Detailing Mass Timber Buildings for Fire Safety

Chicago Wood Design Symposium

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ARUP

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.

What is Mass Timber ?

Glulam

Cross Laminated Timber (CLT)

Nail Laminated Timber (NLT)

Mass plywood panels (MPP)

Dowel laminated timber (DLT and DCLT)

Timber-Concrete composites

Why Mass Timber ?

Sustainability

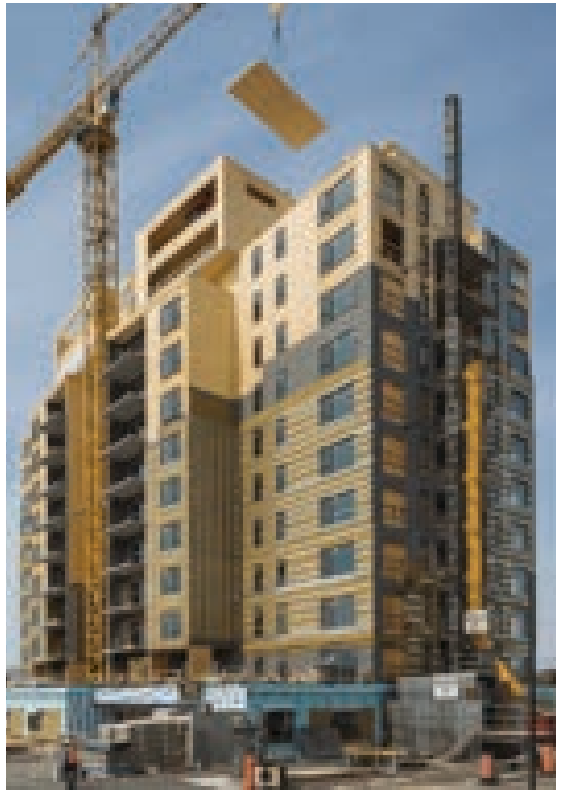
Low carbon footprint
possible local material
lightweight solutions

