Lateral Design for Mass Timber Structures: How to Do It, How It's Been Done

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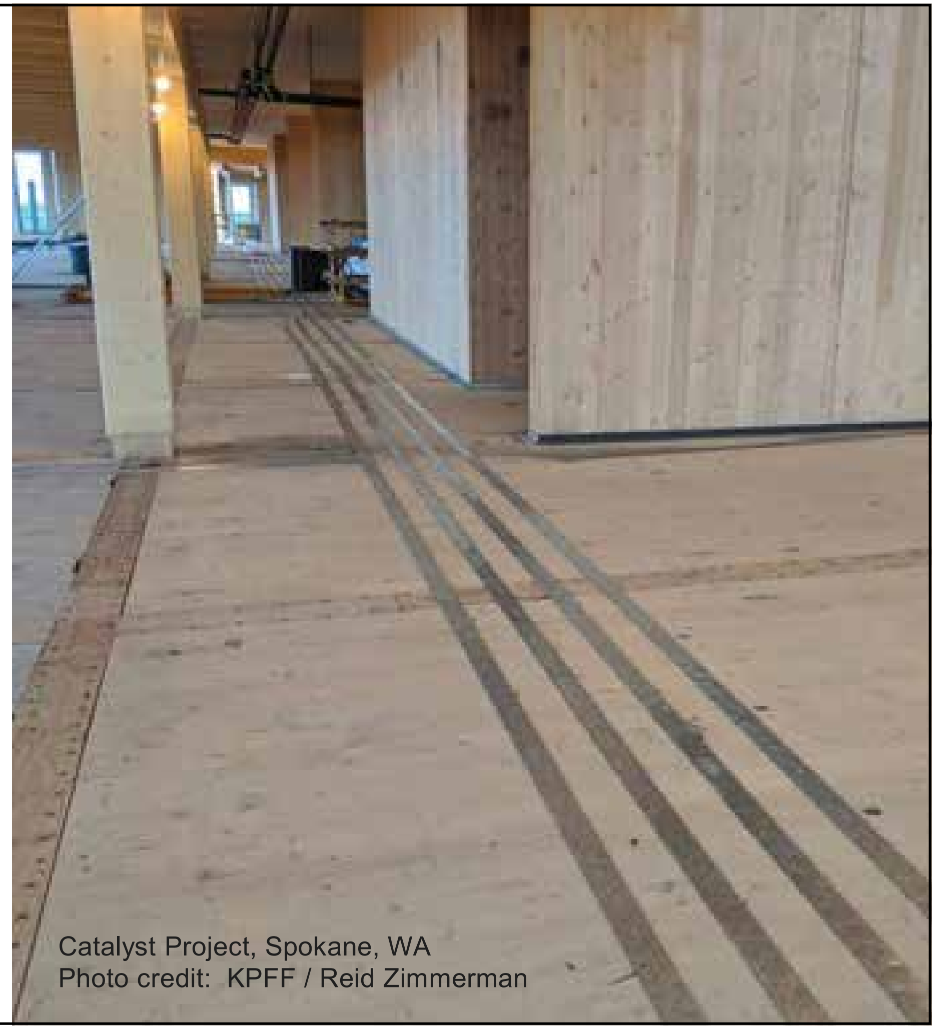

Catalyst Project, Spokane, WA
Photo credit: KPFF / Reid Zimmerman

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

While mass timber floor and roof systems are relatively common, cross-laminated timber (CLT) wall panels—and their use as shearwalls in particular—have been somewhat limited by their lack of recognition in codes and standards—until now. With the American Wood Council's 2021 Special Design Provisions for Wind and Seismic (SDPWS), and two new seismic force-resisting system options in ASCE 7-22, there are now code-recognized methods for designing CLT diaphragms and shear walls to resist wind and seismic loads. This presentation will provide an overview of the standardized lateral systems for CLT, as well as design tools and resources such as the CLT Diaphragm Design Guide, soon to be published by WoodWorks. To demonstrate the range of possibilities, discussion will also include non-standardized lateral systems frequently used in mass timber buildings, such as timber brace frames and balloon-frame CLT shearwall systems. Examples of constructed buildings will be presented to illustrate practical details and lessons learned in the field.

Learning Objectives

1. Develop an understanding of structural design challenges as they pertain to designing CLT for lateral load resistance while meeting the intent of the International Building Code and its referenced standards.

2. Examine common panel-to-panel detailing options for CLT diaphragms and shear walls to understand the impact of detailing on relative strength, stiffness, cost and constructability.

3. Summarize the new design approach for CLT diaphragms and shear walls standardized in AWC's 2021 Special Design Provisions for Wind and Seismic.

4. Describe detailing challenges and solutions for chord and collector conditions in CLT diaphragms.


HUDSON BUILDING
VANCOUVER, WA
DEVELOPER: Killian Pacific and Mackenzie
PHOTO CREDIT: WoodWorks

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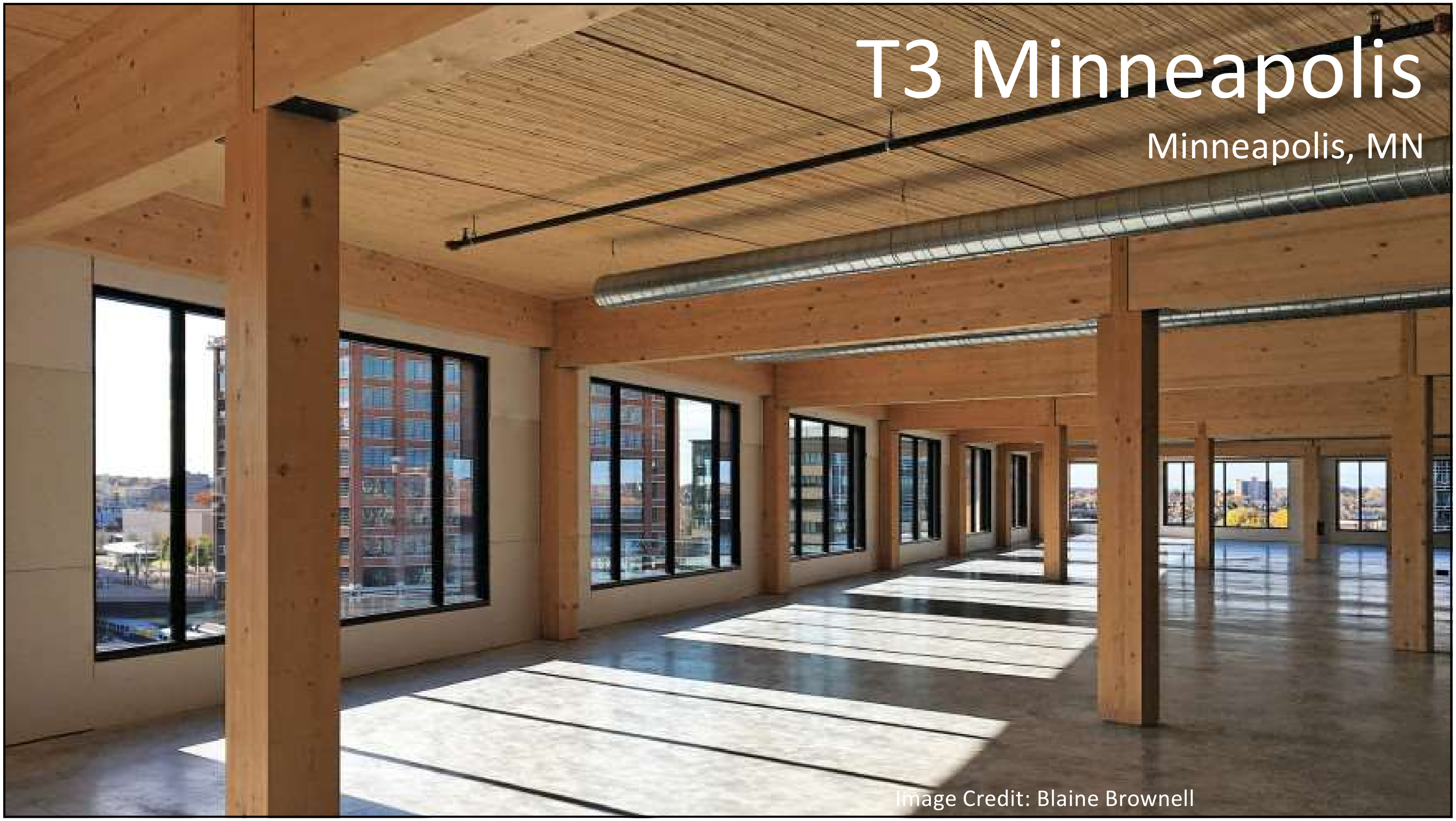
T3 Minneapolis
Minneapolis, MN
Image Credit: Blaine Brownell

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UMass Olver Design Building
Amherst, MA
Photo Credit: Alex Schreyer

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Lateral Systems


Mass Timber Design
Lateral framing systems
Central Core – concrete shearwalls
Photo Credit: structurecraft


Mass Timber Design
Lateral framing systems
Light-frame wood shearwalls
Photo Credit: woodworks

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Mass Timber Design
Lateral framing systems
interior steel moment frame
Photo Credit: woodworks

Mass Timber Design

Lateral framing systems

Exterior steel moment frame

Photo Credit: woodworks

SB [2]14

Code Recognized Vertical Seismic System

Photos: WoodWorks

Slide 13

SB [2]14 new slide since USDA review
Scott Breneman, 6/17/2019

CrossFit Center
Spokane, WA

Photo Credit: WoodWorks

Photo Credit: Mike Bradley, Beacon Builders

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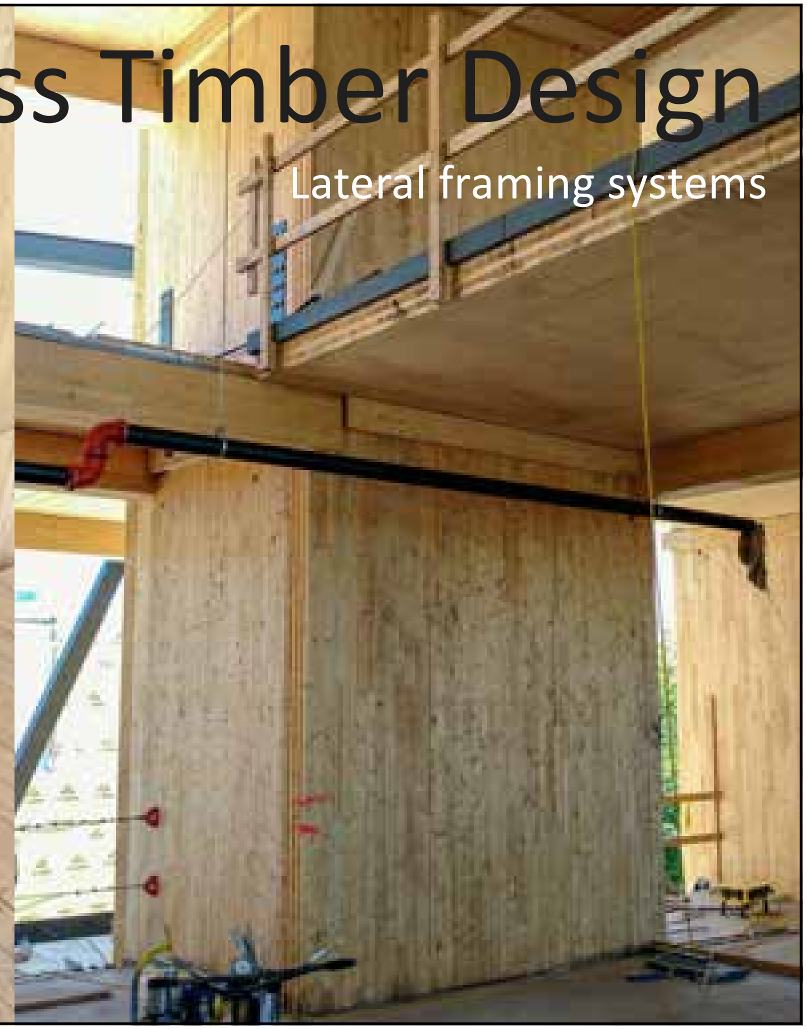
Mass Timber Design

Lateral framing systems



Mass Timber Shearwalls

Photo Credit: alex schreyer

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Candlewood Suites

Redstone Arsenal, AL

- 62,600 SF, 4 story hotel, 92 private rooms
- CLT utilized for walls, roof panels, and floor panels

Image Credit: Lend Lease


Mass timber design
Lateral framing systems
Timber braced frame
Photo Credit: alex schreyer

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Mass Timber Products

Nail-Laminated Timber (NLT)

Cross-Laminated Timber (CLT)

Horizontal Framing

Glue-Laminated Timber (GLT)

Tongue & groove decking (T&G)

Timber concrete composite

Structural Composite Lumber

Image source: StructureCraft

Cross Laminated Timber

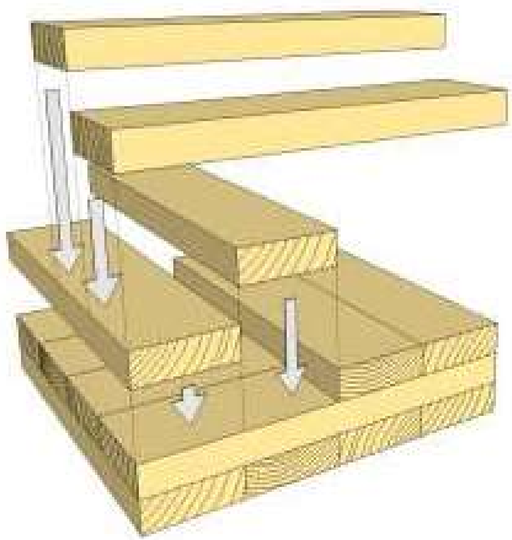
Considerations:

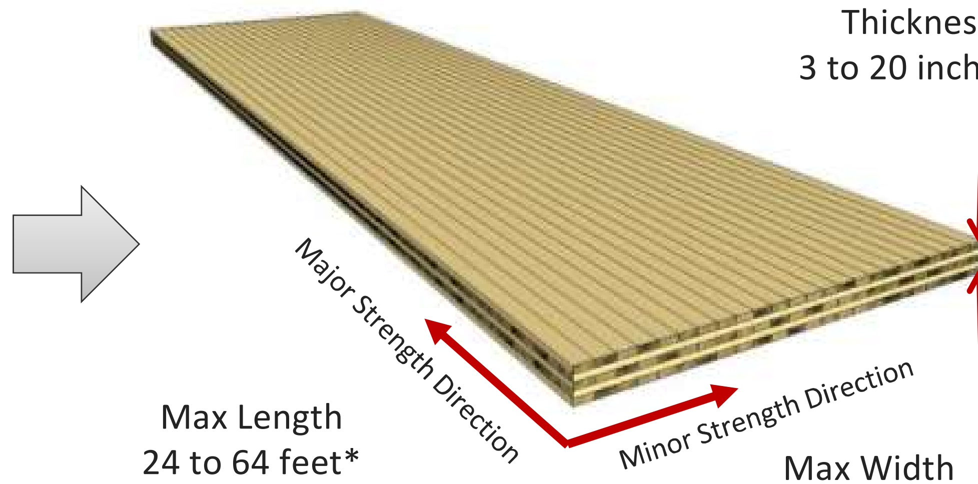
- Large light-weight panels
- Dimensionally stable
- Precise CNC machining available
- Recognized by IBC
- Dual Directional span capabilities
- Often architecturally exposed
- Fast on-site construction

Graphic Credit: StructureCraft

What is CLT?

