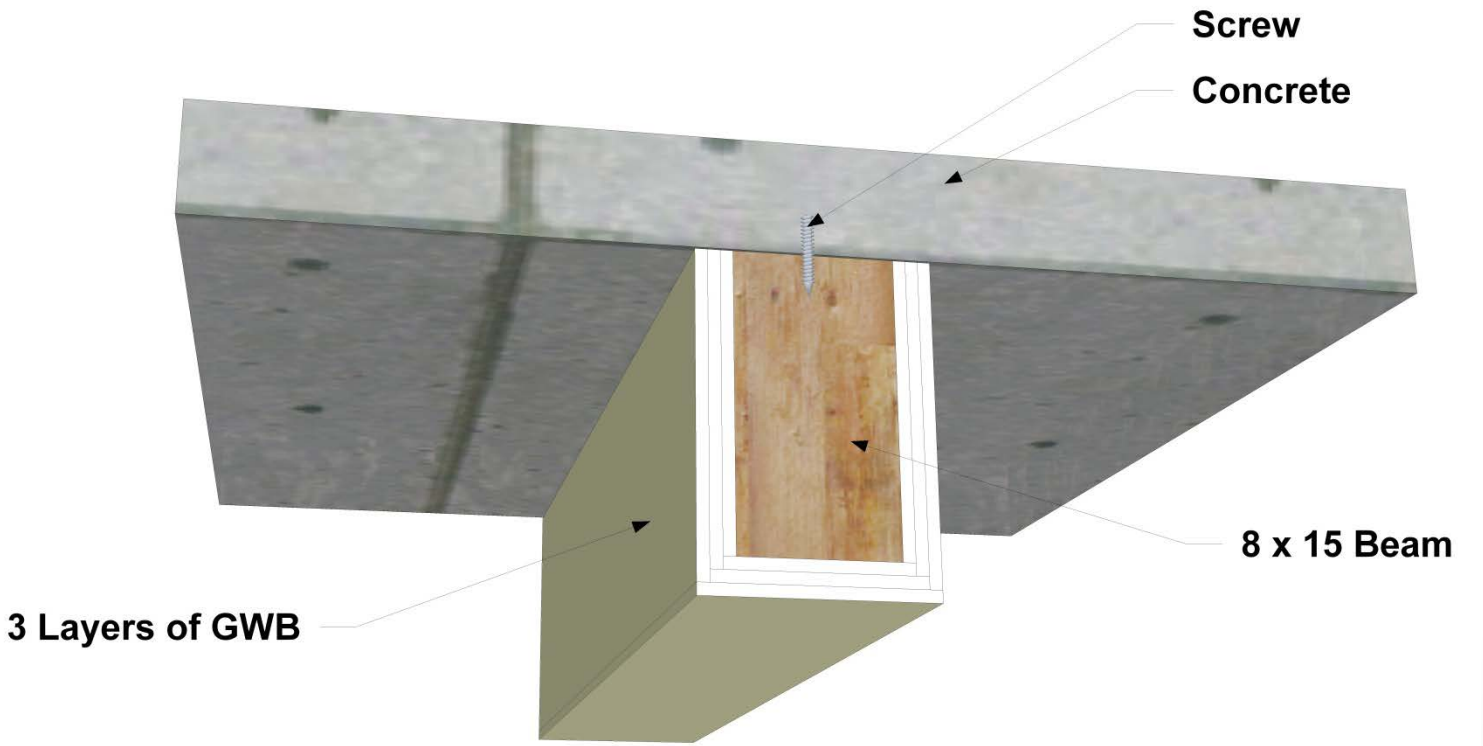
Encapsulation



GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

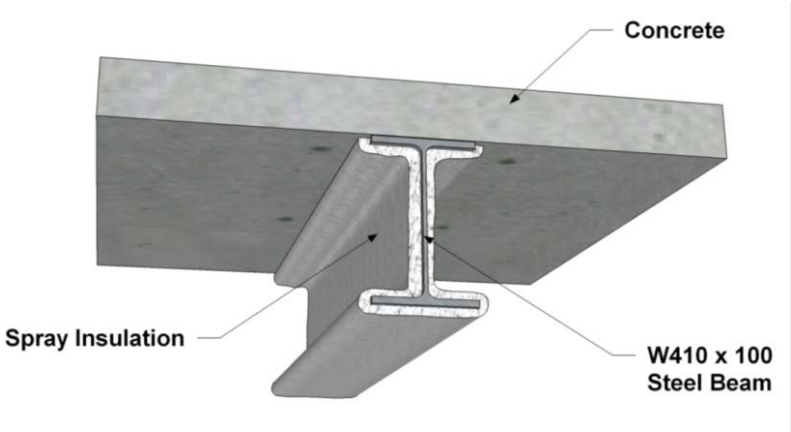
Encapsulation

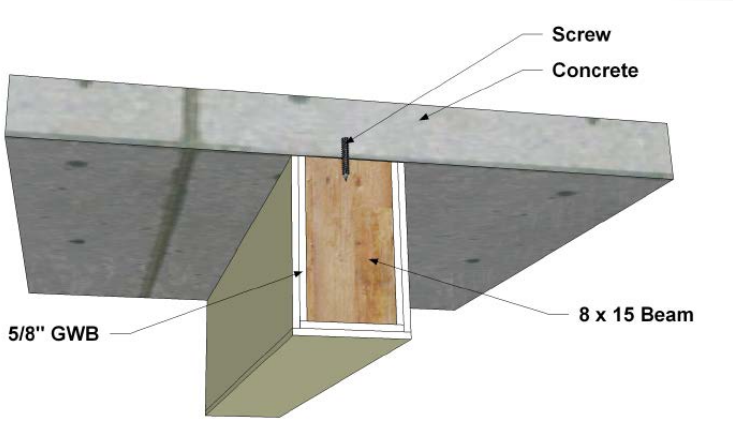


GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

What is the Difference





GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Complete Encapsulation

- Wood not affected by the fire for expected duration.
- Wood does not contribute to the fire for expected duration.
- 4 layers of ½in GWB.
- Makes the point that it CAN BE DONE.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Fire Resistance Rating of Gypsum Board Membranes