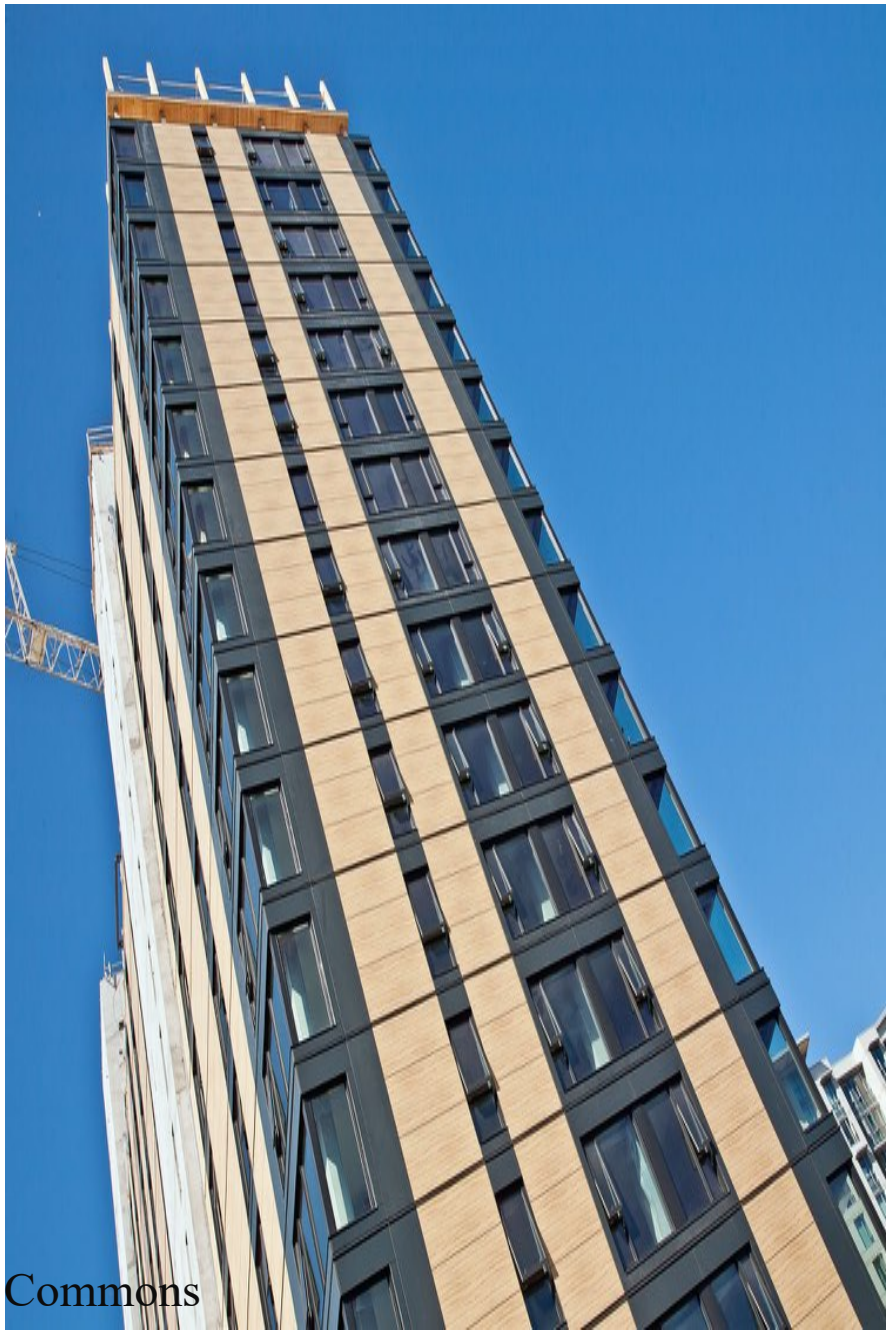
Aesthetics

Structure = finish
biophilia & natural patterns
market differentiator

Speed

Pre-fabrication of engineered wood
composite & hybrid solutions
speed on site



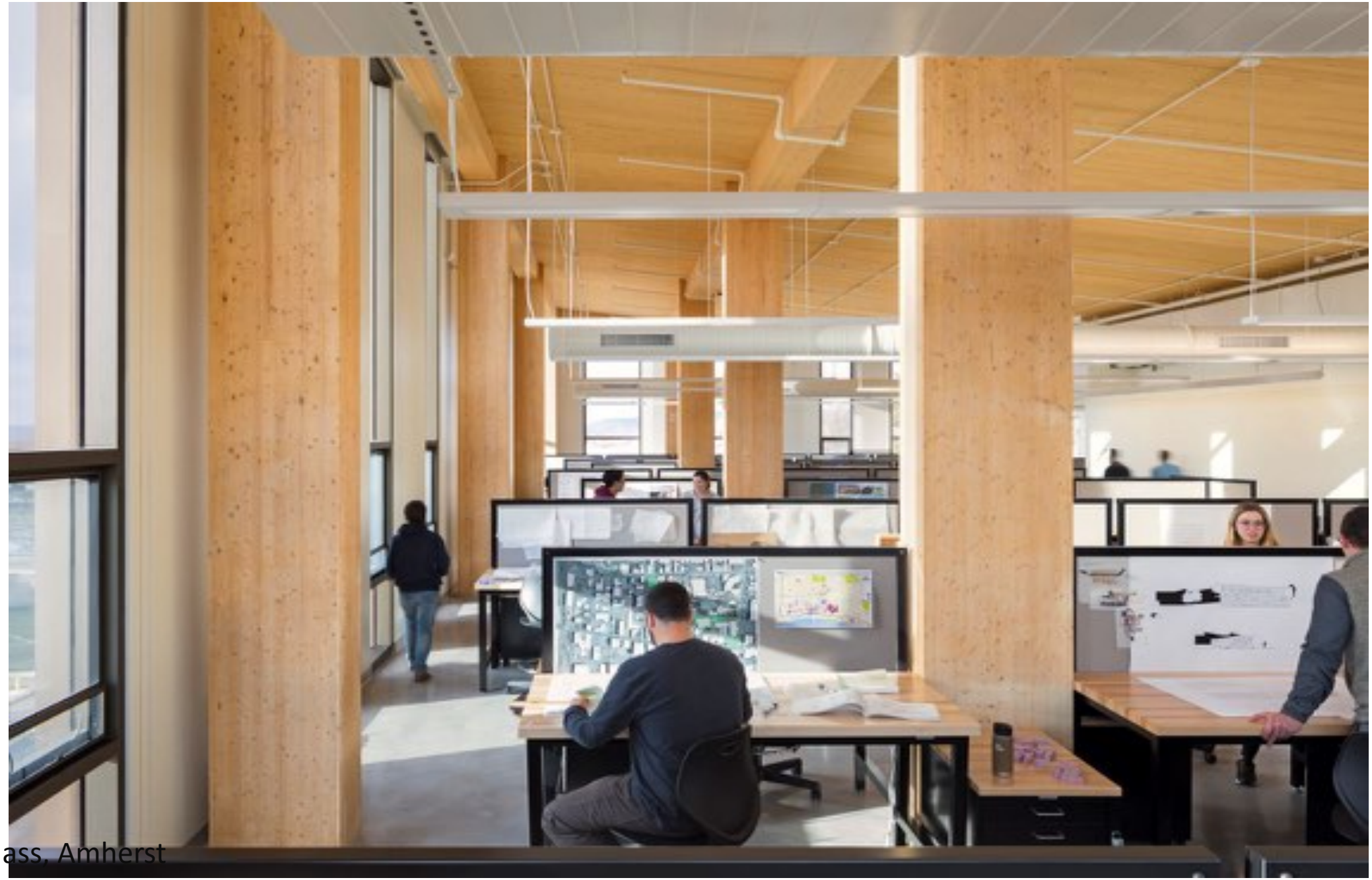


UBC Brock Commons

HoHo, Austria

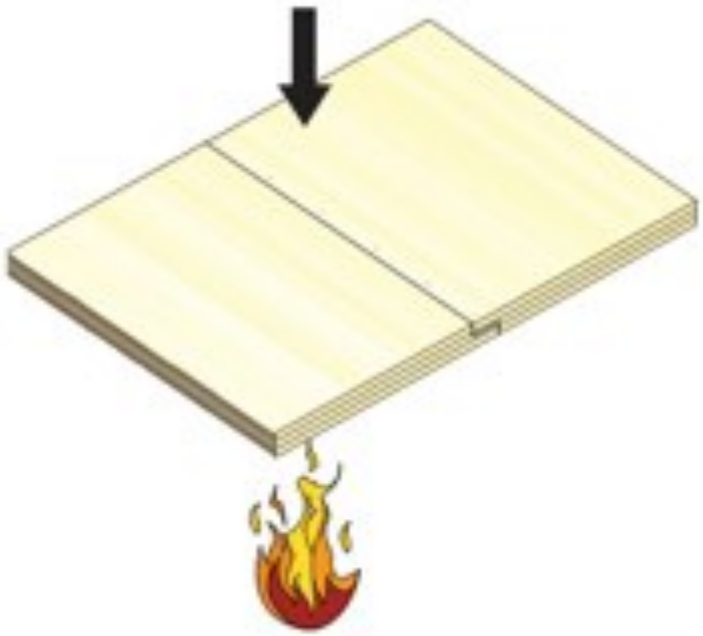
Albina Yards, Portland

T3, Minneapolis

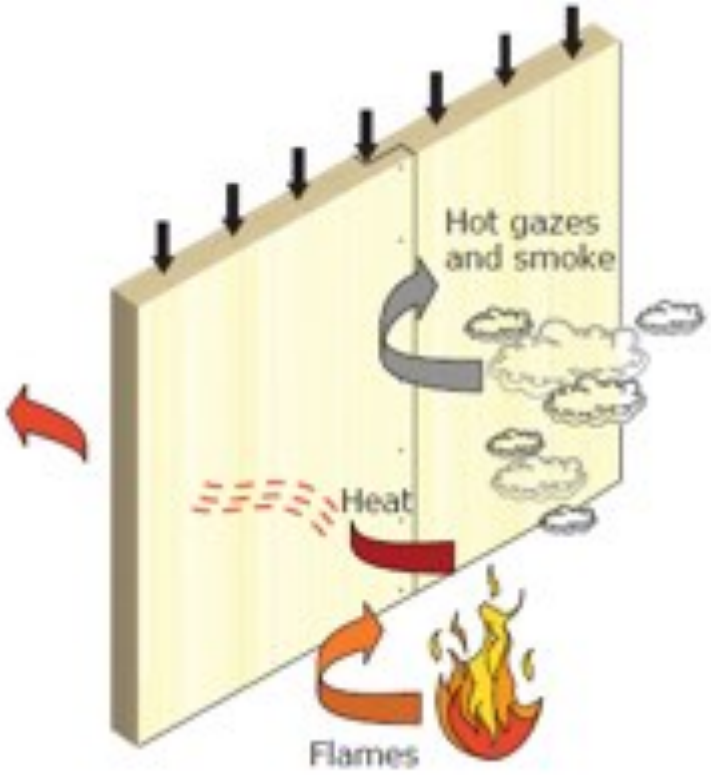


U Mass. Amherst

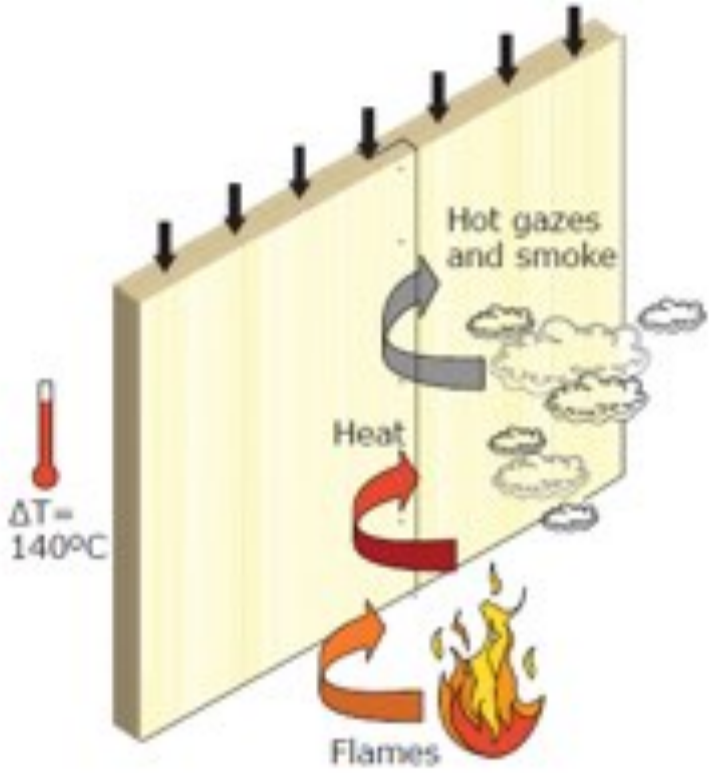
What is a Fire Resistance Rating (FRR)?