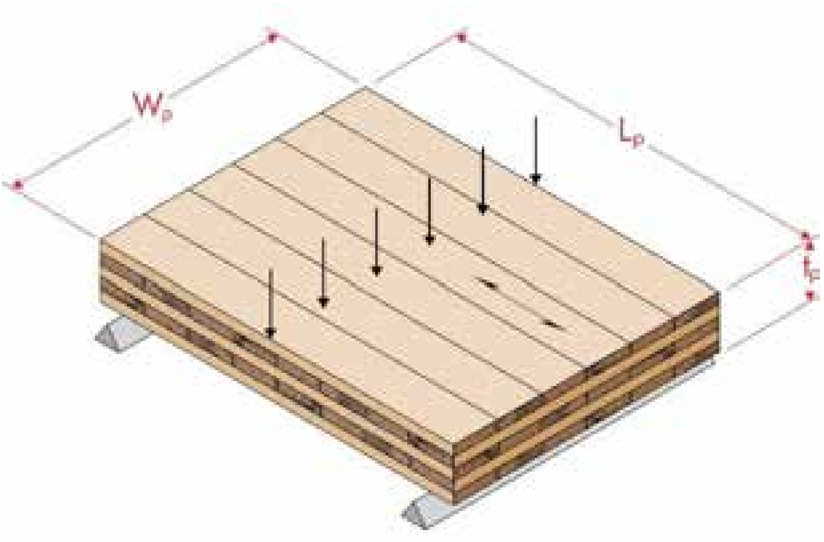
3+ layers of laminations
Solid Sawn or Structural Composite Lumber Laminations
Cross-Laminated Layup
Glued with Structural Adhesives



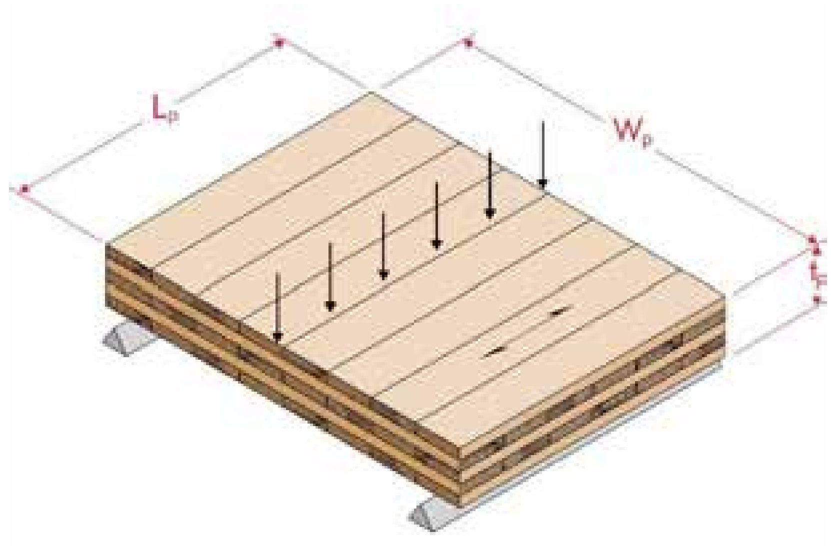


*All dimensions are approximate.
Consult with manufacturers

FLATWISE Panel Loading



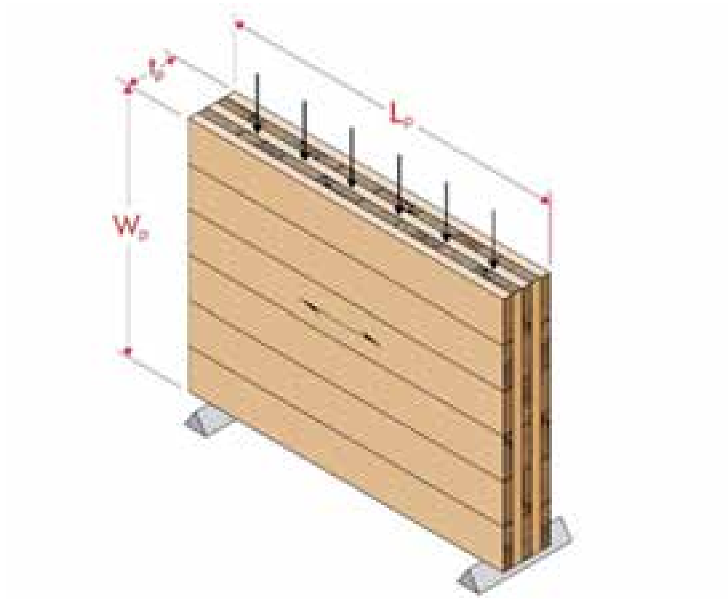
Span in MAJOR Strength Direction
"Parallel" Direction
Use subscript '0' in Notation



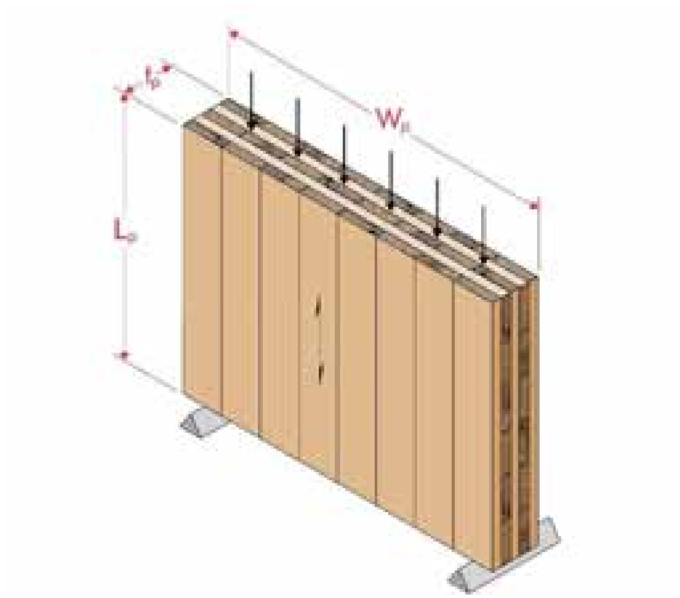
Span in MINOR Strength Direction
"Perpendicular" Direction
Use subscript '90' in Notation

Reference & Source: ANSI/APA PRG 320

EDGEWISE Panel Loading



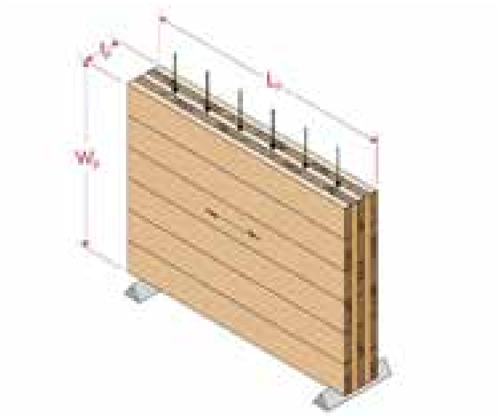
Span in MAJOR Strength Direction



Span in MINOR Strength Direction

Reference & Source: ANSI/APA PRG 320

Shear Force Terminology & Jargon



Source: ANSI/APA PRG 320-2017

Source: NDS 2015 Manual

Through-the-Thickness Shear
In-plane Shear Forces
EDGEWISE Shear in PRG 320-2017

NDS 2015: $F_v(t_v)$
PRG 320-2017: $F_{v,e,0}\,t_p$ & $F_{v,e,90}\,t_p$

CLT in In-Plane (Edgewise) Strength

TABLE 3—REFERENCE DESIGN VALUES FOR IN-PLANE SHEAR OF THE STRUCTURLAM CROSSLAM® CLT PANELS[1]

CLT LAYUP[1]	CLT PANEL THICKNESS DESIGNATION	FACE LAMINATION ORIENTATION[2] (psi)		FACE LAMINATION ORIENTATION[2] (lbf/ft of width)	
		∥[4]	⊥[4]	∥[4]	⊥[4]
V2M1	99 V	175[3]	235[3]	8,200[3]	11,000[3]
	169 V	175[3]	235[3]	14,000[3]	18,800[3]
	239 V	175[3]	235[3]	19,800[3]	26,600[3]
	309 V	175[3]	235[3]	25,600[3]	34,300[3]
V2M1.1	105V	195	290	9,700	14,400
	175V	270	290[3]	22,400	24,000[3]
	245V	270[3]	290[3]	31,300[3]	33,600[3]
	315V	270[3]	290[3]	40,200[3]	43,200[3]

Source: ICC-ES/APA Joint Evaluation Report *ESR 3631*

Reference Design Values for Nordic X-Lam Listed in Table 1 (For Use in

			Major Strength Direction		Minor Strength Direction	
			$F_{v,e,0}$[(a)] (psi)	$G_{e,0}\,t_p$[(d)] (10^6 lbf/ft)	$F_{v,e,90}$[(a)] (psi)	$G_{e,90}\,t_p$[(d)] (10^6 lbf/ft)
			155[(b)]	1.36	190[(b)]	1.36
			155	1.52	190[(b)]	1.52
			155	1.79	190	1.79
			185[(c)]	2.23	215[(c)]	2.23
E1	140-4s	5 1/2	145	2.39	190[(b)]	2.39
	143-5s	5 5/8	185[(c)]	2.44	215[(c)]	2.44
	175-5s	6 7/8	185	2.99	215	2.99
	197-7s	7 3/4	155[(b)]	3.37	215[(c)]	3.37
	213-7l	8 3/8	185[(c)]	3.64	215[(c)]	3.64
	220-7s	8 5/8	185[(c)]	3.75	215[(c)]	3.75
	244-7s	9 5/8	185[(c)]	4.18	215[(c)]	4.18
	244-7l	9 5/8	185[(c)]	4.18	215[(c)]	4.18
	267-9l	10 1/2	155[(b)]	4.56	215[(c)]	4.56
	314-9l	12 3/8	185[(c)]	5.38	215[(c)]	5.38

Source: *APA Product Report PR-L306*

145 to 290 PSI Edgewise Shear Capacity
= 1.7 to 3.5 kips/ft (ASD)
per inch of thickness!

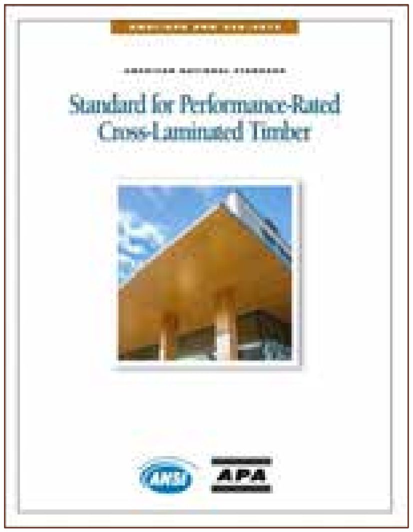
Consult with the Manufacturers for Values

Multiply by ***Cd = 1.6***
for short term ASD strength

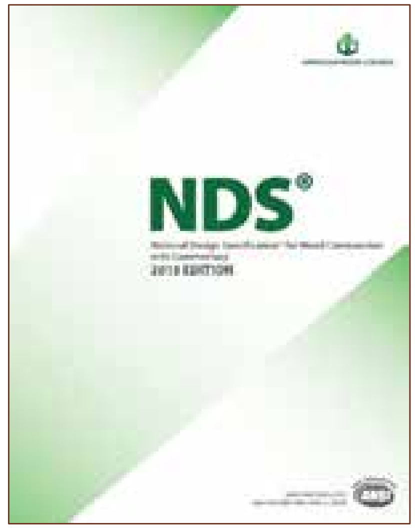
CLT Panels can have > 9 kips / ft in-plane shear capacity

What R Value Can I use?

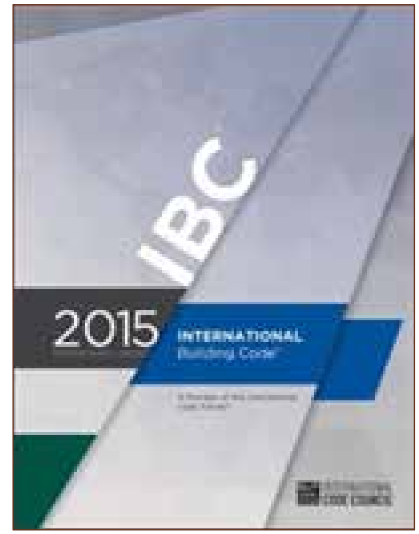
CLT in the U.S. Building Code - IBC 2015



ANSI/APA PRG 320 2011



AWC NDS 2015

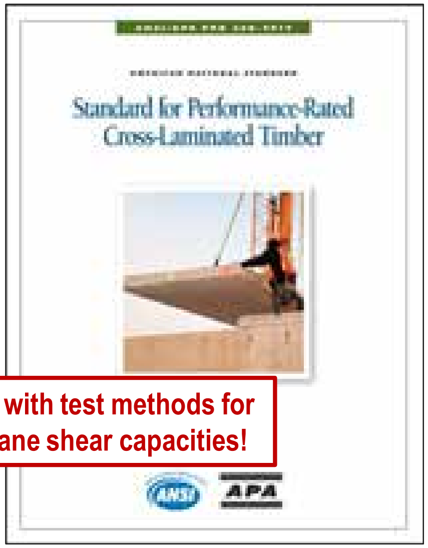


2015 International Building Code

CLT Recognized in the Model Building Code!*

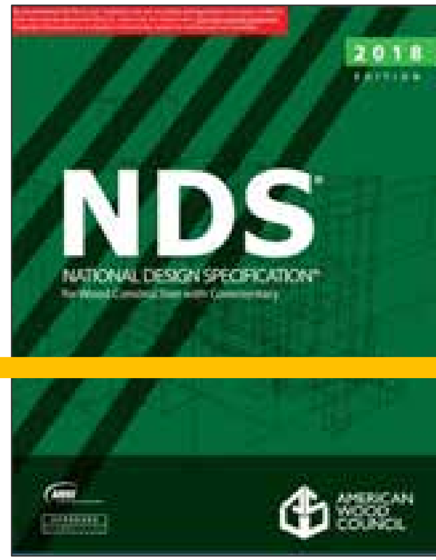
(*for gravity systems with existing Construction Types)

CLT in the U.S. Building Code – IBC 2018



Now with test methods for in-plane shear capacities!

