NYC Buildings

MASS TIMBER

MAY 3, 2022

presented by

KEITH L. WEN, RA

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PRESENTATION DESCRIPTION

This presentation will inform the professional community of the changes made to the NYC Construction Codes as part of the NYC Department of Buildings Code Revision process, collectively known as the 2022 NYC Construction Codes. The 2022 Building Code introduces definitions for cross-laminated timber (CLT) and structural composite lumber (SCL) and allows the use of mass timber as approved materials. Requirements for mass timber cover include design requirements, such as construction class and fire protection, as well as site safety during construction.

AIA Continuing Education Provider

BACKGROUND HISTORY

WHAT IS CLT/SCL? (BC 202)

New materials with new definitions introduced.

- **CROSS-LAMINATED TIMBER (CLT).** A prefabricated engineered wood product made of at least three orthogonal layers of graded sawn lumber or structural composite lumber (SCL) that are laminated by gluing with structural adhesives.

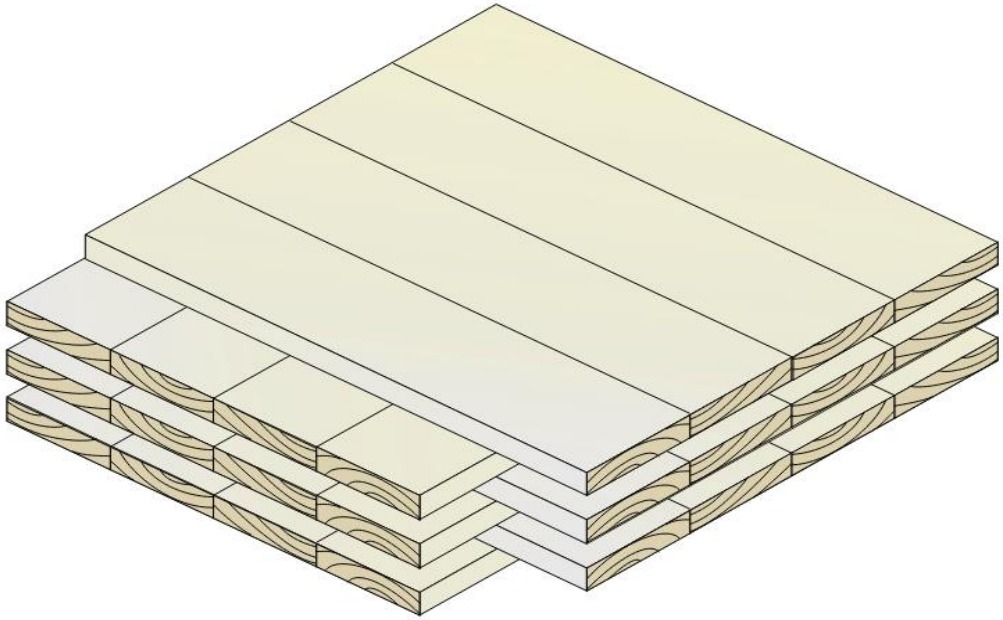
- **STRUCTRAL COMPOSITE LUMBER (SCL).** Structural member manufactured using wood elements bonded together with exterior adhesives. Examples are:
  - Laminated Strand Lumber (LSL)
  - Laminated Veneer Lumber (LVL)
  - Oriented Strand Lumber (OSL)
  - Parallel Strand Lumber (PSL)

WHAT IS CLT/SCL? (BC 202)

New materials with new definitions introduced.

- CLT is an engineered wood product consisting of multiple layers of wood that are adhered to each other perpendicularly

Transverse Planks



Longitudinal Planks

Courtesy of CLT Handbook

WHAT IS CLT/SCL? (BC 202)

Courtesy of Nordic CLT

New materials with new definitions introduced.

- CLT is prefabricated as curved or straight panels
- Sizes range from up to 60 feet long and 10 feet tall
- Thickness ranges from 3” to 20”
- Holes and notches can be pre-cut offsite
- Commonly used for load-bearing walls and floors

WHAT IS CLT/SCL? (BC 202)

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  - Parallel Strand Lumber (PSL)

