Mass Wood Timber & Firestopping: Can This Work?

FCIA Existing Building Fire-Resistance Symposium October 2022



Presenters

FCIA VANCOUVER '22



Julio Lopes (STI)



Matthew Winston (Hilti)



Specified STI. Technologies Inc. FCIA:

State of Mass Timber – Market Growth

Reasons to Watch Mass Timber

- Use of mass timber construction has increased
- Model building codes have expanded prescriptive language for mass timber
- Performance based designs continue to advance the size and scope of mass timber buildings.

TOTAL NUMBER OF PROJECTS PER YEAR BY PROVINCES

(by year of completion, 2007-2019)



Source: Natural Resources Canada, The State of Mass Timber in Canada 2021 report

Specified Technologies Inc.

FCIA

State of Mass Timber – Market Growth



FCIA

State of Mass Timber – Going Taller



Brock Commons - Vancouver
 174 feet

FCIA VANCOUVER '22

18 stories

May 2017



- The Ascent Milwaukee
- 284 feet
- 25 stories 19 mass timber
- Completed 2022



Mjøsa Tower – Norway

Specified Technologies Inc.

FCIA

- 279 ft
- 18 stories
- March 2019

Type of Mass Timber Construction

No.	Name	Description	
1	Cross-Laminated Timber (CLT)	Most commonly uses 2x6 lumber boards in multiple lay 90-degree angle to adjacent layers, with layers glued to	ers (plys). Each layer is stacked at a gether.
2	Glue-Laminated Timber (Glulam)	Defining feature is that the grain of the individual wood of the members. Members are glued together.	members is parallel with the length
3	Dowel-Laminated Timber (DLT)(shown) & Nail-Laminated Timber (NLT)	Uses 2x4, 2x6, or 2x8 lumber stacked on end and fit tog with nails (NLT). This type can be made without any ad	gether with wood dowels (CLT) or Ided materials besides lumber.
4	Mass Plywood Panel (MPP)	Engineered wood product consisting of layers (veneers) that are glued together.
	CLT Glular	n DLT	Mass Plywood Panel



Recent Code Changes for Mass Timber



Recent Code Changes for Mass Timber

 Appendix D of the NBC provides a calculation method for fire resistance of mass timber in accordance with CSA 086, "Engineering Design in Wood"

2020 NBC Language for EMTC Dimensions		
Structural Wood Elements	Minimum Thickness , mm	Width x Depth, mm x mm
Walls that are fire separations or exterior walls	96	
Wall that require a fire resistance rating, but are no fire separations	192	
Floors or roofs	96	
Beams, columns, and arches (2- or 3- sided fire exposure		192 x 192
Beams, columns, and arches (4-sided fire exposure)		224 x 224



Recent Code Changes for Mass Timber

 A new standard was developed to evaluate encapsulation materials for mass timber.

FCIA VANCOUVER '22

CAN/ULC-S146:2019

STANDARD METHOD OF TEST FOR THE EVALUATION OF ENCAPSULATION MATERIALS AND ASSEMBLIES OF MATERIALS FOR THE PROTECTION OF STRUCTURAL TIMBER ELEMENTS

1 Scope

1.1 This test method evaluates the temperature transmission performance of an encapsulation material or assembly of materials installed over a wood substrate when the test specimen is subjected to a standard fire exposure condition following the standard time-temperature curve as described in Section 6 (Test Conditions).

1.2 It is the intent that the encapsulation period established by this test method indicates the period of standard fire exposure when an encapsulated structural timber element is not expected to reach temperatures sufficient to cause charring or combustion, potentially resulting in contribution to fire severity,

and shall not be construed as having determined the fire endurance period of the encapsulation material or assembly of materials, or of the structural timber element.

1.3 It is the intent that the encapsulation period established by this test method indicates performance only during the fire exposure period and shall not be construed as determining suitability for use after fire exposure.



Specified Technologies Inc.

Understanding the Material and Challenges

- Characteristics of wood
- Why is wood good for construction?
- Intricacies of Testing





Wood is Combustible? Why?

- Wood is comprised of two essential things:
 - Water
 - After drying, normal moisture content is 8% to 25% kg_{H2O}/kg_{dry wood}
 - Freshly cut, up to 200% kg_{H20}/kg_{dry wood}
 - Dry Wood
 - Minerals and Metallic ions (about 4-10%)
 - Organic Polymers
 - Lignin (18%-35%)
 - Hemicellulose (25%-35%)
 - Cellulose (about 50%) $(C_6H_{10}O_5)_n$



Comparing wood behavior in fire to typical construction products

- Concrete absorbs heat and is intrinsically noncombustible. Biggest concern is spalling.
- Gypsum Wallboard Calcines at around 250 °F and turns into a non-combustible mineral powder
- Steel Expands with heat, reaches critical strength loss around 1000°F. Melts at 2600°F Non-combustible.
- Wood Framing Encapsulated by these noncombustible elements.

