Guide to Encapsulated Mass Timber Construction in the Ontario Building Code

Second Edition

Applicable as of January 1, 2025

Wood Works

CANADIAN WOOD COUNCIL
CONSEIL CANADIEN DU BOIS

Ontario

Federal Economic Development Agency for Northern Ontario
Agence fédérale de développement économique pour le Nord de l'Ontario

Natural Resources Canada
Ressources naturelles Canada

Acknowledgements

Authors

Trisha Ashworth, P.Eng., M.Eng. – Principal & Senior Code Consultant, Morrison Hershfield, now Stantec

Vusal Ibrahimli, M.A.Sc., E.I.T., Technical Specialist – Fire, Canadian Wood Council

Dana Scherf, P.Eng. – Principal & Senior Code Consultant, Morrison Hershfield, now Stantec

Noah Jalbert, Code Consultant, Morrison Hershfield now Stantec

Contributors

Marc Alam, Ph.D., E.I.T. – Senior Manager, Codes and Standards – Fire and Acoustics, Canadian Wood Council

Noah Fetterly, FPET, Technical Specialist – Fire, Canadian Wood Council

Vusal Ibrahimli, M.A.Sc., E.I.T., Technical Specialist – Fire, Canadian Wood Council

Robert J. Jonkman, P.Eng., Vice President, Codes and Engineering, Canadian Wood Council

Jason Kent, Fire Protection Consultant, Morrison Hershfield, now Stantec

Lauren Maxwell, Project Coordinator, Morrison Hershfield, now Stantec

Ali Mikael, Ph.D., P.Eng., Director, Codes and Standards – Structural Engineering, Canadian Wood Council

Rebecca Sondermeyer, Building Science Consultant, Morrison Hershfield, now Stantec

Eric Wood, Façade Specialist/Practice Lead, Morrison Hershfield, now Stantec

Project Managers

Steven Street – Executive Director, Canadian Wood Council – WoodWorks Ontario

Hailey Quiquero, MASc, P.Eng., Technical Manager, Canadian Wood Council – WoodWorks Ontario

Sarah Hicks – Communications and Outreach Manager, Canadian Wood Council – WoodWorks Ontario

Contact

Canadian Wood Council / WoodWorks Ontario
420 – 99 Bank Street, Ottawa, ON K1P 6B8
www.cwc.ca

Special Acknowledgements

The Canadian Wood Council / WoodWorks Ontario thankfully acknowledges the Ontario Ministry of Natural Resources and Forestry, the Federal Economic Development Agency for Northern Ontario, and Natural Resources Canada for their financial and in-kind contributions that made the publication of this document possible.

Ontario

Federal Economic Development Agency for Northern Ontario
Agence fédérale de développement économique pour le Nord de l'Ontario

Natural Resources Canada
Ressources naturelles Canada

Image Credits

Cover photo © Salina Kassam Photography, provided courtesy of George Brown College.
All other images provided courtesy of Morrison Hershfield, now Stantec, unless otherwise noted.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 | Introduction

Morrison Hershfield Limited, now Stantec (MHnS), has been retained by the Canadian Wood Council (CWC) to document the application of the Ontario Building Code (OBC) relative to the use of Encapsulated Mass Timber Construction (EMTC) and identify features that are required to be provided, as well as conditions or restrictions based on the OBC provisions that initially came into effect on July 1, 2022. The provisions regarding EMTC were further updated on November 5, 2024 and came into effect on January 1, 2025.

The purpose of this guide is to introduce readers to the existing and new provisions governing encapsulated mass timber construction in Ontario, so that readers are aware of the content, intent, and application of the new provisions. The guide is to be read in conjunction with the Ontario Building Code. This is not a design guide.

As these provisions are new in Ontario, designers and authorities having jurisdiction may seek assistance from subject matter experts in both the design and approval of EMTC buildings until such time that in-house expertise is developed.

1.2 | Scope and Methodology

This guide presents the provisions of the 2024 OBC (O.Reg. 163/24 as amended) including amendment O.Reg. 447/24 (applicable as of January 1, 2025). Features that are required to be provided for EMTC are identified along with conditions on the use of EMTC relative to the updated provisions.

This guide is based on a review of applicable changes to the OBC, other industry research, reports and guidelines, and MHnS's experience in interpreting and applying the Building Code. CWC provided input into the development of this guide through regular meetings and continuous feedback as content was developed.

The guide is focused on EMTC buildings of new construction.

1.3 | Limitations

Comments and conclusions within this guide represent the opinion of Morrison Hershfield Limited, now Stantec, and the Canadian Wood Council, which is based on an examination of the applicable Codes, background documentation, our Code analysis, and our experience. In issuing this guide, Morrison Hershfield, now Stantec, does not assume any of the duties or liabilities of the designers, builders, owner, or operators who may use the information herein for the design or construction of a building. Persons who use or rely on the contents of this guide do so with the understanding of the limitations of the documents examined. Such persons understand that Morrison Hershfield, now Stantec, and the Canadian Wood Council cannot be held liable for damages they may suffer in respect to the design, construction, purchase, ownership, use or operation of a subject property.

2 Background

All buildings constructed under the Ontario Building Code are required to achieve a minimum level of life safety through a combination of building size restrictions, specified construction materials, and various fire protection features such as sprinkler protection and fire-resistance ratings. The specific requirements and permissions will depend on the major occupancy and building size. As buildings increase in size or hazard, additional requirements are introduced to maintain the minimum level of life safety.

Historically, the OBC has required the use of noncombustible construction for structures exceeding specified dimensions to address the growth and spread of fires in buildings. Noncombustible construction is intended to confine and contain a fire within its point of origin by limiting the potential contribution of structures to fire growth and spread. However, growing research on compartment fire dynamics[1] demonstrates that a similar degree of fire safety can be attained using other construction materials provided that certain fire protection measures are in place.

Encapsulated mass timber construction showcases recent advancements in fire safety engineering. An EMTC building attains a degree of fire safety through encapsulation, which shields most of the underlying mass timber structural elements and limits the structure from contributing to fire growth and spread. The new and existing EMTC provisions provide a similar level of fire safety relative to the performance of a similarly sized building of noncombustible construction. As highlighted throughout this guide, the new code provisions introduced for EMTC align with provisions for noncombustible construction, which reinforces noncombustible construction as the baseline for the performance of taller and larger buildings.

In Canada, recognition of EMTC as a construction type has occurred in various provinces in recent years. For example, British Columbia adopted EMTC provisions in 2019 for specific jurisdictions under the 2018 British Columbia Building Code, and Alberta has recognized EMTC under Standata 19-BCV-014 since 2020. EMTC has been accepted in other jurisdictions through the alternative solution process. Recognition of EMTC as a new construction type was also reflected in the 2020 National Building Code of Canada (released in March 2022), followed by amendments to the 2012 Ontario Building Code that became effective as of July 1, 2022. Recent amendments to the 2024 Ontario Building Code regarding the use of EMTC became effective as of January 1, 2025. Similarly, the 2024 British Columbia Building Code came into effect as of March 8, 2024 and included similar updates to provisions regarding the use of EMTC.

These amendments reflect the growing knowledge of fire dynamics in buildings of EMTC and advances in understanding fire behaviour in general. As a relatively new construction type, it is expected that the Code will continue to evolve.

1 Brandon et al., 2021, 2018; Su et al., 2018a, 2018b, 2019; Zelinka et al., 2018; Klippel et al., 2017; Janssens, 2015; Medina, 2014; Taber et al., 2014; McGregor, 2013; also see publications from National Research Council of Canada, Canadian Wood Council, U.S. Forest Service, American Wood Council, and RISE Research Institute of Sweden.

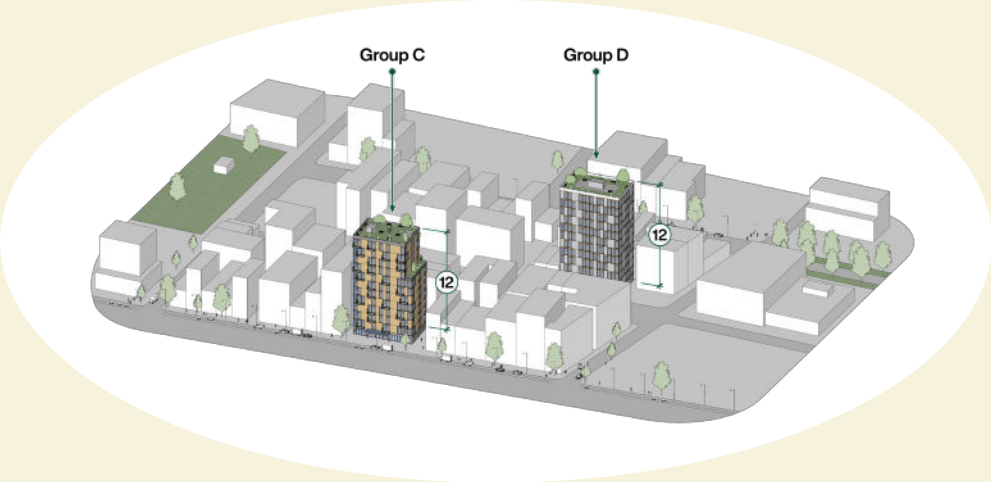


Figure 1
Building types permitted to be of EMTC prior to January 1, 2025 – (image by RDH Building Science Inc.)

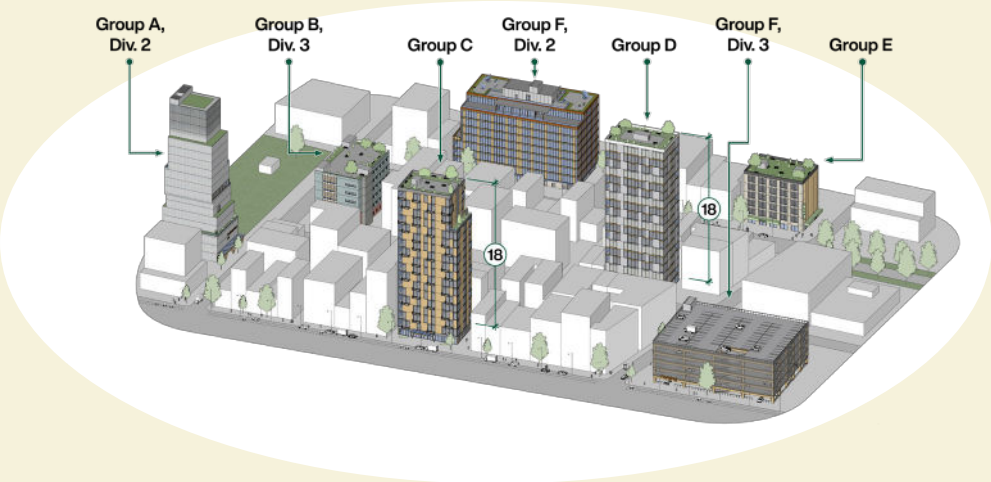


Figure 2
Building types permitted to be of EMTC as of January 1, 2025 – (image by RDH Building Science Inc.)

3 Ontario Building Code

3.1 | Background

The Ontario Building Code (O.Reg. 163/24 as amended) is a set of regulations made under the Building Code Act and sets out the technical requirements for construction of buildings. The Ontario Building Code is a set of minimum requirements for buildings that address objectives of safety, health, accessibility, property protection, resource conservation, environmental integrity, and conservation of buildings.

The 2024 Ontario Building Code (OBC) came into effect January 1, 2025. All references to the OBC in this guide are to the 2024 edition, unless otherwise noted, including all amendments to the date of this guide such as the amendments included in O.Reg. 447/24.

The Code references and paraphrases in this guide represent the minimum requirements for EMTC and are for convenience only. Key EMTC provisions are reproduced in Appendix A of this guide.

For the authoritative text of the Building Code regulations, the official version of Ontario Regulation O.Reg. 163/24, as amended, should be referenced. Official copies of Ontario's regulations are published in the Ontario Gazette and can be found on the Government of Ontario e-laws website.

Unless otherwise stated, Code references in this guide are with respect to Division B, "Acceptable Solutions" of the OBC.

3.2 | Code Changes

The 2012 OBC first permitted the use of encapsulated mass timber construction for buildings of residential and business and personal services occupancies with a maximum height of 12 storeys as of July 1, 2022. The 2024 OBC came into effect January 1, 2025 and included amendments to existing provisions as well as introduced entirely new provisions regarding the design and construction of EMTC buildings.

3.3 | Code Content

The OBC prescribes the minimum technical requirements for the design and construction of new buildings in Ontario. Division B "Acceptable Solutions" contains prescriptive (and some performance) requirements that establish the minimum performance level of the Code. Building Code provisions that influence the use and design of EMTC in buildings are in Division B in the following Parts:

- Part 3 Fire Protection, Occupant Safety and Accessibility
- Part 4 Structural Design
- Part 6 Heating, Ventilation and Air-Conditioning

The following Parts do not contain specific provisions related to EMTC; however, the decision to use EMTC has implications for how the code is applied:

- Part 5 Environmental Separation
- Part 12 Resource Conservation and Environmental Integrity

Provisions that permit or prohibit EMTC are primarily contained in Part 3. Parts 4, 5 and 12 generally do not explicitly require or prohibit EMTC, but rather set out the required performance standards for structural, building envelope and energy elements that every building subject to these Parts must meet.

In addition to the minimum technical requirements, the OBC identifies core objectives associated with each technical requirement. The high-level objectives of the OBC are safety, health, accessibility, fire, structural, water and sewage protection of buildings, resource conservation, environmental integrity and conservation of buildings. Objectives and functional statements that are attributed to the minimum technical requirements are listed in Supplementary Standard SA-1.

3.4 | Alternative Solutions

In addition to following acceptable solutions documented in Division B, the OBC permits the use of alternative solutions in Clause 1.2.1.1.(1)(b) of Division A, as a way to comply with Division B. Alternative solutions allow for the use of innovative designs that do not fit within the prescribed words of the Code, where the design can be shown to meet the same performance level. An alternative solution is required to identify the applicable objectives and functional statements for the corresponding acceptable solution and to demonstrate how the proposed alternative solution will achieve the same level of performance as the acceptable solution within Division B.

Approved alternative solutions are equal to designs that comply with Division B. A specific reason is not required to propose an alternative solution, since the performance level is considered to be equal to a design that complies with Division B. The approval process is required to be based on the performance of a Division B provision when evaluated relative to the objectives and functional statements.

As the use of EMTC in the industry is relatively new, implementation of some acceptable solutions may be challenging in consideration of new materials and construction techniques. These situations are ideal candidates for alternative solutions, where an acceptable level of performance can be documented.

3.5 | Qualifications

Part 1 of Division C identifies buildings that require design and general review by an architect and/or a professional engineer. Since there are no specific distinctions for EMTC buildings, the size and major occupancy of a building remain the conditions that determine the requirements for professional involvement, rather than the construction type.

Part 3 of Division C describes qualifications for individuals associated with the design and construction of buildings, including Qualifications for Chief Building Officials and Inspectors (Subsection 3.1) and Qualifications for Designers (Subsection 3.2).

There are no new provisions associated with specific qualifications for the design and approval of EMTC buildings. As with all buildings, persons involved in design and municipal approvals must have the appropriate qualifications related to their area of expertise and the complexity of the building.

4 What is Encapsulated Mass Timber Construction?

Did you know...

In the Ontario Building Code, where a word or a phrase is *italicized*, e.g., *building height*, *encapsulated mass timber construction*, *noncombustible*, it has a definition for the purposes of the Code. These definitions are listed in Clause 1.4.1.2.(1)(c) of Division A in an alphabetical order.

When a term is not defined in the Code, the subject word has the meaning that is commonly assigned to it, e.g., from a credible dictionary source, per Sentence 1.4.1.1.(1) of Division A.

"An EMTC Building"

Throughout this guide, "an EMTC building" has the same meaning as "a building permitted to be of encapsulated mass timber construction" in the OBC.

This Section introduces the concept of encapsulated mass timber construction, focusing on the fundamental requirements for the new construction type. Structural mass timber and encapsulation concepts are established. The new construction type is put in the context of other permitted construction types, including a summary of where mass timber can be used without encapsulation.

4.1 | A New Construction Type

Prior to the July 1, 2022, amendments to the 2012 OBC which first permitted EMTC, all buildings constructed under the Ontario Building Code were either required to be of noncombustible construction or were permitted to be of combustible construction or noncombustible construction used singly or in combination. The definitions for each type of construction were as follows:

- *Noncombustible construction means a type of construction in which a degree of fire safety is attained by the use of noncombustible materials for structural members and other building assemblies.*
- *Combustible construction means a type of construction that does not meet the requirements for noncombustible construction (pre-July 1, 2022, definition).*

The July 1, 2022 amendments introduced a new construction type – "encapsulated mass timber construction":

- *Encapsulated mass timber construction means that type of construction in which a degree of fire safety is attained by the use of encapsulated mass timber elements with an encapsulation rating and minimum dimensions for structural members and other building assemblies.*

The definition of combustible construction was updated accordingly since it is the “catch-all” for all construction types that do not meet the other two definitions of noncombustible construction or encapsulated mass timber construction:

» *Combustible construction means a type of construction that does not meet the requirements for noncombustible construction or encapsulated mass timber construction (definition as of July 1, 2022).*

Each construction type is permitted for various major occupancies and building sizes, with corresponding construction requirements such as sprinkler protection and fire resistance ratings. See Section 4.5 of this guide for an overview of where structural mass timber can be used without encapsulation in both combustible and noncombustible construction.

The goal of Code development for all three construction types is to attain an acceptable degree of fire safety, as noted in Section 2 of this guide.

From the definition of encapsulated mass timber construction, fire safety is achieved from two key elements (see Figure 3 for a schematic representation of these elements):

1. Encapsulation: Encapsulated mass timber elements with an encapsulation rating, and
2. Minimum dimensions: Minimum dimensions for structural mass timber elements such as beams, columns, walls, floors, and roofs.