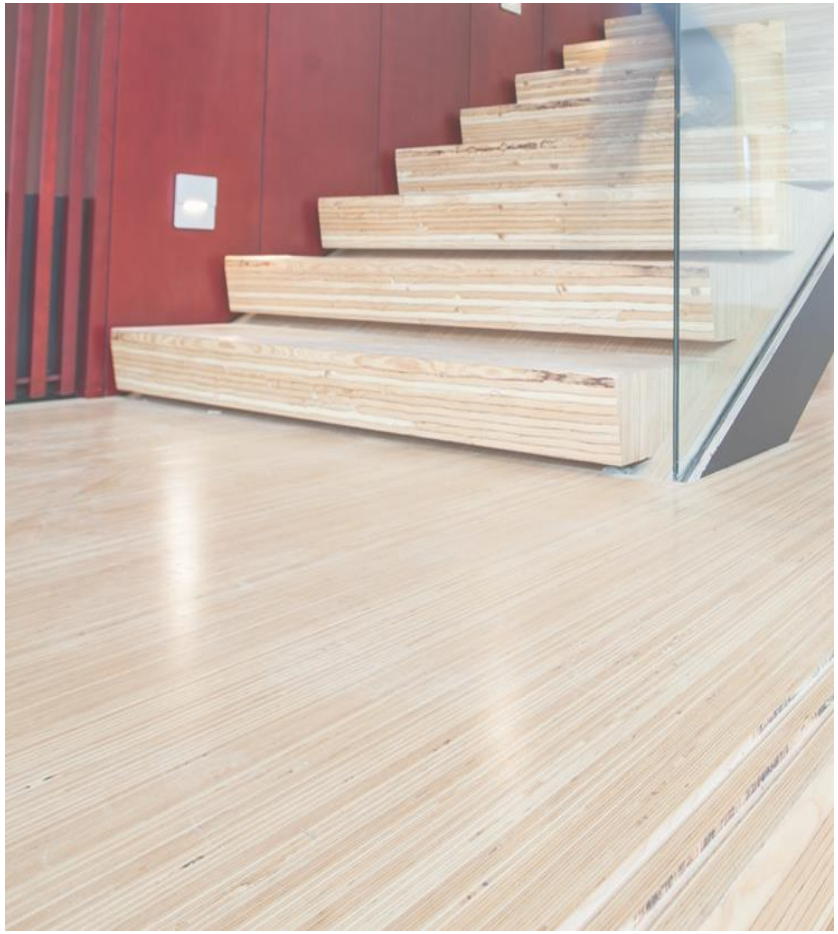
WHAT IS CLT/SCL? (BC 202)

New materials with new definitions introduced.

- SCL consists of multiple layers of wood veneers that are adhered parallel to each other under heat and pressure

Source: apawood.org

WHAT IS CLT/SCL? (BC 202)



Courtesy: Naturallywood.com, Photo credit: Brudder

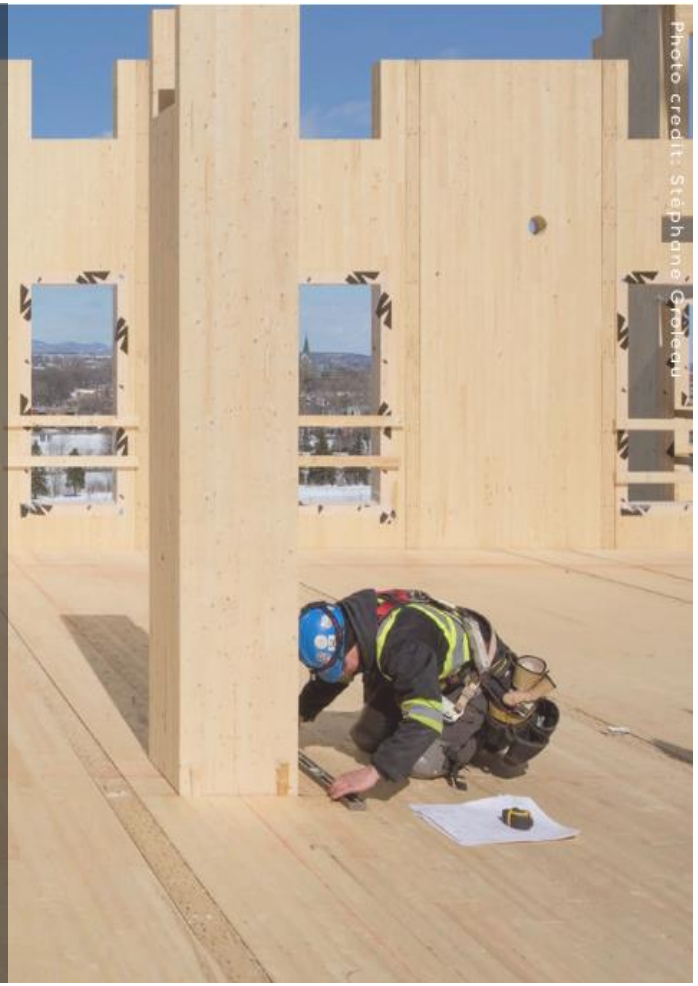
New materials with new definitions introduced.

- SCL is typically used as rafters, headers, beams, joists, studs, columns and I-joist flange material.
- LVL, the most widely used type of SCL, is manufactured in sheets and can be cut to size to be used as beams , planks and panels.

WHY MASS TIMBER?

Advertised benefits of Mass Timber products, such as CLT and SCL:

- Strength and stability with comparably light-weight structural components
- Pre-fabricated to allow greater precision, options, and increased labor efficiency
- Fewer workers at the construction site
- Low-carbon alternative to other construction materials



NYC IS A DENSELY POPULATED CITY

HILLS'S MAP OF NEW YORK, SHOWING INTRENCHMENTS. BRITISH —— AMERICAN

Colonial Laws of New York, Chap. IV: 571

Jan. 1, 1766 - Every Dwelling house or Building erected of any kind, for public or private use, situate "to the Southward of Fresh Water," should "be made of Stone or Brick and Roofed with tile or slate."