Structural resistance



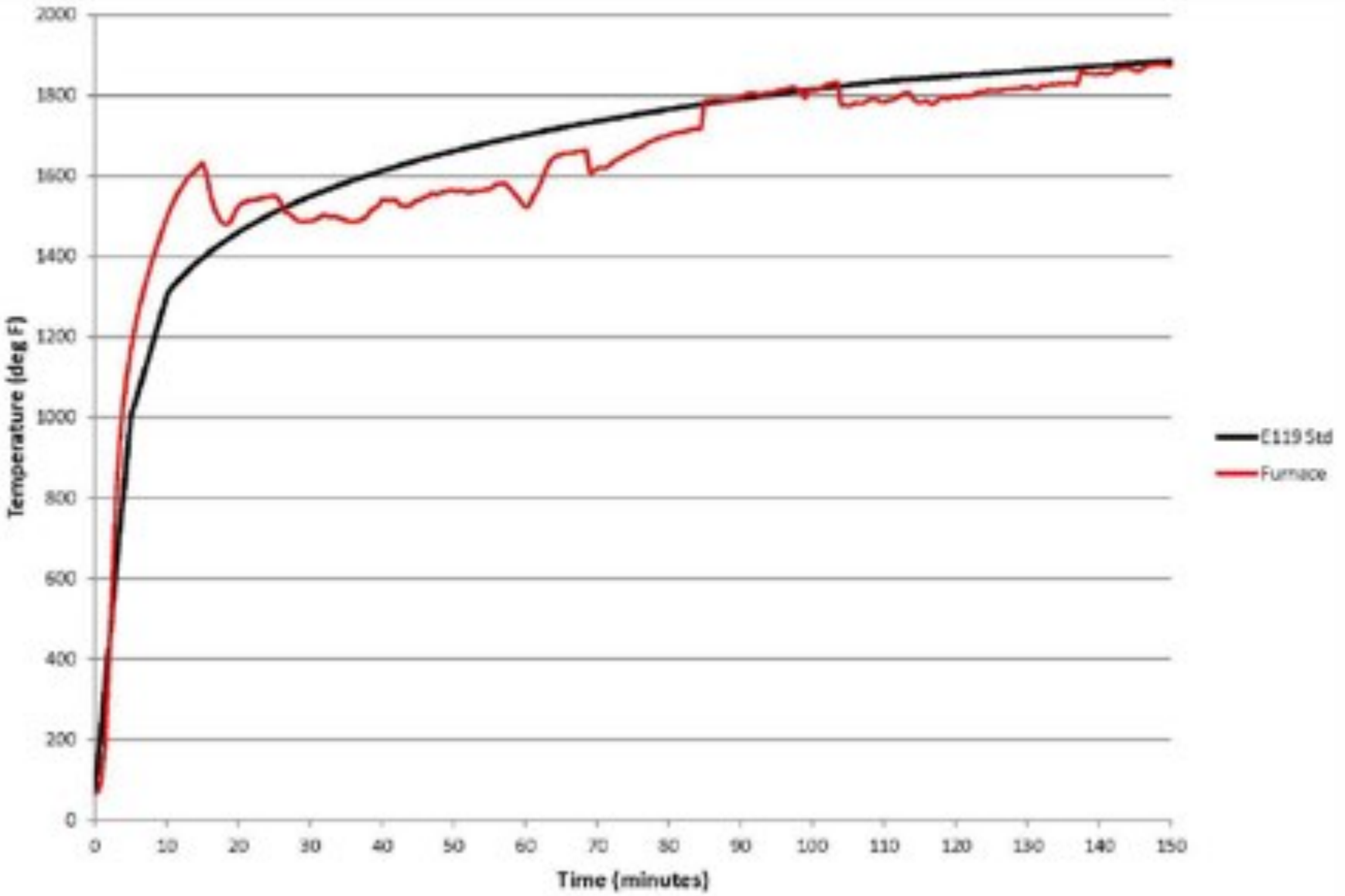
Integrity



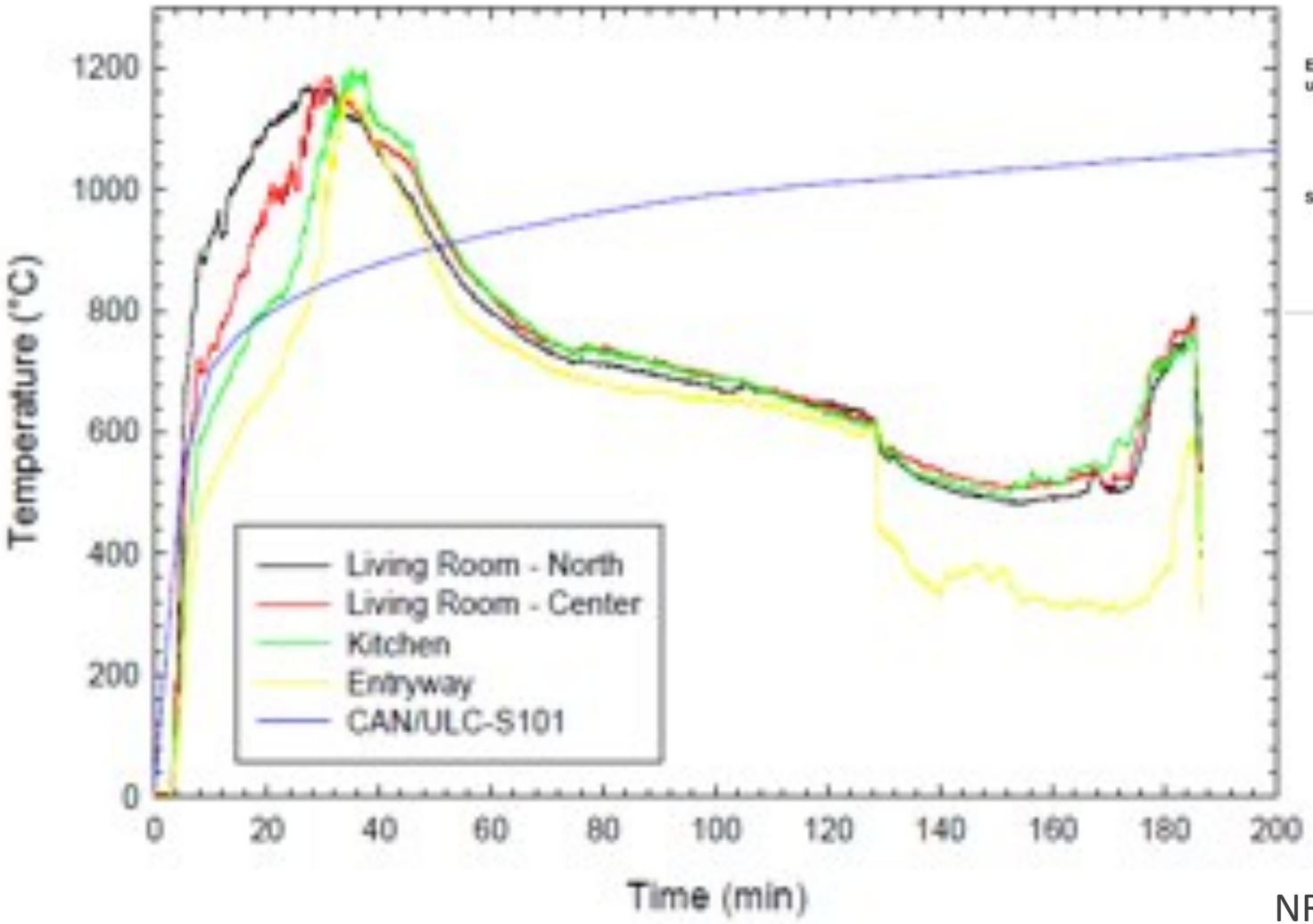
Insulation

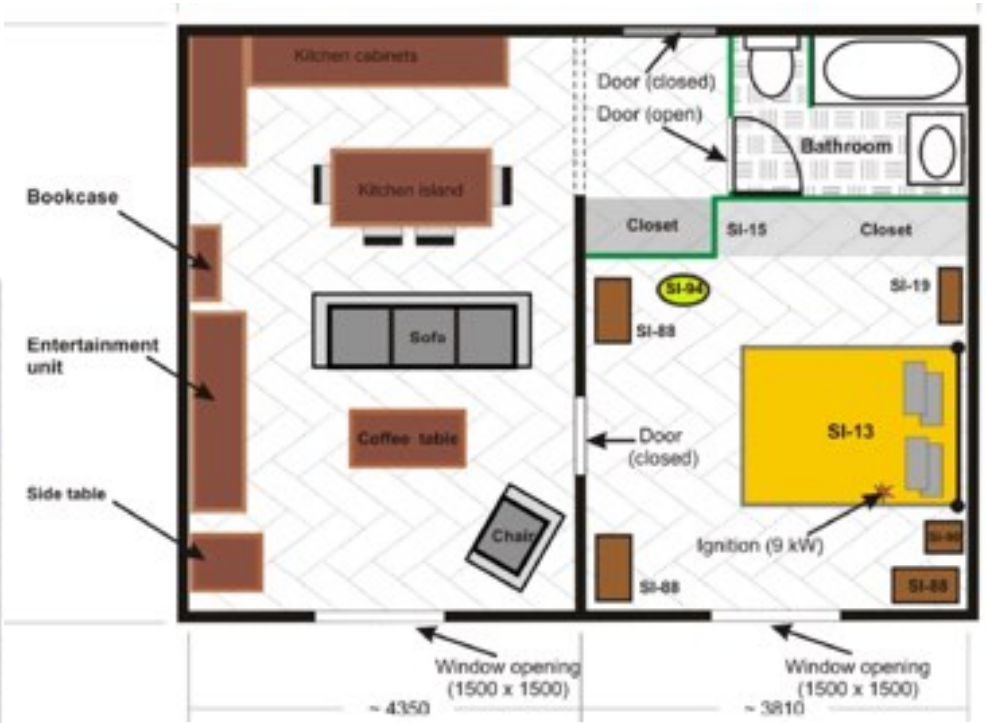
(from “CLT Handbook, US Edition”)

What is a Fire Resistance Rating (FRR)?