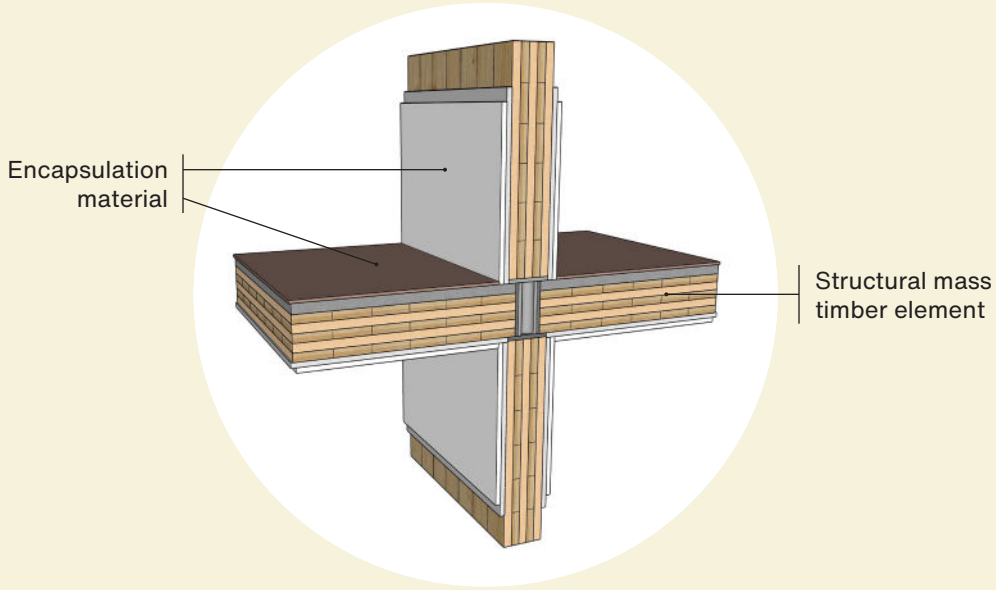


Figure 3
Elements forming encapsulated mass timber construction

Encapsulation is a relatively new concept in the OBC. Encapsulation is the surface protection of structural mass timber elements. The protection is intended to extend the duration of time before the mass timber is directly exposed to fire, to delay ignition and subsequent burning of the mass timber.

Encapsulation materials have an encapsulation rating:

» *Encapsulation rating means the time in minutes that a material or assembly of materials will delay the ignition and combustion of encapsulated mass timber elements when it is exposed to fire under specified conditions of test and performance criteria, or as otherwise prescribed by the Code.*

The encapsulation rating is expressed in minutes and is based on the fire test CAN/ULC-S146, "Test for the Evaluation of Encapsulation Materials and Assemblies of Materials for the Protection of Structural Timber Elements".

The CAN/ULC-S146 standard fire test measures the temperature at the interface between a wood substrate (used to represent a mass timber structural element) and the encapsulation material (or assembly of materials), when exposed to a standard fire exposure. The standard fire exposure condition follows the standard time-temperature curve given in CAN/ULC-S101, "Standard Methods of Fire Endurance Tests of Building Construction and Materials". The encapsulation rating is then determined based on the time for the interface temperature to exceed a certain threshold.

A high-level description of the test procedure and criteria to determine the encapsulation rating are discussed below.

Prior to testing, a test specimen consisting of a wood substrate (measuring at least 3.6 m long, 3.6 m wide, and 76 mm thick) and an encapsulation material is prepared. Temperature sensors are installed at the interface between the wood substrate and the encapsulation material. During a test, the specimen is mounted horizontally and exposed to a fire on the underside. The test starts at the onset of fire exposure, and temperature measurements at the interface are collected throughout the entire test duration. The encapsulation rating of the materials is based on the time at which one of the following two events first occurs:

» An average interface temperature rise of 250°C above its initial temperature, or
» An interface temperature rise of 270°C above its initial temperature at any individual point.

These temperature rise criteria are based on the minimum temperature (around 300°C) at which structural mass timber elements are expected to char. As such, when a material tested to CAN/ULC-S146 is reported to have a 50-minute encapsulation rating, for instance, it is conservatively assumed that the ignition and subsequent burning of (protected) combustible timber elements is delayed for approximately 50 minutes.

In the OBC, technical provisions refer to several specific encapsulation ratings: 25-minute, 50-minute, 70-minute and 80-minute encapsulation ratings. These ratings can be established via the CAN/ULC-S146 test. Alternatively, there are several materials in the Code that are deemed to provide a specific encapsulation rating based on past research and development, as discussed in Section 4.3 of this guide. Section 5.2 of this guide discusses the relationship between encapsulation ratings and fire-resistance ratings.

The two key features of EMTC, structural mass timber elements and encapsulation materials, are further discussed in the next two sections.

4.2 | Structural Mass Timber Elements (Article 3.1.6.3.)

Structural elements refer to those parts of a building which resist forces and moments and include elements such as:

- Beams, columns, and arches,
- Floor and roof slabs,
- Loadbearing walls, and
- All other elements designed to resist forces and moments.

Structural elements do not include doors, windows, or nonloadbearing walls.

Structural mass timber elements include a multitude of large cross-section engineered wood products. Some examples of structural mass timber elements often encountered in modern construction practices are presented below:

Solid-sawn mass timber is oversized structural softwood lumber that is cut from a single log.

Glue-laminated timber (glulam) is an engineered structural product typically composed of multiple layers of dimensional lumber laminated together into a desired depth and form.

Cross-laminated timber (CLT) is a large structural panel product composed of multiple layers of dimensional lumber stacked crosswise on top of each other and held together with adhesives.

Nail-laminated timber (NLT) is manufactured from dimensional lumber nailed to each other to form large panels.

Solid-sawn mass timber
Photo courtesy of Timber Systems Limited

Nail-laminated timber
Photo courtesy of Timmerman Timberworks Inc.

Glue-laminated timber
Photo courtesy of APA – The Engineered Wood Association

Cross-laminated timber
Photo courtesy of Element5

continued »

» *continued*

Dowel-laminated timber
Photo courtesy of StructureCraft

Laminated strand lumber
Photo courtesy of APA – The Engineered Wood Association

Parallel strand lumber
Photo courtesy of Trust Joist Weyerhaeuser 2023

Laminated veneer lumber
Photo courtesy of APA – The Engineered Wood Association

Dowel-laminated timber (DLT) is made from dimensional lumber boards connected together with hardwood dowels.

Laminated Strand Lumber (LSL) is manufactured by cutting veneers of wood into strands and/or large chips and re-assembling them via a bonding process into a large billet from which the final product sizes are cut.

Parallel Strand Lumber (PSL) is manufactured in the same way as Laminated Strand Lumber – by cutting veneers of wood into strands and/or large chips and re-assembling them via a bonding process into a large billet from which the final product sizes are cut.

Laminated Veneer Lumber (LVL) is manufactured by laminating veneers of wood with the grain of the veneers oriented with the length of the member.

To be considered “mass timber” used in EMTC buildings, structural mass timber elements need to satisfy all requirements from Sentence 3.1.6.3.(2) (key concepts underlined):

(a) Be arranged in heavy solid mass having no concealed spaces (exceptions apply – refer to Section 5.4 of this guide for permitted concealed spaces within structural mass timber elements),

(b) Have essentially smooth flat surfaces throughout with no thin sections or sharp projections, and

(c) Have the minimum dimensions in Table 3.1.6.3. which is replicated below Table 1 of this guide, except for cut-outs where outlet boxes are installed (see Section 7.1 of this guide).

Table 1

Minimum dimensions of structural mass timber elements in EMTC (from Table 3.1.6.3.)

Structural Mass Timber Element	Condition	Minimum Dimensions
Walls	» That are fire separations or exterior walls[1] » 1-sided fire exposure	96 mm thick
	» That require a fire-resistance rating, but are not fire separations » 2-sided fire exposure	192 mm thick
Floors and Roofs	» 1-sided fire exposure	96 mm thick
Beams, Columns and Arches	» 2- or 3-sided fire exposure	192 mm wide by 192 mm deep
	» 4-sided fire exposure	224 mm wide by 224 mm deep

[1] The OBC provision includes an erroneous “not”, which MMAH has confirmed is an editorial error.

In addition to minimum dimensions noted in Table 1, there are specific requirements for adhesives for cross-laminated structural mass timber elements. The 2018 edition of ANSI/APA PRG 320, “Standard for Performance-Rated Cross-Laminated Timber” establishes the required performance for adhesives used in cross-laminated structural mass timber elements. It is important to confirm that the adhesives used in CLT meet these requirements, as this version of the standard establishes a higher fire performance relative to previous editions of the standard.

4.3 | Encapsulation Materials (Articles 3.1.6.4. and 3.1.6.6.)

Structural mass timber elements are required to be protected with an encapsulation material with a minimum encapsulation rating as specified per Sentence 3.1.6.4.(1), with some exceptions which will be discussed in later sections of this guide.

An encapsulation material (or assembly of materials) provides a passive means of protection against direct exposure of structural mass timber elements from a fire, by temporarily shielding the surface of the structural mass timber from direct flames and exposure to elevated fire temperatures. Permitted encapsulation materials in Sentence 3.1.6.4.(2) are:

(a) Gypsum board,

(b) Gypsum-concrete,

(c) Noncombustible materials,

(d) Materials that meet CAN/ULC-S135 “Test Method for the Determination of Combustibility Parameters of Building Materials Using an Oxygen Consumption Calorimeter”, provided the proposed assembly of materials is tested, or deemed, to meet the minimum requirements for encapsulation, and

(e) Any combination of materials in (a) through (d) listed above.

These encapsulation materials extend the time before mass timber elements are exposed to fire, delaying their ignition, and limiting their combustion and contribution to the fuel load.

The time that an encapsulation material will delay the ignition and combustion of an encapsulated structural element when exposed to a fire under specified conditions is referred to as “encapsulation rating”, as discussed in Section 4.1 of this guide.

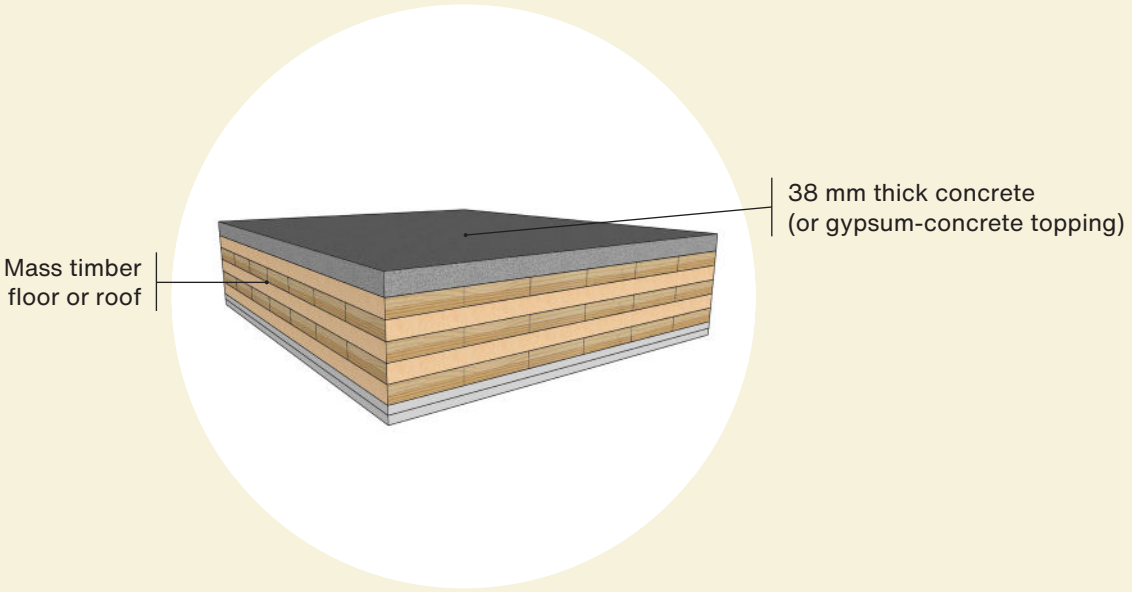
Article 3.1.6.6. describes two key encapsulation materials that are deemed to have prescribed encapsulation ratings when they are affixed to the exposed surfaces of the structural mass timber elements. The deemed encapsulation ratings that can be readily achieved with existing construction methods and materials without the need for new equipment, training or techniques are presented in Table 2 below.

Table 2

Deemed encapsulation ratings per Article 3.1.6.6.

Encapsulation Material	Minimum Thickness (mm)	Deemed Encapsulation Rating (min)	Installation Requirements
Gypsum-Concrete Topping and Concrete	38 mm *See Figure 4(a)*	50 minutes	On the upper side of a mass timber floor or roof assembly.
Type X Gypsum Board	One layer at least 12.7 mm thick	25 minutes	1. Conform to either ASTM C1396/ C1396M or CAN/CSA A82.27-M. 2. Fastened with minimum two rows of screws in each layer, directly to mass timber element or furring channels (see Clause 3.1.6.6.(6)(a)). 3. For multiple layer systems, joints in each layer staggered from those in the adjacent layer (see Clause 3.1.6.6.(6)(b)). 4. For multiple layer systems, installed in conformance with ASTM C840, with no need to tape or finish the joints. *Note: While the joints do not need to be finished for the purpose of achieving an encapsulation rating, the joints may be required to be finished for either aesthetic reasons or to achieve a required fire-resistance rating – see Section 5.2 of this guide.*
	2 layers each 12.7 mm thick *See Figure 4(a) & (b)*	50 minutes	
	2 layers each 15.9 mm thick	70 minutes	
	3 layers each 12.7 mm thick	80 minutes	

(a)



(b)

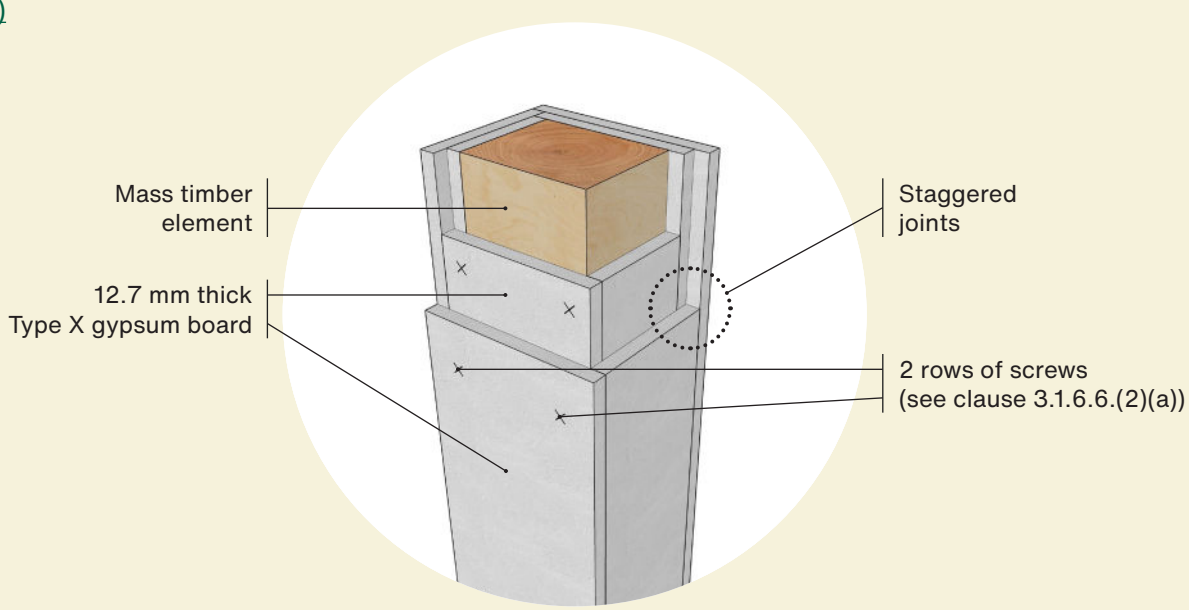


Figure 4
Encapsulation materials: (a) gypsum-concrete topping and concrete and (b) Type X gypsum board (2 layers)

Extensive research has been conducted on different types of encapsulation materials, such as gypsum board, gypsum-concrete and cement board. The results of small- through intermediate-scale fire tests indicate that a mass timber element protected with a 38 mm thick layer of gypsum-concrete topping or with one or multiple layers of Type X gypsum board will neither ignite, nor contribute significant heat to a fire until average temperatures of around 325°C to 380°C are measured at the interface between the encapsulation material (or its assembly) and the combustible substrate. These temperatures are consistent with the ignition temperatures of wood-based materials. These findings are consistent with the acceptance criteria of CAN/ULC-S146, which supports why the materials described in this section are deemed to comply.

Where gypsum board is used as the encapsulation material on the top of a mass timber floor assembly, it should be protected from physical impact arising from normal pedestrian traffic that could damage it and possibly compromise its encapsulation rating.

Section 5.2 of this guide describes how the encapsulation rating differs from the fire-resistance rating, which is required for various mass timber elements, and how encapsulation materials may or may not contribute to fire-resistance rating requirements.

4.4 | Exposed Surfaces of Mass Timber

Encapsulation materials limit the probability that a mass timber element will significantly contribute to fire growth, spread and duration. While encapsulation of mass timber meets this fire safety objective, encapsulation may conflict with a designer's goal to visually showcase the mass timber elements as part of the building aesthetic. Thick mass timber members require a larger heat source to ignite; as such, some mass timber elements can remain exposed subject to certain conditions and area limitations and still meet the objective of limiting the mass timber's contribution to a fire event.

Article 3.1.6.4. describes the conditions related to exposed mass timber surfaces within a suite including limitations on flame-spread rating, orientation, and area of exposed surfaces. These conditions are described more fully in Section 5.3 of this guide.

These conditions reduce the potential of re-radiation between burning mass timber surfaces that face each other and also limit the mass timber's contribution to the fuel load.

4.5 | Using Mass Timber Without Encapsulation

As discussed in the previous sections of this guide, mass timber elements in an EMTC building require minimum dimensions of structural elements and encapsulation, with some exceptions. This section summarizes where mass timber can be used in other construction types without encapsulation and without the minimum dimensions in Table 3.1.6.3.

If a building is not an EMTC building governed by Article 3.2.2.48., Article 3.2.2.57. or Article 3.2.2.93., then the building must be one of the other two construction types:

- A building that is permitted to be of combustible construction, or
- A building that is required to be of noncombustible construction.