"The Iconography of Manhattan Island, 1498-1909," I.N. Phelps Stokes

CHARRING EFFECT OF WOOD

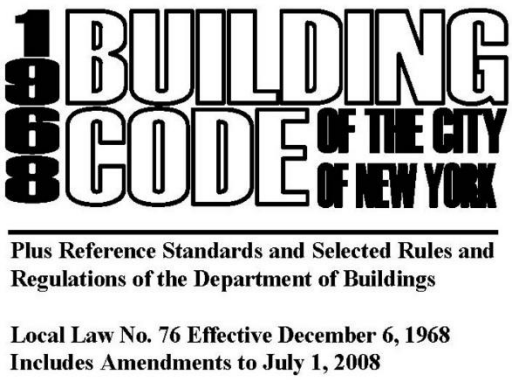
- When exposed to fire, the char layer serves as an insulation that protects the core of the section
- Therefore, important to design structural elements so as to allow sufficient cross section of wood to remain to bear the design loads

CODE EVOLUTION

CODE EVOLUTION

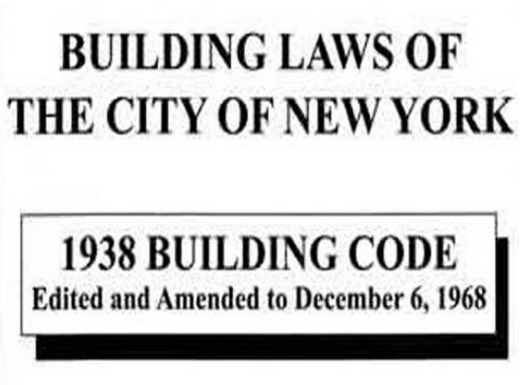
The 2008 Building Code

The 2008 Building Code applies to the construction, alteration, modification, addition, replacement, repair, equipment, use and occupancy, location, maintenance, removal, and demolition of buildings and structures in the City.



The 1968 Building Code

The 1968 Building Code has amendments to July 2008. Included in the Code are instructions on how to add, discard, and replace pages to the current Building Code.



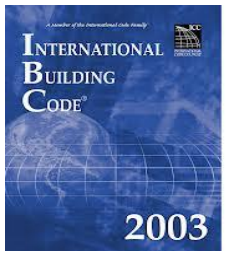
The 1938 Building Code

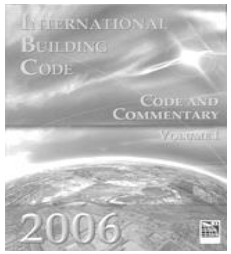
The 1938 Building Code was edited and amended to December 6, 1968 also has Building Laws relating to buildings built before the edited and amended date.

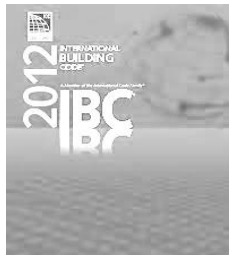
CODE EVOLUTION

Use of ICC Codes

IBC

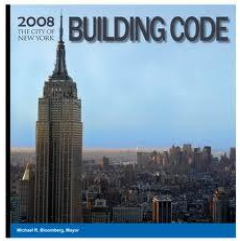






2003 2006 2009 2012

2008 2014



NYC

CODE EVOLUTION

FIGURE D106.1(2)-continued
FIRE DISTRICT MAPS
BOROUGH OF QUEENS

CODE EVOLUTION

APPENDIX D

FIRE DISTRICTS

SECTION BC D101
GENERAL

D101.1 Scope. The provisions of this appendix shall regulate the division of the city of New York into geographical territories known as fire districts and control the occupancy groups and construction classes permitted in the fire districts. Wherever reference is made to the fire district, it shall be construed to mean the fire districts designated and referred to in this appendix.

D101.2 Establishment of fire district. The following city areas are hereby established as being inside the fire districts:

1. All of the borough of Manhattan.
2. All of the borough of Bronx.
3. All of the borough of Brooklyn.
4. Such portions of the boroughs of Staten Island and Queens as are indicated on the "fire district maps" as per Section D106.

SECTION BC D102
BUILDING RESTRICTIONS

D102.1 Types of construction permitted. Every building hereafter erected within the fire district, or located partially in the fire district pursuant to Section D104. 1, shall be either Type I, II, III or IV.

CODE EVOLUTION: 2014 BC TYPE IV CONSTRUCTION

602.4 Type IV. Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section. Fire-retardant-treated-wood framing complying with Section 2303.2 shall be permitted within exterior wall assemblies with a 2-hour rating or less. Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For glued-laminated members the equivalent net finished width and depths corresponding to the minimum nominal width and depths of solid sawn lumber are required as specified in Table 602.4.

Exceptions:

1. In Group I-1, R-1, and R-2 occupancies, all exterior walls, fire walls, exit passageways, and shaft enclosures shall be noncombustible.
2. In Group F occupancies subject to Section 270(1) of the *New York State Labor Law*, all exterior wall assemblies and all structural elements shall meet the requirements for a "fireproof building" as defined in Section 264 of such law.
3. Inside the fire district, exterior load-bearing walls shall be constructed of noncombustible material.
4. Inside the fire district, exterior non-bearing walls may be constructed with fire-retardant-treated wood complying with Section 2303.2 where the building is equipped throughout with an automatic sprinkler system in accordance with Sections 903.3.1.1 through 903.3.1.3, unless otherwise prohibited by Exception 1 or 2 above.