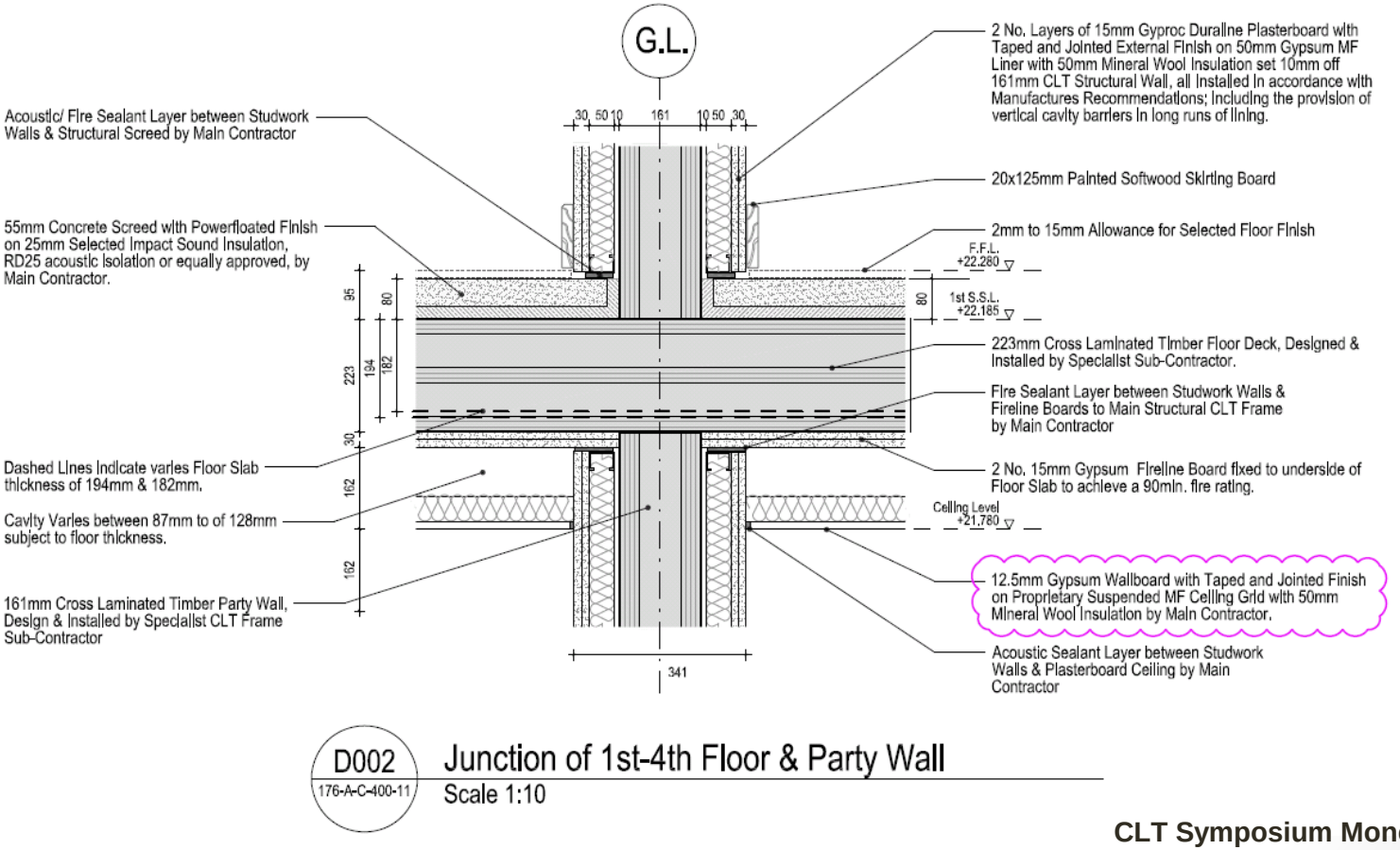
Gypsum Board Members	Fire Resistance Rating
One layer of 12.7mm (½in) GWB	15min
One layer of 15.9mm (⅝in) GWB	30min
Two layers of 12.7mm (½in) GWB	40min
Two layers of 15.9mm (⅝in) GWB	60min
Three layers of 15.9mm (⅝in) GWB	90min
Four layers of 15.9mm (⅝in) GWB	120min

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

UK Early Example – Bridport House

Fire / Acoustic



D002 (176-A-C-400-11) Junction of 1st-4th Floor & Party Wall
Scale 1:10

CLT Symposium Moncton
Philipp Zumbrunn
12 October 2011

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Peel Off the Layers

Then, suggested we peel off the layers.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Char → Fire Resistance

GHL CONSULTANTS LTD

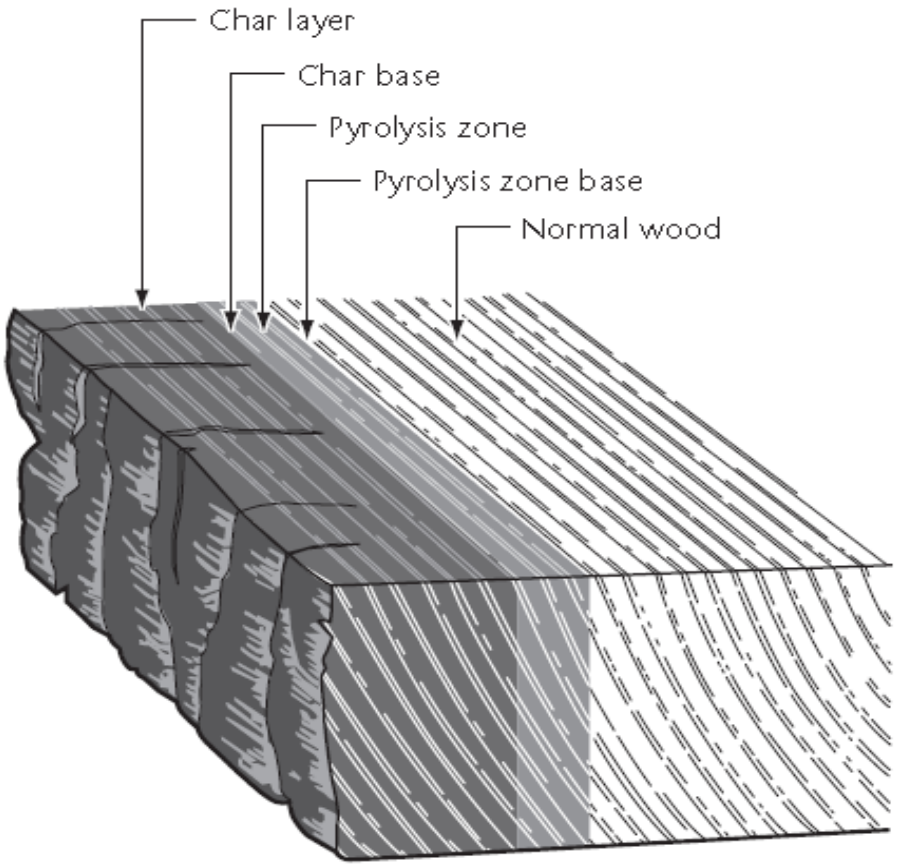
© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Inherent Safety of Mass Timber