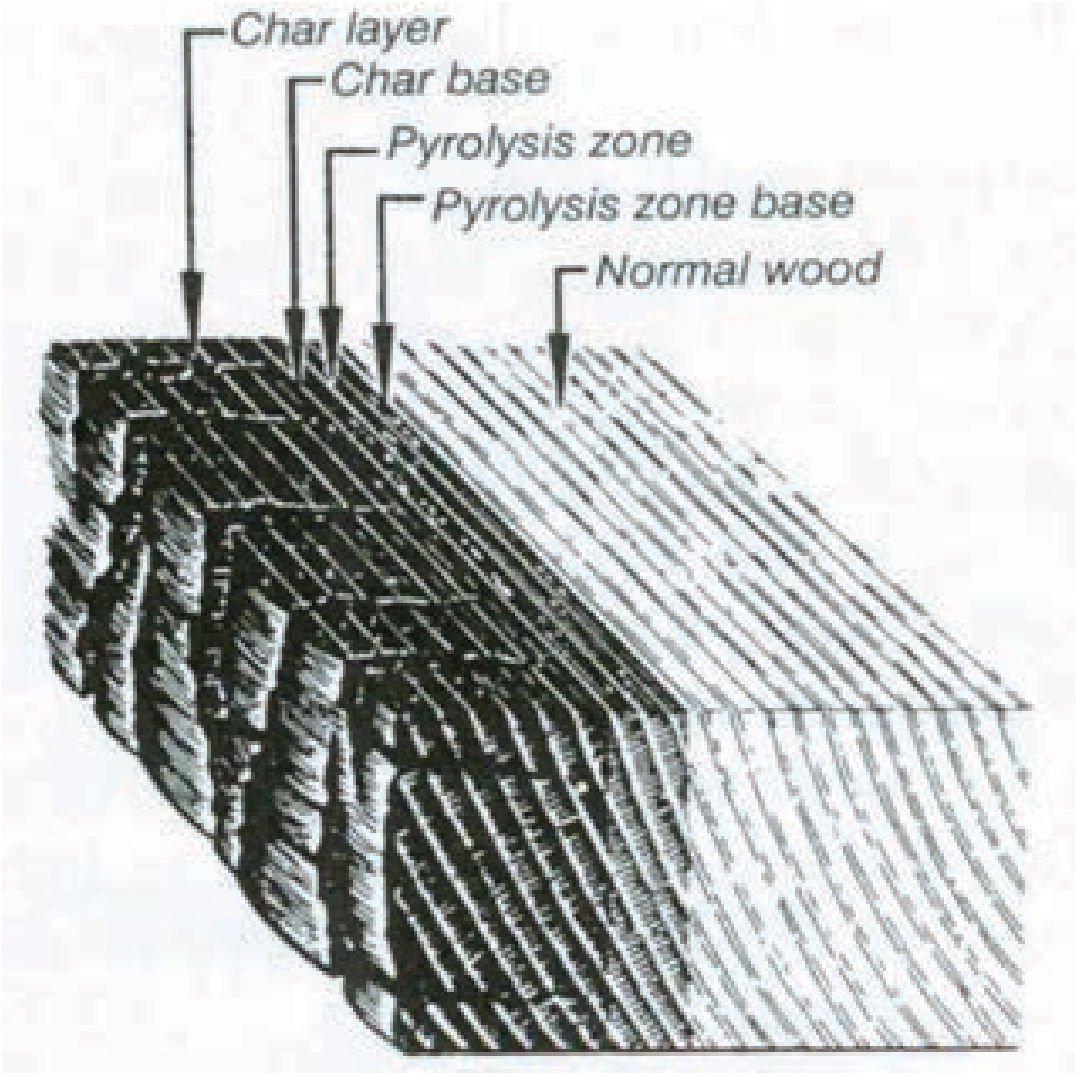


What is a fire ?



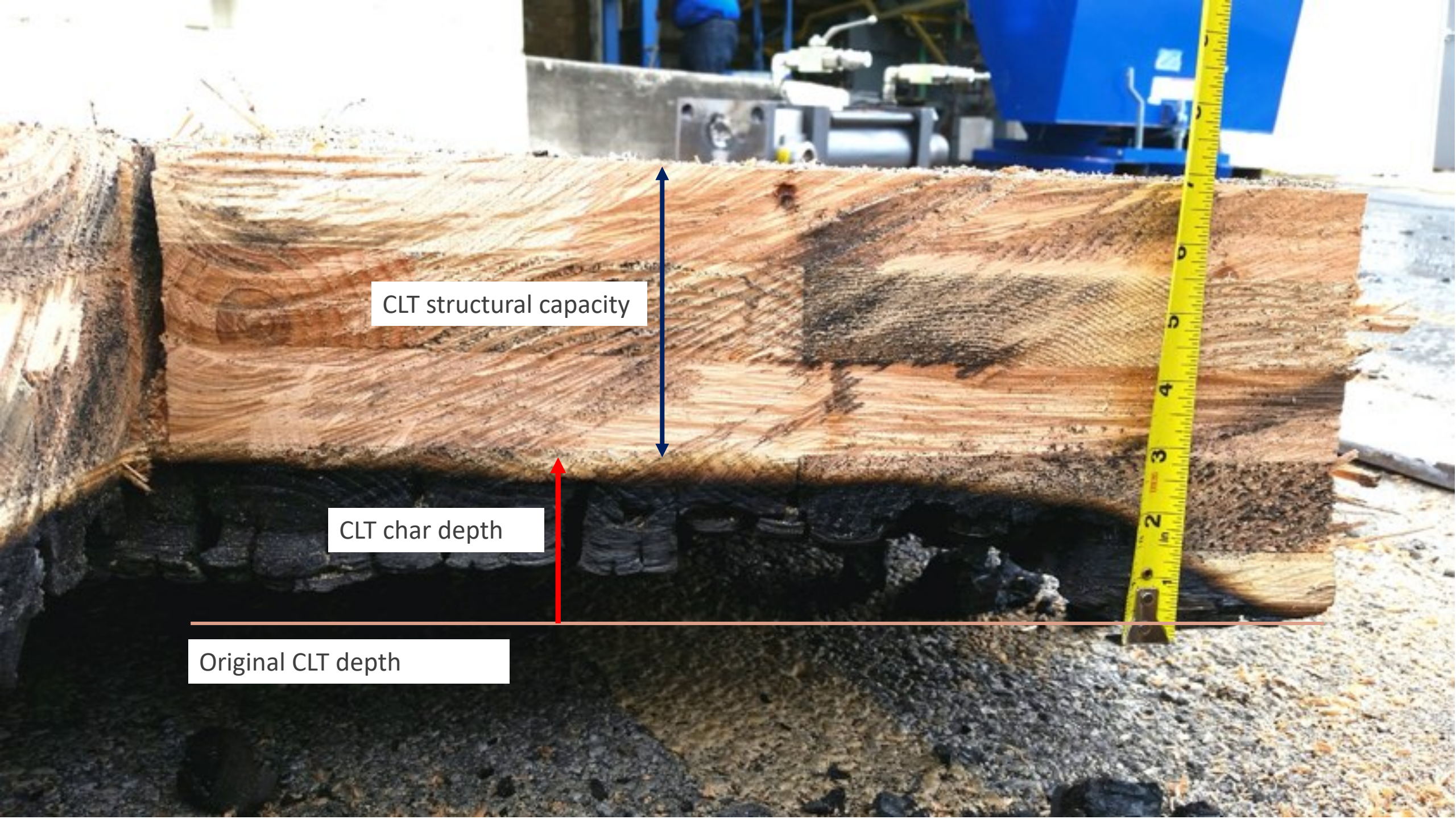


NRC, Canada



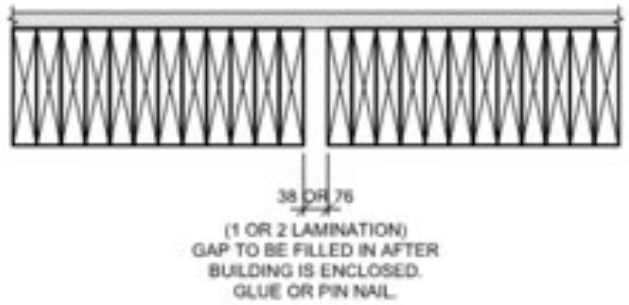
Schaffer, 1966, Forest Products Laboratory