CODE EVOLUTION: 2014 BC TABLE 503

Allowable Building Heights & Areas*

- *Building height limitations shown in feet above grade plane. Story limitations shown as stories above grade plane.*
- *Building area limitations shown id square feet, as determined by the definition of "Area, building," per story.*

GROUP	HEIGHT (feet) HEIGHT (s)	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
		UL	160*	65	55	65	55	65	50	40
R-2	S A	UL UL	UL UL	6 UL	NP NP	6 14,700	3 5,600	6 20,500	NP NP	NP NP
R-3	S A	UL UL	UL UL	6 17,500	3 10,500	4 7,500	3 5,600	6 30,000	3 8,400	3 5,500
S-1	S A	UL UL	6 48,000	5 12,000	3 7,500	6 48,000	3 7,500	4 7,500	3 5,000	2 1,000
S-2[b,c]	S A	UL UL	UL UL	6 15,000	3 10,000	UL UL	4 8,500	6 10,000	3 8,400	2 5,500
U[c]	S A	UL UL	5 35,000	4 19,000	2 8,500	3 14,000	2 8,500	4 18,000	2 9, 000	1 5,500

Not permitted in Fire District

Not permitted in Fire District without sprinklers.

CODE EVOLUTION: 2014 BC SPRINKLER INCREASE

504.2 Automatic sprinkler system increase. Where a building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1, the value specified in Table 503 for maximum building height is increased by 20 feet (6096 mm) and the maximum number of stories is increased by one story. These increases are permitted in addition to the building area increase in accordance with Sections 506.2 and 506.3. For Group R buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.2, the value specified in Table 503 for maximum building height is increased by 20 feet (6096 mm) and the maximum number of stories is increased by one story but shall not exceed 60 feet (18 288 mm) or six stories, respectively.

CODE EVOLUTION: ADOPTION OF THE USE OF CLT & SCL IN THE 2015 IBC

CLT was recognized as a viable structural wood product for construction by its adoption in the International Building Code of 2015. The use of CLT was permitted to be categorized as Type IV-HT construction.

2015 IBC
602.4 Type IV.
Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted. Minimum solid sawn nominal dimensions are required for structures built using Type IV construction (HT). For glued laminated members and structural composite lumber (SCL) members, the equivalent net finished width and depths corresponding to the minimum nominal width and depths of solid sawn lumber are required as specified in Table 602.4. *Cross-laminated timber* (CLT) dimensions used in this section are actual dimensions.

CODE EVOLUTION: CLT & SCL IN 2018 IBC

2018 IBC Heavy Timber Reorg

2018 IBC	2015 IBC	Provision
602.4	602.4	Type IV construction
602.4.1, 602.4.2	602.4.1	Wall assembly thickness
602.4.3	602.4.9	Exterior structural members
2304.11	2304.11	Heavy timber construction
Table 2304.11	Table 602.4	Minimum dimensions
2304.11.1	New	Details of heavy timber structural members
2304.11.1.1	602.4.3, 2304.11.1	Columns
2304.11.1.2	602.4.4, 2304.11.2	Floor framing
2304.11.1.3	602.4.5, 2304.11.3	Roof framing
2304.11.2.1	602.4.8.2	Exterior walls
2304.11.2.2	602.4.8.1	Partitions and interior walls
2304.11.3	602.4.6	Floors
2304.11.3.1	602.4.6.2	CLT floors
2304.11.3.2	602.4.6.1, 2304.11.4	Sawn or glued-laminated plank floors
2304.11.4	2304.11.5	Roof decks

Changes to CLT in 2018 IBC was mainly organizational, moving the location for the CLT provisions from Chapter 6 to Chapter 23. Chapter 23 is dedicated to wood construction. Chapter 23 provides a placement for more detailed provisions that can be added in expanding the use of CLT. The reference standards used in design and manufacturing of CLT was updated in IBC 2018 from 2015 IBC, NDS is the design standard for CLT structure, ANSI/APA PRG 320 is the production/manufacturing standard.

CODE EVOLUTION: CLT & SCL IN IBC 2021

In **the NYC 2022 Building Code**, the limitation of building height with CLT remains equal to that of Type IV-HT, same as 2015 IBC. We have adopted some of the 2021 IBC requirements that are related to design, production quality, and safety standard.

CHANGES IN THE NEW CODE

SCL & CLT (BC 602.4)

PROTOTYPE RENDERING STREETSCAPE

Rendering courtesy of Henriquez Partners Architects

Source: https://www.naturallywood.com/project/prototype/

Type IV construction is that type of construction in which the exterior walls are of noncombustible materials or other materials permitted by **Section 602.4.1** or **602.4.2**, and the interior building elements are of solid wood, glue-laminated timber, heavy timber (HT), structural composite lumber (SCL), or cross-laminated timber (CLT) without concealed spaces.

Analysis: Such new materials are now part of Type IV construction.

SCL & CLT (BC 602.4)

Courtesy of: https://www.naturallywood.com Credit: KK Law

The minimum dimensions for permitted materials including solid timber, glued-laminated timber, SCL, and CLT and details of Type IV construction shall comply with the provisions of **Section 2304.11** and this section.