ANSI/APA PRG 320 2017

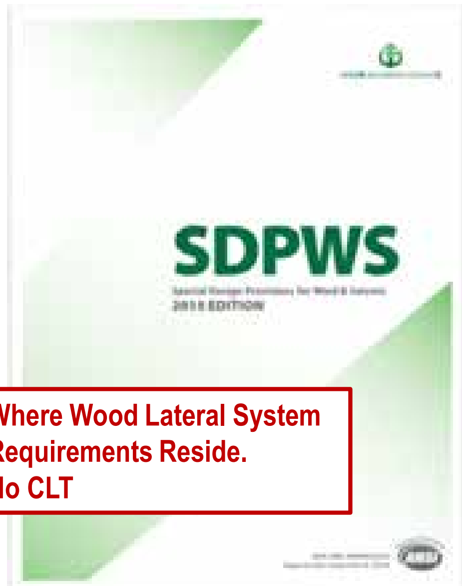


AWC NDS 2018

2018 International Building Code

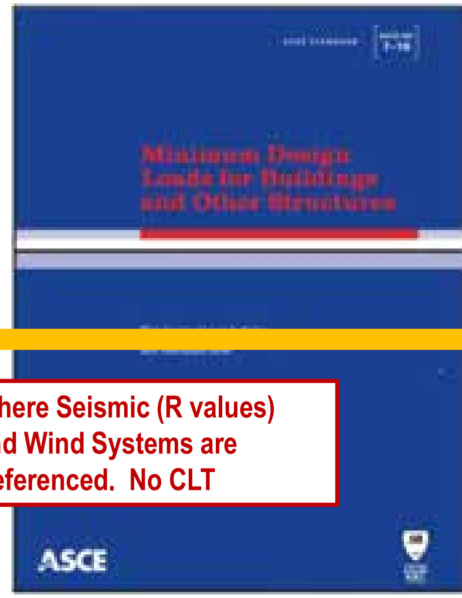
General improvements.

CLT in the U.S. Building Code – IBC 2018 (Lateral)



Where Wood Lateral System Requirements Reside. No CLT

AWC SDPWS 2015



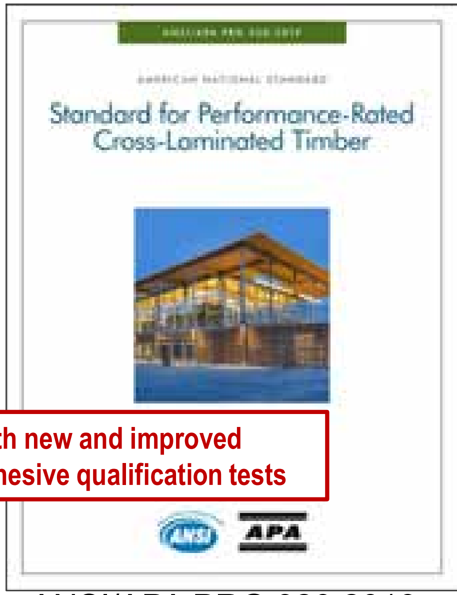
Where Seismic (R values) and Wind Systems are Referenced. No CLT

ASCE/SEI 7-16

2018 International Building Code

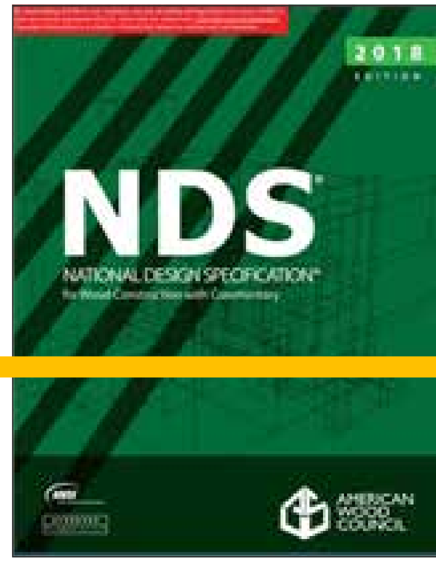
No explicitly recognized requirements for CLT Lateral Systems in 2018 IBC

CLT in the U.S. Building Code – IBC 2021

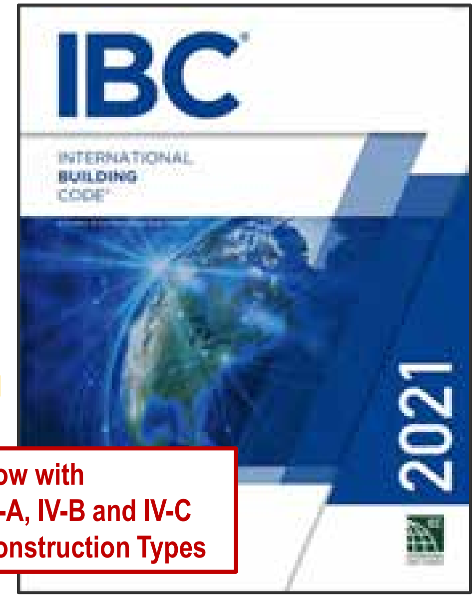


With new and improved adhesive qualification tests

ANSI/APA PRG 320 2019



AWC NDS 2018

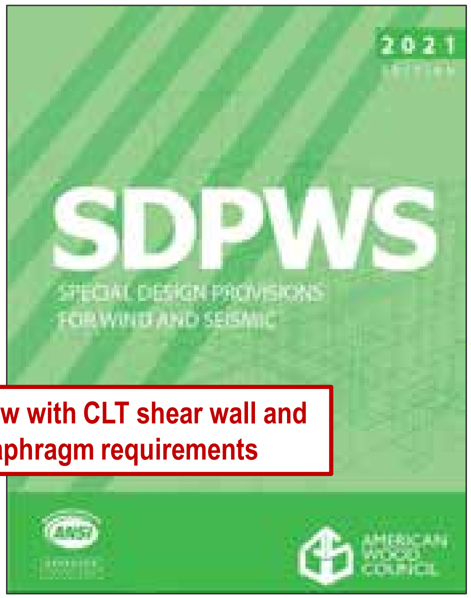


Now with IV-A, IV-B and IV-C Construction Types

2021 International Building Code

New Type IV Mass Timber Construction up to 18 Stories!

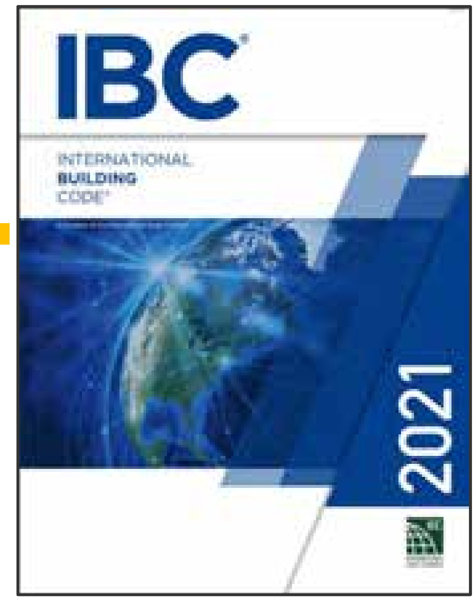
CLT in the U.S. Building Code – IBC 2021 (Lateral)



Now with CLT shear wall and diaphragm requirements

AWC SDPWS 2021

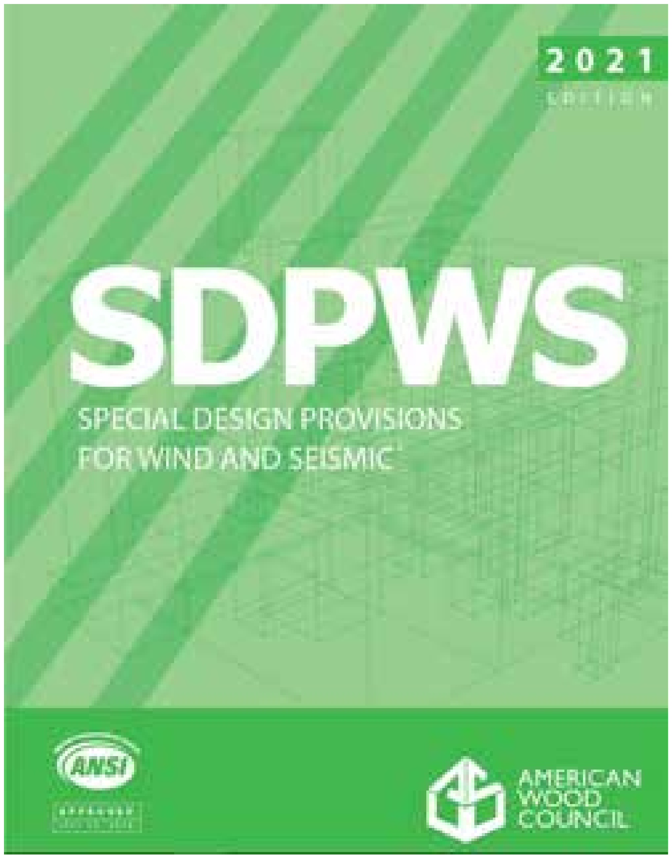
ASCE/SEI 7-16



2021 International Building Code

New Requirements for CLT Lateral Systems in SDPWS 2021!
Referenced from IBC 2021

2021 Special Design Provisions for Wind and Seismic



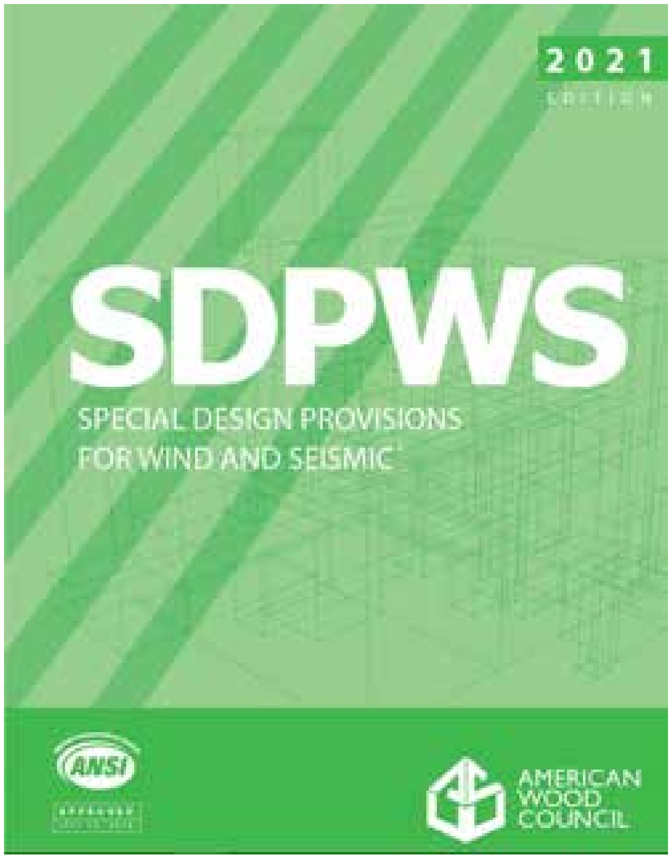
Top Changes Relevant to CLT Lateral Systems:

- New unified nominal shear capacity
- New CLT Shear Wall requirements
- New CLT Diaphragm requirements

View for free at awc.org

PowerPoint IS NOT the CODE!

2021 SDPWS – Unified Nominal Shear Capacity



For sheathed wood frame shear walls and diaphragms, SDPWS 2015 has two nominal shear capacities

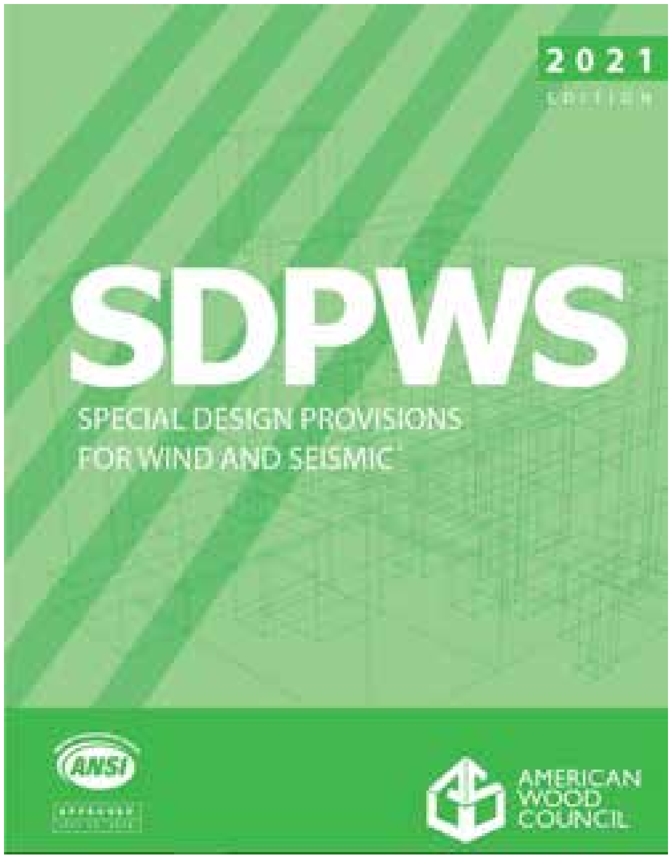
v_s Nominal shear capacity for seismic loads

v_w Nominal shear capacity for wind loads

SDPWS 2021 has one nominal shear capacity for both wind and seismic

v_n Nominal shear capacity

2021 SDPWS – Unified Nominal Shear Capacity

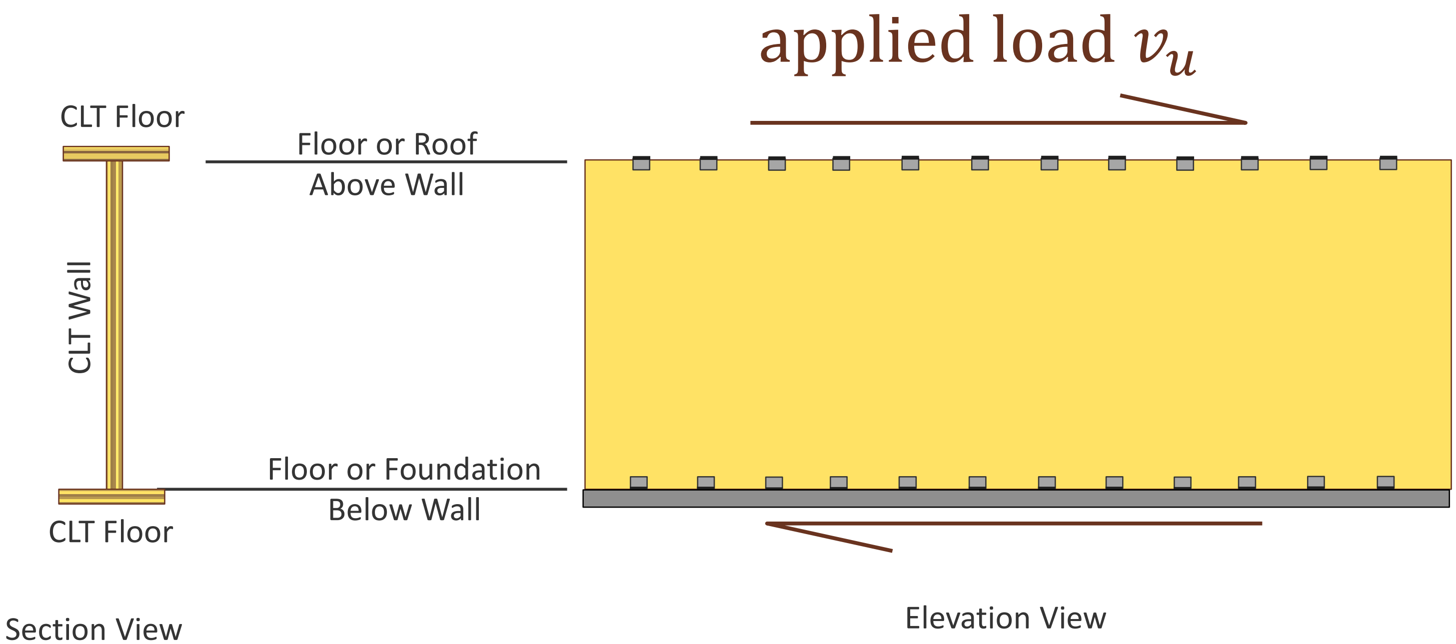


To calculate the ASD or LRFD shear capacity, SDPWS 2021 has different reduction factors for wind and seismic