Once the construction type is confirmed for a building, then the permissions and conditions for using mass timber without encapsulation can be determined as discussed below.

4.5.1 | Mass Timber in Buildings Permitted to be of Combustible Construction

Structural mass timber is permitted in a building that is permitted to be of combustible construction since mass timber meets the definition of combustible construction when it is not intended to meet the requirements for EMTC.

Structural mass timber without encapsulation is permitted for the following buildings that are permitted to be of combustible construction:

- Part 9 Buildings:

  All buildings governed by Part 9 of the OBC as summarized in Table 3 below.

Table 3

Part 9 Building height and area requirements

Building Height	Building Area	Major Occupancy
Up to 3 storeys	< 600 m^2	Group C, residential occupancies other than retirement homes Group D, business and personal services occupancies Group E, mercantile occupancies Group F, Division 2, medium hazard industrial occupancies Group F, Division 3, low hazard industrial occupancies

- Part 3 Buildings:
  - Where *combustible construction* is permitted by Articles 3.2.2.20. to 3.2.2.93., based on the building height and area, major occupancy, sprinkler protection, number of streets, and other considerations.
  - Where *heavy timber construction* is permitted by Articles 3.2.2.20. to 3.2.2.93., based on the building height and area, major occupancy, sprinkler protection, number of streets, and other considerations. Note that only certain Group A and Group F occupancies contain this permission in Subsection 3.2.2.

Where structural mass timber is used for floors, roofs, beams, columns and arches required to have a fire-resistance rating, the structural mass timber is required to demonstrate compliance in one of the following ways:

- The fire-resistance rating is determined based on the results of a CAN/ULC-S101 test, “Fire Endurance Tests for Building Construction and Materials”,
- The fire-resistance rating is assigned based on Supplementary Standard SB-2, “Fire Performance Ratings”, which includes calculation method described in Annex B of CSA O86, “Engineering design in wood”,
- Meeting *Heavy Timber Construction* requirements for a fire-resistance rating of 45 minutes or less per OBC 3.1.4.6. (refer to Section 4.5.3), or
- The assembly or element has a design listing provided by an accredited certifying organization.

In a building permitted to be of combustible construction, interior surfaces, including exposed mass timber elements, are subject to the flame spread requirements in Article 3.1.13.2. which varies between 25 to 150 depending on:

- the occupancy, location, or element,
- the overall area of the exposed surfaces, and
- whether the building is provided with sprinkler protection.

4.5.2 | Mass Timber in Buildings Required to be of Noncombustible Construction

This section highlights instances where mass timber elements can be used in buildings required to be of noncombustible construction. In general, such buildings are required to be constructed with noncombustible materials.

A mass timber product would not meet the definition of a noncombustible material since it would not be tested to or satisfy the acceptance criteria of CAN/ULC-S114, "Test for Determination of Non-combustibility in Building Materials" or CAN/ULC-S135, "Test Method for the Determination of Combustibility Parameters of Building Materials Using an Oxygen Consumption Calorimeter".

However, Article 3.2.2.16. permits heavy timber construction for the roof assembly of a building that is otherwise required to be noncombustible, with the condition that the building is a maximum 2 storeys in building height and is sprinklered. Structural heavy timber members in the storey immediately below the roof assembly are also permitted under Article 3.2.2.16. Refer to Section 4.5.3 for more details on the requirements for *Heavy Timber Construction*.

Mass timber may also be permitted to be used in buildings otherwise required to be of noncombustible construction when supported by an alternative solution, which is subject to approval by the authority having jurisdiction.

4.5.3 | Heavy Timber Construction

In buildings of all three construction types, heavy timber elements may be permitted in various cases/configurations. In buildings required to be of noncombustible construction or permitted to be of encapsulated mass timber construction, exposed heavy timber construction is permitted in some cases as roof and roof-supporting structural members. In buildings of combustible construction, heavy timber can be considered as a method of achieving required fire-resistance ratings with exposed timber in lieu of lightweight wood framing with encapsulation.

Similar to mass timber elements in an EMTC building, heavy timber elements are also required to be arranged in heavy solid masses with essentially smooth flat surfaces and to have minimum dimensions. However, the minimum dimensions of wood elements in heavy timber construction are required to conform to Article 3.1.4.7. instead of Table 3.1.6.3., which is specific to EMTC.

While, by the virtue of their minimum dimensions, mass timber elements used for EMTC may fall under heavy timber construction, not all heavy timber wood elements are necessarily considered to be mass timber, and vice-versa. Heavy timber is described as “solid-sawn timber” or “glued-laminated timber” and must be arranged in prescribed configurations as described in Article 3.1.4.7. depending on how the heavy timber is used in the building. In practice, judgement may be applied by designers to extend these heavy timber provisions to other mass timber configurations when the minimum dimensions are achieved and the approach is approved by the authority having jurisdiction.

Where heavy timber is used for floors, roofs, beams, columns and arches required to have a fire-resistance rating of not more than 45 minutes, the heavy timber is required to demonstrate compliance by meeting the minimum dimensions of wood elements in heavy timber construction, in Article 3.1.4.7., including Table 3.1.4.7. Where structural elements of a building permitted to be of combustible construction include exposed heavy timber, and where the exposed heavy timber elements are required to have a fire-resistance rating of not more than 45 minutes, compliance may be demonstrated using other methods as described in Section 4.5.1.

5 Encapsulated Mass Timber Construction

This section focuses on Part 3 provisions of the Code as related to encapsulated mass timber construction. Topics covered in this section include use and occupancy, construction requirements, encapsulation, concealed spaces, exposed areas of mass timber, exterior wall assembly, spatial separation, exterior cladding and associated components. This section is intended to focus on the "big picture" items related to fundamental structural elements.

5.1 | Use, Occupancy, and Construction

As of January 1, 2025, the Ontario Building Code permits encapsulated mass timber construction for buildings with a maximum height of up to 18 storeys. The prescribed construction requirements, including building height and area limitations, are provided in the following Articles:

- Article 3.2.2.48. for some Group C (residential) major occupancies,
- Article 3.2.2.57. for some Group D (business and personal services) major occupancies, and
- Article 3.2.2.93. for Group A, Division 2 (assembly), Group B, Division 3 (care), Group C, Group D, Group E (mercantile) and Group F, Division 2 and Division 3 (medium- and low-hazard industrial) major occupancies.

These requirements are discussed in greater detail in the following section.

We note that Article 3.2.2.48. and Article 3.2.2.93. explicitly exclude "retirement homes"; as such, the construction requirements associated with EMTC are not intended to apply to retirement homes at this time.

5.1.1 | Encapsulated Mass Timber Construction Requirements by Major Occupancy

The new provisions of the Code permit various major occupancy buildings of encapsulated mass timber construction. The new construction requirements include the following:

- The building is required to be fully sprinklered. The sprinkler requirements of NFPA 13, "Standard for the Installation of Sprinkler Systems" apply, including sprinklering of concealed spaces lined with combustible materials, unless conditions for exemption are met.
    - In addition, balconies greater than 610 mm in depth measured perpendicular to the exterior wall are required to be sprinklered.

- Floor assemblies are to be constructed as fire separations with a minimum 2-hour fire-resistance rating, except as noted below:
  - Floor assemblies completely within individual dwelling units greater than 1 storey in height are required to have a fire-resistance rating of at least 1 hour, but these assemblies are not required to be constructed as fire separations provided that the distance between the lowest floor level to the uppermost floor level within the dwelling unit is not more than 6 m.
  - Mezzanines are to be constructed with a minimum 1-hour fire-resistance rating. This requirement is consistent with buildings of similar height and occupancy.
- The floor assembly of an exterior balcony on an EMTC building is permitted to be either noncombustible or consist of structural mass timber elements (floors, columns, beams, etc.) that conform to the dimensions and other provisions outlined in Article 3.1.6.3. Structural mass timber elements used on an exterior balcony do not need to be encapsulated, but still require a 2-hour fire-resistance rating.
- Loadbearing assemblies are required to have a fire-resistance rating not less than that required for the supported assembly. This requirement is consistent with the remainder of the Code for the portion of supporting assemblies. In an EMTC building, assemblies of noncombustible construction are allowed to be supported by encapsulated mass timber construction (Sentence 3.1.7.5.(4)), unless the building contains a superimposed major occupancy required to be of noncombustible construction.
- The building must not exceed the maximum area or maximum building heights provided in Table 3.2.2.93., or as otherwise specified in Articles 3.2.2.48. and 3.2.2.57., where applicable.
- The building is required to provide a minimum encapsulation rating based on the major occupancy and maximum building height measured in metres and also in storeys, as specified in Table 3.2.2.93. or as otherwise specified in Articles 3.2.2.48. and 3.2.2.57. Note that the maximum building height in metres is measured between the floor level of the first storey[2] and the floor level of the uppermost storey[3].
- Where the roof assembly of an exit stairway or a vertical service shaft that is used as an elevator hoistway is at a height greater than 55 m, the enclosure for the stairway or shaft is required to be constructed of EMTC or concrete, as specified by Sentence 3.2.2.93.(4).

Did you know...

Unlike in Code provisions for low- and mid-rise wood buildings, the maximum building area permitted in an EMTC building does not change as a function of building height – it is always a set maximum building area for each major occupancy.

For some buildings between 2 to 6 storeys in building height, EMTC allows for larger building areas relative to the permissions for combustible construction. Where larger building areas are desired, it may be beneficial to explore EMTC versus using standard mid-rise wood construction techniques.

For example, a 6-storey residential EMTC building under Article 3.2.2.93. can have 4 times the building area (6000 m^2) of a mid-rise wood building (1500 m^2) constructed under Article 3.2.2.51.

A 2-storey mid-rise wood residential building under Article 3.2.2.51. can have a maximum building area of 4500 m^2; in a 2-storey EMTC building, this area is permitted to be 6000 m^2, which is 33% larger.

2 *First storey* means the *storey* that has its floor closest to grade and its ceiling more than 1.8 m above *grade*. Grade means the average level of proposed or finished ground adjoining a building at all exterior walls.

3 The floor level of the uppermost storey means the top of the finished floor of the uppermost storey or any mezzanine within that storey.

The table below compiles the requirements from Articles 3.2.2.48., 3.2.2.57. and 3.2.2.93. for all buildings permitted to be of EMTC.

Table 4

Construction requirements for EMTC buildings

Major Occupancy	Maximum Building Height (Storeys)	Maximum Height (m)	Maximum Building Area (m^2)	Minimum Encapsulation Rating (min)
Group A, Division 2	18	76	7200	70
	12	51		50
	6	26		0
Group B, Division 3	10	42	8000	70
	6	26		50
	4	17		0
Group C	18	76	6000	70
	12[1]	42[1]		50[1]
	8	34		0
Group D	18	76	7200	70
	12[2]	42[2]		50[2]
	9	38		0
Group E	12	51	6000	70
	8	34		50
	6	26		0
Group F, Division 2	10	42	4500	70
	7	30		50
	5	21		0
Group F, Division 3	12	51	7200	70
	8	34		50
	5	21		0

[1] Requirements from Article 3.2.2.48.
[2] Requirements from Article 3.2.2.57.

5.1.2 | Mixed Use Buildings

Articles 3.2.2.48., 3.2.2.57. and 3.2.2.93 contain construction provisions for EMTC buildings based on their principal major occupancy. A building within the scope of these articles is permitted to include additional major occupancies, as outlined in Table 5 below. In these cases, the requirements of Article 3.2.2.7. for superimposed major occupancies need not apply.

Table 5

Permitted major occupancies

Other Permitted Major Occupancy	Principal Major Occupancy		
	Group A, Div. 2	Group C	Group D
Storage Garage	below the fifth storey	below the fifth storey	below the fifth storey
Group A, Division 2	N/A	below the fourth storey	below the fourth storey
Group E	below the third storey	below the third storey	below the third storey
Group F, Division 2	not permitted	not permitted	below the third storey
Group F, Division 3	not permitted	not permitted	below the third storey

When incorporating the major occupancies on the permitted storeys, the construction requirements of Articles 3.2.2.48., 3.2.2.57. or 3.2.2.93. are applicable to the entire building.

Other major occupancy configurations can be incorporated into a building using the concept of multiple major occupancies and superimposed major occupancies, described in Articles 3.2.2.6. to 3.2.2.8. For typical buildings which include multiple major occupancies, the construction requirements for the building are based on the most restrictive major occupancy and are required to be applied as if the whole building is of that major occupancy (subject to the exception of superimposed major occupancies).

Where multiple major occupancies are proposed to be superimposed in an EMTC building, the following requirements are also applicable as per Article 3.2.2.7.:

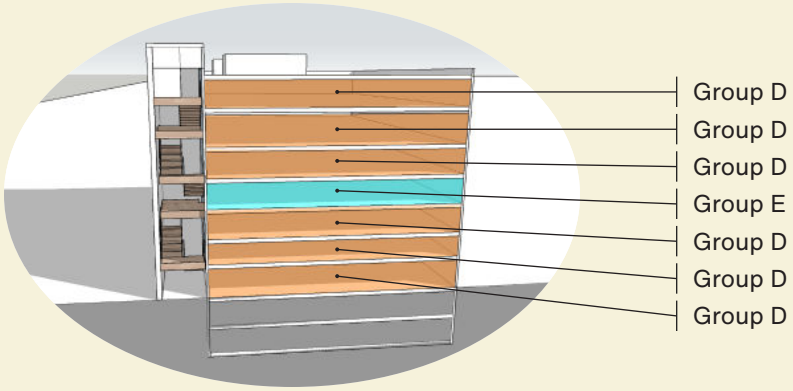
1. The most restrictive encapsulation rating applicable for any major occupancy contained in the building is required on the interior of vertical services spaces and exit stairs, and
2. The encapsulation rating of the upper surface of the separating mass timber floor assembly is to be based on the upper major occupancy, and the rating on the ceiling (i.e., underside) of the mass timber floor assembly is to be based on the lower major occupancy.

Where a storey contains more than one major occupancy, the most restrictive encapsulation rating requirements for any major occupancy contained on that storey is to be applied to the encapsulation required on the interior of a public corridor or exit serving that storey, as per Article 3.2.2.6.

Example 1

Problem: Consider a 7-storey EMTC building containing:

- A Group D (office) occupancy on the 1st to 3rd and 5th to 7th floor levels (see storeys highlighted in orange in the figure below), and
- A Group E (mercantile) occupancy on the 4th floor level (see storey highlighted in cyan in the figure below).



What is the maximum building area and what are the construction requirements governing the construction of this building?

What are the required encapsulation ratings for each storey based on the height of the building?

Solution: Since the building measures 7 storeys in building height and contains a Group D and Group E major occupancy, the following construction requirements from Article 3.2.2.93. apply:

- Group D, Maximum Area of 7200 m^2, Encapsulation Rating of 0 min,
- Group E, Maximum Area of 6000 m^2, Encapsulation Rating of 50 min,

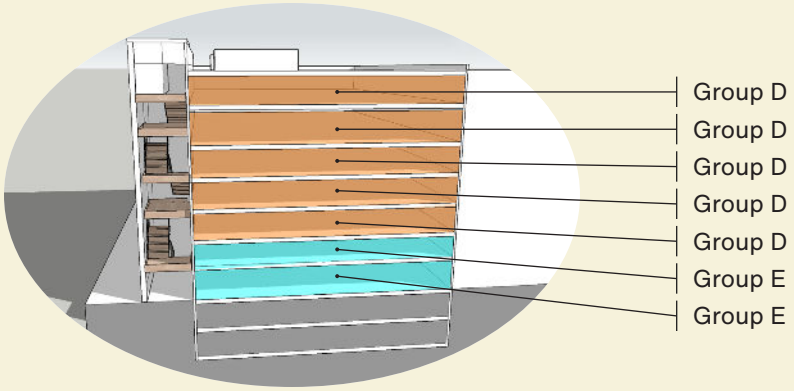
Where it is assumed that the maximum building height in metres between the first storey and the floor of the 7th storey is equal to or less than 34 m. Based on the above construction requirements, the following is applicable:

- The building is limited to a maximum building area of 6000 m^2, since there are no special exceptions for Group E major occupancies on the 4th floor and the provisions for superimposed major occupancies in Sentence 3.2.2.7.(1) apply,
- On storeys containing Group D major occupancy, structural mass timber elements are permitted to be fully exposed, provided mass timber walls and ceilings within public corridors are protected on the interior side with an encapsulation material having a minimum 25-minute encapsulation rating (Sentence 3.1.6.4.(8)),
- Structural mass timber elements on the 4th storey (Group E major occupancy) are required to be protected with encapsulation materials having an encapsulation rating of at least 50 minutes,
- Encapsulation materials in exit stairs and vertical service spaces are required to be provided with an encapsulation rating of at least 50 minutes (due to the encapsulation requirements for Group E major occupancy being the most restrictive).

Example 2

Problem: Consider a 7-storey EMTC building containing:

- A Group D (office) occupancy on the 3rd to 7th floor levels, and
- A Group E (mercantile) occupancy on the 1st and 2nd floor levels.



What is the maximum building area and what are the construction requirements governing the construction of this building?

What are the required encapsulation ratings for each storey based on the height of the building?

Solution: Since the building measures 7 storeys in building height and contains a Group D and Group E major occupancy, the following construction requirements from Article 3.2.2.93. apply:

- Group D, Maximum Area of 7200 m^2, Encapsulation Rating of 0 min,
- Group E, Maximum Area of 6000 m^2, Encapsulation Rating of 50 min,

Where it is assumed that the maximum building height in metres between the first storey and the floor of the 7th storey is equal to or less than 38 m.

Based on the above construction requirements, the following is applicable:

- Since there is an exemption for Group E major occupancies on the 1st and 2nd floors of a Group D major occupancy EMTC building, the storeys containing Group E major occupancies are permitted to be constructed in accordance with the construction requirements for the Group D major occupancy in which it is located, as such:
  - The maximum building area is 7200 m^2, and
  - On all floor levels, structural mass timber elements are permitted to be fully exposed, provided mass timber walls and ceilings within public corridors, exits and vertical service spaces are protected on the interior side with an encapsulation material having a minimum 25-minute encapsulation rating (Sentence 3.1.6.4.(8)).