FCIA VANCOUVER '22

 Mass Timber – ignites around 500°F. Char rate is about 1.5 inches per hour. Effective char rate is dependent on ply thickness per the National Design Specification (NDS).



How much wood do we need?

- CLT Ply thickness is 1.375 in
- 3 plys will hold the load = 4.125 in
- 2 hour FR Requirement
- NDS Chapter 16 states Effective Char Rate = 1.9 inch per hour
- 1.9 x 2 = 3.8 in
- 3.8 + 4.125 = 7.925 in
- 7.925 ÷ 1.375 = 5.76 plys
- 7.925 ÷ 1.37
 6 plys

• 7 plys

FCIA VANCOUVER '22



Specified Technologies Inc.

FCIA



Since wood burns, why should we use it?

- Three essential stages of wood burning
 - Stage 1 Smoking stage Water is driven inward and outward. CO₂ is released.
 Surface charring occurs. Up to about 400F
 - Stage 2 Pyrolysis Conversion of compounds into volatile gases which supports flaming. 400F to 850F
 - Stage 3 Carbon Burn This is where the embers begin to break down into ash.



Specified Technologies Inc.

Firestop Design for Mass Timber

- Intertek first listed CLT firestops in October 2021
- UL first listed CLT firestops in September 2022
- Manufacturers now have a pathway to expand listings



Intertek Listings (Hilti)	UL Listings (Hilti)	Intertek Listings (STI)
HI/PF 120-07	F-G-2001	STI/PF 60-01 & STI/PF 120-01
HI/PF 120-08	F-G-5001	STI/PF 60-02 & STI/PF 120-02
HI/PF 120-09		STI/PF 60-03 & STI/PF 120-03
HI/PF 120-10		STI/PF 60-04 & STI/PF 120-04
HI/PF 120-11		STI/PF 60-05
		STI/PF 60-06

Specified Technologies Inc.

FCIA



Firestop Design for Mass Timber - Intertek

- Expect listing to require mass timber assemblies to comply with ANSI/APA PRG 320
- Allowance for gypsum board on the system
- Allowance for floor toppings on the system



- SUPPORTING CONSTRUCTION: Use Cross- laminated timber (CLT) certified in accordance with ANSI/APA PRG 320 (2018 or later). Use a min. 2 hour fire-rated floor/ceiling assembly or wall assembly constructed in accordance with its listed or prescribed fire-rated design requirements that has a maximum through opening diameter of 6 in. (152 mm) and meets the following minimum construction requirements:
 - A. Cross Laminated Timber (CLT): Use min. 3- 15/16 in. (100 mm) thick CLT with a minimum of 3 plies when gypsum board (Item 1B) is applied. As an option use a min. 5-15/16 in. (132 mm) thick CLT with a minimum of 5 plies when gypsum board (Item 1B) protection is not applied. A minimum individual ply thickness of 1-3/16 in. (30 mm) applies in all cases.
 - B. Gypsum Board: For all CLT having a thickness less than 5-15/16 in. (132 mm), use min. one layer of 5/8 in. (16 mm) thick Type X gypsum board applied directly to the underside of CLT floor/ceiling assemblies or on both sides of CLT wall assemblies. For CLT thickness 5-15/16 in. (132 mm) or greater, and minimum of 5 plies, gypsum wallboard application is optional. Use min. #8 Type S drywall screws, spaced max. 12 in. on center. Screw length shall be as required for min. of 2-3/8 in. penetration into CLT. Increase the fastening requirements if needed to comply with local code requirements.
 - C. Floor Topping (For floor configuration only, Optional, Not Shown) Use a code compliant floor topping when acceptable for use in the listed or prescribed fire rated floor/ceiling design.

Item 1 from STI/PF 120-02 – Mass Timber Description

Specified Technologies Inc.