	Design shear capacity	
	ASD	LRFD
Wind	$v_n/2.0$	$0.8\ v_n$
Seismic	$v_n/2.8$	$0.5\ v_n$

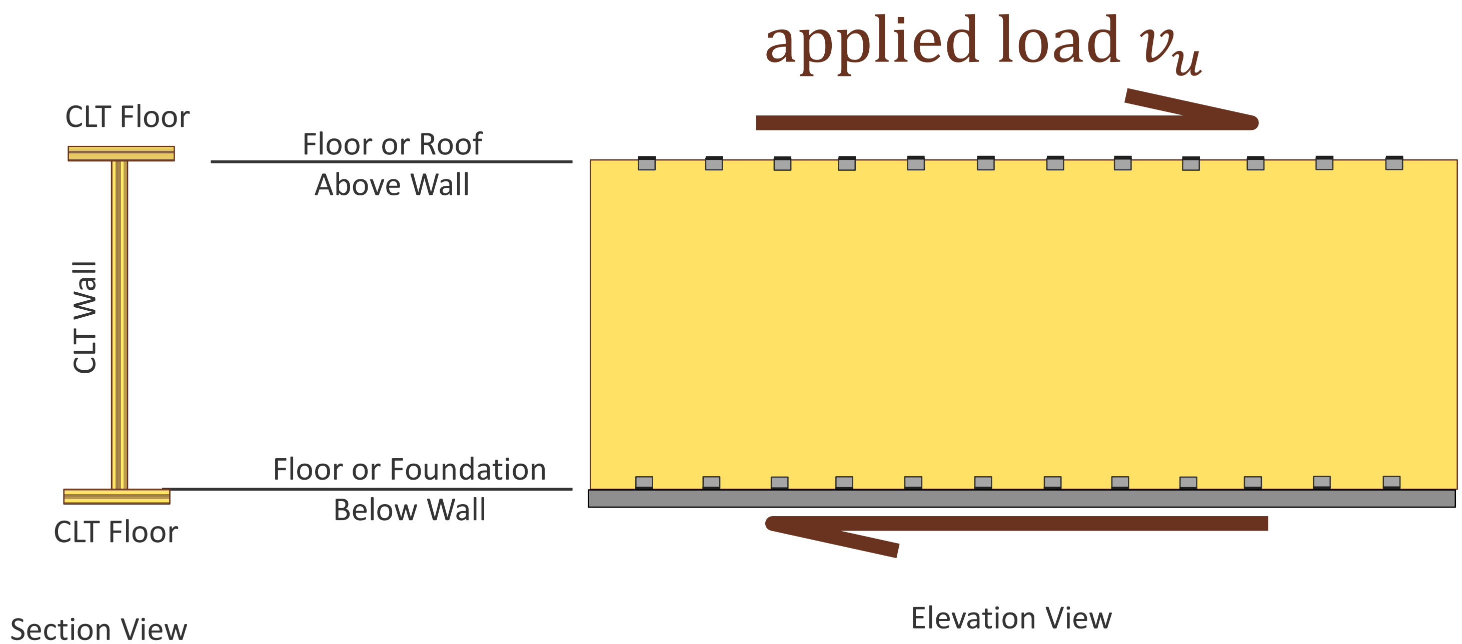
CLT Shear Walls in SDPWS 2021

Platform Framed CLT Construction



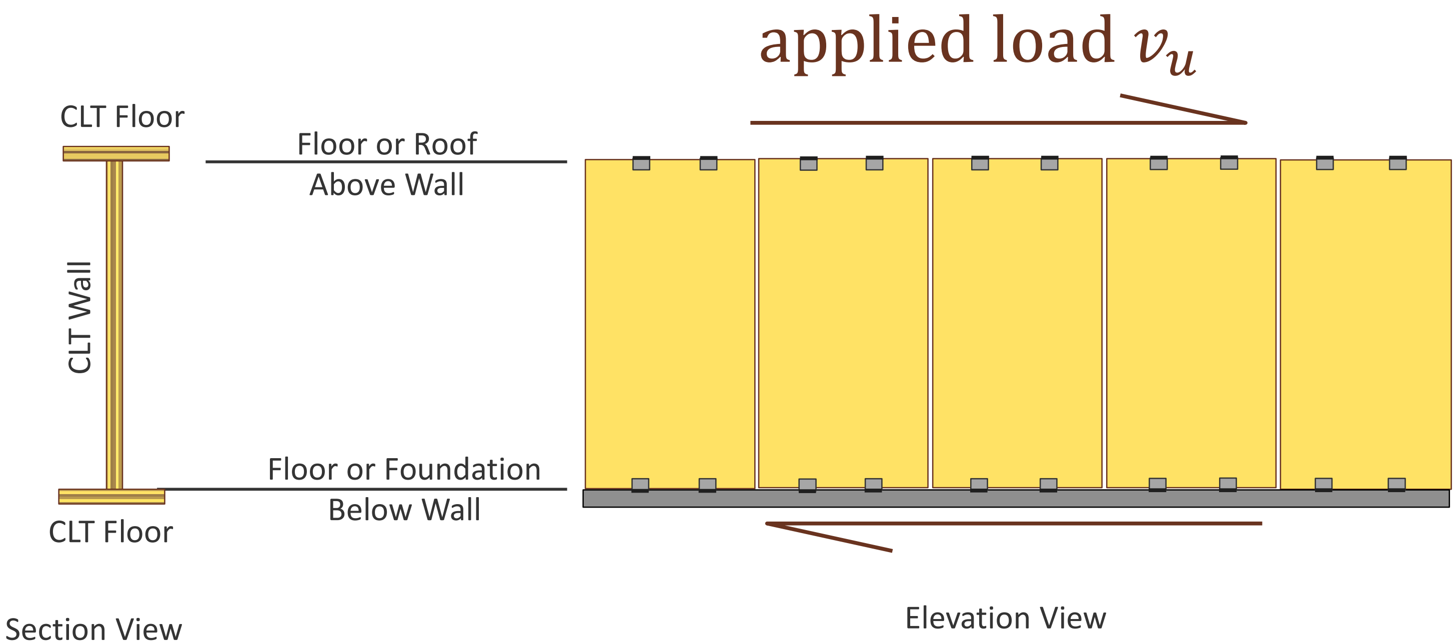
CLT Shear Walls in SDPWS 2021

Platform Frame CLT Construction



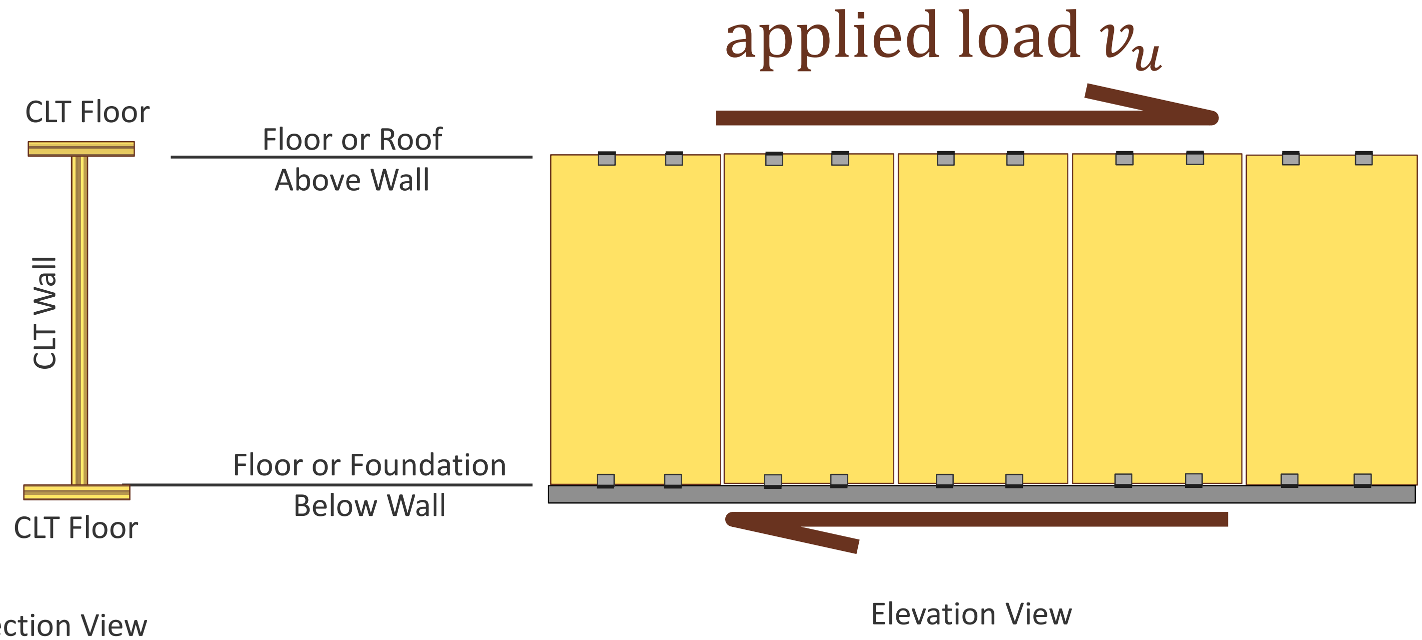
CLT Shear Walls in SDPWS 2021

Platform Frame CLT Construction



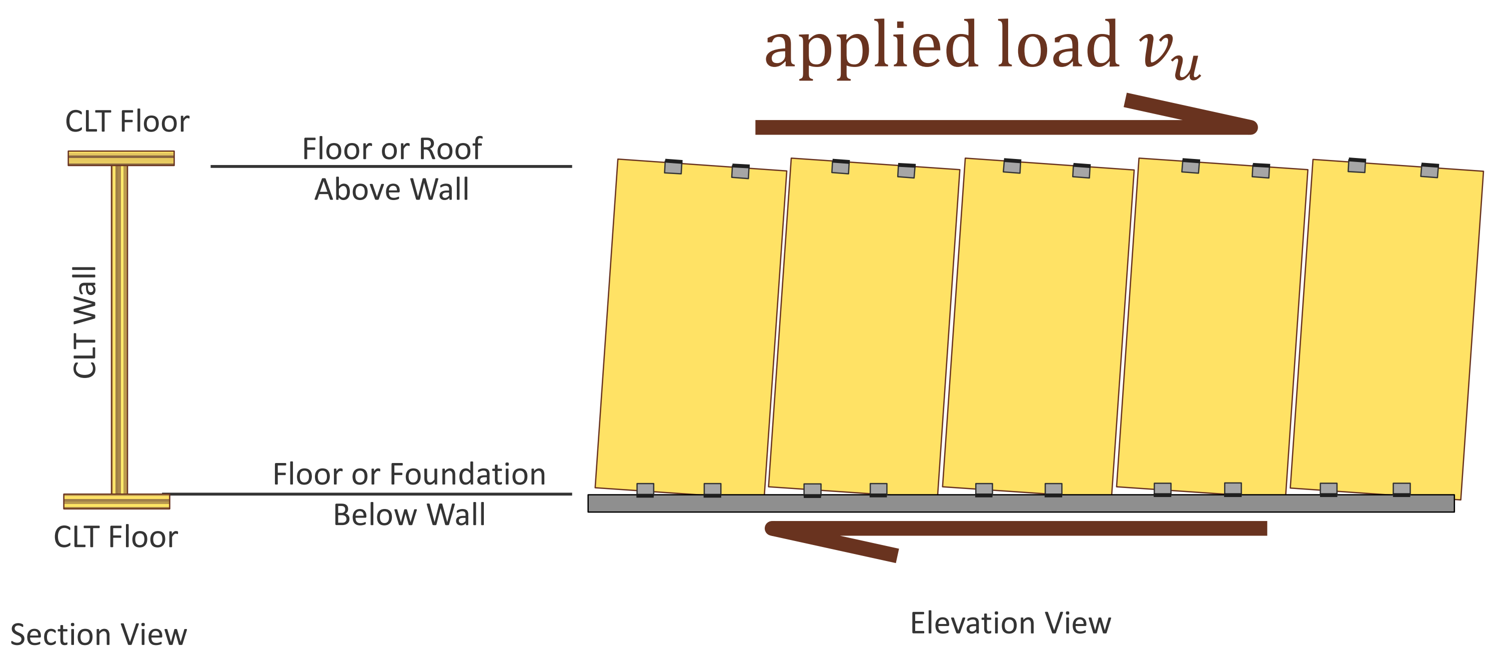
CLT Shear Walls in SDPWS 2021

Platform Frame CLT Construction



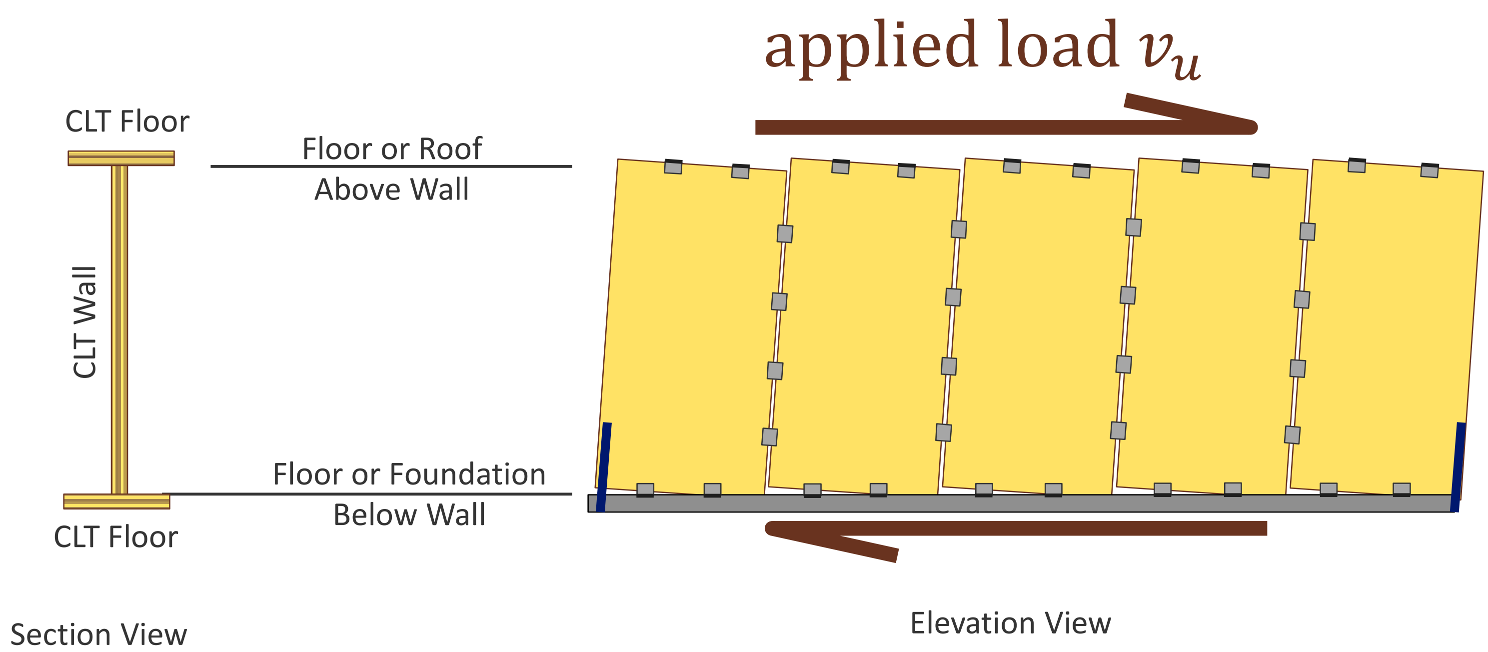
CLT Shear Walls in SDPWS 2021

Platform Frame CLT Construction



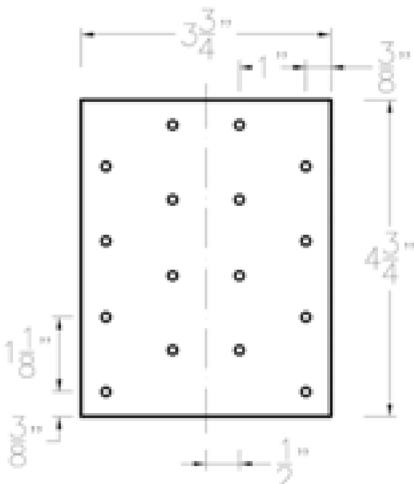
CLT Shear Walls in SDPWS 2021

Platform Frame CLT Construction



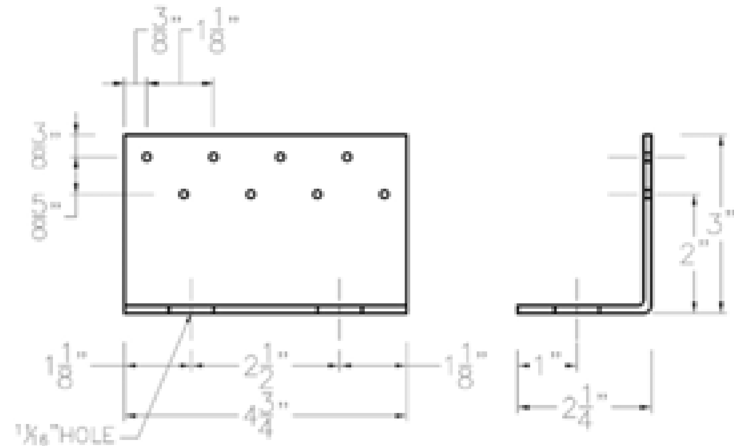
CLT Shear Walls in SDPWS 2021

Panel to Panel Connection



0.105” ASTM A653 Grade 33 Steel
(8) 16d box nails to each wall panel
3.5” long x 0.135”Ø shank with 0.344” Ø head

Panel to Platform Connection



Same steel plate and nails plus
5/8” Ø bolts or lag screws to roof, floor or foundation

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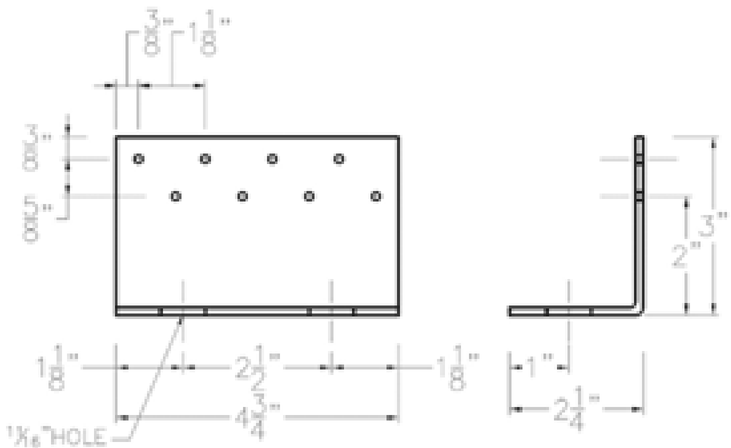
CLT Shear Walls in SDPWS 2021

Panel to Platform Connection



Nominal shear capacity

v_n = 2605 C_G [lbs] per angle connector

C_G adjusts for specific gravity, G of CLT

C_G = 1.0	for $G \geq 0.42$
= 0.86	for G = 0.35
= 1.0 – 2 (0.42-G)	for 0.42 > G > 0.35