Analysis: Such new materials are now part of Type IV construction.

SCL & CLT (BC 602.4)

Source: https://www.naturallywood.com/topics/mass-timber/

Interior walls and partitions not less than 1-hour fire-resistance rating or heavy timber complying with Section 2304.11.2.2 shall be permitted.

Analysis: Such new materials are now part of Type IV construction.

SCL & CLT (BC 602.4 and BC 903.2.13)

Source: https://www.naturallywood.com/wood-performance/fire/

Buildings of Type IV construction utilizing SCL or CLT shall be equipped throughout with an automatic sprinkler system where required by **Section 903.2.13**.

Sprinklers required for:

- Buildings of any occupancy and more than 3-stories above grade plane
- Buildings of Group B occupancy and a floor that exceeds 25,800 sf

Analysis: Sprinkler protection required in most circumstances.

FIRE WATCH (BC 602.4)

Source: https://www.stocklib.com/search?keyword=extinguishers&contributorid=jayzynism&media_type=0

In buildings of Type IV construction utilizing SCL or CLT, a fire watch shall be maintained in accordance with Section 901.7.2 of the New York City Fire Code and **Section 3303.3** of this Code.

Analysis: In Type IV construction, fire watch is required before sprinkler system activation.

EXCEPTIONS FOR CLT & SCL (BC 602.4)

The following exceptions apply to all Heavy Timber construction, including SCL and CTL:

1. In Group I-1, R-1, and R-2 occupancies, all exterior walls, fire walls, exit passageways, and shaft enclosures shall be noncombustible.
2. In Group F occupancies subject to Section 270(1) of the New York State Labor Law, all exterior wall assemblies and all structural elements shall meet the requirements for a **fireproof building** as defined in Section 264 of such law.
3. Inside the fire district, exterior load-bearing walls shall be constructed of noncombustible material.

EXCEPTIONS FOR CLT & SCL (BC 602.4)

(continued)

4. Inside the fire district, exterior non-bearing walls may be constructed with fire-retardant-treated wood complying with Section 2303.2 of this code where the building is equipped throughout with an automatic sprinkler system in accordance with Sections 903.3.1.1 through 903.3.1.3, unless otherwise prohibited by Exception 1 or 2.

A new exception has been added as follows

5. **Inside the fire district, exterior non-bearing walls are permitted to be constructed with cross-laminated timber (CLT)** complying with Section 602.4.2 of this code, unless otherwise prohibited by Exception 1 or 2.

CLT IN EXTERIOR WALLS (BC 602.4.2)

602.4.2 Cross-laminated timber in exterior walls. Cross-laminated timber (CLT) complying with Section 2303.1.4 shall be **permitted within exterior wall assemblies not less than 6 inches (152.4 mm) in thickness with a 2-hour rating or less**, provided the exterior surface of the cross-laminated timber (CLT) is **protected by one of the following**:

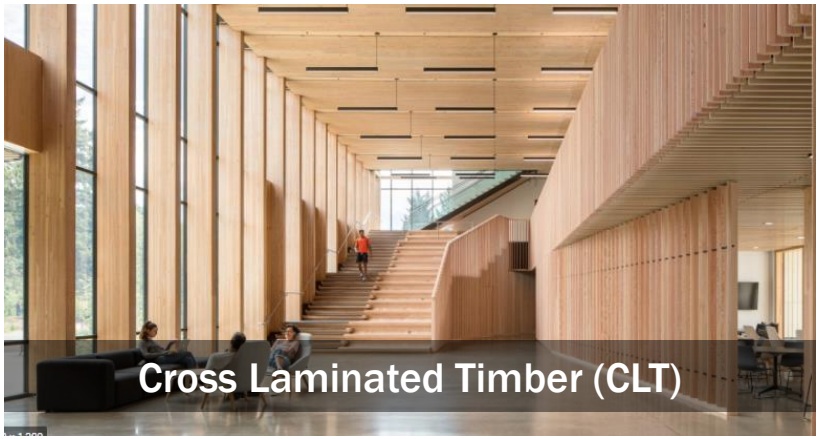
1. **Fire-retardant-treated wood sheathing complying with Section 2303.2 and not less than 15/32 inch (11.9 mm) thick;**
2. **Type X gypsum board not less than ⅝ inch (15.9 mm) thick; *or***
3. **A noncombustible material.**

Analysis: CLT can be used in exterior walls having certain additional construction requirements, unless prohibited by one of the five exceptions in Section 602.4 (see previous slides).

MASS TIMBER: CLT OR SCL

Fire retardant or intumescent coatings shall not be used to achieve the required fire-resistance rating on structural elements composed of heavy timber members including, but not limited to, glued-laminated members, cross laminated timber (CLT) or structural composite lumber (SCL).

Structural Composite Lumber (SCL)



Cross Laminated Timber (CLT)

Analysis:

New requirement which prohibits the used of fire retardant or intumescent coating to achieve the required fire resistance rating on mass timber elements.