FCIA



Firestop Design for Mass Timber - UL

- Expect listing to require mass timber assemblies to comply with ANSI/APA PRG 320 and IBC provisions
- Allowance for gypsum board on the system with detail in Guide Info
- Allowance for floor toppings on the system and in Guide Info
- Will callout the Grade of mass timber used
- Will use the F-G designation for mass timber
 - Floor Assembly -- Minimum 6-7/8 in. (175 mm) thick, 5 ply cross laminated timber (CLT) panel, labeled CLT 175-5S, Grade E1 in accordance with ANSI/APA PRG 320 as required by Chapter 6 of International Building Code (IBC) for Type IVA, IVB or IVC construction. The required hourly rating of the CLT floor shall be determined in accordance with Chapter 16 of the National Design Specification (NDS). Additional information regarding the use of CLT as permitted in the IBC is located in the XHEZ Guide Information. The indicated or calculated fire resistance rating of the assembly (Type IV A, B or C) to meet or exceed the F rating of the firestop system. CLT Panel to have a max through opening diameter of 9 in. (229 mm) to accommodate the penetrant.
 - 2. Gypsum Board* For non-combustible protection of the mass timber assembly. The bottom face of the CLT panel must be protected with 1 layer of 5/8 in. (16 mm) thick Type X Gypsum Board and installed as described in (IBC Sec. 722.7.2.1 for interior surfaces)



Firestop Design for Mass Timber – UL XHEZ Guide Info

MASS TIMBER FLOOR OR WALL

Mass timber is defined by the International Building Code (IBC) as a structural element of Type IV construction. The term mass timber is a broad term that includes cross-laminated timber (CLT). Firestop systems issued by UL which have been tested in a CLT floor or wall assembly will include the alpha character G or O, respectively, as the second alpha character in the system designation.

Mass timber assemblies constructed from CLT must satisfy various requirements for Types IV-A, IV-B and IV-C as specified in the 2021 IBC. CLT is to be labeled in accordance with the 2019 ANSI/APA PRG 320 as required by Section 602.4 of the IBC. Fire resistance ratings for a CLT floor or wall are to be calculated using Chapter 16 of the 2018 National Design Specification (NDS). The firestop system shall have an F rating of not less than the required fire resistance rating of the CLT floor or wall penetrated. The fire resistance rating of the CLT floor or wall is to be as provided in the construction documents. Additional information regarding the use, rating and requirements for CLT are described in IBC Sections 602.4 through 602.4.4, 703.2, 722.1, 722.7; and IBC Tables 722.7.1(1) and 722.7.1(2).

Non-combustible protection is permitted as indicated in the individual firestop systems for CLT floors or walls. Where the non-combustible protection must be fastened to the CLT, securement of the non-combustible protection shall be in accordance with the methods provided in IBC Section 722, unless otherwise specified in the individual firestop system.

Where the firestop system indicates that the CLT floor or wall is fully exposed, the CLT surface may be covered with additional non-combustible protection, unless otherwise specified in the individual firestop system.

- Key Takeaway: UL will update the Guide Info pages when building codes change
- Work is ongoing to create an XHEZ7 (For Canada and CAN/ULC S115) which will include NBC Code References
- Guide Info pages for joint systems will also make reference to CLT



About



Resources

Q



Mass Timber Construction

We have proven firestop systems and the products to meet the needs of this rapidly growing building segment.

Web Link:

Mass Timber Construction | STI Firestop



Firestopping for Mass Timber

Where construction with concrete and steel adds carbon to the atmosphere, wood construction absorbs carbon reducing the overall carbon footprint, leaving increasing potential sustainability credits.

Changes to Building Codes

Changes to building codes have only reinforced the acceptance of this building material. When mass timber elements are qualified for fire-resistance rating purposes, the designer considers the expected char depth when considering load-bearing capability. Wood converted to char has no structural integrity, and the design load must support the uncompromised wood that remains after a prescribed fire duration.

Code Application	2018 IBC	2021 IBC
Type 4 Construction Subtypes	IV-HT	IV-HT, IV-A, IV-B, IV- C
Maximum height range depending on occupancy	60 to 85 feet	IV-HT - 60-85 feet
Allowable stories depending on occupancy	1 to 6 stories A-5 occupancy unlimited with or without sprinklers	IV-HT - 1-6 stories IV-A - 1-18 stories IV-B - 1-12 stories IV-C - 1-9 stories A-5 sprinklered occupancy is unlimited

2018 IBC

- A-5 occupancies, which are for the purpose of viewing outdoor activities such as a grandstand or stadium the allowable stories are unlimited
- Surfaces of CLT required to be protected by fire-retardant treated wood, gypsum wallboard, or other approved noncombustible material.