- Why do we use small wood sticks to start a campfire?

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

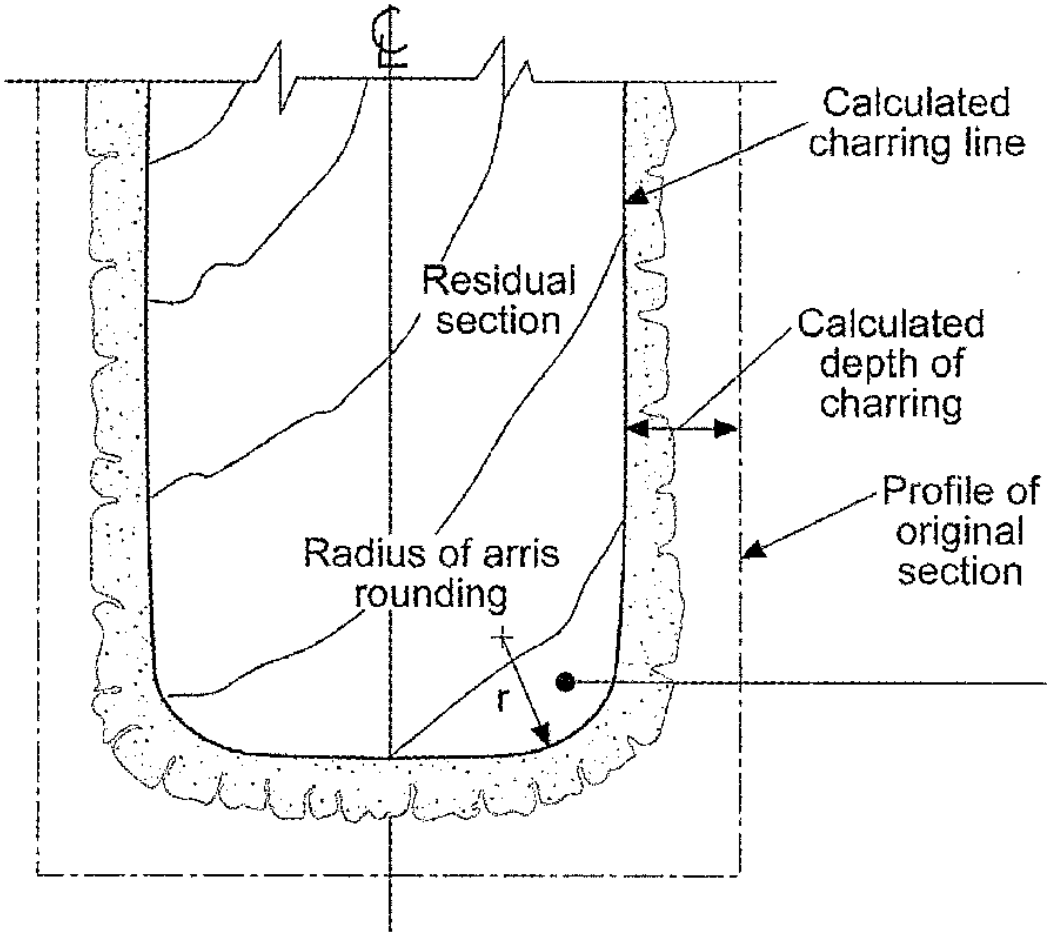
Char Layer – Small-Scale Flame Test



GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Concept of Mass Timber Design for Fire Resistance



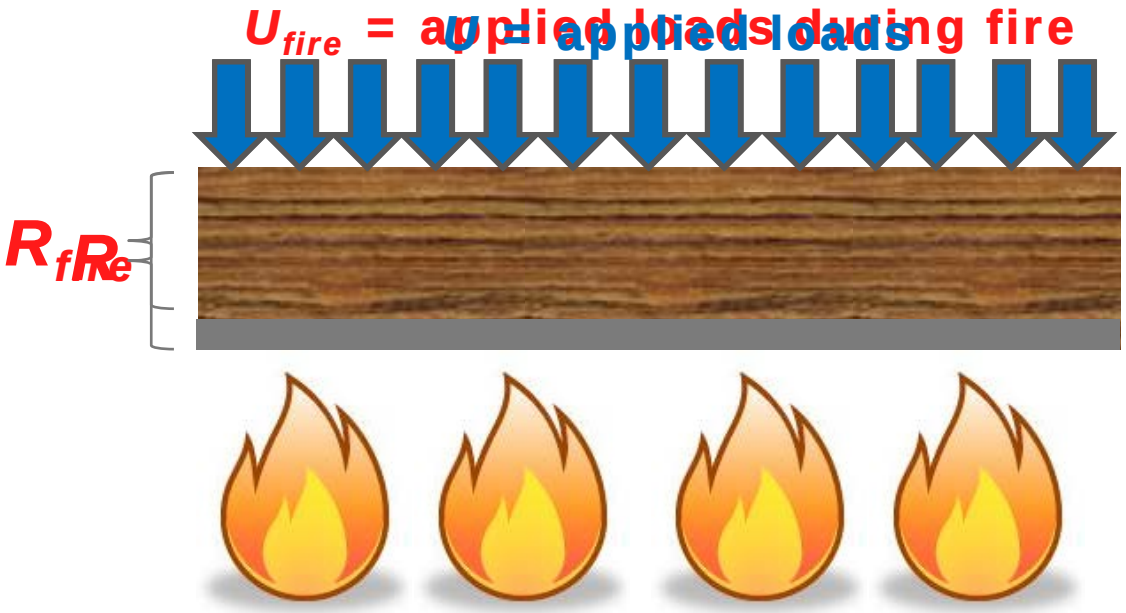
GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Limit State Design – for Fire

$$U_{fire} \leq \Phi_f R_{fire} \qquad (1)$$

where U_{fire} = the design action from the applied load at the time of the fire;
Φ_{fire} = the strength reduction factor for the timber material; and
R_{fire} = the nominal load capacity at the time of the fire, accounting for charring of wood members



GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Size of Members

Upsize of members for fire.