5.2 | Fire Resistance Ratings for EMTC

Various building features that incorporate EMTC may be required to have a fire-resistance rating. Floors, mezzanines, and loadbearing construction features that are required to have a fire-resistance rating are discussed in Section 5.1 of the guide. The fire-resistance rating of exterior walls is discussed in Section 5.5 of this guide. Interior, non-loadbearing partitions may be required to have a fire-resistance rating for various reasons (public corridors, exits, service rooms, etc.).

Fire-resistance rating is defined as:

- *the time in minutes or hours that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived from that test and performance as prescribed in the Code.*

Did you know...

Although the standard fire exposure condition in CAN/ULC-S146 follows the standard time-temperature curve given in CAN/ULC-S101, the transmission of heat (i.e., temperature rise) criteria across the two test methods differ significantly:

In CAN/ULC-S146, the average temperature rise at the interface between the wood and the encapsulation material is limited to 250°C above its initial temperature (measurement taken inside the assembly); whereas in CAN/ULC-S101 test, the average temperature rise is limited to 140°C at the unexposed surface of the test specimen (measurement taken outside the assembly).

Similarly, In CAN/ULC-S146, the maximum temperature rise at any individual point measured at the interface between the wood and the encapsulation material is limited to 270°C above its initial temperature; whereas in CAN/ULC-S101 test, this temperature rise limit is 180°C at any individual point on the unexposed face of the test specimen.

The differences are due to the different functions of a fire resistance rating and encapsulation rating.

In general, for the purposes of the Code, the rating of a building element, such as a building material, assembly of materials, and a structural member, that is required to have a fire-resistance rating is determined in one of the following ways:

- The fire-resistance rating is determined on the basis of the results of tests conducted in conformance with CAN/ULC-S101, “Fire Endurance Tests for Building Construction and Materials”, per Sentence 3.1.7.1.(1).
  - The fire-resistance rating of mass timber elements subjected to the CAN/ULC-S101 test conditions is assigned based on the time at which one of the following five events occurs first:
    - An average temperature rise of 140°C above its initial temperature is recorded on the unexposed surface of the test specimen,
    - A maximum temperature rise of 180°C above its initial temperature is measured by any individual temperature probe on the unexposed surface of the test specimen,
    - There is a passage of flame through the unexposed side of the test specimen,
    - There is a passage of gases hot enough to ignite cotton pads through the unexposed side of the test specimen, or
    - Where the test specimen is loadbearing (e.g., beams and columns), the applied load is no longer sustained; or
- The fire-resistance rating may be assigned based on Supplementary Standard SB-2, “Fire Performance Ratings”, per Sentence 3.1.7.1.(2).

Mass timber can provide a degree of fire resistance, whether encapsulated or not, due to its inherent low surface area-to-volume ratio and the highly predictable charring characteristics of wood.

The encapsulation material may contribute to both the encapsulation rating and the required fire-resistance rating of an assembly. For instance, where two layers of 12.7 mm Type X gypsum board are affixed to a mass timber element, as per Sentence 3.1.6.6.(3), to provide a 50-minute encapsulation rating, these layers can be considered in the determination of the fire-resistance rating when they are installed in accordance with a listed assembly that has been tested to CAN/ULC-S101 or considered in the application of Supplementary Standard SB-2. For example, according to Clause B.8.1. of CSA O86, where two layers of 12.7 mm Type X gypsum board are affixed to exposed surfaces of cross-laminated mass timber elements, the assigned fire-resistance duration can be increased by one hour when the joints are taped and finished as per B.8.3. of CSA O86.

However, if exposed surfaces of structural mass timber elements are provided, as permitted under Article 3.1.6.4. (see Section 5.3 for more detail), the fire-resistance rating, where required, for the element must be based on the mass timber element alone. The encapsulation material cannot be considered as it is not continuous over the entire element.

The designer should be aware of the implications of "losing" the added value of fire resistance from encapsulation and confirm that the EMTC achieves the required fire resistance based on its own performance under fire exposure. As mentioned earlier, mass timber tends to have a high level of fire resistance due to the charring nature of wood. Research has demonstrated that most mass timber products char at an approximate rate of 0.65 mm/min when exposed to the standard fire exposure of CAN/ULC-S101. When a char layer is formed, its insulating effect tends to limit external heat from penetrating further into the timber element.

As such, a sacrificial depth of wood is typically used as a means of achieving the required fire resistance. This sacrificial layer of wood is exposed to fire and undergoes charring, while the uncharred portions of the timber element remain relatively uncompromised. This concept is illustrated schematically in Figure 5 for a cross-section of a beam after a fire exposure. Employing this approach means that where encapsulation is not provided, the thickness of a mass timber element will likely need to be larger compared to that of a timber element protected by means of encapsulation.

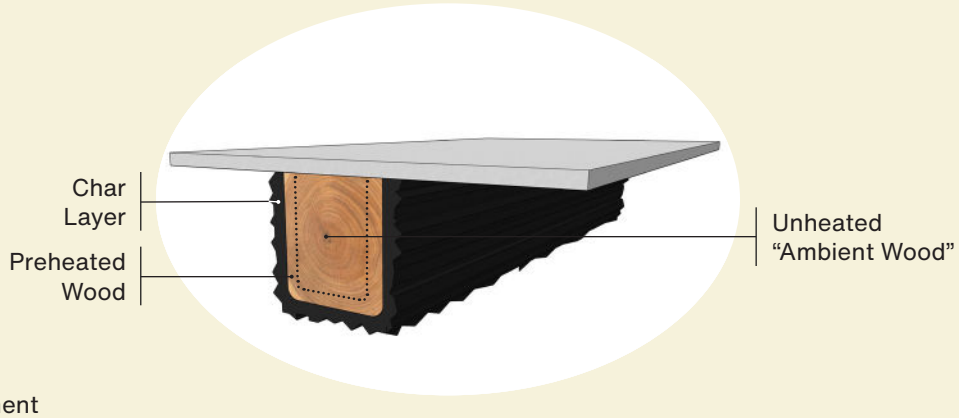


Figure 5
Mass timber element after fire exposure

In lieu of determining the fire-resistance rating of exposed structural mass timber elements on the basis of CAN/ULC-S101 test results, the fire-resistance rating for these timber elements can be based on calculation methods presented in Section 2.11, “Mass Timber Elements” of Supplementary Standard SB-2, “Fire Performance Ratings”. These calculation methods are:

- Method A, which includes calculation formulae based on timber element geometry and load factor, and
- Method B, which is based on the calculation method described in Annex B, Fire resistance of large-cross section wood elements, of CSA O86, “Engineering Design in Wood” and subject to the conditions in Subsection 2.11.4. of SB-2.

The applicable calculation method for a mass timber element depends on the mass timber product. Table 6 highlights which method is appropriate to use based on the mass timber product:

Table 6

Calculation methods for mass timber elements

Fire Rated Mass Timber Element	Mass Timber Product	Applicable Calculation Method
Beams and Columns	Glue-Laminated Timber	Method A described in Subsection 2.11.3., or Method B described in Subsection 2.11.4.
	Solid Sawn Timber	Method B described in Subsection 2.11.4.
	Structural Composite Lumber	Method B described in Subsection 2.11.4.
Wall, Floor and Roof Assemblies	Cross-Laminated Timber	Method B described in Subsection 2.11.4.

Note that Method A and Method B must be applied independently. Currently, the OBC references the 2019 edition of CSA O86.

Additionally, Section 2.4, “Solid Wood Walls, Floors and Roofs” of SB-2 can be used to determine the fire-resistance rating of nail laminated timber, where the features match the configurations described within the supplementary standard.

5.3 | Encapsulation of Mass Timber Elements and Exposed Surfaces

In general, exposed surfaces of structural mass timber elements such as beams, columns, arches, walls, and floors are required to be protected from adjacent spaces in the building[4] by a material, or assembly of materials, having a minimum encapsulation rating, as discussed in Section 4.3 and Section 5.1 of this guide.

However, in some cases, requirements for protection of exposed mass timber elements may be waived, subject to various combinations of area and flame-spread rating limitations, as described in Sentences 3.1.6.4.(3) to (9). Permissions for exposed mass timber elements are summarized in this section.

5.3.1 | Mass Timber Beams, Columns, and Arches

In a building permitted to have an encapsulation rating of 50 minutes, portions of mass timber beams, columns, and arches are permitted to be exposed within a suite or fire compartment when all the following conditions are met, per Sentences 3.1.6.4.(3) and (5):

- The total area of the exposed surfaces does not exceed 35% of the total wall area of the perimeter of the suite or fire compartment,
- All exposed surfaces have a flame-spread rating of not more than 150, and
- The total combined (i.e., aggregate) area of exposed surfaces for mass timber beams, columns, arches, and walls (where permitted within a suite; see Section 5.3.2 of this guide) is not more than 35% of the total wall area of the perimeter of the suite.

These conditions are illustrated in Figure 6, Figure 7 and Figure 8 in Section 5.3.3.

The total area of the exposed mass timber beams, columns and arches is reduced to not more than 20% of the total wall area of the perimeter of the suite, when more than 25% of mass timber ceiling surfaces are exposed (see Section 5.3.3 of this guide).

5.3.2 | Mass Timber Walls

In a building permitted to have an encapsulation rating of 50 minutes, portions of mass timber walls are permitted to be exposed within a suite when all the following conditions are met, per Sentences 3.1.6.4.(4) and (5):

- All exposed wall surfaces either face the same direction, or are separated by a distance of at least 4.5 m,
- All exposed surfaces have a flame-spread rating of not more than 150, and
- The total combined (i.e., aggregate) area of exposed surfaces for mass timber walls, and beams, columns, and arches (see Section 5.3.1 of this guide), is not more than 35% of the total wall area of the perimeter of the suite.

These conditions are illustrated in Figure 6, Figure 7 and Figure 8 in Section 5.3.3.

The flame-spread rating for the exposed mass timber wall surfaces is reduced from 150 as noted above to not more than 75 when exposed mass timber ceiling surfaces make up more than 10% of the suite ceiling area (see Section 5.3.3 of this guide).

4 These adjacent spaces include concealed spaces (for exceptions, see Section 5.4 of this guide).

5.3.3 | Mass Timber Ceilings

In a building permitted to have an encapsulation rating of 50 minutes, the conditions that apply to exposed portions of mass timber ceilings within a suite differ depending on the amount of the ceiling that is proposed to be exposed. These conditions are described as in Sentences 3.1.6.4.(6) and (7):

(Option A – see Figure 6) If up to 10% of the mass timber ceiling is exposed, the suite or fire compartment is subject to the following conditions:

- The total area of the exposed ceiling surfaces does not exceed 10% of the total ceiling area of the suite or fire compartment, and
- All exposed ceiling surfaces have a flame-spread rating of not more than 150.
- There are no additional restrictions on the exposed surfaces for mass timber walls, and beams, columns, and arches, because of the exposed ceiling element.

or

(Option B – see Figure 7) If up to 25% of the mass timber ceiling is exposed, the suite or fire compartment is subject to the following conditions:

- The total area of the exposed ceiling surfaces is limited to 25% of the total ceiling area of the suite or fire compartment,
- All exposed ceiling surfaces have a flame-spread rating of not more than 75, and
- In addition to the restrictions that were previously noted, all exposed mass timber walls are to have a flame-spread rating of not more than 75.

or

(Option C – see Figure 8) If up to 100% of the mass timber ceiling is exposed, the suite is subject to the following conditions (note that Option C applies only to suites, and not all fire compartments):

- The total area of the exposed ceiling surfaces is permitted up to 100% of the total ceiling area of the suite,
- All exposed ceiling surfaces have a flame-spread rating of not more than 75, and
- The permissions for exposed mass timber beams, columns and arches and walls are restricted as follows:
  - The total area of exposed mass timber beams, columns and arches is limited to 20% of the wall area of the perimeter of the suite.
  - All mass timber walls are to be fully encapsulated with protection achieving an encapsulation rating of at least 50 minutes or, where mass timber walls are exposed according to the percentages noted previously, the encapsulation rating on the remaining protected wall elements is to be increased to at least 80 minutes.
  - All exposed mass timber wall surfaces are to have a flame-spread rating of not more than 75.

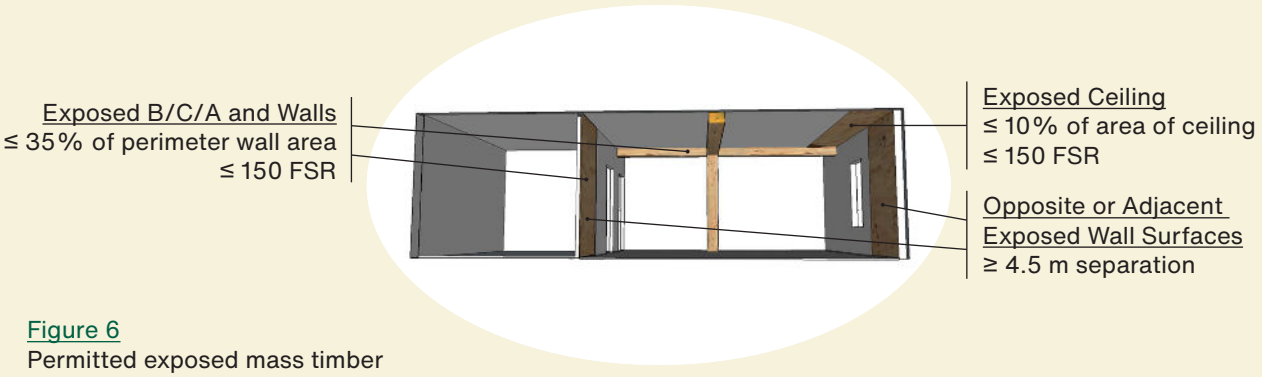


Figure 6
Permitted exposed mass timber within a suite – Option A

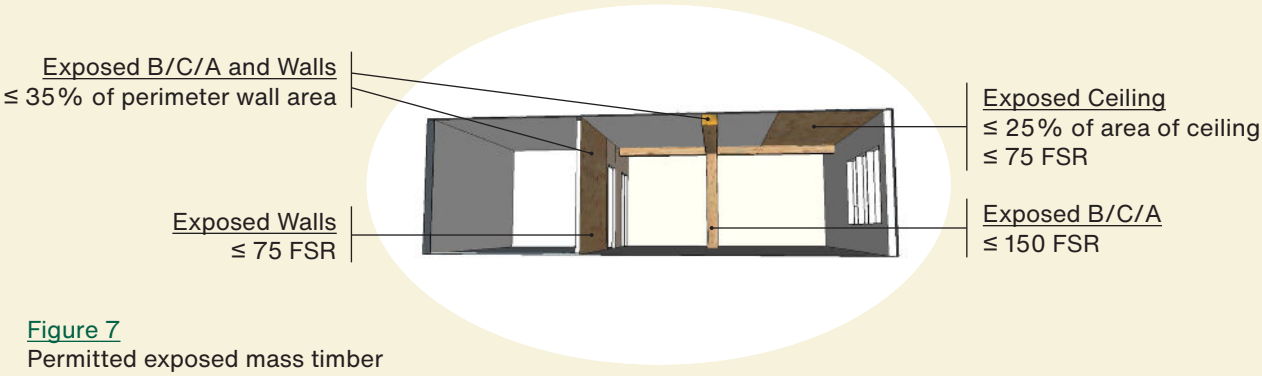


Figure 7
Permitted exposed mass timber within a suite – Option B

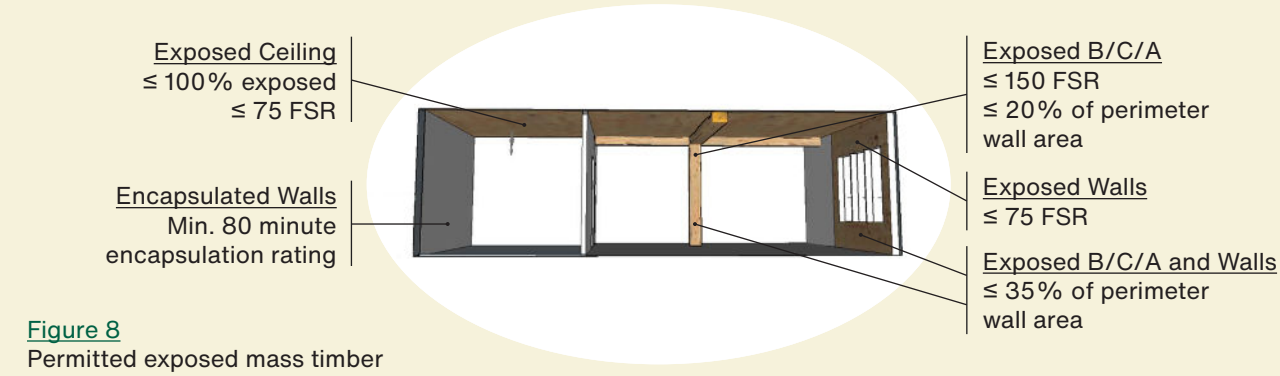


Figure 8
Permitted exposed mass timber within a suite – Option C

5.3.4 | Mass Timber Floors

The upper side of a mass timber floor assembly is typically required to be encapsulated with a material or assembly having an encapsulation rating that complies with Articles 3.2.2.47., 3.2.2.58. or 3.2.2.93., as applicable.

Where the encapsulation rating of a building or part thereof is required to be 70 minutes, the encapsulation rating for the upper side of the mass timber floor assembly is permitted to be 50 minutes as per Sentence 3.1.6.4.(9).

5.3.5 | Mass Timber Roofs

If there is a concealed space above a mass timber roof element (e.g., horizontal service space as permitted by Article 3.1.6.7.), its upper side is typically required to be encapsulated with a material or assembly having an encapsulation rating that complies with Articles 3.2.2.47., 3.2.2.58. or 3.2.2.93., as applicable.

Where the encapsulation rating of a building or part thereof is required to be 70 minutes, the encapsulation rating for the upper side of the mass timber roof assembly is permitted to be 50 minutes as per Sentence 3.1.6.4.(9).