2021 IBC

 Some types of occupancies are not permitted, unless sprinklered. Primarily this is for H-1 (High hazard) and I-1 (Institutional for individuals requiring custodial care)Unlimited stories for A-5 occupancies as long as they're sprinklered

Systems & Products

Features and benefits for all Listings:

- Min. 3-15/16 in (100mm) 3 ply systems for 1 and 2hour applications
- Optional gypsum protection for 1 hour
- Optional gypsum protection for 2 hours with min 5-15/16 inch (132mm) floor or wall assemblies
- Optional floor toppings for floor applications

Click hyperlink to see systems: STI/PF 60-01 and STI/PF 120-01

- Max 4 in PVC, closed or vented
- Largest plastic pipe penetration system offered currently

STI/PF 60-02 and STI/PF 120-02

- AC Lineset Penetration
- Max 1 in copper tube, steel, cast iron, ductile iron pipe insulated with ³/₄ in. AB/PVC
- Two control wires
- Max 1 in copper tube, steel, cast iron, ductile iron pipe condensate line

STI/PF 60-03 and STI/PF 120-03

- Max 4 inch bundle of multiple cable
- Percent fill range from 0% to 44%

Application	1 Hour Listing	2 Hour Listing	Product
4 [™] PVC pipe (vented of closed)	STI/PF 60- 01	STI/PF 120- 01	SSWBLU2/ SSWRC/LCI
AC Lineset	STI/PF 60- 02	STI/PF 120- 02	LCI
Cable Bundle	STI/PF 60- 03	STI/PF 120- 03	LCI
Metallic Pipe	STI/PF 60- 04	STI/PF 120- 04	LCI
Insulated Metallic Pipe	STI/PF 60- 05		LCI
4"" ABS pipe (vented of closed)	STI/PF 60- 06		SSWBLU2/ SSWRC/LCI
Blank Opening	STI/PF 60- 07		LCI

STI/PF 60-04 and STI/PF 120-04

• Up to 6 in diameter copper tube, steel, cast iron, ductile iron pipe, or conduit

STI/PF 60-05

- Up to 6 in diameter copper tube, steel, cast iron, ductile iron pipe
- Up to 2 in fiberglass insulation

STI/PF 60-06

- Max 4 in ABS, closed or vented
- Largest plastic pipe penetration system offered currently

Hilti Firestops & Mass Timber



PRODUCTS BUSINESS OPTIMIZATION SUPPORT AND DOWNLOADS COMPANY

Uncompromise with Nuron Experience the latest cordless innovation. Discover Nuron >

Home / Business Optimization / Solutions / Future Trends / Mass Timber

MASS TIMBER CONSTRUCTION ON THE RISE

Customers turn to Hilti for mass timber solutions

Mass timber construction has been on the rise in recent years thanks to its many features, such as smaller carbon footprints, faster construction times, and the ability to do more on-site fabrication.

As a result, Hilti is focusing on how to better support this construction type and has become a leader in innovative and efficient pre-fabricated solutions while offering superior options for the firestopping needs of complex mass timber projects.



FIRESTOP SUPPORT AND SOLUTIONS

You are invited to visit the Hilti Mass Timber page: Link

All Hilti firestop solutions for mass timber can be found here.

Hilti is proud to support life safety and the industry with the first North American mass timber firestop listings (with UL and Intertek)

Hilti Firestop Testing in Mass Timber – ASTM E2037 Designs Coming Soon

Hilti Corporation HI/BPF 180-01 Perimeter Fire Barrier System Edge of Slab QuickSeal CFS-EOS QS ASTM E2307, ULC-S115, UL 2079 (Air Leakage Only)

Table 1.	
	Edge of Slab QuickSeal, CFS-EOS QS
F-Rating	3 Hour
T-Rating	41 minute or 3 Hour (see Item 2F)
Cycling	None
Air Leakage	< 2.0 SCFM/LF



- We will have four (4) EOS systems for mass timber
 - 2 Hr and 3 Hr F & T
 - CLT and Mass Plywood Panel
 - Generic callouts
- Will involve all possible combos:
 - MWT floor and wall
 - MWT floor concrete wall
 - Concrete floor and MWT wall
- Systems with and without a spandrel beam
- World's first test and listing of its kind! Systems coming online asap.

Hilti Firestops & Mass Timber



Videos

CASE STUDY of Hilti Firestop testing in cross-laminated timber (CLT): <u>https://www.youtube.com/watch?v=9VIpcjOh7Jo</u>

INTRODUCING Pass Fire Protection in Wood Construction: https://www.youtube.com/watch?v=946oio_-tD8

HILTI at the 2019 International Mass Timber Conference: https://www.youtube.com/watch?v=UxVi1Jnqwa0

Presentations and Firestop Design Guides

- <u>Strides in Fire Safety for Mass Wood</u> <u>Timber Buildings</u> – Published with GreenBuilder Media
- <u>2019 International Mass Timber</u> <u>Conference presentation</u> – Available on AskHilti
- <u>Firestop Templates</u> Available on Ask Hilti
- AskHilti <u>www.ask.hilti.com</u>
 - One can search keywords to find posts on topics of interest