BC 903.2.13

Type IV construction with cross-laminated timber (CLT) or structural composite lumber (SCL). Automatic sprinkler systems in accordance with NFPA 13 shall be required throughout buildings utilizing Type IV construction with CLT or SCL as follows:

1. In all occupancies where the building is more than three stories above grade plane.
2. In Group B occupancies, where a floor exceeds 28,500 square feet (2647.7 m2).

Analysis: SCL and CLT materials are now allowed. As a result, this section was added to address such materials and mandate that a sprinkler system be provided in accordance with NFPA 13.

PROHIBITED EXTERIOR WALL COVERINGS

Source: https://trysquare.com/cladding

1406.2.1 Type I, II, III and IV construction. In buildings of Type I, II, III and IV construction, exterior wall coverings shall be permitted to be constructed of combustible materials in accordance with Section 1406.2.1.1, subject to the following limitations:

...

5. Combustible exterior wall coverings shall not be permitted on buildings of Type IV construction utilizing CLT or SCL complying with Section 602.4

...

Analysis:

- New Section
- Combustible exterior wall coverings not permitted for CLT or SCL, Type IV construction buildings

PROHIBITED EXTERIOR WALL COVERINGS

Source: https://wfmmedia.com/aluminium-composite-panels-leading-sustainable-architecture/

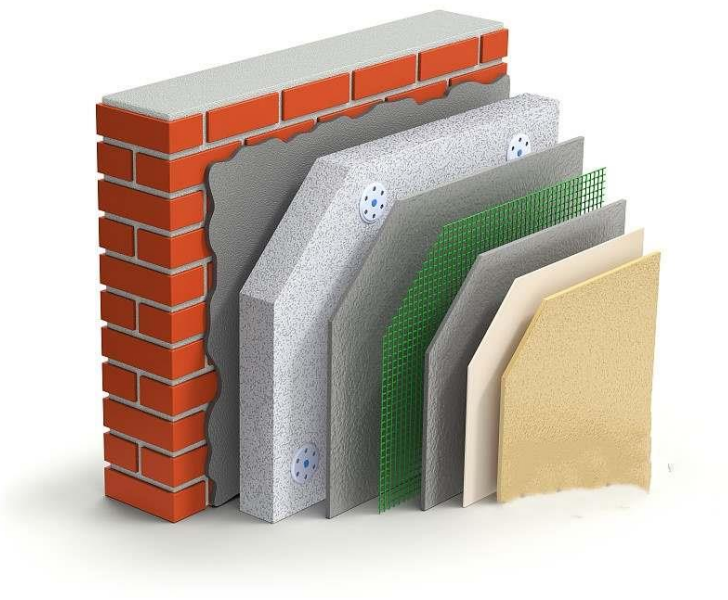
1407.1.2 Prohibited locations. The use of MCM in exterior wall coverings is subject to the following limitations:

1. MCM is prohibited in exterior wall coverings in Type IV construction utilizing cross-laminated timber (CLT) or structural composite lumber (SCL) complying with Section 602.4.
2. …

Analysis:

- New Section
- Metal Composite Material (MCM) exterior wall covering not permitted for CLT or SCL, Type IV construction buildings

PROHIBITED EXTERIOR WALL COVERINGS



Source: https://www.anxinchemistry.com/exterior-insulation-finishing-system-eifs/

1408.1.1 Prohibited locations. The use of EIFS containing foam plastic insulation in exterior wall coverings is subject to the following limitations:

1. EIFS containing foam plastic insulation is prohibited in exterior wall coverings in Type IV construction utilizing cross-laminated timer (CLT) or structural composite lumber (SCL) complying with Section 602.4.
2. …

Analysis:

- New Section
- Exterior Insulation and Finish Systems (EIFS) exterior wall covering not permitted for CLT or SCL, Type IV construction buildings

PROHIBITED EXTERIOR WALL COVERINGS

Source: https://fundermax.us/product/exterior-architectural-panels/

1409.1.1 Prohibited locations. The use of HPL in exterior wall coverings is subject to the following limitations:

1. HPL is prohibited in exterior wall coverings in Type IV construction utilizing cross-laminated timber (CLT) or structural composite lumber (SCL) complying with Section 602.4.
2. …

Analysis:

- New Section
- High-Pressure Decorative Exterior-Grade Compact Laminates (HPL) exterior wall covering not permitted for CLT or SCL, Type IV construction buildings

PROHIBITED EXTERIOR WALL COVERINGS

Source: https://enviroclad.com/external-cladding/

2601.2 Exterior wall coverings. The use of plastics in exterior wall coverings is subject to the following limitations:

1. Exterior wall coverings containing plastics shall not be permitted on Type IV construction utilizing cross-laminated-timber (CLT) or structural composite lumber (SCL) complying with Section 602.4.
2. ...

Analysis:

- New Section
- Exterior wall covering containing plastics are not permitted for CLT or SCL, Type IV construction buildings.

WOOD: CHAPTER 23

Cross Laminated Timber

2303.1.4 Cross-laminated timber. Cross-laminated timber shall be manufactured and identified in accordance with ANSI/APA PRG 320.