5.3.6 | Mass Timber Exterior Walls

The exterior side of a mass timber exterior wall assembly need not be protected in conformance with Sentence 3.1.6.4.(1). However, the provisions of Article 3.1.6.9. and Subsection 3.2.3. for exterior walls still need to be considered (see Section 5.5).

5.3.7 | Permission for No Encapsulation

As noted at the beginning of Section 5.3, the root requirement is that all structural mass timber elements are required to be encapsulated.

In buildings permitted to have a 0-minute encapsulation rating, there is a greater opportunity for exposed mass timber elements. In this case, most of the structural mass timber elements are permitted to be unprotected (i.e., fully exposed), as per Sentence 3.1.6.4.(8), provided that:

- Mass timber walls and ceilings within vertical service spaces, public corridors and exits are protected on the interior side with a material or assembly having an encapsulation rating of at least 25 minutes, and
- Concealed spaces are protected in conformance with Sentence 3.1.6.3.(4) (see details in Section 5.4).

This 25-minute protective layer reduces the likelihood of fire spread between storeys via the vertical service shaft as a result of the exposed mass timber and increases the performance of public corridors and exits to facilitate occupant egress.

5.3.8 | Summary

The requirements and limitations regarding the maximum area of structural mass timber elements that are permitted to be exposed (i.e., not encapsulated) are summarized in Table 7 below:

Table 7

Permitted area of exposed mass timber elements

Exposed Mass Timber Element	Maximum Aggregate Surface Area (% of total perimeter wall area)	Maximum Flame-Spread Rating	Other Requirements
Walls	35[1]	150	» Exposed walls to face the same direction or ≥ 4.5 m horizontal distance between exposed walls » Flame-spread rating to be min. 75 when exposed ceiling area is >10% of total ceiling area
Beams, Columns and Arches (B/C/A)	35[1][2]	150	» Exposed B/C/A limited to 20% of area of perimeter walls, when exposed ceiling area is >25% of total ceiling area
Exposed Mass Timber Element	**Maximum Surface Area (% of total ceiling area)**	**Maximum Flame Spread Ratings**	**Other Requirements**
Ceilings	10[2]	150	N/A
	25[2]	75[3]	N/A
	100	75[3]	» Exposed B/C/A limited to 20% of area of perimeter walls, and » Increased wall encapsulation requirements

[1] Where simultaneously permitted, aggregate exposed surface area of walls and beams, columns and arches combined are not permitted to exceed 35% of the perimeter wall area of the suite.

[2] Also applies to fire compartments as well as suites.

[3] Applies to exposed wall and ceiling surfaces, not beams, columns or arches.

5.4 | Concealed Spaces

Structural mass timber elements in encapsulated mass timber construction are required to *"...be arranged in heavy solid masses containing no concealed spaces,"* per Clause 3.1.6.3.(2)(a).

However, concealed spaces are inherent in building construction, whether that be an EMTC building or a noncombustible or combustible building. Concealed spaces may simply be a part of the building construction or may serve a specific purpose such as facilitating installation of building services.

Section 4.3 of this guide describes the base requirement for surfaces of the mass timber elements, including mass timber that surrounds a concealed space, to be protected by materials providing an encapsulation rating in accordance with Sentence 3.1.6.4.(1). In buildings permitted to have an encapsulation rating of 0 minutes, unless otherwise exempt, exposed materials are limited to construction materials and components permitted in noncombustible construction.

The Code recognizes that providing an encapsulation rating on all sides of concealed spaces may be challenging, but also acknowledges that concealed spaces bound by combustible surfaces may allow for fire growth and spread since both oxygen and fuel are present in a concealed space. Unprotected concealed spaces may also contribute to the fire spread extending beyond the point of fire origin, serving as a channel for fire and its products of combustion to spread through a building. Considering that fires within concealed spaces may not be detected by the fire alarm system and may be difficult to extinguish, it is important to limit the probability of fire spread within concealed spaces in encapsulated mass timber construction.

The Code provides exemptions for encapsulation of concealed spaces if certain conditions that limit the potential for fire spread are satisfied:

For Concealed Spaces Created by Attachment of Encapsulation Materials

In general, encapsulation materials can be directly attached to mass timber elements; however, in some instances where the encapsulation materials are not directly attached to the mass timber (e.g., installed on resilient metal channels to improve acoustic performance), exposed surfaces are permitted per Sentence 3.1.6.16.(2)., provided the concealed space is not more than 25 mm deep as shown schematically in Figure 9.

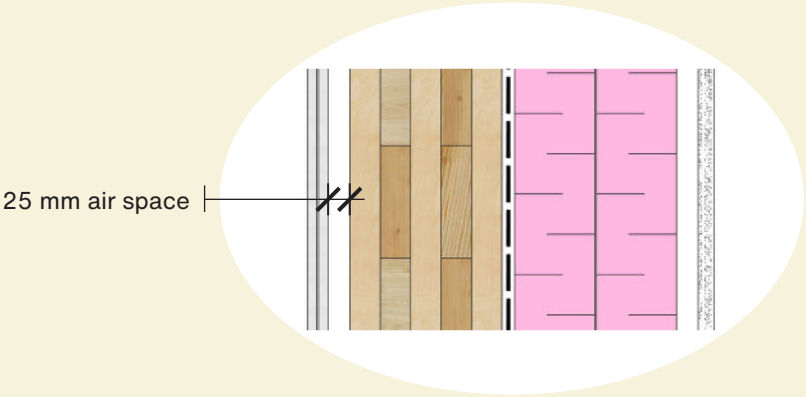


Figure 9
Concealed space created by encapsulation materials

For Other Concealed Spaces

Sentence 3.1.6.3.(4) also permits concealed spaces within structural mass timber elements, without requiring the prescribed encapsulation rating, if one of the following four conditions is satisfied:

Exception (a):

Where concealed spaces are (i) sprinklered and (ii) divided into compartments by fire blocks conforming to Subsection 3.1.11., such as gypsum board and sheet steel (see Article 3.1.11.7.).

Exception (b):

Where concealed spaces are completely filled with minimum 32 kg/m^3 dense rock or slag fibre insulation conforming to CAN/ULC-S702.1, “Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification”.

Exception (c):

Where a concealed space is horizontal and lined with:

- At least a single layer of 12.7 mm thick Type X gypsum board, or
- Noncombustible material having a minimum 25-minute encapsulation rating.

Exception (d):

Where a concealed space is vertical and:

(i) Lined with:

- At least a single layer of 12.7 mm thick Type X gypsum board, or
- Noncombustible material having a minimum 25-minute encapsulation rating, and

(ii) divided into compartments by fire blocks conforming to Subsection 3.1.11., such as gypsum board and sheet steel (see Article 3.1.11.7.).

Visual representation of these exceptions, (a) through (d), is illustrated in Figure 10.

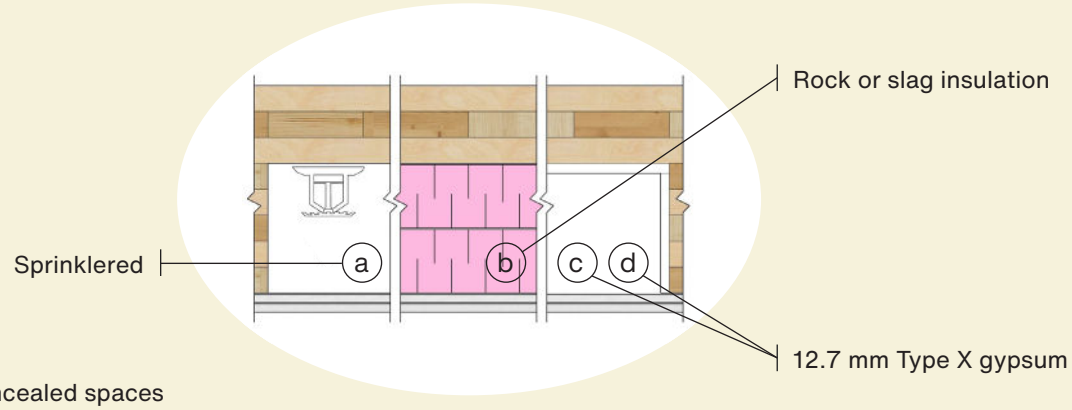


Figure 10
Protection of concealed spaces in EMTC buildings

Where concealed spaces are present, Article 3.1.6.16. identifies permitted exposed mass timber construction materials and components in concealed spaces, which are the same as those typically permitted in noncombustible construction.

Additional provisions related to fire blocking are discussed in Section 7.4 of this guide.

5.5 | Exterior Wall Assemblies

This Section highlights the requirements for construction of exterior wall assemblies forming part of an EMTC building. The base requirement is that an EMTC building is required to be of either encapsulated mass timber construction or noncombustible construction (see Section 5.1 of the guide). This type of construction applies to the construction materials for an exterior wall assembly – structure, insulation, sheathing, air and vapour barriers, exterior cladding, interior finish, etc.

However, combustible materials can be used where they are permitted and the associated Code provisions are satisfied. Combustible cladding is permitted on the exterior walls of EMTC buildings in Article 3.1.6.9., and combustible components such as insulation, sheathing, studs, specialty attachments, etc. are addressed in Article 3.1.6.10.

Although provisions outlined in Subsection 3.1.6. are applicable to an EMTC building, Subsection 3.2.3. Spatial Separation and Exposure Protection needs to be consulted to determine if there are limitations on the use of combustible cladding or components in exterior walls due to the building's location relative to property lines or adjacent buildings.

Generally, the closer a building is to a property line or an adjacent building, the more restrictive the permission for combustible cladding and components. Buildings that are very close to a property line are not permitted to have combustible construction or cladding.

Sections 5.5.1 to 5.5.6 of this guide provide additional information on exterior cladding and combustible components in exterior walls of EMTC buildings.

5.5.1 | Exterior Cladding – Article 3.1.6.9.

Article 3.1.6.9. governs exterior cladding on an exterior wall assembly of an EMTC building. The root requirement in Sentence 3.1.6.9.(1) is that cladding on an EMTC building is required to be noncombustible or meet the permissions that would apply to cladding in a noncombustible building. These permissions recognize two additional fire tests that can be applied subject to specified acceptance criteria to permit additional construction materials, namely CAN/ULC-S135 "Test Method for the Determination of Combustibility Parameters of Building Materials Using an Oxygen Consumption Calorimeter" as an alternative material test or CAN/ULC-S134, "Fire Test of Exterior Wall Assemblies" for combustible cladding. Sentence 3.1.6.9.(1) recognizes that any combination of the above noted materials satisfies the requirements for noncombustible construction.

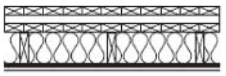
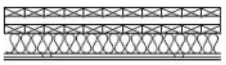
An exterior wall assembly constructed in conformance with Section 6 of Supplementary Standard SB-2 "Fire Performance Ratings" is deemed to comply with CAN/ULC-S134. This option is provided in Sentence 3.1.6.9.(6). Table D-6.1.1. is reproduced in Table 8.

Note: While the assemblies in Table D-6.1.1. are deemed to comply with CAN/ULC-S134 and demonstrate sufficient performance related to fire spread, not all assemblies are appropriate for all building types and sizes from an environmental separation perspective. See Section 10 of this guide for more information.

Table 8

Table D-6.1.1. from Supplementary Standard SB-2

Construction Specifications for Exterior Wall Assemblies that are Deemed to Satisfy the Criteria of Clause 3.1.5.5.(1)(b) when Tested in Accordance with CAN/ULC-S134

Wall Number	Structural Members	Absorptive Material	Sheathing	Cladding	Design
EXTW-1	38 mm x 89 mm wood studs spaced at 400 mm o.c.	89 mm thick rock or slag fibre in cavities formed by studs	–	12.7 mm thick fire-retardant-treated plywood siding	
EXTW-2	38 mm x 140 mm wood studs spaced at 400 mm o.c.	140 mm thick rock or slag fibre in cavities formed by studs	Gypsum sheathing ≥ 12.7 mm thick	Noncombustible exterior cladding	
EXTW-3	38 mm x 140 mm wood studs spaced at 400 mm o.c.	140 mm thick rock or slag fibre in cavities formed by studs	15.9 mm thick fire-retardant-treated plywood	Noncombustible exterior cladding	
EXTW-4	38 mm x 140 mm wood studs spaced at 600 mm o.c. attached to cross-laminated timber (CLT) wall panels ≥ 38 mm thick	140 mm thick glass, rock or slag fibre in cavities formed by studs	Gypsum sheathing ≥ 12.7 mm thick	Noncombustible exterior cladding	
EXTW-5	89 mm horizontal Z-bars spaced at 600 mm o.c. attached to CLT wall panels ≥ 105 mm thick	89 mm thick rock or slag fibre in cavities formed by Z-bars	–	Noncombustible exterior cladding attached to 19 mm vertical hat channels spaced at 600 mm o.c.	

Additionally, Sentence 3.1.6.9.(2) provides three primary options for combustible cladding applicable only to EMTC buildings not more than 12 storeys in building height, that are permitted to be used on their own, or in combination:

Option 2(a): Narrow, Vertical Combustible Cladding

Combustible exterior cladding –

- is not contiguous over more than 4 storeys,
- represents not more than 10% of the exterior cladding on each storey,
- is not more than 1.2 m wide,
- is separated from other portions of combustible cladding on the same storey by at least 1.2 m,
- is separated from other portions of combustible cladding on adjacent storey by at least 2.4 m, and
- has a surface or cut-through flame-spread rating of 75 or less.

This option is schematically depicted in Figure 11 below.

Figure 11
Combustible exterior cladding arrangement per Option (a) above first storey

Option 2(b): Discrete, Wider Panels of Combustible Cladding

Combustible exterior cladding –

- is not contiguous across adjacent storeys,
- represents not more than 10% of the exterior cladding on each storey,
- is separated from other portions of combustible cladding on adjacent storey by at least 2.4 m, and
- has a surface or cut-through flame-spread rating of 75 or less.

This option is schematically depicted in Figure 12 below.

Figure 12
Combustible exterior cladding arrangement per Option (b) above first storey

Option 2(c): First Storey Combustible Cladding

Combustible exterior cladding –

- represents up to 100% of the exterior cladding on the first storey, and
- all portions of which can be directly accessed and located not more than 15 m from a street or access route.

Option 2(c) is schematically depicted on both Figure 11 and Figure 12 on the first storey assuming that a street or access route is within 15 m from the face of the building.

Clause 3.1.6.9.(2)(d) permits combinations of the above Options 2(a) through 2(c) with the various “noncombustible” options, as illustrated schematically in Figure 13 below to demonstrate some possible arrangements that would satisfy the Code requirements:

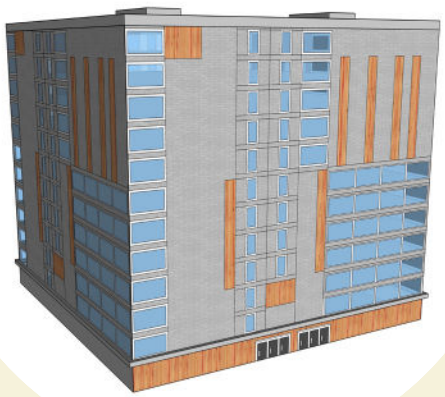


Figure 13
Exterior building face with windows and cladding options

In addition to the above, there are three less restrictive permissions for combustible cladding based on the height of the EMTC building, Option 4(a), 4(b) and 5:

- Buildings not more than 6 storeys in building height:
  - Option 4(a): Combustible cladding is permitted to make up to 10% of the cladding on each exterior wall of each storey provided it has a surface and cut-through flame-spread rating of not more than 75. See Figure 14.
  - Option 4(b): A combination of Option 4(a) and Option 2(c) is permitted.

    While the 10% permission is consistent with the earlier options, the combustible cladding in this case is not subject to the specific dimensional and configuration provisions.

- Buildings not more than 4 storeys in building height:
  - Option 5: Combustible cladding is permitted to make up 100% of the cladding on the building, provided it has a surface and cut-through flame-spread rating of not more than 75.

Figure 14
Exterior building face and cladding arrangement per option 4(a)

There are further conditions related to combustible exterior cladding in Article 3.1.6.9. related to some of the Options above, that reduce the permitted areas:

- Fire Department Response: Where fire department response time exceeds 10 minutes after receipt of fire alarm notification, the area of combustible cladding is restricted to a maximum of 5% of the cladding on each exterior wall of each storey. This restriction impacts the options in Clauses 2(a) or 2(b) under Sentence 3.1.6.9.(2) that otherwise permit a maximum area of 10% combustible cladding on each exterior wall of each storey.
- Combustible Cladding Facing Other Combustible Cladding: Where combustible cladding described in Options 2(a), 2(b) or 4(a) is exposed to another Option 2(a), 2(b) or 4(a) combustible cladding, and the planes of the two exterior walls are parallel or facing each other at an angle of less than 135°, the portions of exterior cladding must:
  - be separated by a horizontal distance of at least 3 m (vs. 2.4 m), and
  - not be contiguous over more than 2 storeys (vs. 4 storeys per Option (a)). See Sentence 3.1.6.9.(9). This condition is illustrated schematically in Figure 15.

These minimum separation distances reduce the probability that fire on the combustible cladding will prematurely ignite the facing combustible cladding.

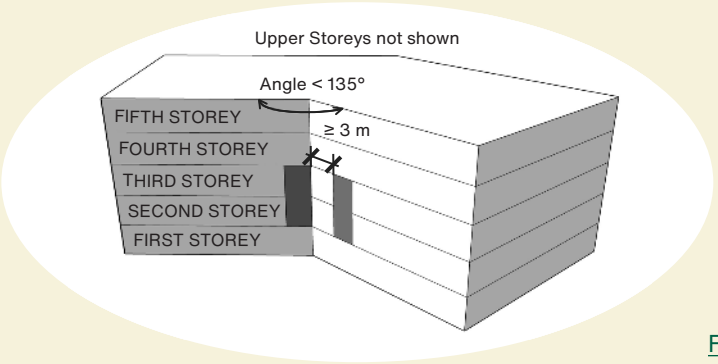


Figure 15
Minimum distance between combustible claddings

Additionally, to ensure long term performance of fire-retardant treated wood cladding, where an exterior wall assembly contains a combustible fire-retardant-treated wood cladding, this cladding needs to be subjected to the accelerated weathering test per ASTM D2898, "Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing", before the wall assembly is tested for fire exposure, per Sentence 3.1.6.9.(8).