But this refers to critical collapse loads only.

Often performance governs (vibration, deflection).

Members may not need to increase in size.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

What has greater risk?

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

2h Noncombustible

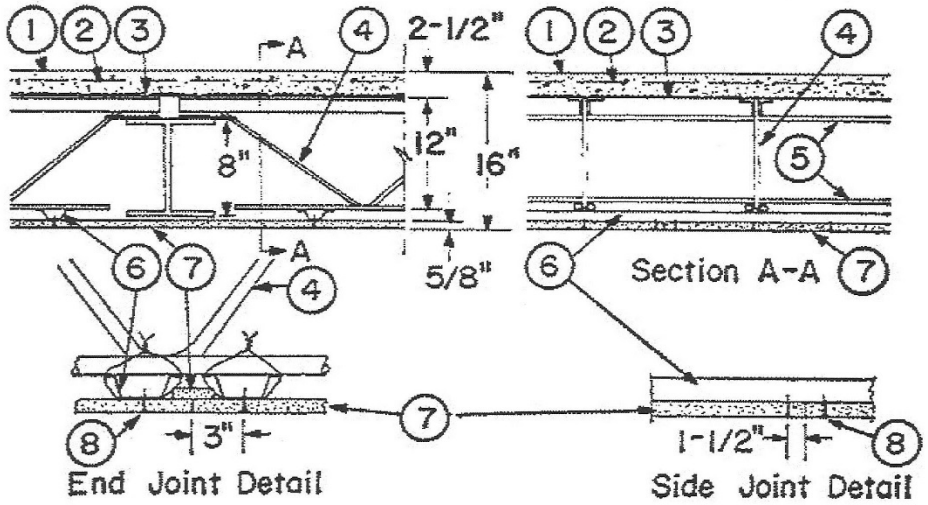
Fire Resistance Ratings - ANSI/UL 263

See General Information for Fire Resistance Ratings - ANSI/UL 263

Design No. G512

February 18, 2010

Restrained Assembly Rating — 3 Hr.
Unrestrained Assembly Rating — 3 Hr.
Unrestrained Beam Rating — 3 Hr.
Load Restricted for Canadian Applications — See Guide BXUV7



Beam — W8x35, min size.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

2h FRR

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

This, especially if wrapped in 2 layers of GWB

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Comparison

Code refers to comparison of level of performance of the alternative solution.

Useful to look at an acceptable solution for Earth Sciences Building compared to the proposed solution.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Risk Analysis

- Another approach.

- UBC Earth Sciences Building.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

5 Storey A-2 Occupancy
UBC Earth Sciences Building

Acceptable solution for A-2 occupancies:

- 1h noncombustible construction
- Alternative solution to address 1h mass timber

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Earth Sciences Building

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Approach

Risk Analysis

Pre-Flashover

Post-Flashover

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Pre - Flashover

95% sprinkler reliability.

Only necessary to address 5% probability.

Low occupant load, extra fire separations.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Peer Reviewed

GHL was the proponent.

Gage-Babcock & Associates Ltd was the reviewer.

All large UBC buildings done by peer review.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Mass Timber vs Steel

Wood

- Expensive to protect.
- Highly reliable.
- Reproducible results.
- Contributes fire load.

Steel

- Cheap to protect.
- How reliable?
- How reproducible are the results?
- Burns out.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Concrete

Concrete

- Agreed generally more fire safe than mass timber.
- Are fire rating designs and cover still applicable?
- Is 1/2in of cover acceptable per IBC?
- Spalling is unpredictable.

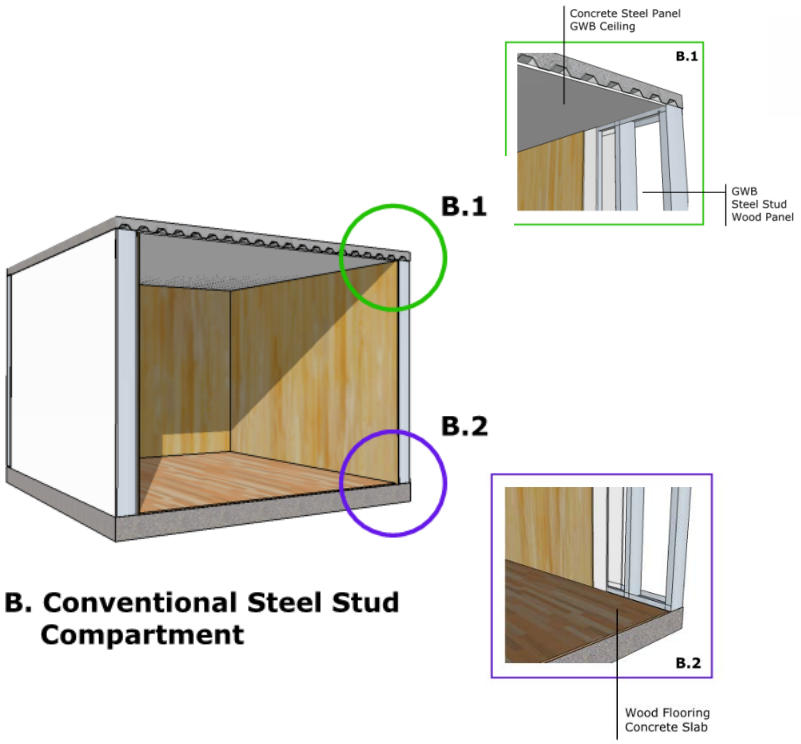
Concrete – how do you repair it - $30B loss in NZ

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Firefighting Considerations

- If Sprinklered – no difference from sprinklered noncombustible building – 96%
- Encapsulation == encapsulated steel.
- Performance in the first half hour will be the same as concrete or steel building of the same design.
- Evacuation the same.
- Difference may be clean-up, as mass timber may continue to burn and char.
- Difference – If the sprinklers fail, longer clean-up.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.



