Statewide Alternate Method
No. 15-01

Cross-laminated timber
Seismic force-resisting systems

Building Codes Division
Department of Consumer and Business Services

Statewide Alternate Methods are approved by the division administrator in consultation with the appropriate advisory board. The advisory board's review includes technical and scientific facts of the proposed alternate method. In addition:

- *Building officials shall approve the use of any material, design or method of construction addressed in a statewide alternate method;*
- *The decision to use a statewide alternate method is at the discretion of the applicant; and*
- *Statewide alternate methods do not limit the authority of the building official to consider other proposed alternate methods encompassing the same subject matter.*

Code/edition/section:	2022 Oregon Structural Specialty Code (OSSC)—Section 1613 American Society of Civil Engineers (ASCE) 7-16 or 7-22
Date:	Issued—Jan. 15, 2015 Updated—Feb. 2, 2023
Subject:	Cross-laminated timber (CLT)—Seismic force-resisting system

Background:

Cross-laminated timber (CLT) is a wood product with both residential and nonresidential applications. CLT is defined and recognized as a viable construction material subject to specific construction requirements within Chapters 2, 5, 6, 7, 17 and 23 of the 2022 OSSC. Building Codes Division has prepared this statewide alternate method to recognize CLT shear walls as a seismic force-resisting system (SFRS) for the application of ASCE 7-16 or ASCE 7-22, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, Section 12.2, utilizing prescriptive design procedures.

Structures exceeding the prescriptive design procedures contained in this statewide alternate method will need to follow the performance-based procedures as outlined in OSSC Section 104.10 and ASCE 7-16 Section 1.3.1.3.

Discussion:

Prescriptive design procedures

ASCE 7-16 is the standard referenced in OSSC Section 1613 for the development of seismic design loads and associated criteria for structures. ASCE 7-16 Chapter 12 establishes seismic design coefficients and factors for various types of SFRSs typically used in building construction. These design coefficients and factors for SFRSs, identified in ASCE 7-16 Table 12.2-1, are the Response Modification Coefficient, R, the Overstrength Factor, Ω_o and the Deflection Amplification Factor, C_d.

These seismic design coefficients and factors are not included for CLT shear walls in ASCE 7-16. However, they have been introduced for platform-framed CLT shear walls meeting certain limitations in ASCE 7-22. Two paths are provided in this statewide alternate method for the use of CLT shear walls.

> **Alternate method path 1:** Utilize the "cross-laminated timber shear walls" and "cross-laminated timber shear walls with shear resistance provided by high-aspect ratio panels only" systems in ASCE 7-22 Table 12.2-1. These systems are restricted to platform-framed construction with specific detailing requirements and use a response modification coefficient, R, of 3 or 4, respectively. This path utilizes the seismic chapters of ASCE 7-22 and all of the requirements and limitations therein. However, when using this path, design for dead, live, snow, wind, and other effects would follow ASCE 7-16. The specific chapters of ASCE 7-22 referenced are for seismic design only. (See below for details.)

Alternate method path 2: The use of a platform-framed or balloon-framed moderate ductility CLT shear wall system with less restrictive detailing requirements and a response modification coefficient, R, of 2. It should be noted that a complete FEMA P-695 study has not been performed for the moderate ductility CLT shear wall system. Rather, it is substantiated through a combination of expert opinion and limited analyses (i.e., Chapter 4 Appendix B of the U.S. Edition of the CLT Handbook). The moderate ductility CLT shear wall system has been permitted in the State of Oregon through this statewide alternate method since 2015. The 2022 OSSC update to this statewide alternate method expands the criteria for the design of such a system to (1) align height limits with the platform-framed CLT shear wall system in ASCE 7-22, (2) provide more specific design and detailing requirements for a designated ductile mode, (3) specify CLT stiffness modeling, (4) clarify deformation compatibility requirements for CLT walls not part of the SFRS, and (5) limit notches and holes in moderate ductility CLT shear walls. These changes were motivated by lessons learned from application of the previous version of this statewide alternate method to real building projects in Oregon as well as from on-going seismic research and testing of CLT shear wall systems. (See below for details.)

Performance-based design procedures

Projects that fall outside the prescriptive parameters of this statewide alternate method are not limited by these provisions or the provisions within the OSSC. Reference is made to OSSC Section 104.10 and ASCE 7-16 Section 1.3.1.3 for alternate materials, design and methods. The state building code should not be viewed as a barrier, limitation or preference for any method or material of construction which can meet performance or prescriptive requirements.

Conclusion:

Under application of the OSSC, CLT shear walls may be used as a SFRS in accordance with Alternate method path 1 or Alternate method path 2. Mixing the two alternate design method paths for a given building is not permitted. CLT used in the cross-laminated shear walls designed in accordance with this statewide alternate method shall be manufactured and identified in accordance with ANSI/APA PRG 320-19, *Standard for Performance-Rated Cross-Laminated Timber*, available electronically at https://www.apawood.org/ansi-apa-prg-320.

Alternate method path 1: When this alternate method path is selected, CLT shear walls shall be designed and detailed for seismic effects as “Cross-laminated timber shear walls” or “Cross-laminated timber shear walls with shear resistance provided by high-aspect ratio panels only” in accordance with the requirements and limitations of ASCE 7-22 Chapters 11, 12, 16, 19, 20, 21, 22 and 23 as well as Section 14.5 in lieu of the respective chapters and sections in ASCE 7-16. All other requirements of the 2022 OSSC and ASCE 7-16 shall apply.