The above permissions for combustible cladding do not apply when the exterior wall is permitted not more than 10% unprotected openings under Article 3.2.3.7. for spatial separation, as this proximity to the property line means that the exterior wall requires noncombustible cladding with no permitted exceptions. See Section 5.5.3 of this guide for further discussion.

5.5.2 | Combustible Components in Exterior Walls – Article 3.1.6.10.

The use of combustible components (beyond those permitted in Article 3.1.6.9.) in exterior walls of EMTC buildings is addressed under Article 3.1.6.10. These combustible components include wood framing, combustible insulation, foamed plastic insulation, combustible sheathing, and similar elements. According to Article 3.1.6.10.:

- Combustible components are allowed in an exterior wall of an EMTC building provided the exterior wall assembly:
  - has been tested to CAN/ULC-S134, "Fire Test of Exterior Wall Assemblies" and meets the acceptance criteria of Clause 3.1.5.5.(1)(b), or
  - is constructed per one of the wall assemblies specific in Section 6 of Supplementary Standard SB-2, "Fire Performance Ratings".
- Non-loadbearing wood elements permitted in Article 3.1.5.6. can be used in an exterior wall of an EMTC building and need not conform to the requirements of Article 3.1.6.3. such as the minimum dimensions stated in Table 3.1.6.3. For example, wood studs within exterior wall assemblies tested to CAN/ULC-S134 are permitted in an exterior wall without encapsulation.

5.5.3 | Spatial Separation Requirements

In addition to the permissions in Articles 3.1.6.9. and 3.1.6.10., the requirements of Subsection 3.2.3. also need to be considered, since Code provisions related to spatial separation and exposure protection can further limit the use of combustible materials in exterior wall assemblies of EMTC buildings. In limiting the extent of combustible materials used, the intent is to also limit the probability that these materials will ignite, subsequently contributing to fire growth and spread from the subject building to an adjacent building. A brief introduction to spatial separation requirements and implications on the use of combustible materials in exterior wall assemblies is presented below.

5.5.4 | Unprotected Openings

The use of combustible materials in exterior wall assemblies of EMTC buildings is driven by the maximum permitted area of unprotected openings. The area of unprotected openings is expressed in percent (%) and represents a ratio of aggregate area of unprotected openings to the total area of an exterior wall face. Examples of unprotected openings are a window with plain glazing, a door, or a mechanical intake or exhaust, which is not protected with a closure with a fire-protection rating. Portions of a wall assembly that do not meet the required fire-resistance rating requirements are also considered unprotected openings.

The maximum permitted area of unprotected openings by exterior wall depends on:

- The occupancy for the building and/or fire compartments,
- The area of the exterior wall face or fire compartment(s), and
- The limiting distance for each exterior wall.

This information is used to determine the maximum area of permitted unprotected openings from Tables 3.2.3.1.D. and 3.2.3.1.E. since all EMTC buildings are required to be sprinklered under Articles 3.2.2.48., 3.2.2.57. and 3.2.2.93.

Example 1

Problem: Consider a 10-storey EMTC building containing:

- A Group E (mercantile) occupancy on the 1st and 2nd floor levels, and
- A Group C (residential) occupancy on the 3rd floor level and above,

And having a maximum exterior wall face per fire compartment of 25 m^2 facing one direction, from which:

- A limiting distance of 1.2 m is measured from floor levels containing the Group E occupancy, and
- A limiting distance of 2.5 m is measured from floor levels containing the Group C occupancy.

Find the maximum area of unprotected openings permitted by the fire compartment for this elevation, i.e., each exterior wall.

Solution: The maximum area of unprotected openings permitted in each fire compartment is determined from Tables 3.2.3.1.D. and 3.2.3.1.E. for sprinklered fire compartments of Group C and Group E occupancies, respectively. As such, the maximum area of permitted unprotected openings (%) are:

- 8% for the 1st and 2nd floor levels, and
- 38% for the 3rd to 10th floor levels.

Table 3.2.3.1.D.

Unprotected Opening Limits for a Building or Fire Compartment **that is Sprinklered**

Forming Part of Article 3.2.3.1.

Exposing Building Face	Area of *Unprotected Opening* for Groups A, B, C, D and F, Division 3 *Occupancies*, %											
	Limiting Distance, m											
Maximum Area, m^2	0	1.2	1.5	2	2.5	3	4	5	6	7	8	9
10	0	16	24	42	66	100						
15	0	16	20	34	50	74	100					
20	0	16	20	30	42	60	100					
25	0	16	18	26	38	52	90	100				
30	0	14	18	24	34	46	78	100				
40	0	14	16	22	30	40	64	96	100			
50	0	14	16	20	28	36	56	82	100			
60	0	14	16	20	26	32	50	72	98	100		
80	0	14	16	18	22	28	42	58	80	100		
100	0	14	16	18	22	26	36	50	68	88	100	
150 or more	0	14	14	16	20	22	30	40	52	66	82	100

Table 3.2.3.1.E.

Unprotected Opening Limits for a Building or Fire Compartment **that is Sprinklered**

Forming Part of Article 3.2.3.1.

Exposing Building Face	Area of *Unprotected Opening* for Groups E and F, Division 1 and 2 *Occupancies*, %																	
	Limiting Distance, m																	
Maximum Area, m^2	0	1.2	1.5	2	2.5	3	4	5	6	7	8	9	10	11	12	13	14	15
10	0	8	12	20	34	50	96	100										
15	0	8	10	16	26	36	68	100										
20	0	8	10	14	22	30	54	86	100									
25	0	8	10	14	18	26	44	70	100									
30	0	8	8	12	18	24	40	60	88	100								
40	0	8	8	12	16	20	32	48	68	94	100							
50	0	8	8	10	14	18	28	40	58	76	100							
60	0	8	8	10	12	16	24	36	50	66	86	100						
80	0	8	8	10	12	14	20	30	40	52	66	84	100					
100	0	8	8	8	10	12	18	26	34	44	56	70	84	100				
150	0	8	8	8	10	12	16	20	26	32	40	50	60	72	84	98	100	
200 or more	0	8	8	8	8	10	14	18	22	28	34	42	50	60	68	80	92	100

The maximum % of unprotected openings is then used to determine the construction requirements for the exterior wall assembly, including if the wall itself needs to be entirely noncombustible, and if the cladding is permitted to be combustible. Determination of construction requirements for the exterior wall assembly is shown in Example 2.

5.5.5 | Construction of Exposing Building Face

The maximum area of permitted unprotected openings (%), along with occupancy of the fire compartment, dictates minimum exterior wall construction requirements. There are three components to minimum construction requirements for exterior walls:

- Minimum required fire-resistance rating,
- Type of construction required, and
- Type of cladding required.

These construction requirements are laid out visually in Table 3.2.3.7. and are reproduced in Table 9 below.

Table 9

Minimum construction requirements (from Subsection 3.2.3.) for exposing building faces

Forming part of Sentences 3.1.6.9.(5) and 3.2.3.7.(1) to (4)

Occupancy Classification of *Building* or *Fire Compartment*	Maximum Area of *Unprotected Openings* Permitted, % of *Exposing Building Face* Area	Minimum Required *Fire-Resistance Rating*	Type of Construction Required	Type of Cladding Required
Group A, B, C, D, or Group F, Division 3	0 to 10	1 h	Noncombustible	Noncombustible
	> 10 to 25	1 h	Combustible, Encapsulated Mass Timber Construction, or Noncombustible	Noncombustible
	> 25 to 50	45 min	Combustible, Encapsulated Mass Timber Construction, or Noncombustible	Noncombustible
	> 50 to < 100	45 min	Combustible, Encapsulated Mass Timber Construction, or Noncombustible	Combustible or Noncombustible
Group E, or Group F, Division 1 or 2	0 to 10	2 h	Noncombustible	Noncombustible
	> 10 to 25	2 h	Combustible, Encapsulated Mass Timber Construction, or Noncombustible	Noncombustible
	> 25 to 50	1 h	Combustible, Encapsulated Mass Timber Construction, or Noncombustible	Noncombustible
	> 50 to < 100	1 h	Combustible, Encapsulated Mass Timber Construction, or Noncombustible	Combustible or Noncombustible

Note that if the area of permitted unprotected openings is not restricted (i.e., 100% permitted unprotected openings), then specific construction requirements for the exterior wall face do not apply under Sentences 3.2.3.7.(1) and (5). However, the Code provisions outlined in Articles 3.1.6.9. and 3.1.6.10. will still apply for the use of combustible cladding and combustible components in exterior walls of EMTC buildings. Note (2) to Table 3.2.3.7. reinforces that while combustible cladding is permitted, when the permitted unprotected openings exceed 50%, the conditions for combustible cladding in Article 3.1.6.9. still apply.

5.5.6 | Combustible Cladding in Articles 3.1.6.9. and 3.2.3.7.

There are permissions (with conditions) to use combustible cladding in exterior wall assemblies of EMTC buildings in two key articles in the OBC that are intended to provide an acceptable performance level for vertical fire spread on the building (Article 3.1.6.9.), and fire spread between adjacent buildings (Article 3.2.3.7.). The provisions of one Article cannot be used to contravene the other Article.

Table 10 summarizes the requirements and permissions for exterior cladding on EMTC buildings. If fire compartments contain Group E or Group F, Division 2 occupancies in the EMTC building (where permitted by Subsection 3.2.2.), the cladding permissions will be the same, but the minimum fire-resistance rating of the exterior wall will be different per Table 3.2.3.7.

Table 10

Type of exterior cladding on EMTC buildings per Articles 3.1.6.9. and 3.2.3.7.

Maximum Area of Permitted Unprotected Openings (%)	Type of Cladding[1]	
	Required	Permitted
Not more than 10%	Noncombustible only; no exceptions.	
> 10% up to 25%	Noncombustible	Combustible cladding is only permitted as a part of an exterior wall assembly that meets Article 3.1.5.5. (including the assemblies in Table 8).
> 25% up to 50%	Noncombustible	In addition to the combustible cladding described in the second row, other combustible cladding as permitted by Article 3.1.6.9. can also be used, if at least one of the conditions of Sentence 3.2.3.7.(4) is met.
> 50% up to < 100%	Noncombustible	In addition to the combustible cladding described in the second row, other combustible cladding as permitted by Article 3.1.6.9. can also be used.
100%	No specific Article 3.2.3.7. requirements apply, but the combustible cladding needs to conform to Article 3.1.6.9.	

[1] Where multiple exterior cladding options are available, they can be used singly or in combination.

Example 2

Problem: Consider a 10-storey EMTC building from Example 1. The maximum area of permitted unprotected openings (%) is:

- 8% for the 1st and 2nd floor levels containing Group E (mercantile) occupancy, and
- 38% for the 3rd to 10th floor levels containing Group C (residential) occupancy.

Find the following:

1. What is the type of construction:
   a. required for each wall?
   b. permitted for each wall?
2. What is the minimum required fire-resistance rating of each wall?
3. What is the type of cladding:
   a. required for each wall?
   b. permitted for each wall?

Solution: According to Table 9 and Table 10:

Major Occupancy Classification		Group E	Group C
The Maximum Area of Permitted Openings (%)		8%	38%
1. Type of Wall Construction	(a) Required	Noncombustible, as Permitted Area of Unprotected Openings < 10%	Encapsulated Mass Timber or Noncombustible, per Article 3.2.2.48.
	(b) Permitted	No exceptions, must be noncombustible	
2. Minimum Required Fire-Resistance Rating		2 hours, as Permitted Area of Unprotected Openings < 10%	45 minutes, since Permitted Area of Unprotected Openings > 25% up to 50%
3. Type of Cladding	(a) Required	Noncombustible, as Permitted Area of Unprotected Openings < 10%	Noncombustible, per Sentence 3.1.6.9.(1).
	(b) Permitted	No exceptions, must be noncombustible	Since Permitted Area of Unprotected Openings > 25% up to 50%: Combustible cladding permitted, provided the exterior wall assembly meets the requirements of Sentence 3.1.5.5.(1) when tested to CAN/ULC-S134. OR Combustible cladding per one option or a combination of options under Sentence 3.1.6.9.(2) is permitted, as shown in Table 8.

6 Other Combustible Materials in Encapsulated Mass Timber Construction

Subsection 3.1.6. contains several permissions to use combustible materials in EMTC buildings. These permissions align with the explicit permissions and conditions for combustible materials that are permitted in buildings that are required to be of noncombustible construction.

Since the new Subsection 3.1.6. is similar to Subsection 3.1.5., this section of the guide compares the two subsections to show how combustible material permissions in EMTC and noncombustible construction are similar, and where they differ.

Did you know...

The permissions for combustible features in EMTC buildings follow the structure of the permissions for buildings of noncombustible construction. The following Table provides a quick reference for parallel Articles in the 2024 OBC.

Combustible Feature	EMTC Article	Noncombustible Article
Roofing	3.1.6.7.	3.1.5.3.
Window Sashes and Frames	3.1.6.8.	3.1.5.4.
Nailing Elements	3.1.6.11.	3.1.5.8.
Flooring	3.1.6.12.	3.1.5.10.
Stairs	3.1.6.13.	3.1.5.11.
Interior Finishes	3.1.6.14.	3.1.5.12.
Partitions	3.1.6.15.	3.1.5.16.

Subsections 3.1.4., 3.1.5. and 3.1.6. contain permissions for construction materials in buildings of combustible construction, noncombustible construction, and encapsulated mass timber construction and explicitly state the additional combustible elements and prescriptive requirements applicable in buildings based on type of construction. These subsections include provisions to address the protection of various components and assemblies. New provisions in Subsection 3.1.6. include specific requirements related to EMTC buildings designed under Article 3.2.2.48., Article 3.2.2.57. or Article 3.2.2.93.

Unless modified by other provisions within Part 3, materials used in buildings permitted to be of EMTC are required to conform to the requirements of Subsection 3.1.5. for noncombustible construction. The following sections of the guide describe how the requirements for EMTC buildings differ from the requirements for noncombustible buildings.

6.1 | Roofing

Buildings required to be of noncombustible construction are permitted to have combustible roof coverings provided they have an A, B or C classification determined in conformance with CAN/ULC-S107, “Fire Tests of Roof Coverings”. An EMTC building may only have combustible roofing provided it has a Class A classification.

Combustible roof sheathing and supports are permitted on any building of noncombustible construction provided the sheathing and supports are installed above a concrete deck conforming to the specifications of Clauses 3.1.5.3.(2)(a) to (f), which prescribe requirements for the concrete deck thickness, roof space height and fire blocking, opening protection, parapets, and restrictions on building services.

EMTC buildings are permitted to have wood roof sheathing installed above a deck of EMTC where:

- The EMTC deck is encapsulated with a material that has an encapsulation rating of not less than 50 minutes.
- The roof space above the EMTC deck has similar restrictions to a roof space in a noncombustible building: the height of the roof space is not more than 1,000 mm, the roof space is divided into compartments, and the roof space is not permitted to contain building services other than noncombustible roof drains and plumbing piping.
- For a building of noncombustible construction, openings in the deck which require protection are to be protected with masonry or concrete shafts which act as fire separations with a minimum 1-hour fire-resistance rating that extend 150 mm above the sheathing. For an EMTC building, shafts at openings requiring protection must still be constructed as a fire separation with a minimum 1-hour fire-resistance rating and still extend 150 mm above the sheathing, but the shaft is not restricted to masonry or concrete. Shafts can be constructed of EMTC.
- For a building of noncombustible construction, a noncombustible parapet around the perimeter of the roof is required to extend at least 150 mm above the adjacent combustible sheathing. There is no requirement for a parapet around a deck of EMTC.

Other combustible components used in the installation of roofing are permitted in keeping with the requirements for noncombustible buildings.

6.2 | Combustible Window Sashes and Frames (Combustible Glazing)

The provisions for combustible window sashes and frames are similar between buildings of noncombustible construction and EMTC. Where noncombustible walls are required to separate windows from other openings and storeys in noncombustible buildings, buildings permitted to be of EMTC are also permitted to use mass timber wall construction in place of the noncombustible walls, provided the mass timber is not less than 96 mm for 1-sided fire exposure, as noted in Table 3.1.6.3.

The maximum 40% aggregate area of window openings per fire compartment remains the same.

6.3 | Nailing Elements

For a noncombustible building, wood nailing elements are permitted for the purpose of attaching interior finishes, provided a concealed space created by the wood elements is not more than 50 mm deep. For an EMTC building, the same wood nailing elements for the purpose of attaching interior finishes has an additional requirement: Exposed surfaces in the concealed space require a flame-spread rating of not more than 25, or the concealed space must be filled with noncombustible insulation. This permission in both noncombustible and EMTC buildings is specific to wood and does not extend to other combustible materials.

Wood nailing elements are also permitted in an EMTC building for the purpose of attaching encapsulation materials. In this case, the concealed space created by the wood nailing elements is permitted to be not more than 25 mm deep. When the concealed space is not more than 25 mm deep, there are no additional flame spread or insulation requirements.

6.4 | Flooring

Combustible finished flooring is permitted in buildings of noncombustible construction and EMTC.

Where additional wood construction is provided to create a raised platform (greater than 50 mm high) additional requirements apply to limit the size of the concealed spaces within the platform. The wood construction for the raised platform is permitted to be applied directly to the mass timber elements of the floor assembly or set into a noncombustible floor slab. Where the raised floor is attached directly to the mass timber, encapsulation of the mass timber floor assembly is only required to be provided in between the elements of the raised platform (i.e., the wood elements of the raised platform are not required to be encapsulated).

For a noncombustible building and an EMTC building, the height of the raised platform is the same at 300 mm.

The fire blocking requirements for the concealed spaces within a raised platform are also the same in both the noncombustible building and the EMTC building. Fire blocks are to be provided to divide the concealed space within the raised platform into compartments that are not more than 10 m^2.

A raised platform is permitted to include combustible subflooring as well as combustible finished flooring.

6.5 | Stairs

Combustible stairs are typically restricted to use within dwelling units in buildings required to be of noncombustible construction.