B. Conventional Steel Stud Compartment

Wood Panelling 25mm thick permitted in a sprinklered building

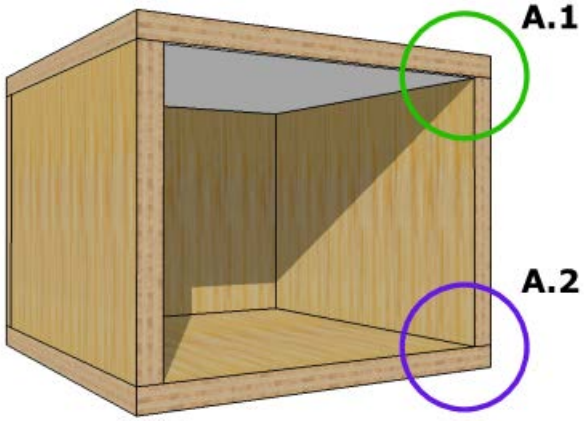
Typical FSR 100 to 150

Burnout of panelling and contents:
25mm/ 0.8mm/min

Approximately 30min

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

CLT Box



A. CLT Panel Compartment

- FSR 40 (FSR 37 and 38)

First 30 to 45min – Same as Wood Panels

Perhaps less than wood panels with FSR 40

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NEWBuildS

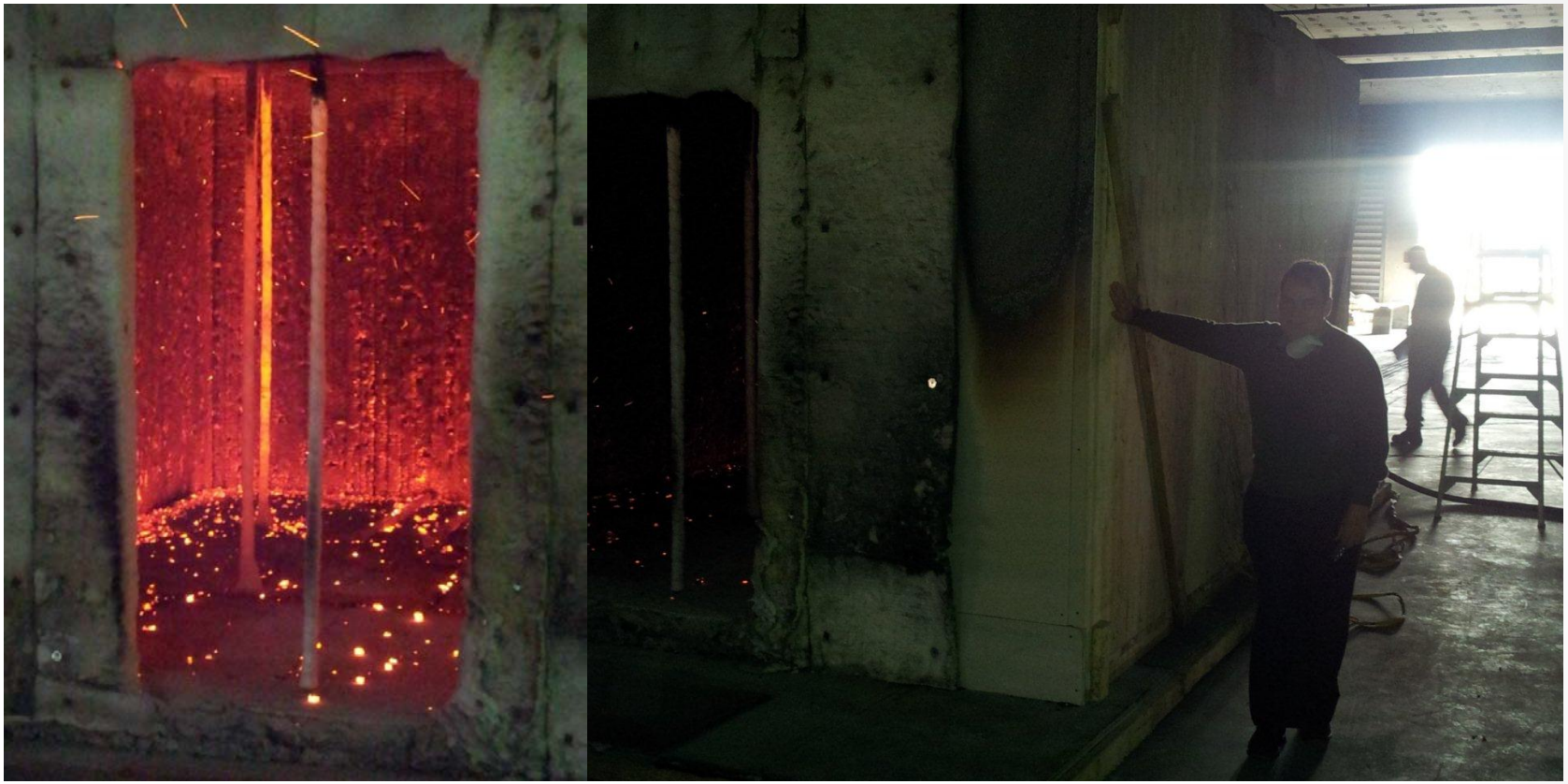
GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NEWBuildS

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.



GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Connections

Not specifically addressed for steel or concrete.

Especially intumescent – problems noted.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Intumescent Paint

Most tested on steel beams – no movement or cracking.