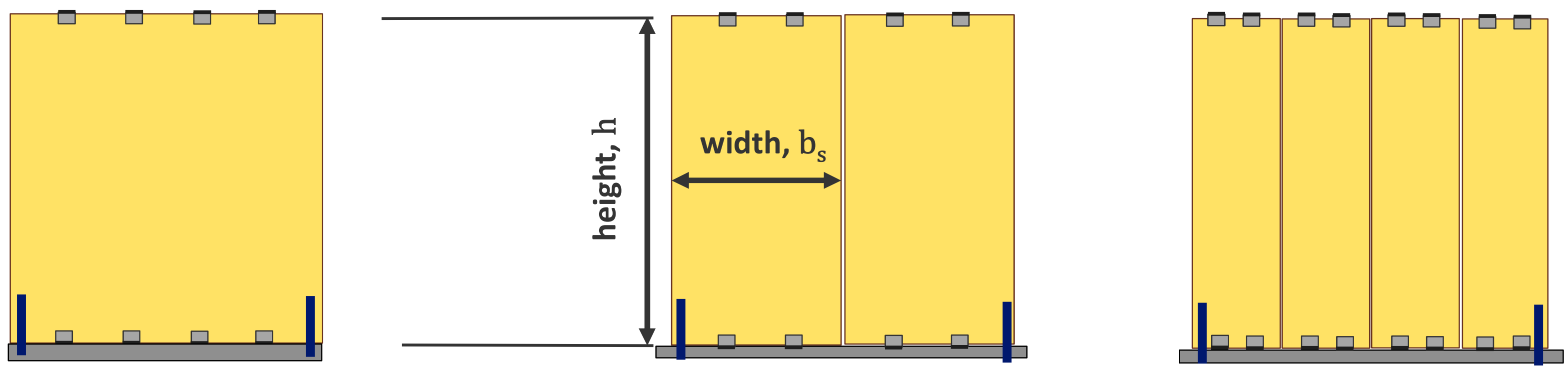
Nominal unit shear capacity:

v_n = n (2605 / b_s) C_G [lbs/ft]

CLT Shear Walls in SDPWS 2021

(other)
CLT Shear Walls
not meeting Appendix B

CLT Shear Walls
meeting SDPWS 2021 Appendix B



Seismic Design Category A or SDC B and ≤ 65’ tall in SDPWS 4.6.3 Exception

Panel aspect ratios
$2 \leq h/b_s \leq 4$

with shear resistance provided by high aspect ratio panels only (SDPWS B.3.7)

Panel aspect ratios
$h/b_s = 4$

R = 3?

or 4 or 1.5?

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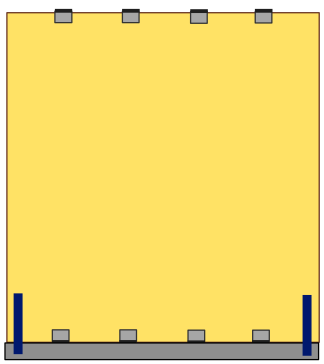
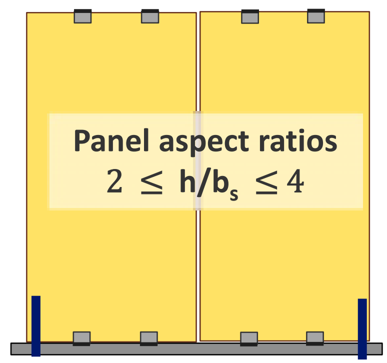
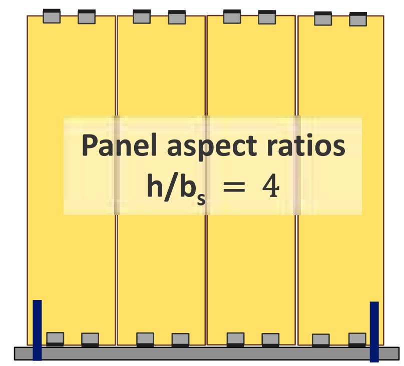
R Values for CLT Shear Walls in SDPWS 2021

(other)
CLT Shear Walls
not meeting Appendix B

CLT Shear Walls
meeting SDPWS 2021 Appendix B







R = 1.5

$C_d = 1.5$ $\Omega_o = 2.5$

In SDPWS 2021 4.6.3

R = 3.0*

$C_d = 3.0$ $\Omega_o = 3.0$

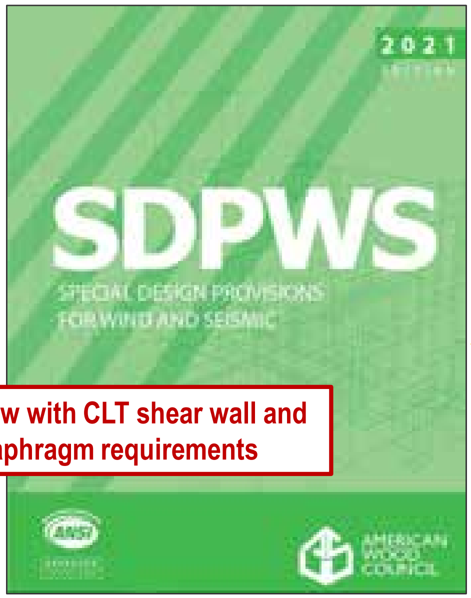
R = 4.0*

$C_d = 4.0$ $\Omega_o = 3.0$

* ASCE 7-22

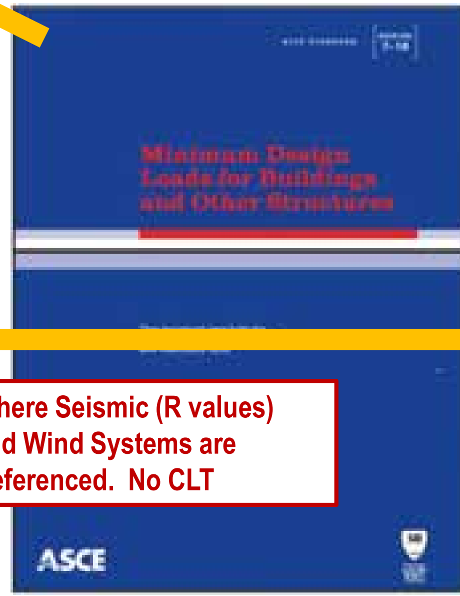
CLT in the U.S. Building Code – Lateral in IBC 2021

SDPWS 2015



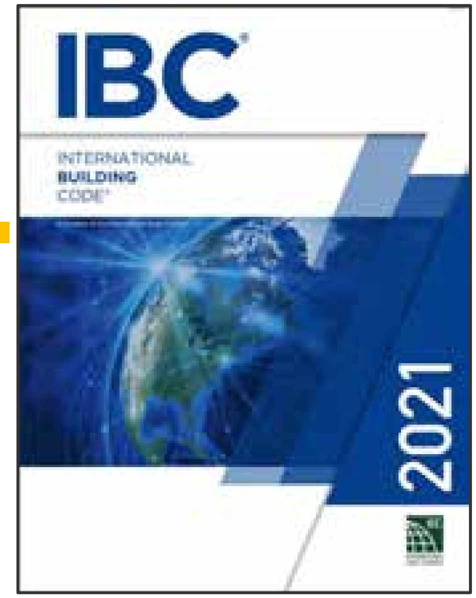
Now with CLT shear wall and diaphragm requirements

AWC SDPWS 2021



Where Seismic (R values) and Wind Systems are Referenced. No CLT

ASCE/SEI 7-16

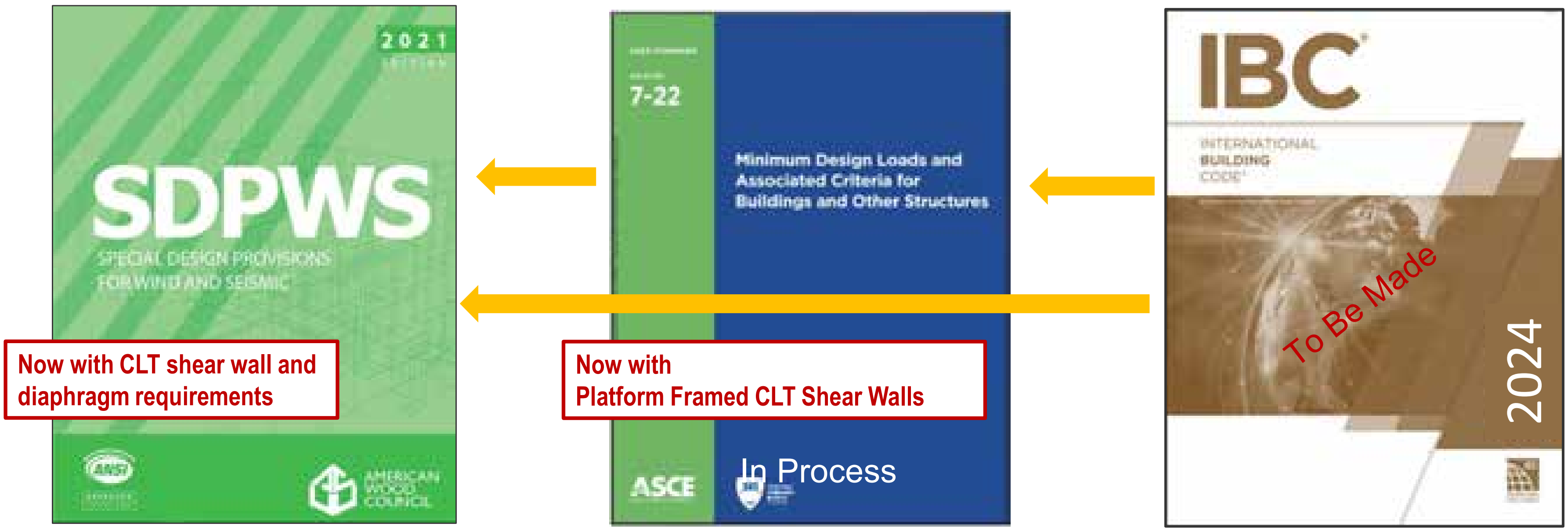


2021 International Building Code

New Requirements for CLT Lateral Systems!