$$a_{eff} = 1.2\ \beta_t t^{0.813}$$

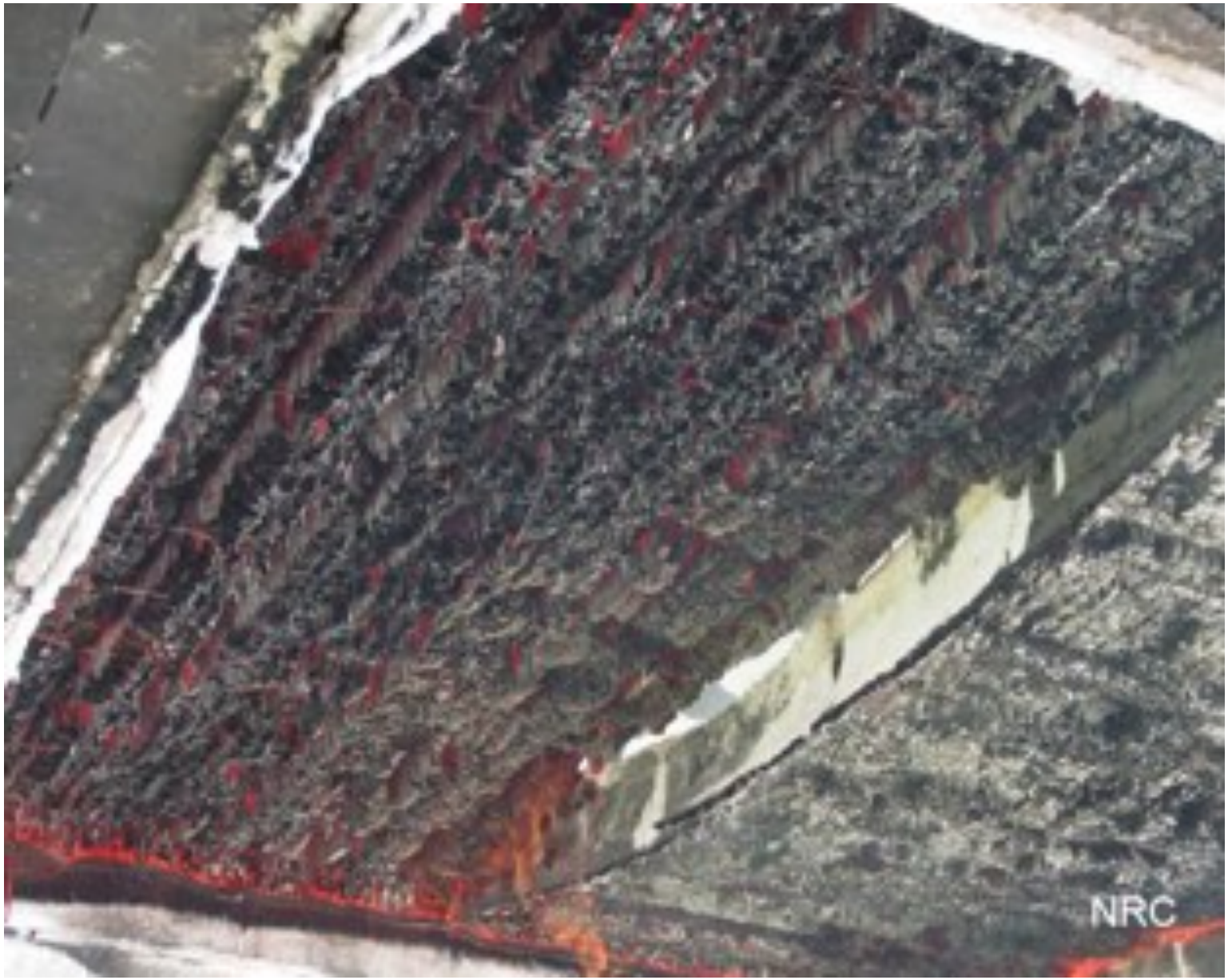

CLT structural capacity
CLT char depth
Original CLT depth


GAS

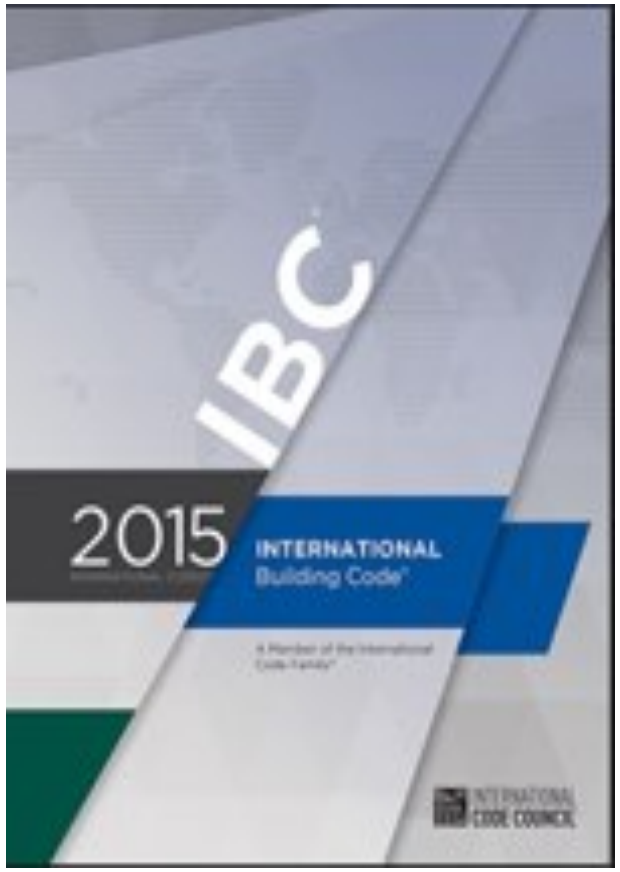

010105

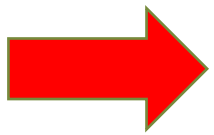

38 OR 76
(1 OR 2 LAMINATION)
GAP TO BE FILLED IN AFTER
BUILDING IS ENCLOSED.
GLUE OR PIN NAIL.

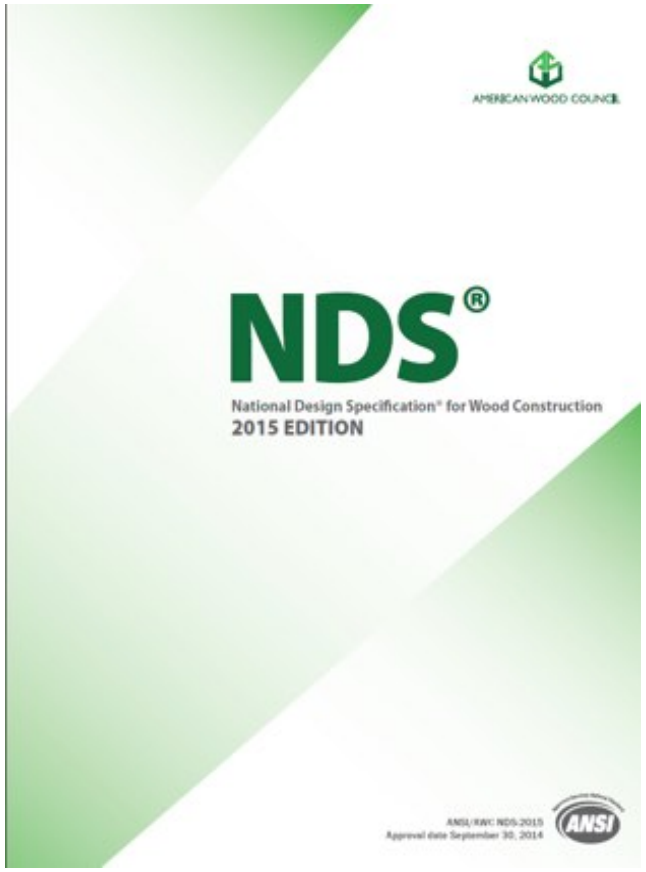
Tall Wood Building Institute

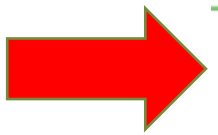


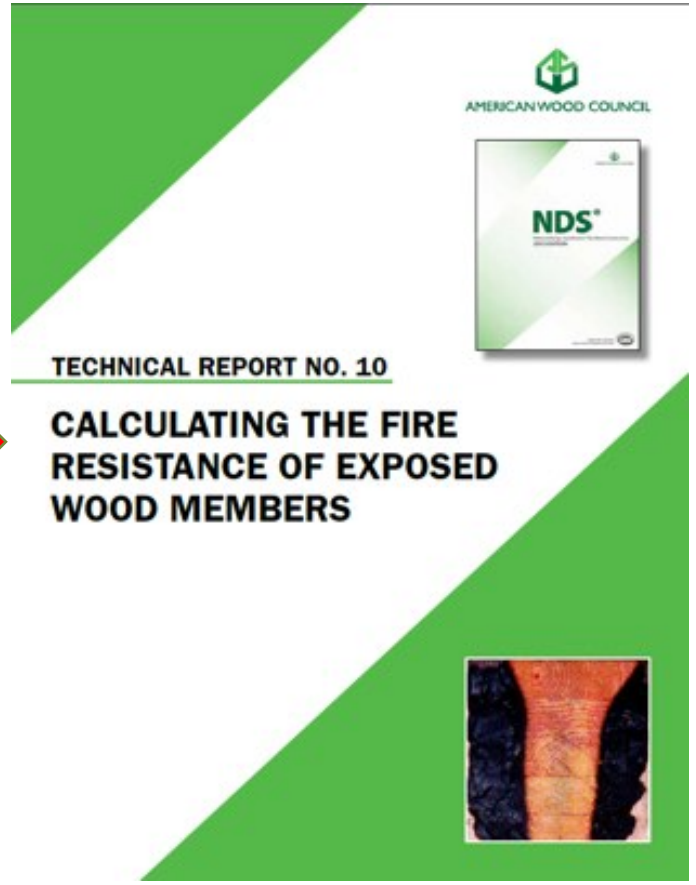
National Research Council, Canada


IBC
2015
INTERNATIONAL
Building Code®
INTERNATIONAL CODE COUNCIL




AMERICAN WOOD COUNCIL
NDS®
National Design Specification® for Wood Construction
2015 EDITION
ANSI