Courtesy of: https://www.naturallywood.com Credit: Ema Peter Photography

Analysis:

- New Section
- Cross-laminated timber must be manufactured and identified in accordance with referenced standard

WOOD: CHAPTER 23

Cross Laminated Timber

2304.10.8 Connection fire resistance rating. Wood structural connections, including connectors, fasteners, and portions of wood members included in the connection design, shall be protected from fire exposure for the required fire resistance time. For connections in Type IV construction, the required fire resistance time shall be at minimum one hour or as required for the building element by Table 601 and Section 602.4. Fire resistance ratings for connections shall be determined by one of the following:

1. Testing in accordance with Section 703.2 where the connection is part of the fire resistance test.

2. Engineering analysis that demonstrates that the temperature rise at any portion of the connection is limited to an average temperature rise of 250°F (139°C), and a maximum temperature rise of 325°F (181°C), for a time corresponding to the required fire resistance rating of the structural element being connected. For the purposes of this analysis, the connection includes connectors, fasteners, and portions of wood members included in the structural design of the connection.

Analysis: ***NEW SECTION***

- Wood connectors, fasteners, etc. shall be protected from fire
- In Construction Class IV, a minimum of 1-hour fire-resistance rating is required
- Testing criteria and engineering analysis required

WOOD: CHAPTER 23

CLT Sizing

2304.11 Heavy timber construction. Where a structure, portion thereof or individual structural elements are required by other provisions of this code to be of heavy timber, the building elements therein shall comply with the applicable provisions of Sections 2304.11.1 through 2304.11.4. Minimum dimensions of heavy timber shall comply with the applicable requirements in Table 2304.11 based on roofs or floors supported and the configuration of each structural element, or the applicable requirements in Sections 2304.11.2 through 2304.11.4. Lumber decking shall be in accordance with Section 2304.9.

2304.11.1.4 Cross-laminated timber. Cross-laminated timber shall be used only when engineered by a registered design professional. The design shall take into account the effects of openings cut into the panels. Cross-laminated timber shall not be used as individual columns or beams.

Analysis: ***NEW SECTION***

- Minimum dimension addressed in Chapter 23
- Registered design professional is responsible for the engineering
- CLT not to be used as columns and beams

WOOD: CHAPTER 23

CLT Sizing

2304.11.3.1 Cross-laminated timber floors. Cross-laminated timber shall be not less than 4 inches (102 mm) in actual thickness. Cross-laminated timber shall be continuous from support to support and mechanically fastened to one another. Cross-laminated timber shall be permitted to be connected to walls without a shrinkage gap providing swelling or shrinking is considered in the design. Corbelling of masonry walls under the floor shall be permitted to be used.

2304.11.4.1 Cross-laminated timber roofs. Cross-laminated timber roofs shall be not less than 3 inches (76 mm) nominal in thickness and shall be continuous from support to support and mechanically fastened to one another.

Analysis: ***NEW SECTION***

- Minimum CLT floor and roof dimensions addressed in Chapter 23

WOOD: CHAPTER 23

SCL Sizing

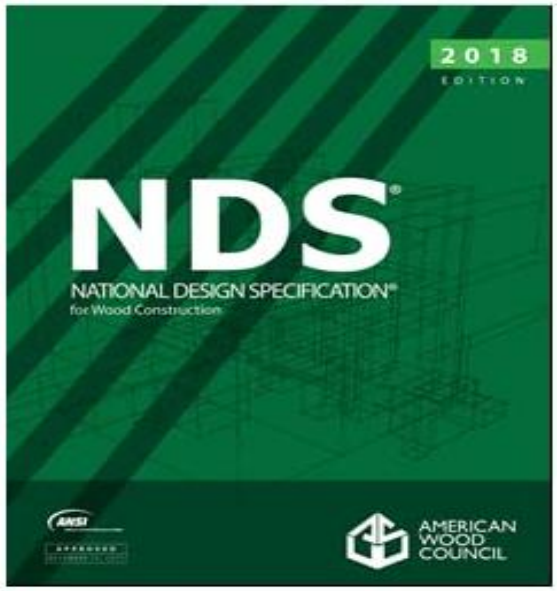
TABLE 2304.11
MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS

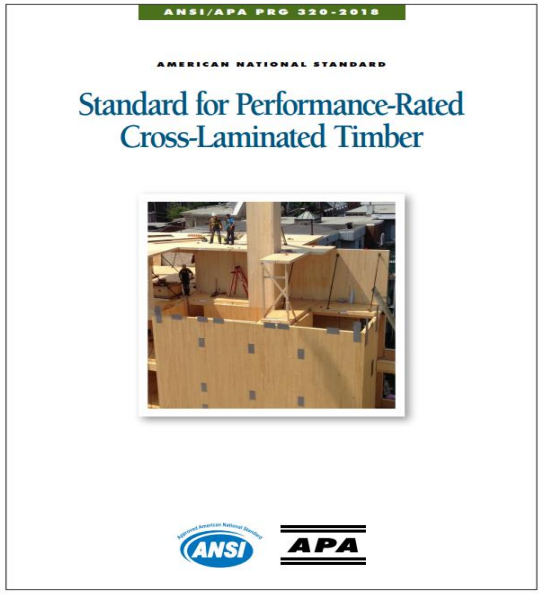
SUPPORTING	HEAVY TIMBER STRUCTURAL ELEMENTS	MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED LAMINATED NET SIZE		MINIMIM STRUCTURAL COMPOSITE LUMBER NET SIZE	
		Width, Inch	Depth, Inch	Width, Inch	Depth, Inch	Width, Inch	Depth, Inch
Floor loads only or combined floor and roof loads	Columns; Framed sawn or glued-laminated timber arches that spring from the floor line; Framed timber trusses	8	8	6¾	8¼	7	7½
Roof loads only	Wood beams and girders	6	10	5	10½	5¼	9½
	Columns (roof and ceiling loads); Lower half of: wood-frame or glued-laminated arches that spring from the floor line or from grade	6	8	5	8¼	5¼	7½
	Upper half of: wood-frame or glued-laminated arches that spring from the floor line or from grade	6	6	5	6	5¼	5½
	Framed timber trusses and other roof framing[a]; Framed or glued-laminated arches that spring from the top of walls or wall abutments	4[b]	6	3[b]		3½[b]	5½