(but R values for CLT Shear Walls not in ASCE 7-16)

CLT in the U.S. Building Code – Lateral in the IBC 2024?



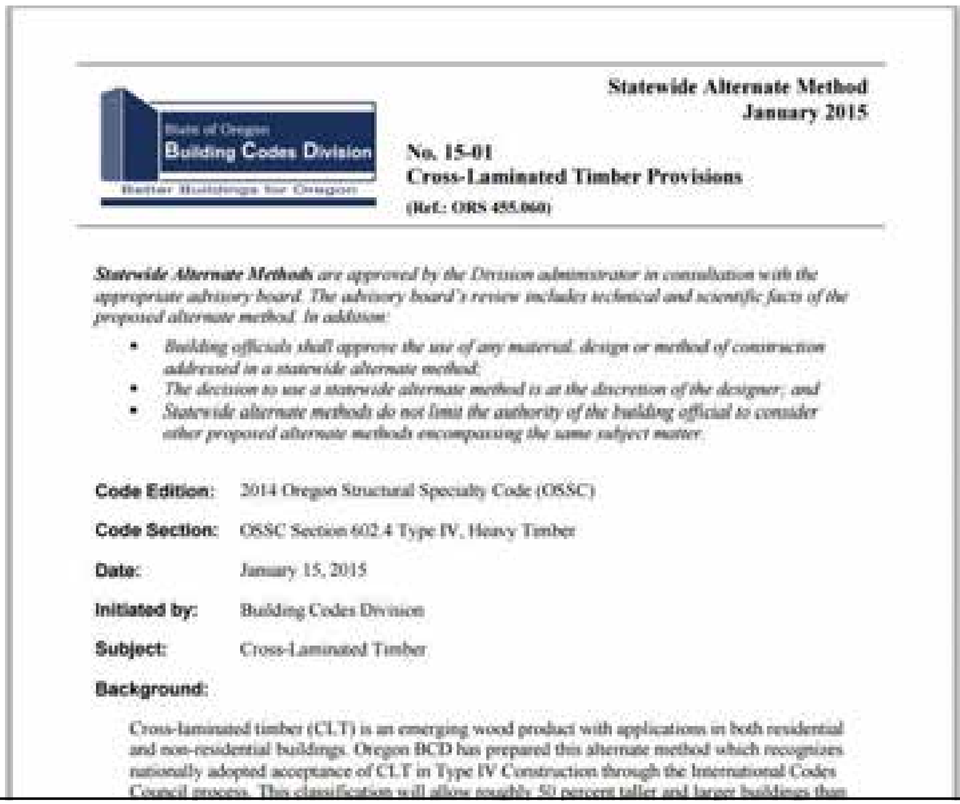
AWC SDPWS 2021

ASCE/SEI 7-22
(now available)

2024 IBC
(in process)

Possible Future Full Recognition of CLT Lateral Systems

State of Oregon Statewide Alternative



State of Oregon
Building Codes Division
Better Buildings for Oregon

Statewide Alternate Method
January 2015

No. 15-01
Cross-Laminated Timber Provisions
(Ref.: ORS 455.060)

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 designer; 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:	2014 Oregon Structural Specialty Code (OSSC)
Code Section:	OSSC Section 602.4 Type IV, Heavy Timber
Date:	January 15, 2015
Initiated by:	Building Codes Division
Subject:	Cross-Laminated Timber

Background:

Cross-laminated timber (CLT) is an emerging wood product with applications in both residential and non-residential buildings. Oregon BCD has prepared this alternate method which recognizes nationally adopted acceptance of CLT in Type IV Construction through the International Codes Council process. This classification will allow roughly 50 percent taller and larger buildings than

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State of Oregon Statewide Alternative

ASCE 7-10 Table 12.2-1 modified by Oregon Buildings Code Division

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, Ω_0^g	Deflection Amplification Factor, C_d^b	Structural System Limitations Including Structural Height, h_n (ft) Limits[c] — Seismic Design Category B	C	D[d]	E[d]	F[e]
A. BEARING WALL SYSTEMS									
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance	14.5	6 ½	3	4	NL	NL	65	65	65
19. Cross-laminated timber shear walls[i]	14.1 and 14.5	2	2 ½	2	NL	NL	NL	NL	NL

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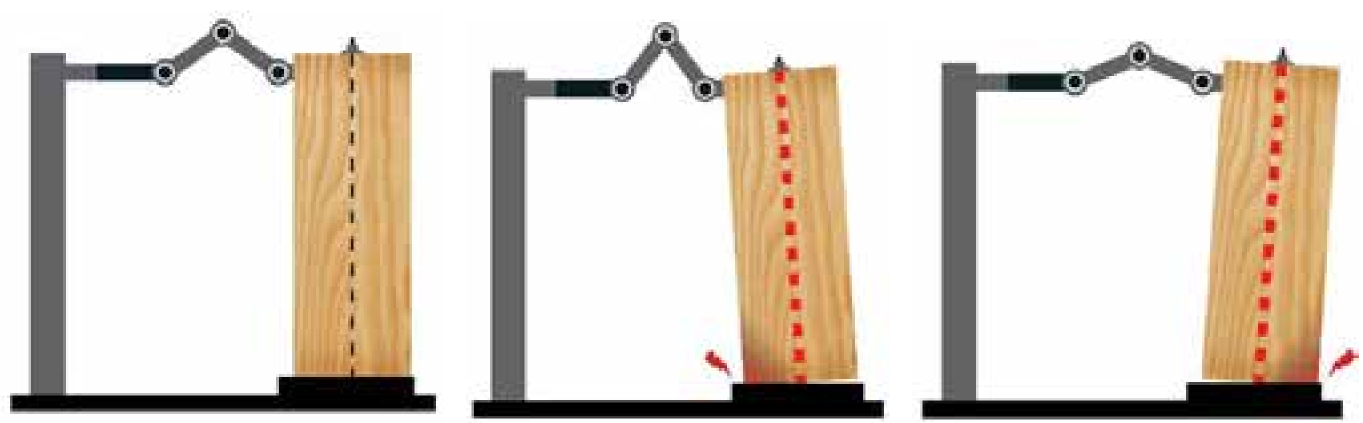
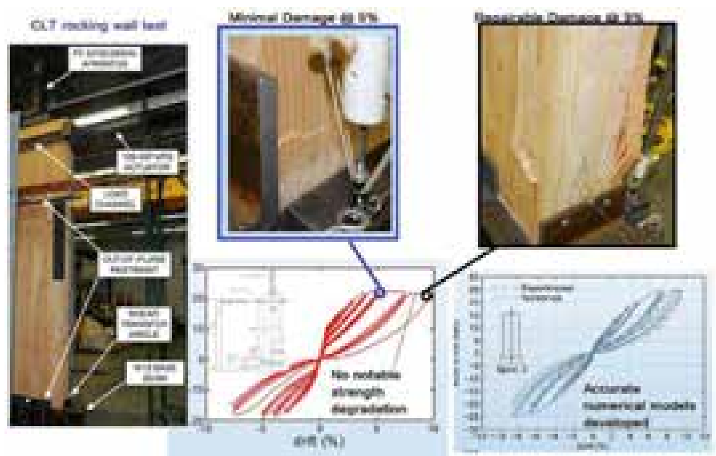
Range of Systems in Research



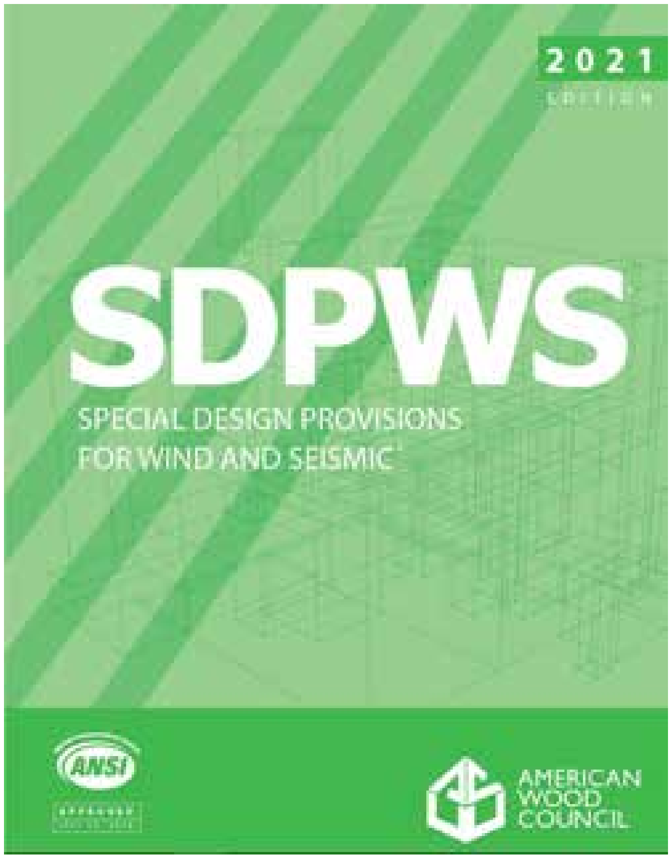
Mass Timber Post-Tensioned Rocking Shear Walls
CLT Balloon Framed Shear Walls

Mass Timber Post Tension Rocking Shear Wall Tests



Source: S. PEI et al. http://nheritallwood.mines.edu/

2021 Special Design Provisions for Wind and Seismic



Top Changes Relevant to CLT Lateral Systems:

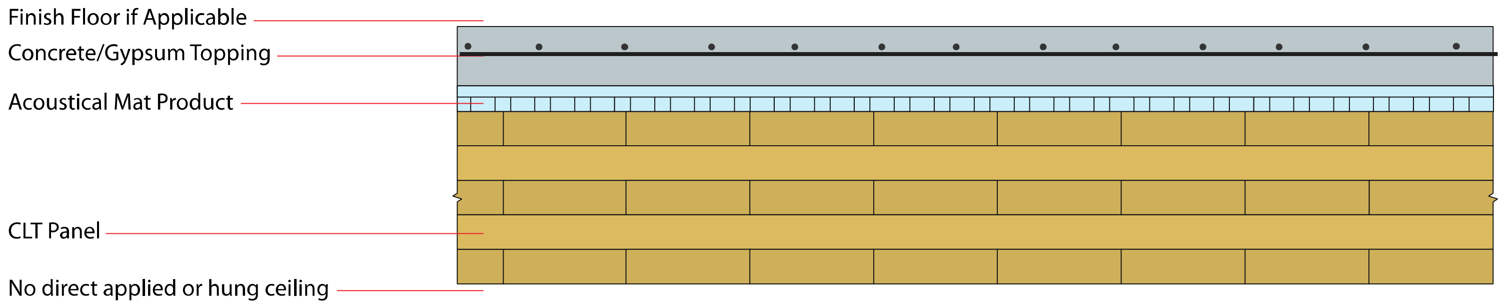
- New unified nominal shear capacity
- New CLT Shear Wall requirements
- **New CLT Diaphragm requirements**

View for free at awc.org

PowerPoint IS NOT the CODE!

Diaphragm Strategies with Horizontal CLT

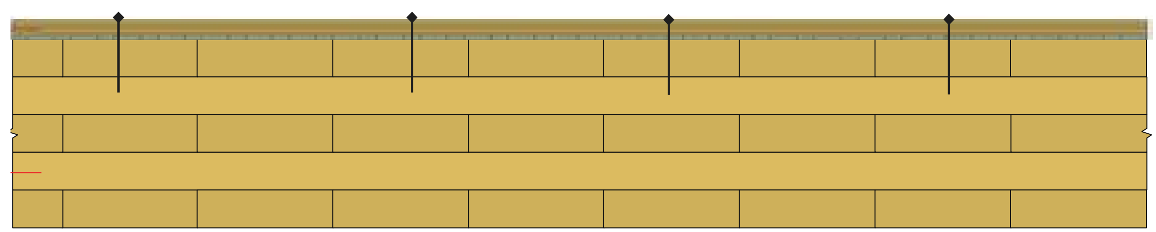
Option 1: Structural Topping as Horizontal Diaphragm
(1A) Structural Concrete Topping



Careful detailing to provide adequate load path, minimum rebar cover, etc.

Diaphragm Strategies with Horizontal CLT

Option 1: Structural Topping as Horizontal Diaphragm
(1B) Wood Structural Panel Topping



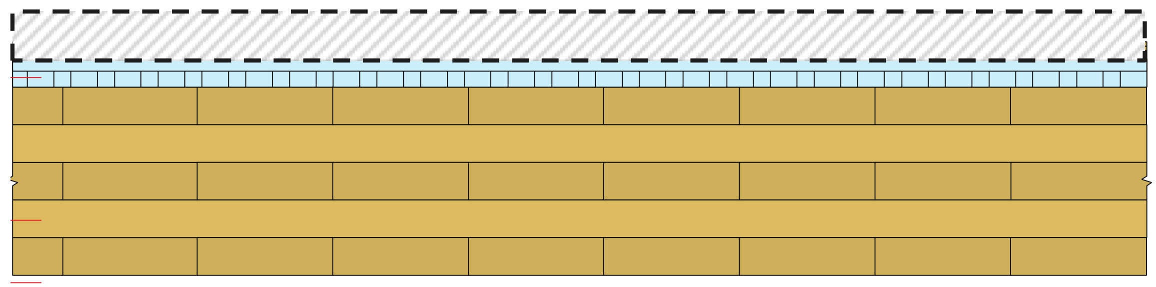
Classify as blocked WSP diaphragm per SDPWS 2015 4.2.7.1?
19/32" thick 4ft by 8ft panel vs 4 1/8" thick 8ft by 24 ft panel?