EMTC buildings are permitted to have wood stairs in dwelling units and other suites without encapsulation, per Sentence 3.1.6.13.(2). This means that an office suite which spans two storeys could have a set of convenience stairs which are made of wood and are not required to meet any specific requirements for the purpose of mitigating damage to the structural wood elements. Where wood stairs attach to edges of mass timber floor slabs, the edges of the floor slab must still meet the encapsulation requirements.

EMTC buildings are also permitted to have wood stairs and landings in exit stairwells provided that the wood stairs and landings have a minimum thickness of 96 mm and the wood elements are encapsulated with a material that provides the encapsulation rating required by the construction requirements.

In a building permitted to have a 0-minute encapsulation, wood stairs and landings in an exit stairwell are permitted to be exposed, provided the walls, ceiling and underside of the stairs and landings within the exit enclosure are protected with an encapsulation rating of at least 25 minutes, per Sentence 3.1.6.4.(8).

6.6 | Interior Finishes

Sentences 3.1.6.4.(3) to (8) describe limits on the amount of the mass timber beams, columns, arches, walls and ceilings that can remain exposed, as discussed in Section 5.3 of this guide. The permissions associated with other combustible interior finishes in Article 3.1.6.14. are independent of the permissions to have some of the structural mass timber elements exposed.

In general, combustible interior wall and ceiling finishes including fabric, paint, plastic, veneer, or wallpaper that are not more than 1 mm thick are permitted in both noncombustible and EMTC buildings.

Similarly, combustible interior wall finishes, other than foamed plastic, not more than 25 mm thick are permitted in both noncombustible and EMTC buildings, provided the interior wall finishes have a flame-spread rating of not more than 150 when exposed.

The requirements for combustible interior ceiling finishes, other than foamed plastic, are the same for both noncombustible and EMTC buildings. The ceiling finishes are limited to 25 mm in thickness and are required to have a flame-spread rating of not more than 25 when exposed, except that not more than 10% of the ceiling area is permitted to have a flame-spread rating of not more than 150. This permission is independent of the area permissions for exposed mass timber ceilings described in Sentence 3.1.6.4.(6) to (8).

6.7 | Partitions

Solid lumber partitions not less than 38 mm thick and partitions containing wood framing are permitted in a noncombustible, sprinklered building equivalent to most major occupancies permitted to be an EMTC building provided the partitions are not installed in a retirement home, Group B, Division 3 occupancy or as enclosures for exits or vertical service spaces or as vertical fire separations constructed to achieve the continuity of the floor fire separation. For a noncombustible building there are no specific requirements for protective membranes.

In EMTC buildings, these types of partitions are also not permitted to be installed in exits or vertical service spaces and there is an additional requirement for membrane protection, which includes the following options:

- A single layer of 12.7 mm thick Type X gypsum board, with all joints either backed or taped and filled, conforming to ASTM C1396/C1396M, “Standard Specification for Gypsum Board”, or CAN/CSA-A82.27-M, “Gypsum Board”,
- A single layer of 19 mm thick fire-retardant-treated wood, on solid lumber partitions, or
- A single layer of 19 mm thick fire-retardant-treated wood, on partitions containing wood framing, with wood stud cavities filled with noncombustible insulation.

6.8 | Other Combustible Content

As noted at the beginning of this Section, Subsection 3.1.5. describes prescriptive requirements which can be applied to permit the use of specific combustible materials in buildings required to be of noncombustible construction. Sections 7.1 to 7.5 of this guide describe where the requirements for EMTC buildings are different from noncombustible buildings based on the code provisions in Subsection 3.1.6.

Additionally, other combustible components are permitted in EMTC buildings where these features are provided as if they were in a noncombustible building (subject to the provisions of Subsection 3.1.5.) as noted below:

- Combustible skylights and vertical glazing (Article 3.1.5.4.),
- Factory-assembled panels (Article 3.1.5.7.),
- Combustible millwork (Article 3.1.5.9.),
- Gypsum board (Article 3.1.5.13.),
- Combustible insulation (Article 3.1.5.14.),
- Foamed plastic insulation (Article 3.1.5.15.),
- Storage lockers in residential buildings (Article 3.1.5.17.),
- Combustible ducts (Article 3.1.5.18.),
- Combustible piping materials and plumbing fixtures, wires, cables, and nonmetallic raceways (Articles 3.1.5.19. to 3.1.5.23.),
- Decorative wood cladding and marquees (Article 3.1.5.24. and Article 3.1.5.29.),
- Small mezzanines (Article 3.1.5.27.), and
- Combustible solar collector systems (Article 3.1.5.28.).

7 Additional Code Provisions Impacted by EMTC

In addition to the combustible materials listed in Section 6 of this guide, there are other Code provisions that change in an EMTC building. The following section describes provisions that are modified in buildings of EMTC designed under Article 3.2.2.48., Article 3.2.2.57. or Article 3.2.2.93.

7.1 | Outlet Boxes

In general, outlet boxes are permitted to be installed in assemblies that are required to have a fire-resistance rating without adversely impacting the assembly's rating where the outlet boxes are either sealed with a fire stop system that maintains the fire-resistance rating or, in the case of vertical fire separations, the outlet boxes are limited in size and number to reduce the impact of fire exposure, as documented in Subsection 3.1.9.

Similarly, the minimum dimensions of structural mass timber elements are not required to be maintained at localized cutouts for outlet boxes, where the outlet boxes are sealed with a fire stop or meet dimensional requirements in Article 3.1.9.3., as per Article 3.1.6.17. The exposed surfaces of the cutouts are also not required to comply with the typical encapsulation requirements. Outlet cutouts on opposite sides of a structural mass timber element having a fire-resistance rating are required to be separated by a distance of at least 600 mm. This new article addresses the continuity of the EMTC and not the fire-resistance rating of the assembly.

Subsection 3.1.9. still applies to address the continuity of the fire separation at penetrations.

7.2 | Fire Stopping

Fire stopping systems are used to fill penetrations in fire separations, as per Subsection 3.1.9. The requirements for fire stopping do not change in an EMTC building; however, the products used and/or installation methods for a particular fire stop system may vary from other types of construction. There is a growing library of fire stop systems that have been tested for use in conjunction with EMTC.

7.3 | Fire Blocking

Fire blocking is a material or system that is installed to mitigate fire spread within a concealed space or from the concealed space to an adjacent space by dividing the space into smaller compartments. Fire blocks in concealed spaces are required to be provided as per Subsection 3.1.11.

Prior to the adoption of EMTC as a new construction type, the requirements for fire blocks between nailing and supporting elements were specific to buildings required to be of noncombustible construction. Two new fire blocking provisions were added so that the fire blocking requirements that applied to buildings of noncombustible construction would also apply in EMTC buildings:

- Where a concealed space has an exposed ceiling with a flame-spread rating of more than 25, fire blocks are required to ensure the maximum area of the concealed space is not more than 2 m^2; and
- Where concealed spaces are created by wood members in raised platforms, fire blocks are required so that the maximum area of the concealed space is not more than 10 m^2.

Like concealed spaces created by combustible construction in mid-rise wood buildings, concealed spaces within floors or ceilings composed of EMTC are required to be separated into compartments with the following dimensions:

- Maximum area of 600 m^2 with no dimension more than 60 m if the exposed construction materials within the space have a maximum flame-spread rating of not more than 25.
- Maximum area of 300 m^2 with no dimension more than 20 m if the exposed construction materials within the space have a flame spread rating of more than 25.

The above fire blocking requirements do not apply if the concealed space is filled with noncombustible insulation (e.g., mineral wool) such that any air gap between the insulation and the underside of the floor or roof deck is a maximum of 50 mm. These requirements also do not apply to crawl spaces that conform to Article 3.1.11.6.

7.4 | Flame-Spread Rating

The flame-spread ratings described in Subsection 3.1.13. apply in an EMTC building in addition to the flame-spread requirements in Subsection 3.1.6.

Exit finishes in an EMTC building have additional requirements. Exit interior wall and ceiling finishes, as well as any surface in an exit that could be exposed by cutting through the material, are required to have a flame-spread rating of 25. This additional requirement does not apply to doors, structural mass timber elements, heavy timber construction, and fire-retardant treated wood.

This requirement is consistent with the requirements for the flame-spread ratings for noncombustible buildings, except that the EMTC provision also includes an exception for structural mass timber elements.

7.5 | Plenums

Concealed spaces being used as a plenum within the floor or roof of any building are not required to conform to the requirements of Combustible Ducts (Article 3.1.5.18.) or Duct Materials (Article 3.6.5.1.) when the materials either have a specified flame-spread rating or meet the specific exemptions in Article 3.6.4.3. Various pneumatic control tubing, optical fibre cables, electrical wires and cables, and totally enclosed non-metallic raceways are exempt from the flame-spread requirements.

In particular, totally enclosed nonmetallic raceways with an FT6 rating are exempt from the flame-spread rating and smoke development classification requirements in both noncombustible and EMTC buildings.

8 What Does Not Change With Encapsulated Mass Timber Construction

For EMTC buildings, the designer is to undertake an analysis of all the traditionally required fire and life safety features of a building. An EMTC building may require a fire alarm system, standpipe system, etc. depending on the design of the building. This section includes key provisions of the OBC that do not change with the expanded opportunities for encapsulated mass timber construction.

- Fire Department Access: Each building is required to be served by a Fire Department (FD) access route, which can be a street, highway, road, boulevard, square, or other improved thoroughfare. Additional conditions for FD access routes are listed in Article 3.2.5.6. The conditions are independent of the construction type.
- Fire Alarm: Buildings are required to have a fire alarm system based on factors listed in Article 3.2.4.1. Since all EMTC buildings are required to be sprinklered, they will be required to be provided with a fire alarm system as per Sentence 3.2.4.1.(1).
- Sprinkler Protection: Sprinkler systems are to be provided for all EMTC buildings based on the construction requirements of Articles 3.2.2.48., 3.2.2.57., and 3.2.2.93. of the OBC. The sprinkler system is to be designed, installed, tested, and commissioned in accordance with NFPA 13 and Articles 3.2.5.12. to 3.2.5.15. Adequate water is required to be provided to serve the sprinkler system plus allowances for hoses.
- Standpipe Systems: Buildings more than 3 storeys or 14 m high measured between grade and the ceiling of the top storey are required to be provided with a standpipe system.
- Emergency Power: All buildings have basic emergency power requirements for emergency lighting, exit signs (where required) and the fire alarm system (where required).
- High Building: While the design of high building features does not change for an EMTC building, the classification as a high building will change for some major occupancies permitted to be constructed of EMTC. Similar to the existing restriction for all Group B and C major occupancies, if the floor level of the highest storey of a Group A, D, E, and F EMTC building is more than 18 m above grade, the building is considered a high building. High buildings must satisfy the additional requirements for high buildings listed in Subsection 3.2.6., which include fire and life safety features that are intended to limit the potential for smoke movement between floors, to protect exits for evacuating occupants and for responding firefighters, and to provide additional protection for the integrity of building systems.
- Exiting: The number, design, and location of required exits are based on the provisions of Subsection 3.4.2. As noted in Section 6.5 of this guide, wood stairs and landings are permitted in exits where these features meet specific requirements.

9 OBC Part 4 Structural Design

9.1 | Introduction

This section highlights key provisions of the OBC that apply to the structural design of buildings of encapsulated mass timber construction. While these provisions were already in the Code prior to July 1, 2022 (with two exceptions), special considerations for structural design for EMTC buildings are identified in this section.

An EMTC building over 3 storeys in building height or more than 600 m^2 in building area, or containing a Group A assembly major occupancy, will require design and general review by an architect and professional engineer (see Division C Subsection 1.2.2.), which would include a structural engineer.

9.2 | Wood as a Structural Material

The OBC does not dictate the types of materials for specific building structures, beyond the requirement to either be noncombustible, or the permissions to be EMTC or combustible. As such, the OBC essentially provides the designer with the freedom to select and utilize the material(s) of their choice, subject to the physical properties and limitations inherent to that material.

The OBC generally permits the use of wood as a structural material. The application and use of wood as a structural material in the Code starts with Division A, Subsection 1.3.3., which dictates what parts of the OBC apply based on the size and occupancy of a building.

As discussed in Section 4.5.1. of this guide, mass timber elements may be used in buildings permitted to be of combustible construction without encapsulation, including buildings falling under Part 9 of the OBC, given that they have adequate fire-resistance rating as required. However, Part 9 structural provisions focus on lightweight wood framing, and only provide for limited applications of glulam as floor beams or lintels. Most mass timber elements will fall outside of the scope of Part 9 and are governed by Part 4 Structural Design.

In general, Part 4 of the Code does not contain restrictions on the use of wood or timber structures, except for limitations for specific seismic force restricting systems (e.g., wood in structural features to resist forces generated by earthquakes); see further discussion in the next section.

9.3 | Design of Encapsulated Mass Timber Structures

Part 4 of the Code provides a framework of procedures and requirements for determining the minimum structural loads and design standards to be applied so that buildings and their structural members have sufficient structural capacity and structural integrity to safely and effectively resist all loads and effects. Parameters to be considered include structural strength, serviceability, and reliability.

The minimum loads specified in the Code are primarily based on the use and occupancy of the building, as well as the building's geographic location and exposure (e.g., climatic and seismic influences). The use and occupancy structural loads in Part 4 are not based on the type of structural materials to be used, so are as equally applicable to wood buildings as they are to concrete or steel buildings.

However, the design of any structure will be governed by the applicable design standard appropriate to the structural material(s). Section 4.3 of the OBC identifies design standards for wood, masonry, concrete, steel, aluminum and glass. CSA-O86 "Engineering design in wood" is the design basis for buildings and structural members made of wood.

Part 4 does not prohibit wood as a structural material; however, there are limitations when wood elements are included as part of the seismic force resisting system (SFRS). The SFRS is the part of the structural system that is designed to provide the required resistance to earthquake forces and effects (Article 4.1.8.9.). The July 1, 2022 changes to the OBC include the addition of cross-laminated timber (CLT) shear walls into Table 4.1.8.9. for SFRS factors (reproduced below in Table 11).

Table 11

Table 4.1.8.9. of the Code on SFRS factors

SFRS Ductility-Related Force Modification Factors, R_d, Overstrength-Related Force Modification Factors, R_o, and General Restrictions

Forming Part of Sentences 4.1.8.9.(1) and (5), 4.1.8.10.(5) and (6), 4.1.8.11.(12), 4.8.1.15.(9) and 4.1.8.20.(8)

			Restrictions			
			Seismic Category			
Type of SFRS	R_d	R_o	SC1	SC2	SC3	SC4
Timber Structures Designed and Detailed According to CSA O86						
Shear Walls						
Nailed shear walls: wood-based panel	3.0	1.7	NL	NL	30	20
Shear walls: wood-based and gypsum panels in combination	2.0	1.7	NL	NL	20	20
Moderately ductile cross-laminated timber shear walls: platform-type construction	2.0	1.5	30	30	30	20
Limited ductility cross-laminated timber shear walls: platform-type construction	1.0	1.3	30	30	30	20
Braced or moment-resisting frames with ductile connections						
Moderately ductile	2.0	1.5	NL	NL	20	20
Limited ductility	1.5	1.5	NL	NL	15	15
Other wood- or gypsum-based SFRS(s) not listed above	1.0	1.0	15	15	NP	NP

Under the Code the SFRS can be designed using CLT, but the SFRS is subject to height restrictions that vary based on design parameters such as the geographic seismic zone in which the building is located, the importance category of the building and the type of SFRS utilized per Table 4.1.8.9. Height restrictions exist for the other common structural materials (i.e., steel, concrete, and masonry), again based on design parameters such as the geographic seismic zone in which the building is located, the importance category of the building and the level of ductility in the utilized SFRS.

There are additional seismic design restrictions applicable to EMTC buildings with more than 4 storeys of continuous wood construction, and that use cross-laminated timber shear walls, braced frames or moment-resisting frames. These requirements can be found in Sentences 4.1.8.10.(5) and (6), 4.1.8.11.(12), and 4.1.8.12.(12).

9.4 | Design of Mass Timber Products

The CSA O86 “Engineering design in wood” Standard provides criteria for the structural design and evaluation of structures or structural elements made from wood or wood products, which include sawn lumber, glued-laminated timber, cross-laminated timber, structural composite lumber, nail laminated decking, and structural connections. The 2019 edition of CSA O86 is the applicable (i.e., mandatory) edition; however, the 2024 edition of CSA O86 has been issued with updates and errata and can be applied if the performance level is not reduced relative to the 2019 edition, and with the agreement of the local authority having jurisdiction.

Structural mass timber elements designed in accordance with the requirements of CSA O86 are permitted in EMTC buildings. The standard prescribes the design calculations and requirements for various wood products. The standard also permits proprietary structural wood products that can demonstrate compliance with CSA O86 requirements via testing. Further, cross-laminated timber is to be fabricated within the manufacturing requirements for dimensions and tolerances, performance, test methods, quality assurance, and markings according to ANSI/APA PRG 320, “Standard for Performance-Rated Cross-Laminated Timber”.

Notably, the adhesives used in cross-laminated timber are required to conform to the elevated temperature performance requirements in ANSI/APA PRG 320, per Sentence 3.1.6.3.(3). It is important to note that the 2018 edition of PRG 320 is applicable per Table 1.3.1.2. since the performance requirements for adhesives have changed from previous editions of the PRG 320.

10 OBC Part 5 Environmental Separation

10.1 | Introduction

This Section highlights key provisions of the OBC that are required to be applied to the design of environmental separations in buildings of encapsulated mass timber construction. While these provisions were all in the Code prior to July 1, 2022, special considerations for design of environmental separations in EMTC buildings are identified in this Section.

An EMTC building over 3 storeys in building height or more than 600 m^2 in building area, or containing a Group A assembly major occupancy, will require design and general review by an architect and professional engineer (see Division C Subsection 1.2.2.), so design of environmental separations in typical EMTC buildings (i.e., more than 3 storeys) is expected to be undertaken by an architect and/or a building envelope engineer.