Analysis:
NEW SECTION

- SCL minimum sizing in Table 2304.11

REFERENCE STANDARDS





Analysis: *UPDATED REFERENCE STANDARDS*

- NDS 2018 – Recognized Design Standard for CLT, Design values has been adjusted for Cross-Laminated Timber. 2018 edition updated in consideration of char depth specifically for CLT.
- ANSI/APA PRG 320-2018 – Production Standard for CLT. 2018 edition updated with more stringent testing requirement for quality of adhesive.

CONNECTIONS

NDS reference to AWC Technical Report 10 for design consideration of connections and wood protection

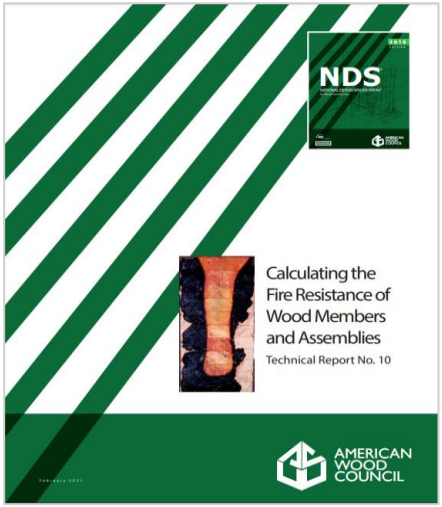


Table 4.1.1.4B Effective Char Depth (for CLT with β_n=1.5 inches/hour)

Required Fire Resistance (hr)	Lamination Thickness, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
	Char Depth, a_{char} (in.)								
1-Hour	1.8	1.8	1.7	1.7	1.7	1.6	1.5	1.5	1.5
1½-Hour	2.8	2.7	2.6	2.5	2.4	2.4	2.4	2.3	2.2
2-Hour	3.7	3.6	3.4	3.4	3.2	3.2	3.0	3.0	3.0
	Effective Char Depth, a_{eff} (in.)								
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

Figure 4-3 Beam to Column Connection
Beam and Column Exposed to Fire Where Appearance is a Factor

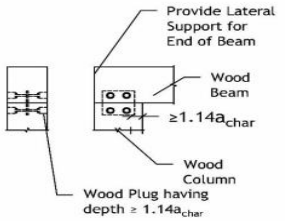
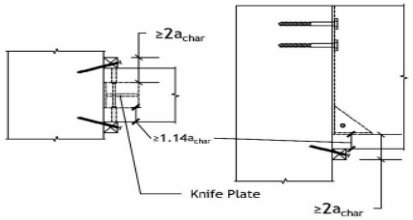


Figure 4-4 Beam to Girder – Concealed Connection



Analysis:

- Adjustment provided for Char Contractions rate for CLT where a laminated wood product in different axis has influence on material lost due to charring.
- Performance standard for protection of wood structural connections based on limitation of average temperature rise and maximum temperature rise.

SPECIAL INSPECTION FOR OF TYPE IV CONSTRUCTION USING CLT OR SCL ELEMENTS

TABLE 1705.5.6
REQUIRED SPECIAL INSPECTIONS OF TYPE IV CONSTRUCTION UTILIZING CROSS-LAMINATED TIMBER OR STRUCTURAL COMPOSITE LUMBER

Type	Continuous Special Inspection	Periodic Special Inspection	Referenced Standard	Code References
1. Inspection of anchorage and connections of mass timber construction to timber deep foundation systems	—	X		1705.7, 2308.3, 2304.10
2. Inspect erection of mass timber, including material verification		X	PRG-320, ASTM D5456	2303.1.4, 2303.1.10
3. Inspection of connections where installation methods are required to meet design loads				
3.1. Threaded fasteners				
3.1.1. Verify use of proper installation equipment				
3.1.2. Verify use of pre-drilled holes where required	—	X	NDS 11-14 ANSI/ASME Standard B18.2.1, B18.6.1	
3.1.3. Inspect screws, including diameter, length, head				2304.10, 2304.11.1.1

BC 1705.5.6 requires special inspections of Type IV construction utilizing cross-laminated timber or structural composite lumber elements.

Inspection and frequency schedule performed in accordance with Table 1705.5.6

Inspection is required for Type IV construction utilizing the following:

- Cross-laminated timber
- Structural composite lumber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