AMERICAN WOOD COUNCIL
NDS®
TECHNICAL REPORT NO. 10
CALCULATING THE FIRE RESISTANCE OF EXPOSED WOOD MEMBERS

Mass timber and the IBC

Simple Banking HQ, Portland

IBC limits for mass timber construction

Non-combustible construction – Type I, II

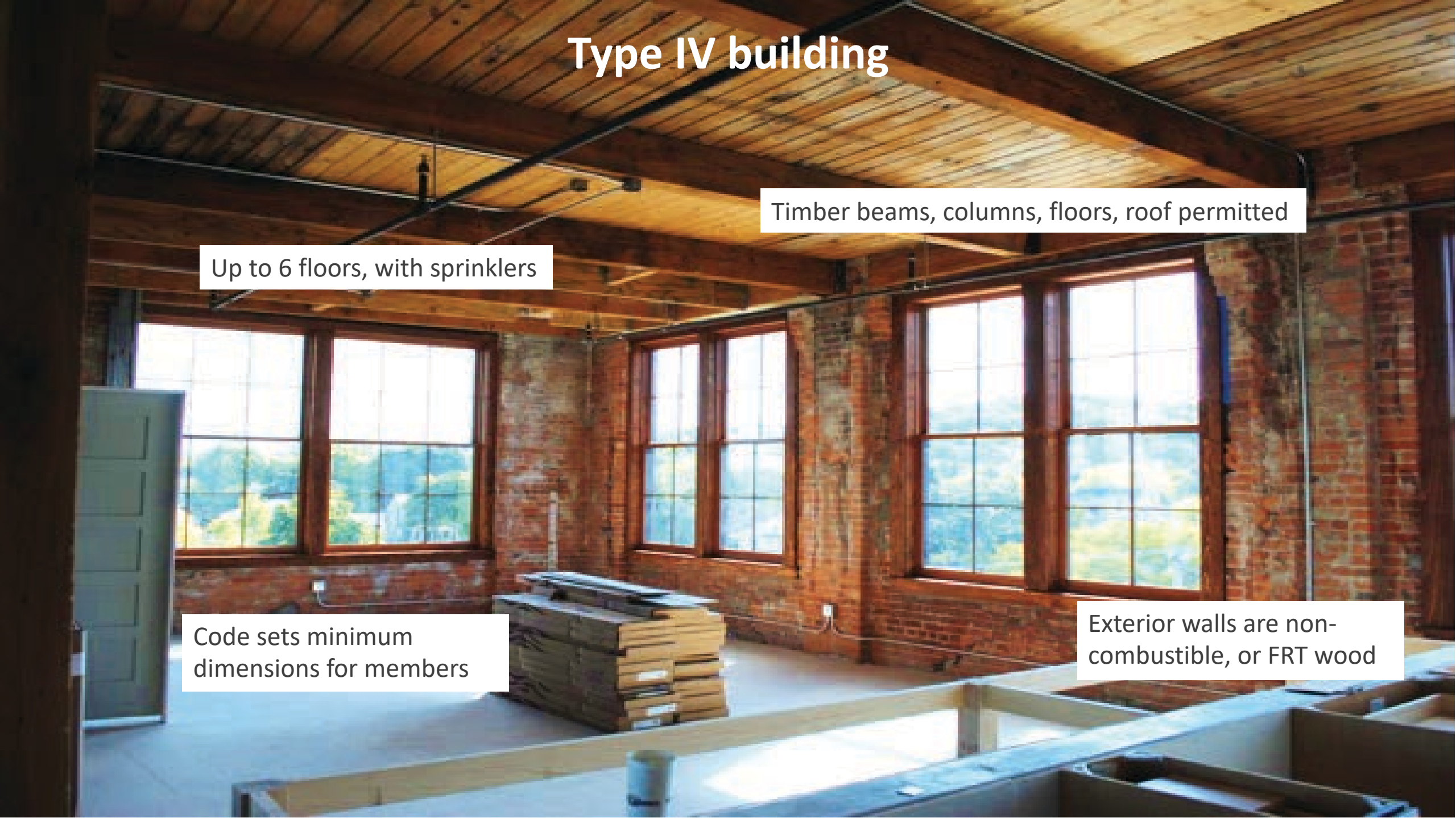
Combustible construction – Type III, IV, V

Mass timber - Code compliant use in Types III, IV, V

Type IV – Heavy Timber:

- Up to 6 floors (office) 5 floors (resi)
- Additional floors with “podium construction”
- 85ft in building height

Type IV building



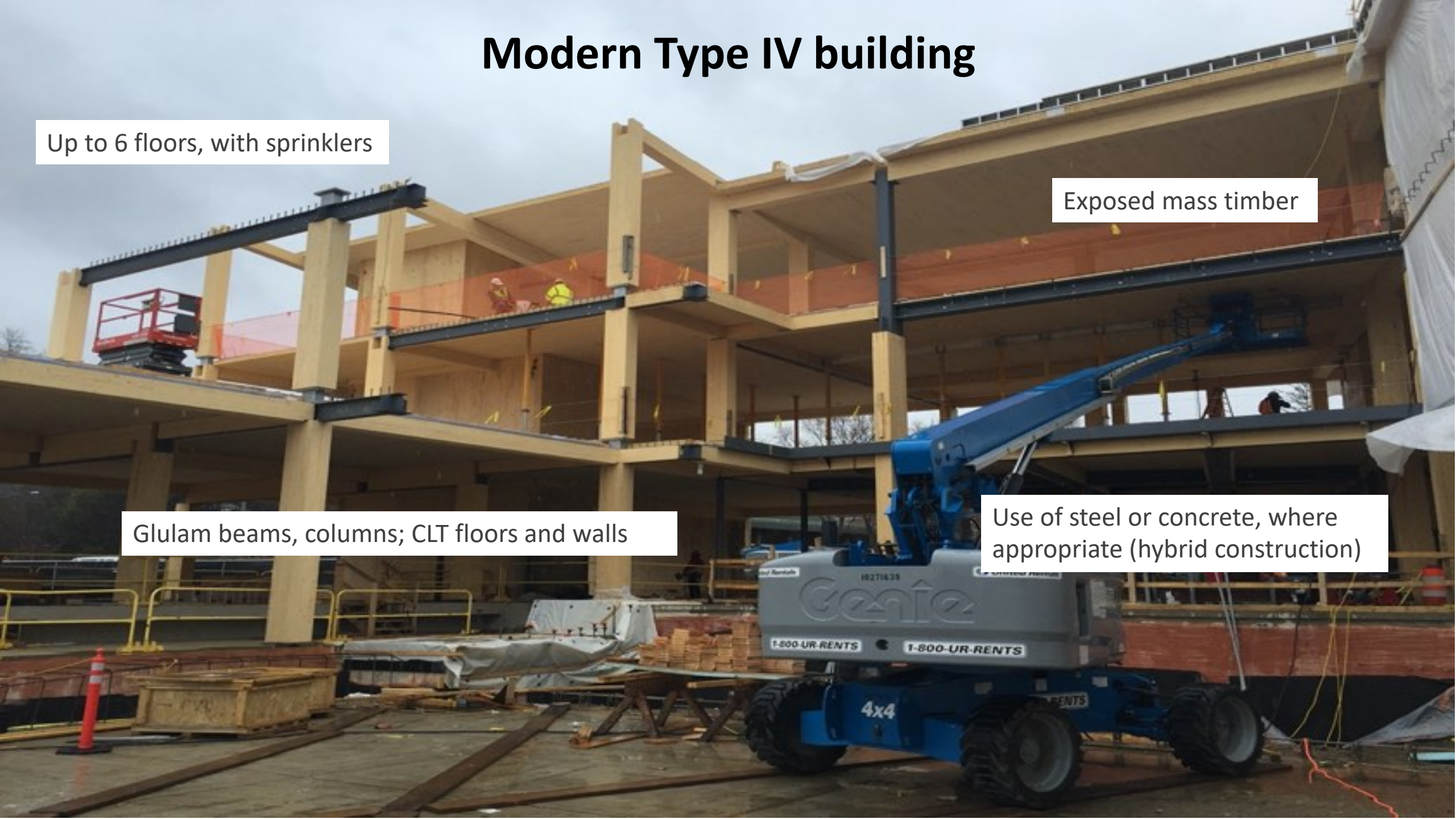
Timber beams, columns, floors, roof permitted

Up to 6 floors, with sprinklers

Code sets minimum dimensions for members

Exterior walls are non-combustible, or FRT wood

Modern Type IV building



Up to 6 floors, with sprinklers

Exposed mass timber

Glulam beams, columns; CLT floors and walls

Use of steel or concrete, where appropriate (hybrid construction)