Diaphragm Strategies with Horizontal CLT

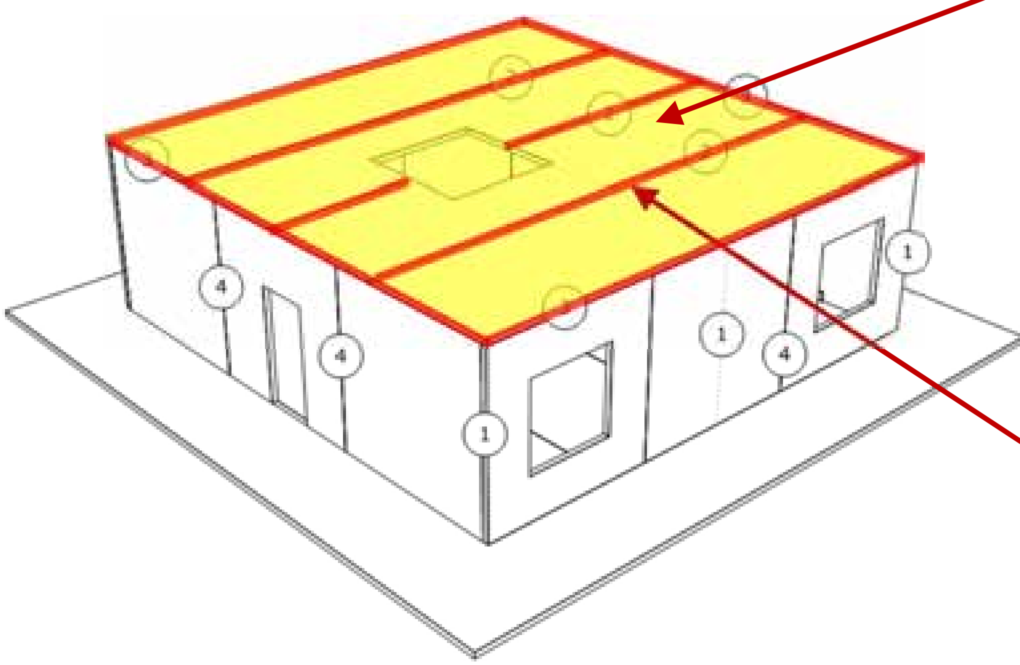
Option 2: CLT as a Diaphragm

Topping and Flooring as needed

CLT Panel as Diaphragm



CLT Diaphragms



Strength of CLT rarely governs.

Strength of Connections covered by NDS and Proprietary Fastener Evaluation Reports

2021 Special Design Provisions for Wind and Seismic

4.5 Cross-Laminated Timber (CLT) Diaphragms

4.5.1 Application Requirements

CLT diaphragms shall be permitted to be used to resist lateral forces provided the deflection in the plane of the diaphragm, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the maximum permissible deflection limit of attached load distributing or resisting elements. Permissible deflection shall be that deflection that will permit the diaphragm and any attached elements to maintain their structural integrity and continue to support their prescribed loads as determined by the applicable building code or standard.

4.5.2 Deflection

CLT diaphragm deflection shall be determined using principles of engineering mechanics.

4.5.3 Unit Shear Capacity

CLT diaphragms shall be designed in accordance with principles of engineering mechanics using design values for wood members and connections in accordance with NDS provisions.

The nominal unit shear capacity, v_n, of CLT diaphragms shall be based on the nominal shear capacity for dowel-type fastener connections used to transfer diaphragm shear forces, as calculated per 4.5.4, Item 1. ASD allowable shear capacity or LRFD factored shear resistance for the CLT diaphragm and diaphragm shear connections shall be determined in accordance with 4.1.1.

4.5.4 Additional CLT Diaphragm Design Requirements

CLT diaphragms shall meet the following additional requirements:

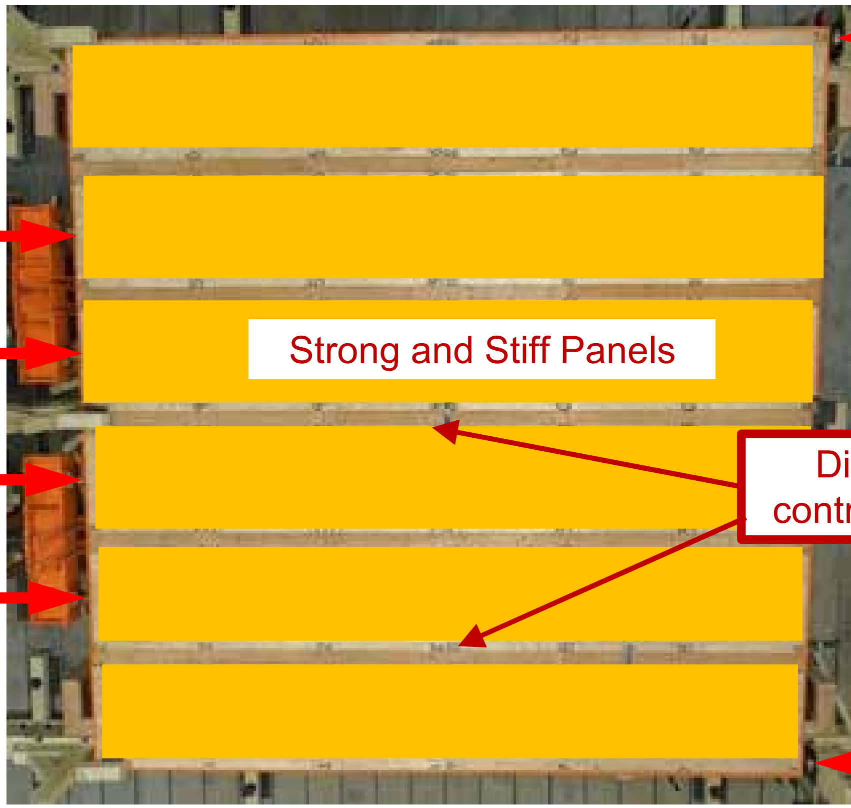
1. The nominal shear capacity for dowel-type fastener connections used to transfer diaphragm shear forces between CLT panels and between CLT panels and diaphragm boundary elements (chords and collectors) shall be taken as 4.5Z*, where Z* is Z multiplied by all applicable NDS adjustment factors except C_D, K_F, ϕ, and λ, and Z shall be controlled by Mode IIIs or Mode IV fastener yielding in accordance with NDS 12.3.1.
2. Connections used to transfer diaphragm shear forces shall not be used to resist diaphragm tension forces.
3. Wood elements, steel parts, and wood or steel chord splice connections shall be designed for 2.0 times the diaphragm forces associated with the shear forces induced from the design loads.

Exceptions:

1. Wood elements and wood splice connections shall be permitted to be designed for 1.5 times the diaphragm forces associated with the shear forces induced by the wind design loads.
2. Where dowel-type fasteners are used in chord splice connections and the connection is controlled by Mode IIIs or Mode IV fastener yielding in accordance with NDS 12.3.1, fasteners in the connection shall be permitted to be designed for 1.5 and 1.0 times the diaphragm forces associated with the shear forces induced by the prescribed seismic and wind design loads, respectively.

Diaphragm chord elements and chord splice connections using materials other than wood or steel shall be designed using provisions in NDS 1.4.

24’ x 24’ CLT Diaphragm Test with Plywood Spline by AWC



Diaphragm behavior controlled by connections

Photo: (add better one)

2021 Special Design Provisions for Wind and Seismic

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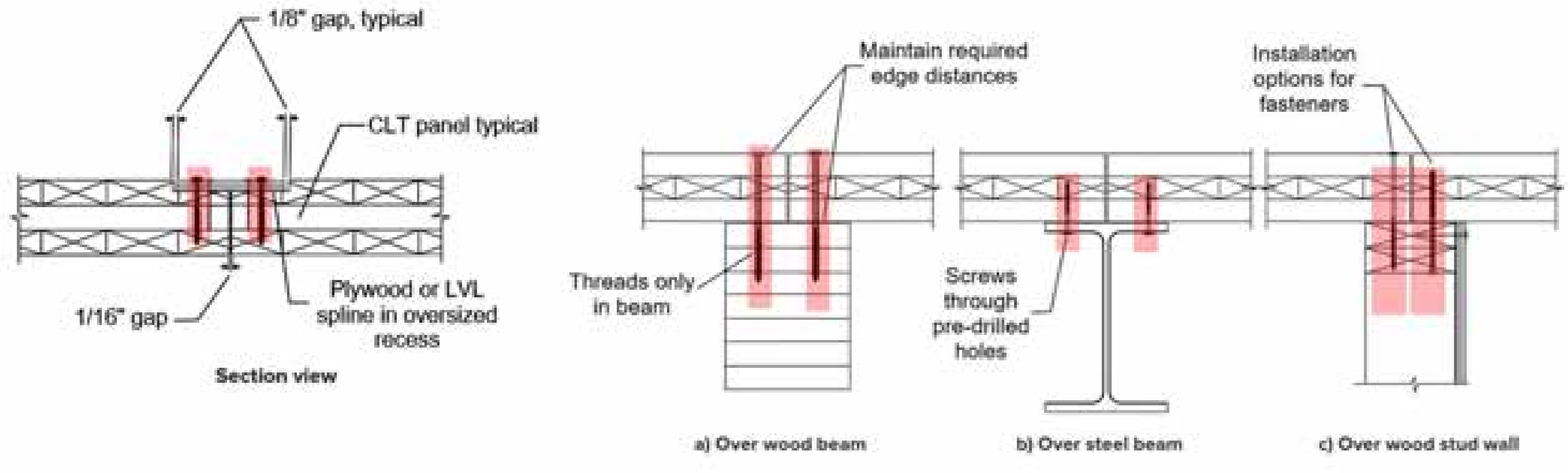
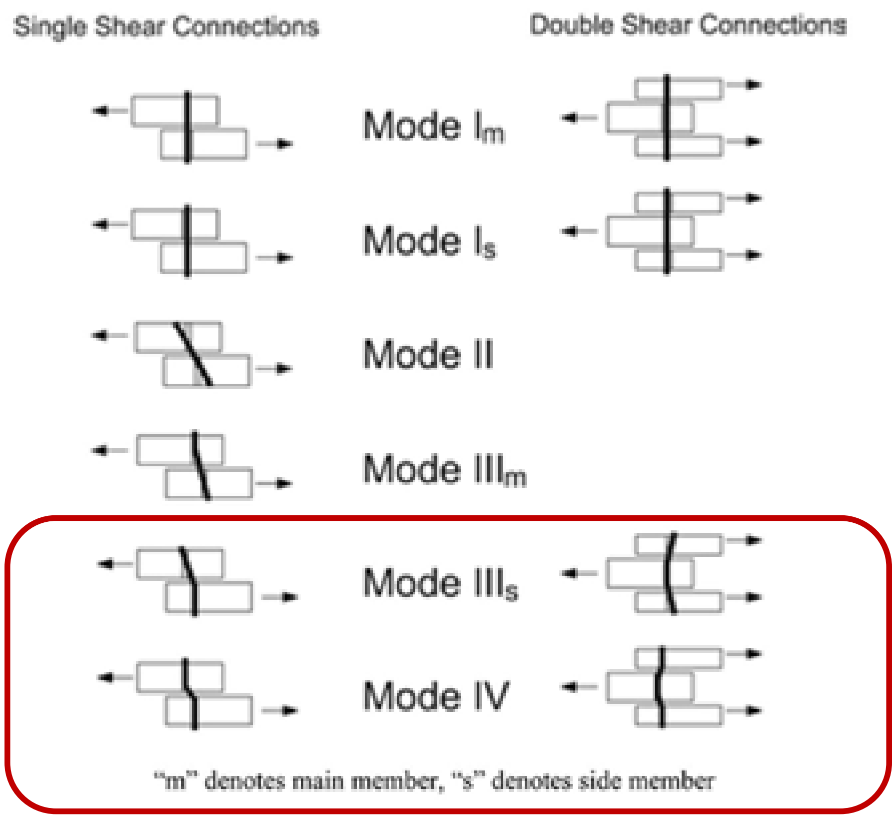
CLT Diaphragm Shear Connections



Diaphragm **shear connections** at CLT panel edges:

- Use dowel-type fasteners in shear (nails, screws, bolts)
- Yield **Mode IIIs or Mode IV** per NDS 12.3.1 controls capacity

Connection Yield Modes Per the NDS



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CLT Diaphragm Shear Connection Design

Nominal capacity of CLT diaphragm shear connection fastener:

$$Z_n = 4.5\,Z^*$$

Where Z^* is reference lateral capacity Z of NDS multiplied by all applicable factors *except* C_D, K_F, ϕ, λ = 1.0

SDPWS 2021 Section 4.5.4(1) and NDS Table 11.3.1

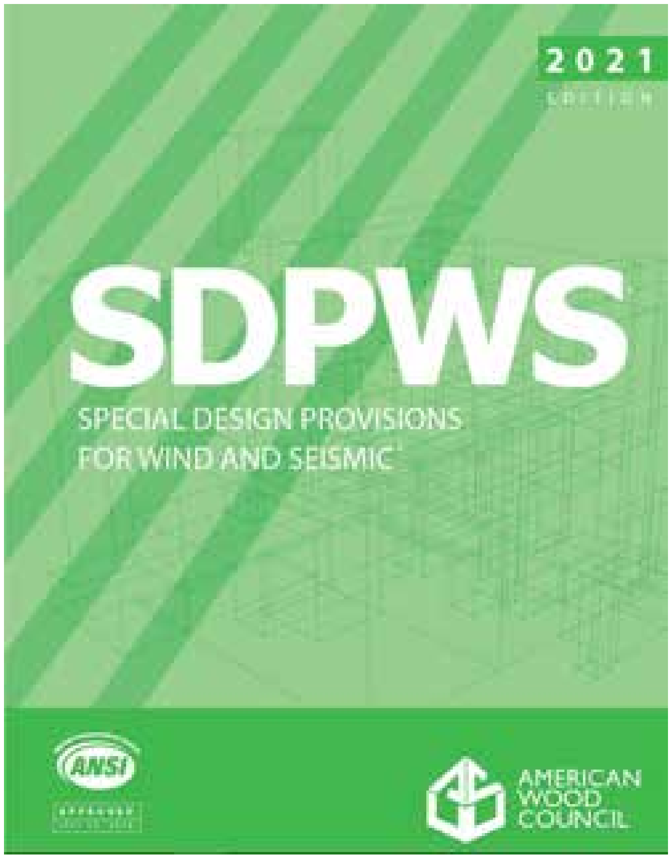
Table 11.3.1 Applicability of Adjustment Factors for Connections