Effectiveness on connections, steel or wood is not known.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

We Used to Know How to Do It

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Protected Connections for Enhanced Fire Performance

b) Connection covered with wood paneling

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Protected Connections for Enhanced Fire Performance

a) Fire-resistance test conducted on concealed plate
(credit: L. Peng (Peng, Hadjisophocleous, Mehaffey, & Mohammad, 2010))

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Issues

A few issues that came up worth discussing.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Issues

Performance targets not clear.

Why 2h FRR?

Why does ULC S101 only require 1 test?

Is criteria set by residential 1h compartment rating?

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Sprinkler Reliability

To what degree can we rely on sprinklers?

Consensus of authors:

- On site water supply needed.

Addresses – seismic concerns:

- Fire after 2h?

US data confirms that sprinklers are 90% reliable; Canadian data, if monitored and supervised, reliability is much higher.

In my opinion, a fully sprinklered 2h combustible building can meet risk fully exposed, but not politically saleable in most areas.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Seismic

"An internal report of the City of Vancouver concludes that, at present, an M-7 earthquake would render the Greater Vancouver Water District supply system completely dysfunctional with 1000 water main breaks and 1000 service breaks." (Robertson 2000)

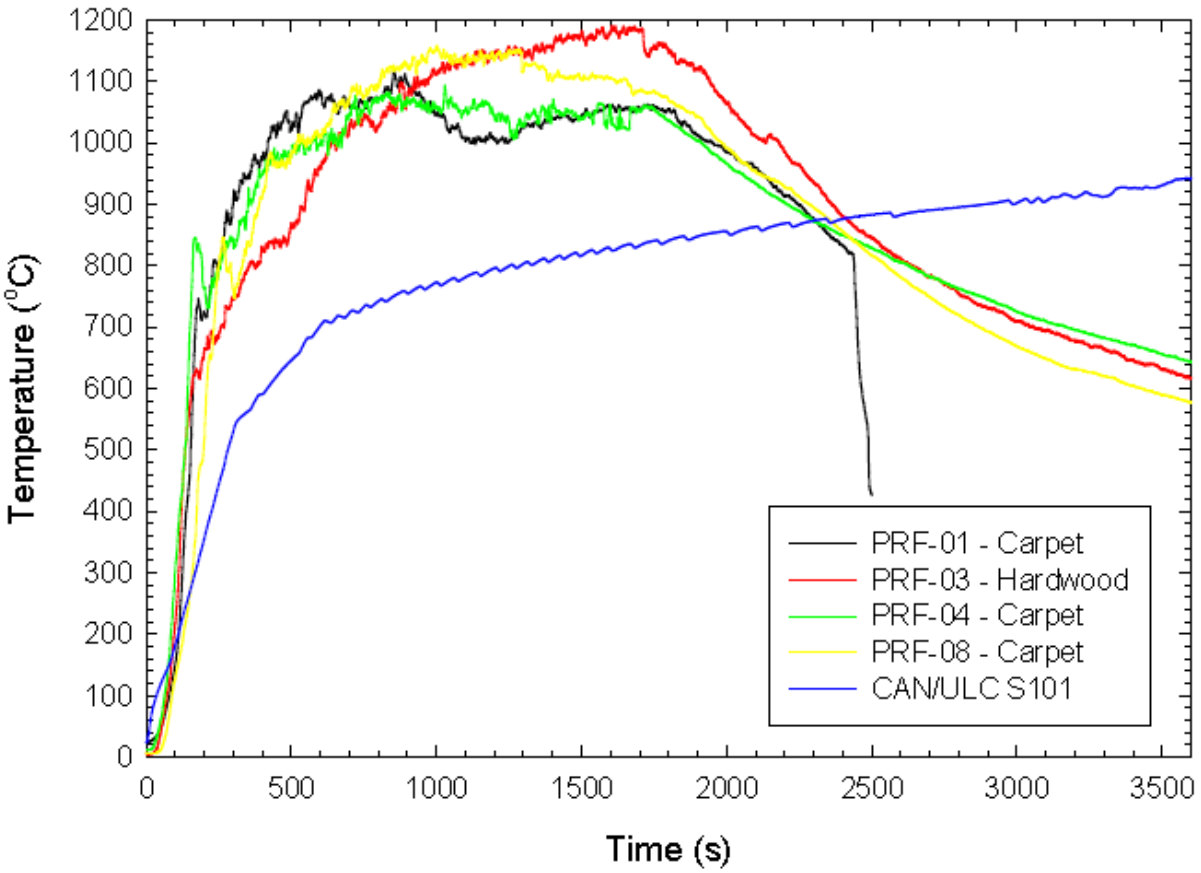
Conclusion: - We need an on site water supply

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Standard Fire vs. Design Fire



GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Design Fire

Is the standard fire acceptable, or do we need to look at real fires?

Conclusion:

- Office, Residential Occupancies – standard fire is acceptable.
- High hazard, should probably assess real fires.

Note if using reduced load, must use 'natural fire'.

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Void Spaces

Limited but they will occur.

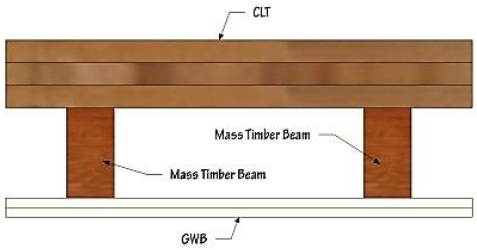
How big a void space is acceptable?

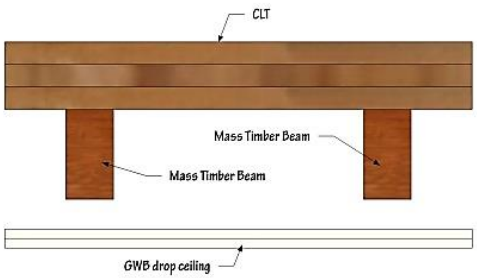
Unsprinklered (NFPA 13 provisions applicable).

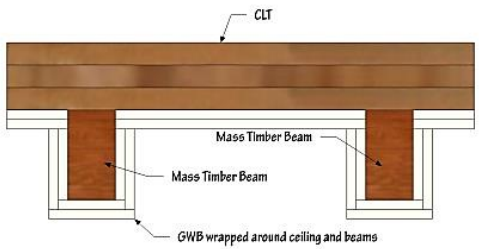
- Sprinklered?