IBC: Heavy timber = mass timber

TABLE 602.4
WOOD MEMBER SIZE EQUIVALENCIES

MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED-LAMINATED NET SIZE		MINIMUM STRUCTURAL COMPOSITE LUMBER NET SIZE	
Width, inch	Depth, inch	Width, inch	Depth, inch	Width, inch	Depth, inch
8	8	$6^{3}/_{4}$	$8^{1}/_{4}$	7	$7^{1}/_{2}$
6	10	5	$10^{1}/_{2}$	$5^{1}/_{4}$	$9^{1}/_{2}$
6	8	5	$8^{1}/_{4}$	$5^{1}/_{4}$	$7^{1}/_{2}$
6	6	5	6	$5^{1}/_{4}$	$5^{1}/_{2}$
4	6	3	$6^{7}/_{8}$	$3^{1}/_{2}$	$5^{1}/_{2}$

Solid or laminated timber (Chapter 23) – LVL, glulam, CLT

Type IV – mass timber can be exposed (Chapter 8)

Mass timber construction -

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls									
Exterior[e, f]	3	2	1	0	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1^{1}/_{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

Detailing in mass timber buildings for fire safety

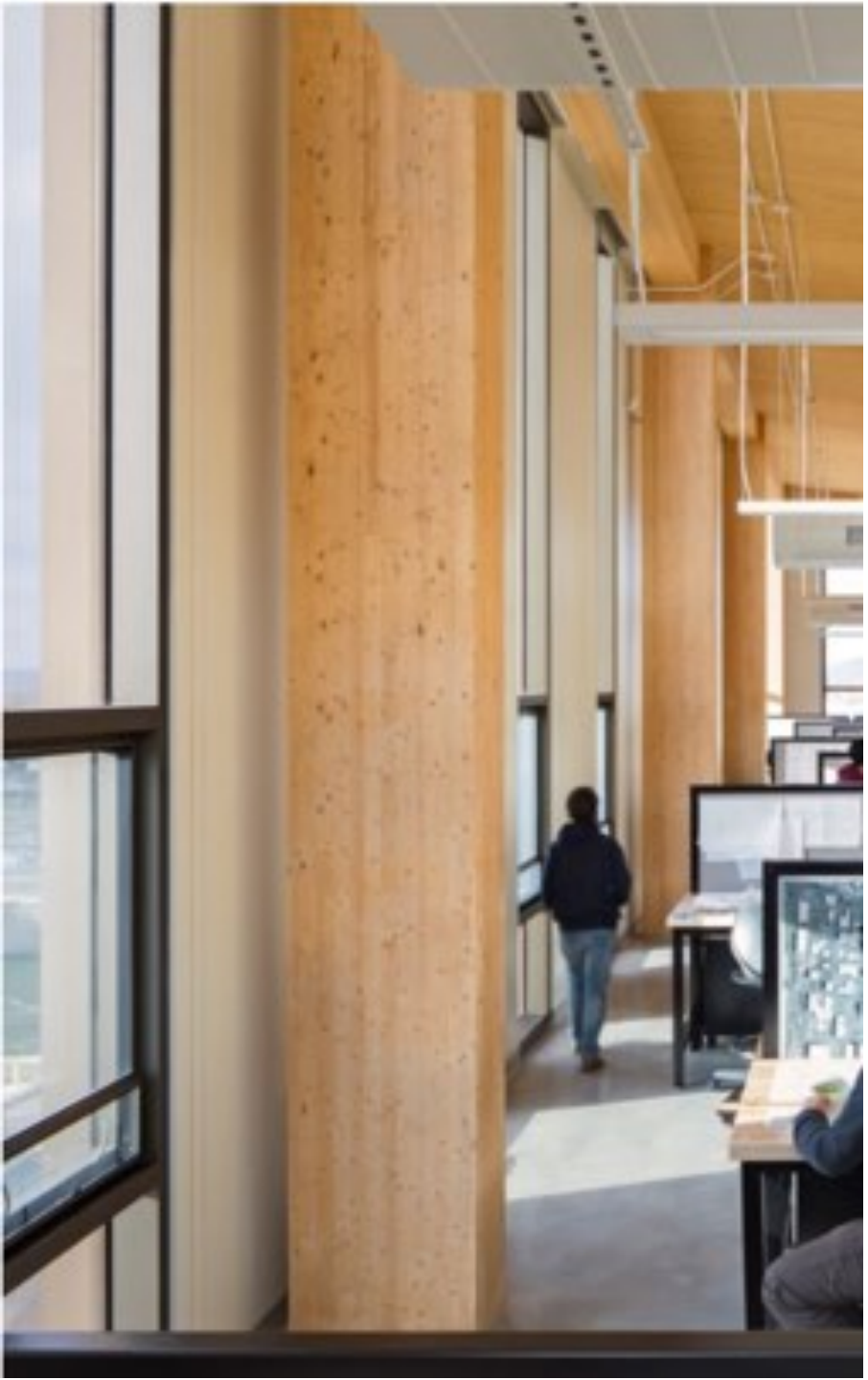
DR Johnson

Be careful of:

Concealed spaces within Type IV

4th floor and above:

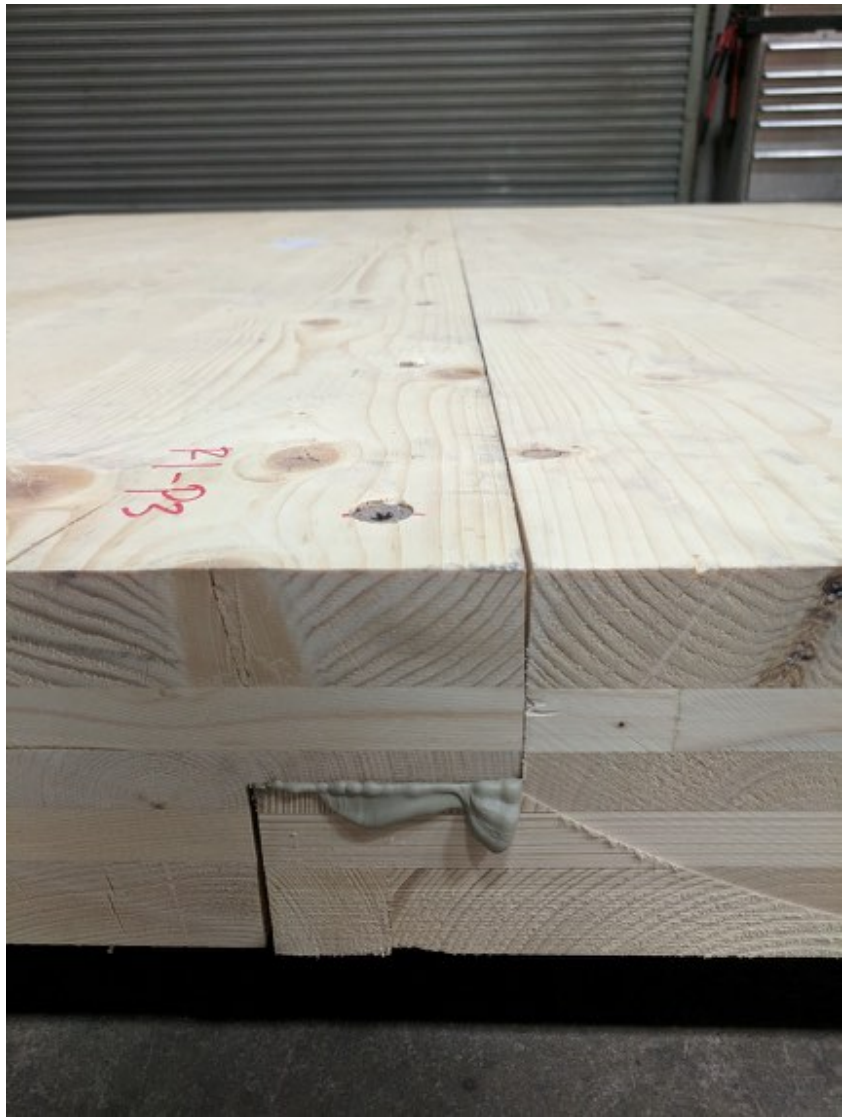
- 2hr shafts connecting to 1hr or HT, for mass timber
- Assembly use – 4th floor limit