10.2 | Use of EMTC in Environmental Separations

Part 5 “Environmental Separation” of the OBC applies to all buildings except those within the scope of Part 9 or the scope of the National Farm Building Code of Canada. Under this context, Part 5 applies to building elements (e.g., walls, floors, roofs, windows, doors) that separate dissimilar environments. This environmental separation includes both the separation between indoors (i.e., conditioned space) and outdoors (including the ground), as well as between interior spaces that have significantly different environments (e.g., between an indoor pool and classroom space).

In general, Part 5 deals with the control of heat, air and moisture, where moisture includes the control of vapour, precipitation, surface water and ground water. Part 5 of the Code generally does not restrict the use of wood (or other materials) provided that the materials or assemblies fulfill the prescriptive requirements for their intended function within the building envelope (i.e., control of heat, air, and/or moisture), and that any of the applicable reference standards are satisfied.

The ability of a material or assembly to achieve the required performance related to the transfer of heat, air and moisture must be determined based on sound engineering principles and practices.

The Part 5 requirements have not been modified by the July 1, 2022 or January 1, 2025 amendments to the Code. However, a designer may not be able to use the same methods and approaches for EMTC buildings as are applied to noncombustible buildings, or shorter buildings of combustible construction. Careful design and analysis will be required to meet Part 5 requirements of the Code, in particular, for resistance to deterioration.

10.3 | Resistance to Deterioration

Building components and assemblies that separate dissimilar environments, or in assemblies that are exposed to the exterior, are required to be compatible with adjoining materials, and resilient to any mechanisms of deterioration that may be reasonably expected.

Article 5.1.4.2. indicates that the potential for mechanisms of deterioration is to be considered based on the nature and function of the materials, the exposure of the materials, and the climatic conditions in which the materials will be installed. In the case of EMTC buildings, engineered timber is subject to wood deterioration.

Wood deterioration is caused by biological, physical and chemical decay. Biological agents can cause wood deterioration prior to and during its processing or when it is in service as part of a building. In buildings, fungi and wood-boring insects can attack the wood. The pattern or character of attack is often the only evidence of the identity of the organism and fungus attack.

Factors that can be controlled to limit the deterioration of wood are:

- Moisture,
- Sunlight (UV rays),
- Heat/cold cycles including freeze/thaw cycles and differential movement,
- Chemicals including electrochemical action and oxidation,
- Abrasion by windblown materials, and
- Biological agents.

All wood contains a certain amount of moisture; air-dried wood may contain as much as 18 percent, although it is generally considered that wood in this condition is immune to fungal attack. About 35 to 50 percent moisture is required for wood-rotting fungi to flourish. Fungal spores do not germinate readily on wood that has a moisture content below the fibre saturation point, commonly reached at around 25 to 30 percent moisture content.

Potential development of fungi on wood structures used as part of an EMTC building will largely be controlled by the moisture content; all wood-decaying fungi require moderate amounts of water for growth. Best practices for design and construction should encompass measures to ensure a rise in moisture content can be avoided.

Concise detailing of junctions, connections, and interfaces to ensure these features meet acoustic, fire and durability requirements during construction and operation is critical in EMTC buildings. Design should explore measures beyond compliance with building regulations to address the risks to long-term durability of mass timber buildings.

10.4 | Design for Durability

Sentence 5.1.4.2.(3) requires that the design and construction of assemblies separating dissimilar environments and assemblies exposed to the exterior is to be in accordance with good practice, such as the practices described in CSA S478-19, “Guideline on Durability in Buildings”. Design for durability should consider the intended service life for materials and components, as well as the ease of access to materials for inspection, maintenance, repair, and replacement.

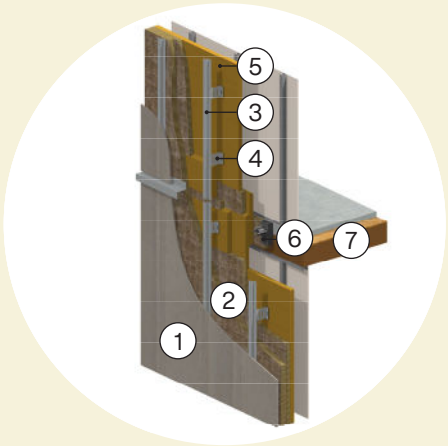
Given the potential mechanisms for deterioration of wood, the design and construction of EMTC buildings should avoid sources of bulk water ingress either from the interior of the building or exterior of the building, or in combination for:

- Integrated structures (e.g., façade and building envelope interface with a floor or roof slab), and
- Areas of EMTC that require special protection, such as façade and/or occupied roof decks where design for air and moisture barriers also includes the elimination of concealed spaces.

Best practice building envelope design for other structural systems also applies to buildings of EMTC. Additionally, in order to maintain the durability of structural wood elements, it is imperative that enclosure assemblies are detailed to avoid prolonged and/or undetected exposure to moisture both during construction and during occupancy. A few design considerations include:

- Airtightness is of high importance, as air leakage through enclosures can carry moisture. As such, attention to detailing for a high level of airtightness will reduce the amount of moisture that wood elements may be exposed to, especially at joints between structural panels that may form gaps with timber shrinkage.
- Enclosure assemblies should be designed to allow moisture to dry outwards or inwards, on either side of the vapour control layer. If panelized mass timber elements are included in the exterior wall assembly, special care is required as mass timber panels are not typically vapour permeable. In this case, the assembly should be designed to reduce the risk of condensation with the use of vapour permeable thermal insulation and membrane products, potentially making use of a "vapour-smart" membrane, depending on the location within the assembly. For colder climates, the thickness of the exterior insulation must be increased to avoid condensation accumulation at timber panels within the wall assembly.
- Attention should be given to slab-edge locations where wood end-grains may be exposed to moisture with increased risk of wood fibre saturation, especially in concealed or inaccessible areas. Care should be taken in the detailing of control layers, connections and penetration to reduce the risk of water accumulation at these locations.

Figure 16 shows an example of an enclosure assembly with panelized mass timber elements.



1. Cladding
2. Mineral Fibre Insulation
3. Vertical Rail
4. Cladding Attachment Brackets
5. Engineered Timber Panel
6. Integrated Façade Connector
7. Engineered Timber Floor with or without Concrete Topping

Figure 16
EMTC façade assembly

11 OBC Part 12 Resource Conservation and Environmental Integrity

11.1 | Introduction

This Section highlights the requirements relevant to OBC Part 12 and Supplementary Standard SB-10 of Part 12 of the OBC, in addition to the adoption of the Toronto Green Standard applicable for only the City of Toronto. While these provisions were all in the Code prior to July 1, 2022, special considerations for energy efficiency in EMTC buildings are identified in this Section for context in applying the OBC.

An EMTC building over 3 storeys in building height or more than 600 m^2 in building area, or containing a Group A assembly major occupancy, will require design and general review by an architect and professional engineer (see Division C Subsection 1.2.2.), so analysis of building elements and systems contributing to energy efficiency in typical EMTC buildings (i.e., more than 3 storeys) is expected to be undertaken by an architect and/or a professional engineer.

11.2 | Energy Efficiency Design

Part 12 of the Ontario Building Code is titled *"Resource Conservation and Environmental Integrity"* and applies to any construction for which a permit has been applied. This Part of the Code references specific Divisions and Chapters of MMA Supplementary Standard SB-10 "Energy Efficiency Requirements", which also lists requirements relating to energy efficiency. SB-10 Division 3, Chapter 2 modifies ASHRAE 90.1-2013 (including amendments issued to June 26, 2015), Chapter 5 to suit Ontario's requirements. ASHRAE 90.1-2013, Chapter 5, Building Envelope, contains the requirements for envelope compliance including the mandatory provisions. Section 5.6 and Appendix C describe the method for trading between building elements.

On the path towards zero carbon emissions in cold climates, the implications of building envelope performance are hard to ignore, as the traditional trade-off of efficiencies from the mechanical, electrical, and plumbing (MEP) systems can no longer account for poor envelope performance. Instead, the full potential of an integrated mass timber building system can be realized to create both embodied and operational carbon reductions.

As offsite-prefabricated systems, EMTC buildings have an inherent level of construction precision that is a compelling reason for furthering strategic integration of the building's structure, building envelope, and facade with low carbon energy systems. Greenhouse gas emissions in the form of carbon dioxide equivalents (CO_2e) are regulated by SB-10. Buildings which comply at a minimum with the prescriptive requirements of SB-10 will generally meet these requirements.

Exterior wall assemblies commonly consist of secondary structural elements of wood, steel, or concrete which bear on a slab edge and create a thermal bridge where the more conductive slab material protrudes through the assembly. High-performance detailing at slab edge bypasses utilizing mass timber panels or wood elements may provide a more thermally resistant envelope system with reduced thermal bridging.

In addition, the area of the vertical building envelope includes the area of walls below grade surrounding conditioned spaces. EMTC buildings generally have reduced foundation requirements due to the reduced weight of the above grade building. Therefore, there is also an opportunity for proportionally reduced building envelope area of below grade assemblies and an improvement of the overall effective building envelope performance.

EMTC buildings constructed under Articles 3.2.2.48., 3.2.2.57. or 3.2.2.93. will be subject to glazing limitations in Part 12 and SB-10 and ASHRAE 90.1. However, the amount of glazing may be increased by using higher performance glazing provided the product of the Area and U value in the design building is less than that of the code compliant building. ASHRAE requires the use of energy modelling software to determine the trade-off values. The above noted building envelope and façade improvements could provide the opportunity for increased glazing area within the prescriptive and ASHRAE 90.1 energy modelling trade-off requirements.

While there are no new provisions related specifically to EMTC for energy efficient designs, the use of EMTC provides designers with opportunities to explore new designs.

12 Practicing Fire Safety During Construction

12.1 | Ontario Requirements

Buildings which are undergoing new construction face an increased risk of fire relative to a fully constructed and occupied building. While a new building is being constructed it experiences ignition sources and fuel loads that would not be expected in an occupied building. In addition, fire suppression and detection systems are not typically active, building sites are less secure, and Fire Departments may have trouble accessing the site in a timely manner.

In Ontario, neither the OBC nor the Ontario Fire Code (OFC) have jurisdiction for fire safety of buildings undergoing new construction. There are currently no prescribed requirements for construction fire safety related to EMTC buildings. Despite this, the Fire Protection and Prevention Act grants fire departments the authority to issue orders requiring mitigation measures if they believe there is an undue risk to fire safety.

Careful consideration should be taken by the contractor to mitigate fire risk during the course of construction in the interest of life safety as well as property protection. Mitigating measures may include preparing a construction fire safety plan, preparing a hot works plan, and hiring additional security to monitor the site for trespassers as well as performing routine fire watches.

Section 3.11 of the “Ontario’s Tall Wood Building Reference” includes considerations for Fire Safety During Construction.

12.2 | National Fire Code Considerations

Unlike the OBC and OFC, the 2020 National Fire Code (NFC) has requirements for Construction and Demolition Sites which can be referenced for additional guidance. There are additional considerations for Group C and Group D major occupancies (including EMTC buildings), which include additional provisions related to smoking, site identification, disposal of combustible refuse, water supply, hydrant access, construction access, and site security. There are also specific provisions for EMTC buildings.

Key considerations include:

- Mitigation of Fire Spread to Adjacent Buildings: Construction sites are to include measures to mitigate fire spread to adjacent buildings. These can include spatial separation requirements, installing water curtains, using gypsum sheathing, or erecting a temporary fire barrier such as a fire tarpaulin.
- Protective Encapsulation: Up to 4 storeys contiguous from the top of the building are permitted to remain unprotected, recognizing the sequencing of construction while providing protection at lower levels. Mass timber features on the lower levels are to be protected with an encapsulation material that achieves a minimum 25-minute encapsulation rating (such as a single layer of 12.7 mm Type X gypsum board), subject to the exposure permissions in Sentence 5.6.4.3.(1) of Division B of the 2020 NFC.

- Fire Safety Planning: A construction fire safety plan, including provisions for fire watch, means for notifying site personnel of a fire which must be capable of being heard throughout the building or facility, and smoking restrictions, among other content, is to be prepared and implemented.
- Fire Department Access: Unobstructed access for firefighters is to be provided to the site (through security fencing), main entrance, fire department connections, fire extinguishers, elevators, standpipes, and at all levels of the building, as applicable.
- Fire Extinguishers: Unobstructed and accessible fire extinguishers are to be provided where hot works operations are active, where combustibles are stored, near/on internal combustion engines, where flammable and combustible liquids or gasses are stored, and near fuel-fired equipment.
- Water Supply and Hydrants: A firefighting water supply is to be provided as soon as combustible or EMTC materials arrive on site. Hydrants are to be clearly marked and unobstructed (2 m of clearance).
- Standpipe System: A standpipe system is to be progressively installed in conformance with the NBC, where floors in the building are occupied. For EMTC buildings, progressive pressure testing of the standpipe system is required for each new level. Additional pressure gauges (depending on whether the system is maintained as dry or wet) are required, as well as signage specific to the type of standpipe system. The standpipe system is to be maintained in operable condition when it is not actively under construction.
- Control of Fire Hazards: Procedures to control fire hazards are to be implemented and include items such as controlling roofing operations and other surface applications that involve heat sources and hot processes, maintaining clearance between combustible material and ignition sources (sources of heat), fastening fabrics and films used to temporarily enclose a building to prevent risk of contact with heaters or other ignition sources, installing fuel supplies to appropriate CSA standards, and storing of dangerous goods and disposing of combustible refuse in accordance with the NFC.
- Containment: Fire separations between construction areas and occupied areas of the building are to be provided.
- Egress: In general, at least one accessible exit is to be maintained at all times for buildings under construction. For EMTC buildings, access to two stairways is required. Minimum stairway features are defined in Article 5.6.3.7. of Division B of the 2020 NFC.

While these requirements may not be enforceable, they provide a reasonable benchmark to control fire hazards associated with both construction activities and combustible content related to exposed mass timber elements.

13 Closing

13.1 | Summary

The Ontario Building Code has been amended to allow for expanded use of encapsulated mass timber construction. This guide presents the changes to the Ontario Building Code, applicable as of January 1, 2025, that permit the use of encapsulated mass timber construction for taller and larger buildings across various major occupancy types. This guide introduces new Code provisions and highlights conventional Code requirements applicable to the design and construction of buildings of encapsulated mass timber construction.

13.2 | Resources and Additional Information

Resources consulted at the time of preparation of this guide, and further information on mass timber and encapsulated mass timber, are presented below:

- Ontario Building Code O. Reg. 163/24 as amended by 447/24
  (http://www.e-laws.gov.on.ca/)
- "Encapsulated Mass Timber Construction: Guidelines for Encapsulation Details and Techniques", by Morrison Hershfield Limited and FPInnovations
  (Encapsulated mass timber construction: Guidelines for encapsulation details and techniques | Research Library | FPInnovations)
- "Technical Guide for the Design and Construction of Tall Wood Buildings in Canada: 2022 – Second Edition" by FPInnovations
  (Technical Guide for the Design and Construction of Tall Wood Buildings in Canada - FPInnovations)
- "Encapsulated Mass Timber Construction up to 12 Storeys," by Architectural Institute of British Columbia and Engineers and Geoscientists British Columbia
  (Joint Professional Practice Guidelines: Encapsulated Mass Timber Construction Up to 12 Storeys Now Available (aibc.ca))
- "Tall Wood Building Demonstration Initiative 2021" by Natural Resources Canada, Canadian Forest Service, and Green Construction through Wood (GCWood) Program
  (Tall Wood Building Demonstration Initiative | Canadian Forest Service Publications | Natural Resources Canada (nrcan.gc.ca))

- "The State of Mass Timber in Canada 2021", by Natural Resources Canada, Canadian Forest Service, and Green Construction through Wood (GCWood) Program
  (The State of Mass Timber in Canada 2021 | Canadian Forest Service Publications | Natural Resources Canada (nrcan.gc.ca))

- "Ontario's Tall Wood Building Reference", by Ontario Ministry of Natural Resources and Forestry and Ontario Ministry of Municipal Affairs
  (ontarios_tall_wood_building_reference.pdf)

- "Bâtiments de construction massive en bois encapsulé d'au plus 12 étages: Directives et guide explicative" by Régie du bâtiment du Québec and FPInnovations
  (Bâtiments de construction massive en bois encapsulé d'au plus 12 étages – Directives et guide explicatif – Version révisée 2022 (gouv.qc.ca))

- "Mass Timber Buildings and the IBC", by American Wood Council and International Code Council
  (MASS TIMBER BUILDINGS AND THE IBC® (iccsafe.org))

An extensive library is available on mass timber as a construction material and on encapsulation techniques for use by designers, contractors, and owners. The providers of this information intend to facilitate the use of mass timber in construction projects and aim for consideration of wood as a sustainable construction material early in the design process. There are many websites, brochures, design guides, and other resources that document the benefits of wood and assist designers in applying the Building Codes for wood and encapsulated mass timber construction. Some examples include:

- WoodWorks at wood-works.ca
  (Wood-Works – Program of the Canadian Wood Council)

- Canadian Wood Council at cwc.ca
  (Home - The Canadian Wood Council - CWC)

- Canadian Wood Council Technical Publications at cwc.ca
  (Technical Publications (Free) Archives - The Canadian Wood Council - CWC)

- American Wood Council at awc.org
  (American Wood Council (awc.org))

- FPInnovations at fpinnovations.ca/publications
  (Publications - FPInnovations)

- Natural Resources Canada at nrcan.gc.ca
  (Forest products and applications (nrcan.gc.ca))

Funders

Ontario

Federal Economic Development Agency for Northern Ontario

Agence fédérale de développement économique pour le Nord de l'Ontario

Natural Resources Canada

Ressources naturelles Canada

WoodWorks Partners

Premier Level:

Boise Cascade® ENGINEERED WOOD PRODUCTS

KALESNIKOFF TIMBER INSPIRES

SIMPSON Strong-Tie®

Western Archrib Structural Wood Systems

Weyerhaeuser

Woodsure

Champion Level:

certainteed SAINT-GOBAIN

StructureCraft

ELEMENT5

HASSLACHER NORICA TIMBER From wood to wonders.

BARRIERTEK

Supporter Level:

AcoustiTECH

TIMBERWOOD INNOVATIONS

Ontario Structural Wood Association