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Approaches to Encapsulation Creating Concealed Spaces







GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Mass Timber within Occupied Spaces

Mass Timber typically FSR 40 to 50

- Wall and ceiling finishes up to 25 mm in thickness.
- Floor finishes of any thickness.
- Solid wood partitions that are not a part of floor to floor separations or exit separations.
- Light wood framing in partitions that are not a part of floor to floor separations or exit separations.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Firestopping

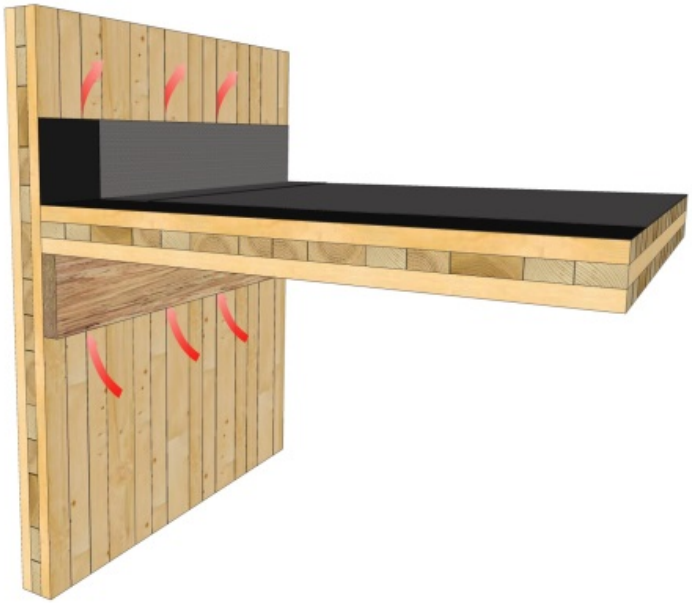
Don’t see a lot of issues.

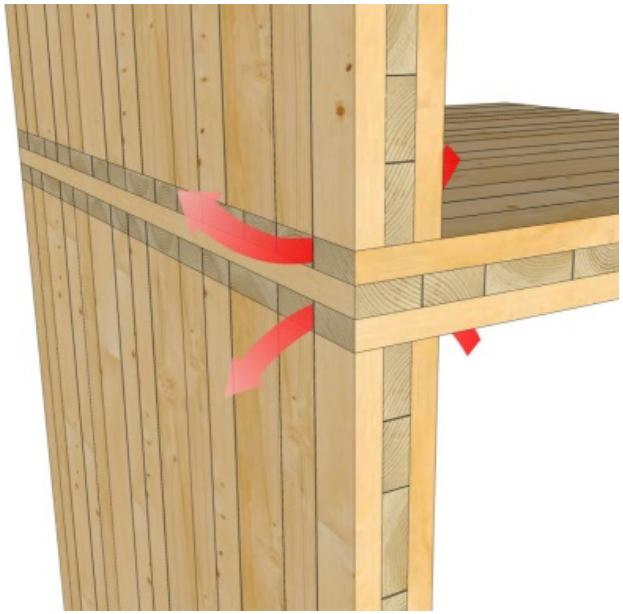
Some public testing being done for WIDC.

But, be careful.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

CLT Smoke Leakage Paths





GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Fire Tests Not So Bad

Results to come

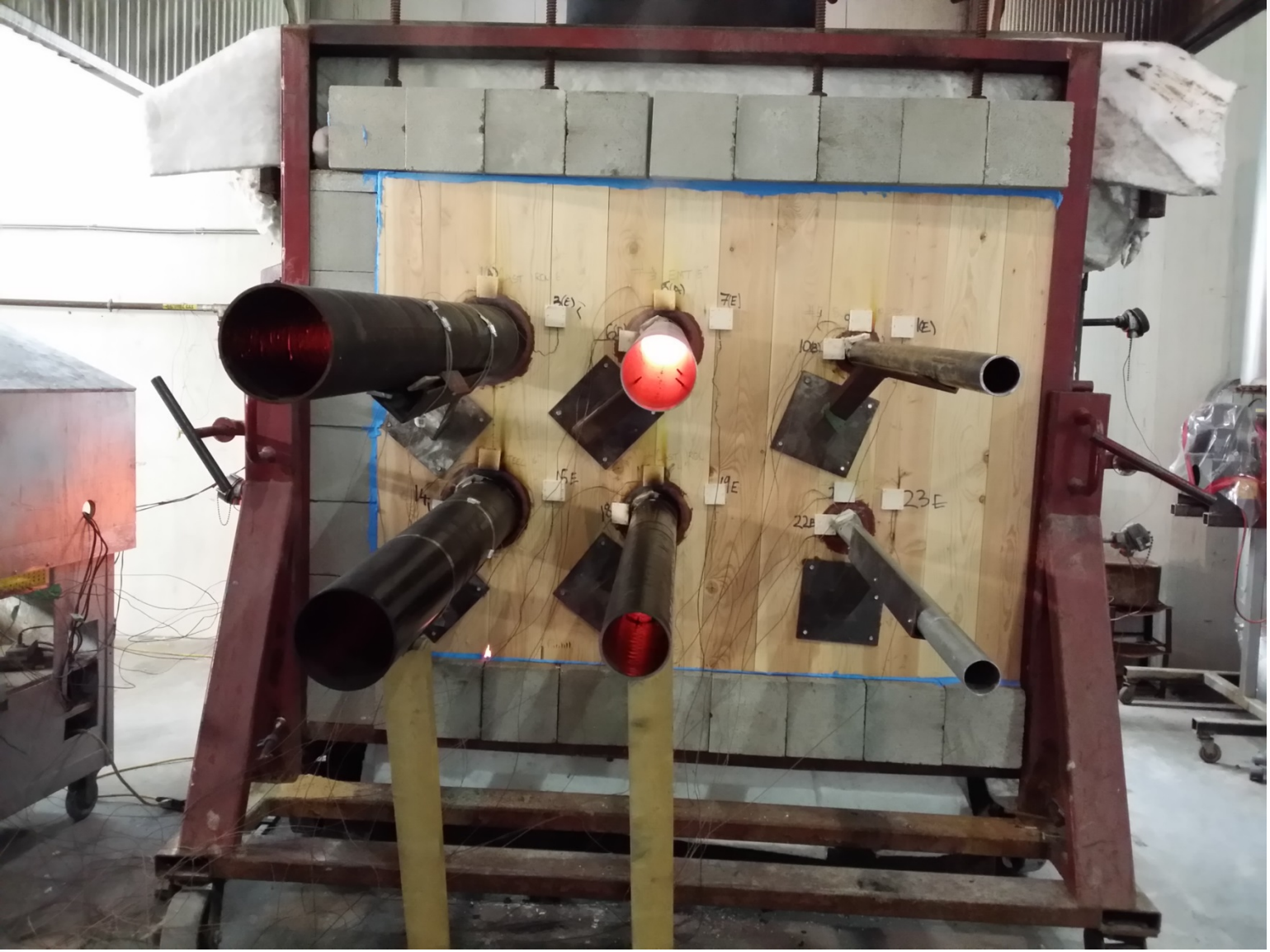
GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Firestop Test 2013/02/04