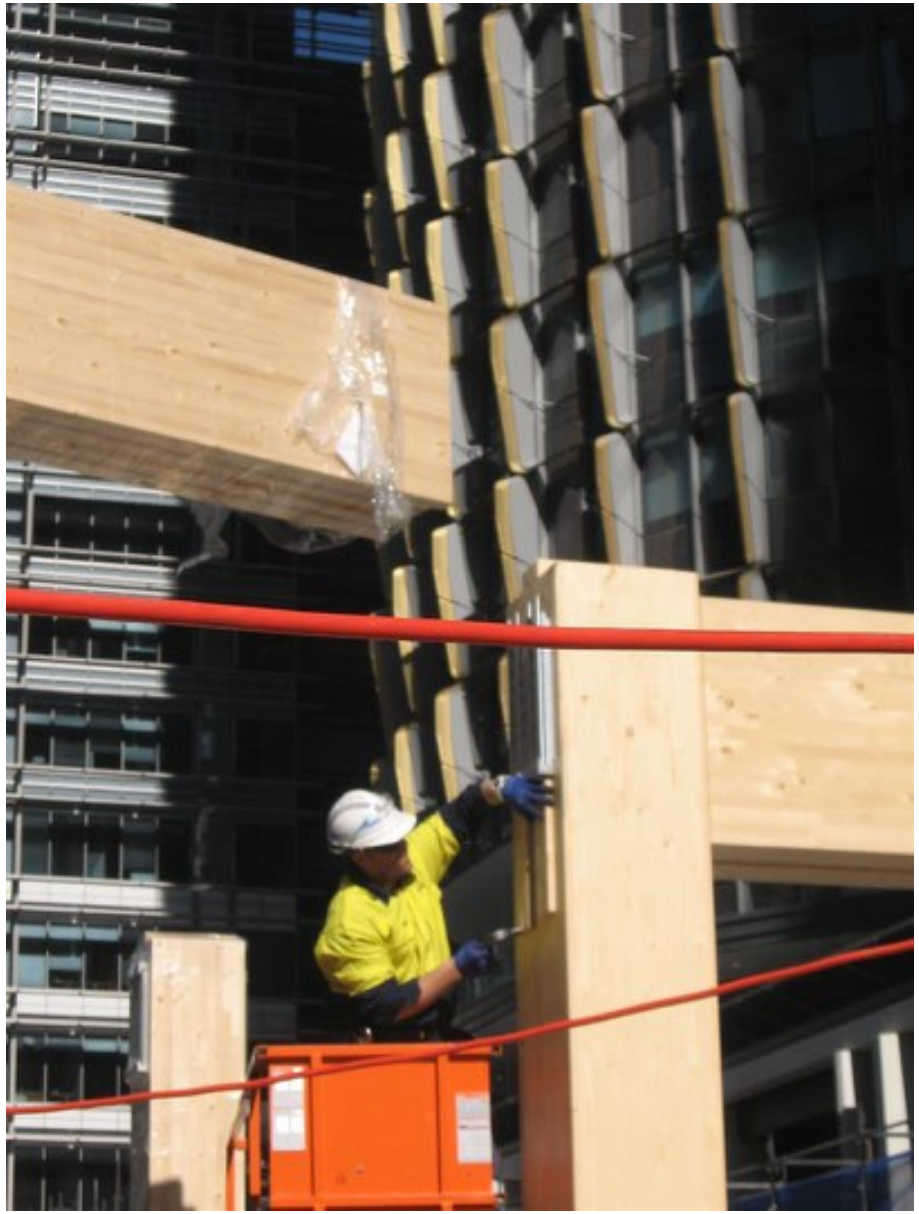


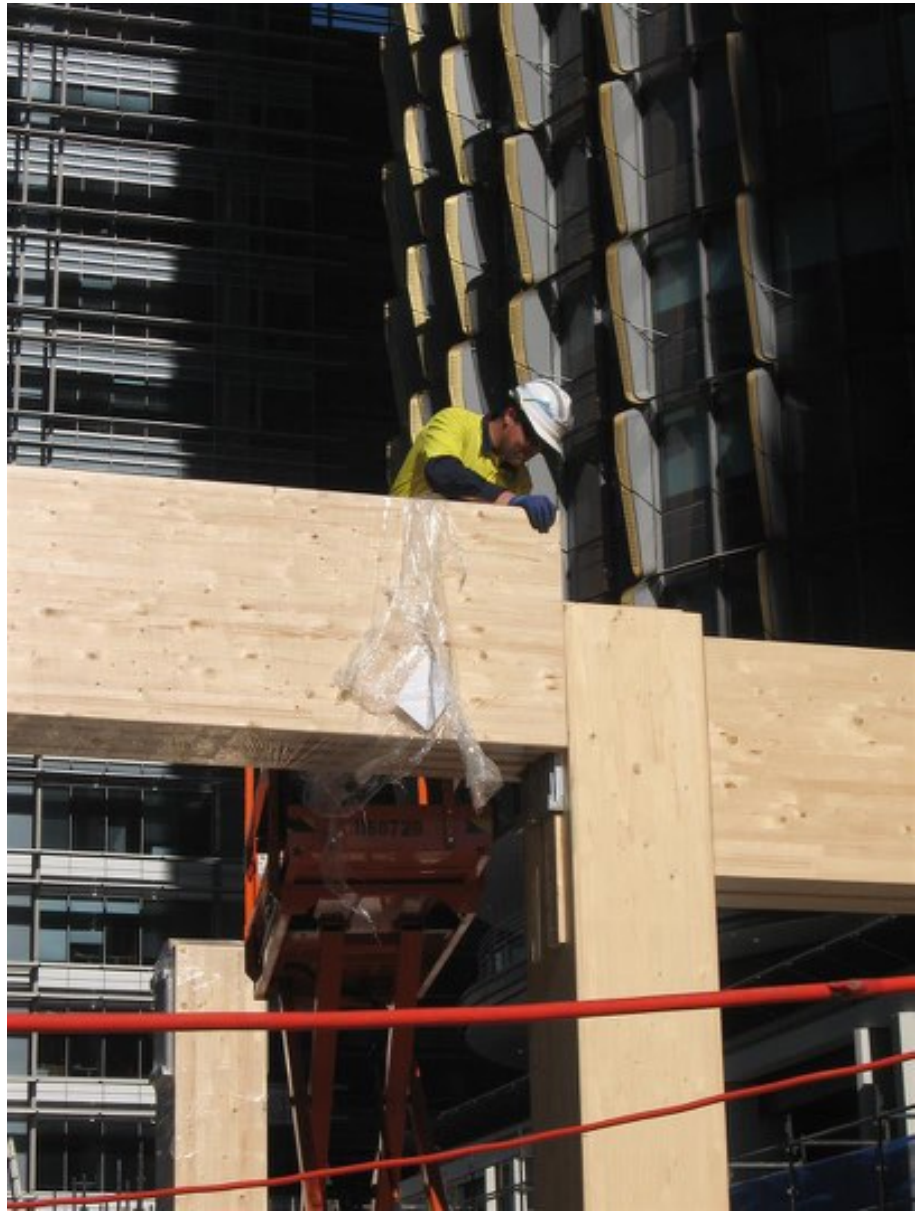
Exterior walls:

- Can CLT be used in an exterior wall?
  - Chapter 6 – CLT can be used in Type IV (not Type III)
  - Chapter 14 – limits timber to 40ft, or 60ft with FRT, or pass NFPA 285

- Keep timber columns and beams out the exterior wall


21-03





Fire resistance for glulam connectors:

Fire test reports – very few to choose from and only one for 2hrs (Framework connector)

Calculation methodology – see TR-10 (Part V, Example 9)

Cannot just add “char layer” to a concealed connector

Intumescent paint on steel connectors does not work

Gyp can work, if properly detailed


ARUP

Beam

Beam + pipe

Beam + pipe and char

And there are also:

Joints between concrete slabs and CLT
Fire barrier or partition wall meeting glulam or CLT
Curtain wall edge details
Kitchen exhaust shafts
CLT encapsulation by gyp ceiling - edge details

and many more……

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

Photo credits:

Lever Architecture, Hines, Waugh Thistleton Architects, DPR Construction, Luk Kramer, Moelven, Ivan Brodey, Shigeru Ban Architects, Nordic, Hacker Architects, Ivan Brodey, Alex Schreyer, KLH, Michael Green Architecture, Katerra, Voll Arkitekter , CREE, Fentress Architects, Miller Hull Architects, Kate Simonen, BVN, NRCC, Tall Wood Building Institute

Please contact me with any mass timber fire questions:

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Type IV
- Max 85ft
- 6 floors (timber)
- Timber fully exposed

Type IV-C
- Max 85ft
- 8 floors
- Timber fully exposed
- 2hr FRR

Type IV-B
- Max 180ft
- 12 floors
- Timber partly exposed
- Protected timber shafts
- 2hr FRR

Type IV-A
- Max 270ft
- 18 floors
- Timber fully protected
- Concrete shafts
- 3hr FRR

E119 test, CLT floor after 2hrs, with char fall-off

E119 test, CLT floor after 2hrs, with no char fall-off


Crielaard


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2:14 16