Alternate method path 2: When this alternate method path is selected, moderate ductility CLT shear walls shall be used as a SFRS subject to all of the following requirements.

I. Seismic design factors

Moderate ductility CLT shear walls shall be considered a bearing wall SFRS per ASCE 7-16 Section 12.2.1.

ASCE 7-16, Table 12.2-1, *Design Coefficients and Factors for Seismic Force-Resisting Systems*, shall be modified to include the following item no. 19 under *Bearing Wall Systems*:

Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R^a	Overstrength Factor, $\Omega_0{}^b$	Deflection Amplification Factor, $C_d{}^c$	Structural System Limitations Including Structural Height, h_n (ft) Limits^d — Seismic Design Category: B	C	D^e	E^e	F^f
A. BEARING WALL SYSTEMS									
19. Moderate ductility cross-laminated timber shear walls	14.5	2	2½	2	65	65	65	65	65

II. **Designated moderately ductile global mode.** Moderate ductility cross-laminated shear walls designed in accordance with this statewide alternate method shall be designed and detailed to achieve ductility through any of the following global yield modes:

A. Yielding of the hold-downs/straps at the base of balloon-framed moderate ductility CLT shear walls

B. Yielding of the shear connectors at the base of balloon-framed moderate ductility CLT shear walls

C. Yielding of the hold-downs/straps at the base in combination with yielding of the shear connectors at wall panel vertical joints for balloon-framed moderate ductility CLT shear walls

D. Yielding of the hold-downs/straps at horizontal panel joints of platform-framed moderate ductility CLT shear walls

E. Yielding of the shear connectors at horizontal panel joints of platform-framed moderate ductility CLT shear walls

F. Yielding of the hold-downs/straps at horizontal panel joints in combination with yielding of the shear connectors at wall panel vertical joints for platform-framed moderate ductility CLT shear walls

The global yield mode shall be selected independently for each plan direction of the building from the list above and applied to all moderate ductility CLT shear walls in that direction. Where the global yield mode selected designates yielding of hold-downs/straps and/or shear connectors at a given story, all stories at or below that story shall have the hold-downs/straps and/or shear connectors designed and detailed to yield.

Any of the following actions shall be considered acceptable for achieving yielding hold-downs/straps and/or shear connectors per items A through F above:

A. Axial, flexural or shear yielding of steel;

B. Dowel-type connections with fasteners acting in shear controlled by mode III or IV fastener yielding in accordance with Section 12.3.1 of the 2018 National Design Specification (NDS) for Wood Construction;

C. Other actions demonstrated to achieve a deformation ductility not less than 3 when subjected to reverse-cyclic loading in accordance with ASCE 41-17 Section 7.6 and subject to approval by the building official.

III. **Overstrength load combinations in Seismic Design Categories D through F.** For structures assigned to Seismic Design Category D, E or F, all components and elements of the SFRS except those actions which contribute to the ductile mode shall be designed for the overstrength loads of ASCE 7-16 Section 12.4.3 using the lesser of the Overstrength Factor, Ω_0, and the capacity-limited load effect in ASCE 7-16 Section 12.4.3.2. The capacity-limited load effect shall be calculated for the ductile global mode using resistance factors of unity and expected material properties for the actions contributing to the ductile global mode. Expected material properties shall be calculated in accordance with ASCE 41-17 or material standards referenced in the OSSC. The capacity-limited load effect shall not be permitted to be taken less than the demands from the seismic load combinations of OSSC Section 1605.

EXCEPTIONS:

1. Foundation and soil actions need not be designed for the overstrength loads unless required elsewhere in the OSSC or ASCE 7-16.
2. Diaphragms and diaphragm chords need not be designed for the overstrength loads unless required elsewhere in the OSSC or ASCE 7-16.

IV. **Structural modeling.** In addition to the requirements of ASCE 7-16 Section 12.7.3, edgewise bending stiffness of moderate ductility cross-laminated shear walls shall only consider the contribution of the vertical laminations. In-plane shear stiffness shall be determined by any of the following:

A. In accordance with manufacturer testing;

B. In accordance with Equations 17 and 18 of “Shear strength and shear stiffness of CLT-beams loaded in plane” by M. Flaig and H.J. Blaß available for free download at the following URL:

https://www.researchgate.net/publication/346942816_Shear_strength_and_shear_stiffness_of_CLT-beams_loaded_in_plane

C. In accordance with other rational methods substantiated by testing and subject to approval by the building official.

V. **Drift limits.** Moderate ductility cross-laminated shear walls shall comply with the serviceability requirements of OSSC Section 1604.3, and the story drift limits for “All other structures” in ASCE 7-16 Table 12.12-1.

VI. **Deformation compatibility for Seismic Design Categories D through F.** For structures assigned to Seismic Design Category D, E or F, every structural component not included in the SFRS including cross-laminated walls not part of the designated SFRS shall satisfy the requirements of ASCE 7-16 Section 12.12.5 and ANSI/AWC 2021 Special Design Provisions for Wind and Seismic (SDPWS) Section B.2 Item 4.

VII. **Holes, notches or other modifications.** Holes, notches or other modifications to moderate ductility cross-laminated shear walls shall not be permitted unless the effects of removal of material on load-carrying capacity is determined by an approved rational analysis.

The technical and scientific facts for the statewide alternate method are approved.

Signature on file	**Feb. 2, 2023**
Alana Cox, Administrator **Building Codes Division**	**Date**