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.



Firestop Test 2013/02/04

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Exterior Cladding

Unlikely to be fully exposed.

Take a walk in the forest – how much wood do you see?

Code has a nice performance Standard for this, just needs to be applied to the whole wall assembly.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Cladding

Performance Standards

Exterior:
ULC S1.3.5 /Article 3.1.5.5

Interior:
Standard Firestop

If we meet that, why do we need additional provisions of noncombustible?

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

What Was Accomplished

Various reports out there on tall wood.

Limited review of fire issues, many said very little.

Green/Kharsh/Triggs – some more detail and a lot of effort on detailing to address approach – good first step but needed a lot more detail.

First full summary of all the fire issues.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Bridport House / Facts

- 8 Storey Residential in London.
- Eurban / CarbonEng, A Design Build Contractor with CLT.
- Courtesy of Philipp Zumbrunnen. Eurban / CarbonEng, A Design Build Contractor with CLT.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Bridport House / The Installation

Day 40

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Developments in Canada

NEWBuildS - Network for Engineered Wood-based Building Systems.

CAN/CSA O86 Task Group on Wood Fire Ratings.

NRC/CWC Research consortium on higher wood buildings.

FP Innovations CLT Development.

National Code Process.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NEWBuildS

NEWBuildS - Network for Engineered Wood-Based Building Systems:

- History of the Code studies
- Fire Tests of CLT rooms
- Hybrid Construction (Steel/Wood and Concrete/Wood)

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium

Research consortium on higher wood buildings:

- Looking at 6 storey combustible frame construction.
- Learned group similar to Code Committee.
- Comparative performance testing (fire and sound).

GHL CONSULTANTS LTD

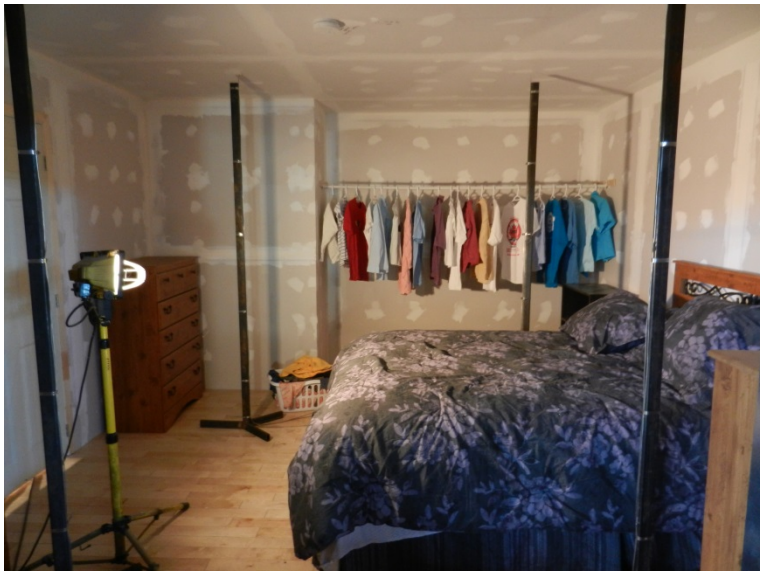
© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium



Fire Test Fuel

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium

LWF Start of Test

CLT Start of Test

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium

LWF Fire Test

CLT Fire Test

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium

LWF

CLT

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

NRC/CWC Research Consortium

Steel

GHL CONSULTANTS LTD

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

The Future

My opinion:

- 6 storey is probably the practical limit for wood frame.
- 8 storey with prefab quality control.
- No significant limit on area for wood frame.
- Structures will set limit on height for Heavy Timber.
- Hybrid buildings of unlimited height and area.

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Useful Links

- GHL CONSULTANTS LTD: www.ghl.ca
  Tall Wood Presentation: http://www.ghl.ca/shared/Tall_Wood_Presentation.pdf
- Woodworks! National:
  ww.woodworks.org/index.php?option=com_content&view=featured&Itemid=112
- Woodworks! Alberta:
  www.wood-works.org/index.php?option=com_sobipro&sid=61:Wood-WORKS-Alberta&Itemid=228
- Woodworks! BC:
  www.wood-works.org/index.php?option=com_sobipro&sid=61:Wood-WORKS-Alberta&Itemid=228
- Canadian Wood Council: Mid-Rise Construction in BC:
  http://www.cwc.ca/documents/case_studies/Mid-Rise-Construction-in-BC.pdf
- Canadian Wood Council: Innovating with Wood:
  http://www.cwc.ca/documents/case_studies/Four%20demonstration%20Case%20Study_May_30.pdf
- Technical Guide for the Design and Construction of Tall Wood Buildings in Canada:
  http://ghl.ca/shared/Tall_Wood_Building_Technical_Guide.pdf

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Questions?

© Copyright GHL Consultants Ltd. Distribution and reproduction by permission only.

Thank you

A copy of this presentation is available at:

- **http://www.ghl.ca/shared/Tall_Wood_Presentation (CoR Feb 2014.pdf**

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

Phone: (604) 689-4449 Fax: (604) 689-4419
Email: ah@ghl.ca Web: www.ghl.ca