	ASD Only	ASD and LRFD									LRFD Only		
	Load Duration Factor [1]	Wet Service Factor	Temperature Factor	Group Action Factor	Geometry Factor [3]	Penetration Depth Factor [3]	End Grain Factor [3]	Metal Side Plate Factor [3]	Diaphragm Factor [3]	Toe-Nail Factor [3]	Format Conversion Factor	Resistance Factor	Time Effect Factor
											K_F	ϕ	
Lateral Loads													
Dowel-type Fasteners (e.g. bolts, lag screws, wood screws, nails, spikes, drift bolts, & drift pins) $Z^* =$ Z x	1.0	C_M	C_t	C_g	C_Δ	-	C_{eg}	-	1.0	C_{tn}	1.0	1.0	1.0

Also 1.0 for CLT Diaphragm Shear Connections

SDPWS 2021 Section 4.5.4(1) and NDS Table 11.3.1

2021 SDPWS – Unified Nominal Shear Capacity



To calculate the ASD or LRFD shear capacity, SDPWS 2021 has different reduction factors for wind and seismic

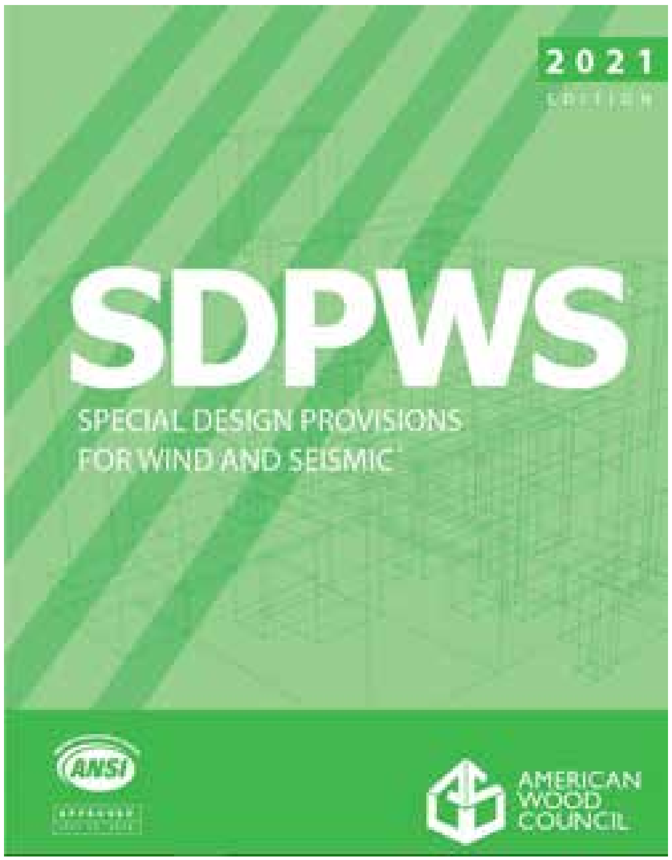
Loading	ASD Design Capacity v_n / Ω_D	LRFD Design Capacity $\phi_D v_n$
Seismic	$v_n/2.8$	$0.50\ v_n$
Wind	$v_n/2.0$	$0.80\ v_n$

For ASD seismic:

$$4.5\ Z^* / 2.8 = 1.61\ Z^* \approx C_D\ Z = 1.6\ Z$$

SDPWS 2021 Section 4.1.4

2021 SDPWS – Unified Nominal Shear Capacity



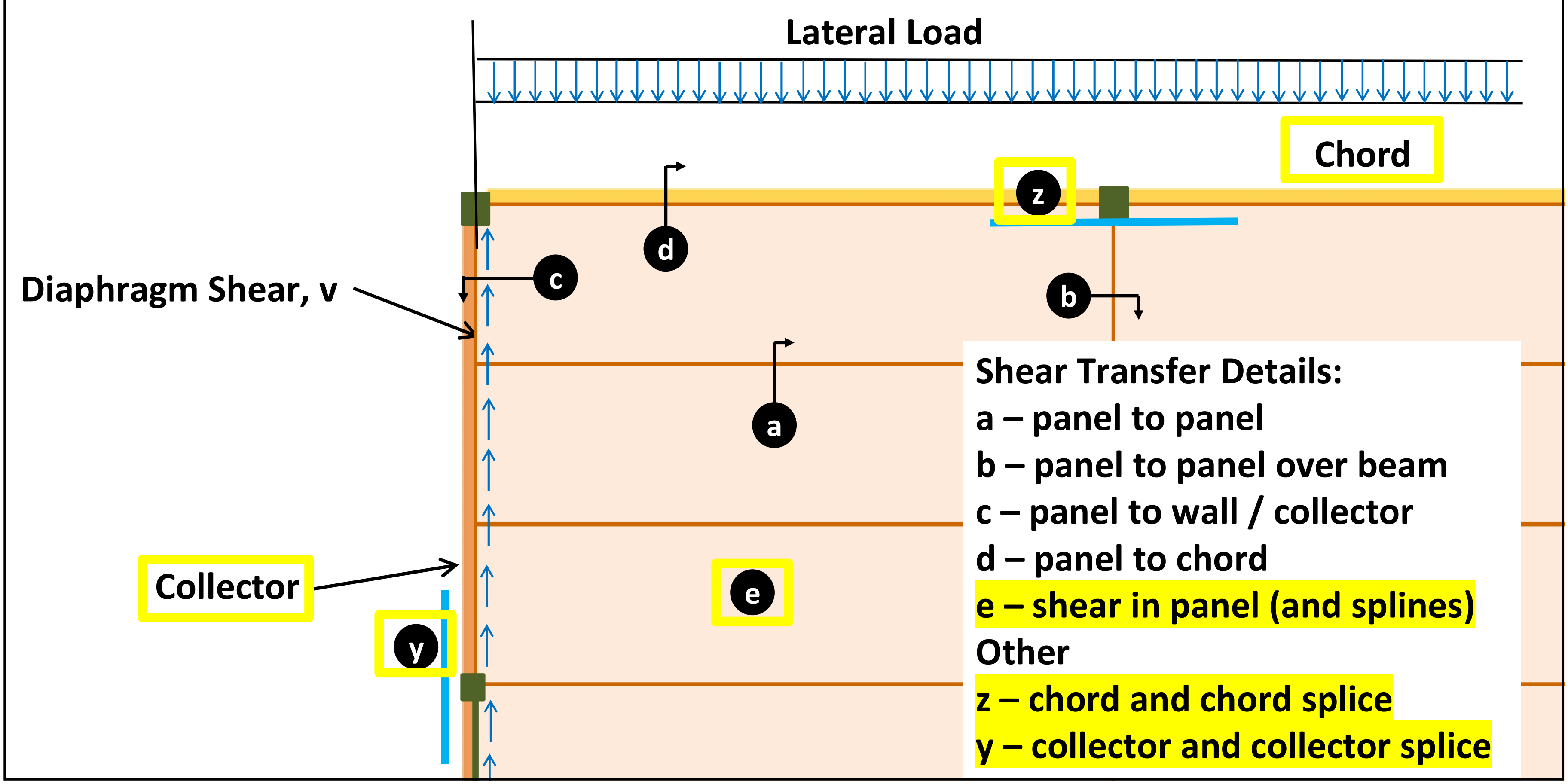
Loading	ASD Design Capacity v_n / Ω_D	LRFD Design Capacity $\phi_D v_n$
Seismic	$v_n/2.8$	$0.50\ v_n$
Wind	$v_n/2.0$	$0.80\ v_n$

$$\frac{v_n}{\Omega_D} \geq F_{design,ASD}$$

$$\phi_D v_n \geq F_{design,LRFD}$$

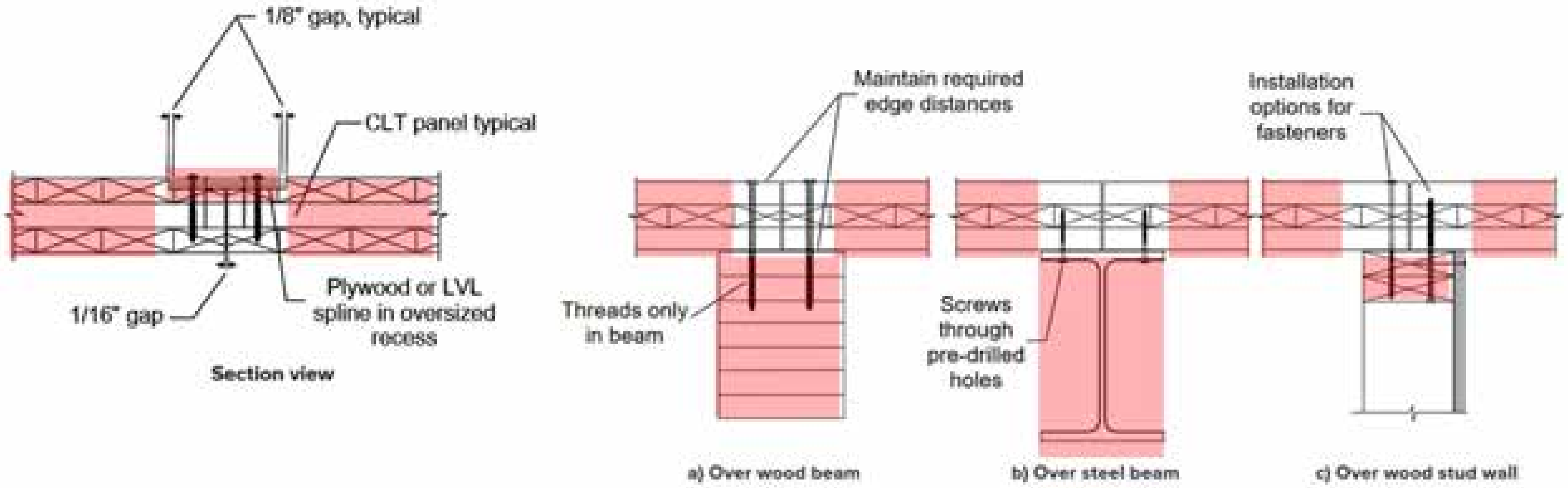
SDPWS 2021 Section 4.1.4

Other CLT Diaphragm Components



Shear Transfer Details:
a – panel to panel
b – panel to panel over beam
c – panel to wall / collector
d – panel to chord
e – shear in panel (and splines)
Other
z – chord and chord splice
y – collector and collector splice

Remainder of Diaphragm (Force-Controlled)



2021 Special Design Provisions for Wind and Seismic

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Other CLT Diaphragm Components

$$R'_{NDS} \geq \gamma_D F_{design,ASD}$$

$$R'_{NDS} \geq \gamma_D F_{design,LRFD}$$

Component	Force Increase Factor γ_D	
	Seismic	Wind
Chord splice connections between wood elements where the connection is using fasteners in shear controlled by yield mode III_s or IV	1.5	1.0
Wood elements and connections between wood elements not meeting the above	2.0	1.5
Steel elements including connections between steel elements	2.0	2.0

2. Connections used to transfer diaphragm shear forces shall not be used to resist diaphragm tension forces.

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*See **SDPWS 2021 Section 4.5.4** for the full information*

More information

- Detailing for performance and constructability
- Determination of diaphragm flexibility
- Calculation of diaphragm deflections
- Precalculated connection capacities
- Combination SDPWS γ_D and ACSE 7 Ω_o and ρ

Available from woodworks.org

WOODWORKS

CLT Diaphragm Design for Wind and Seismic Resistance

Using SDPWS 2021 and ASCE 7-22

AWC SDPWS 2021

Shear Capacity

WoodWorks CLT Diaphragm Design Guide

WOODWORKS
WOOD PRODUCTS COUNCIL

CLT DIAPHRAGM DESIGN GUIDE

BASED ON THE 2021 SDPWS

Under Development By:

WOODWORKS WOOD PRODUCTS COUNCIL

Holmes

kpff

SWINERTON MASS TIMBER

Funded By:

U.S. Endowment for Forestry and Communities

USDA

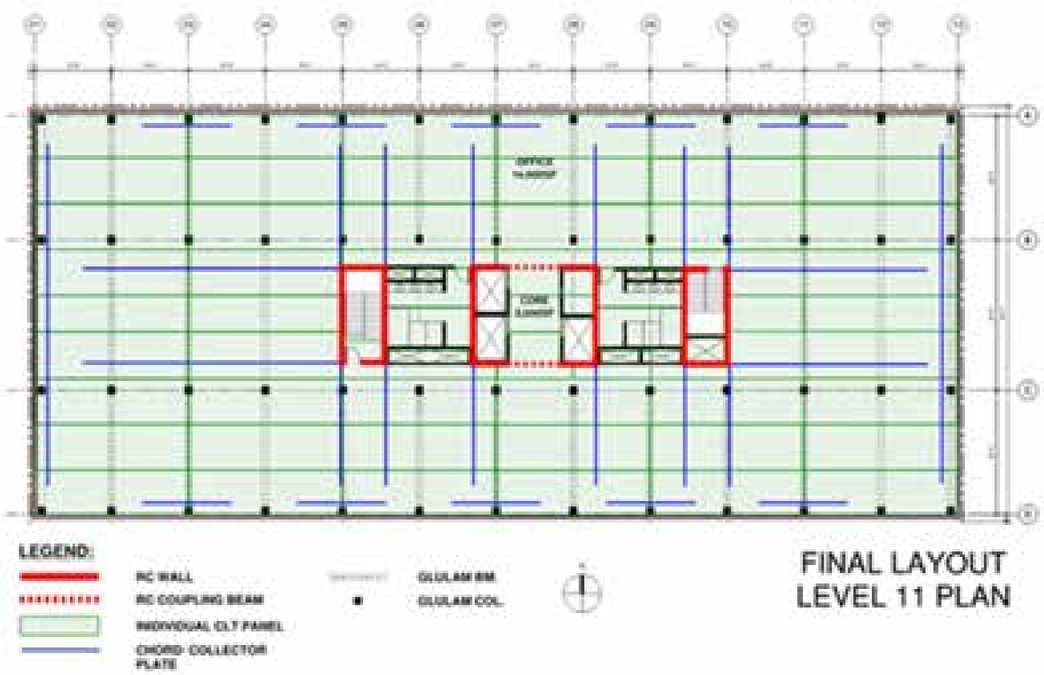
WoodWorks CLT Diaphragm Guideline with Examples

Worked Examples:

- Geographic Distribution
  - High Seismic
  - Low Seismic & High Wind
- Varying vertical lateral systems
  - Core Configurations
  - Distributed Layout
  - Light Framed Shear Walls

WoodWorks CLT Diaphragm Guideline with Examples

Core Configuration:



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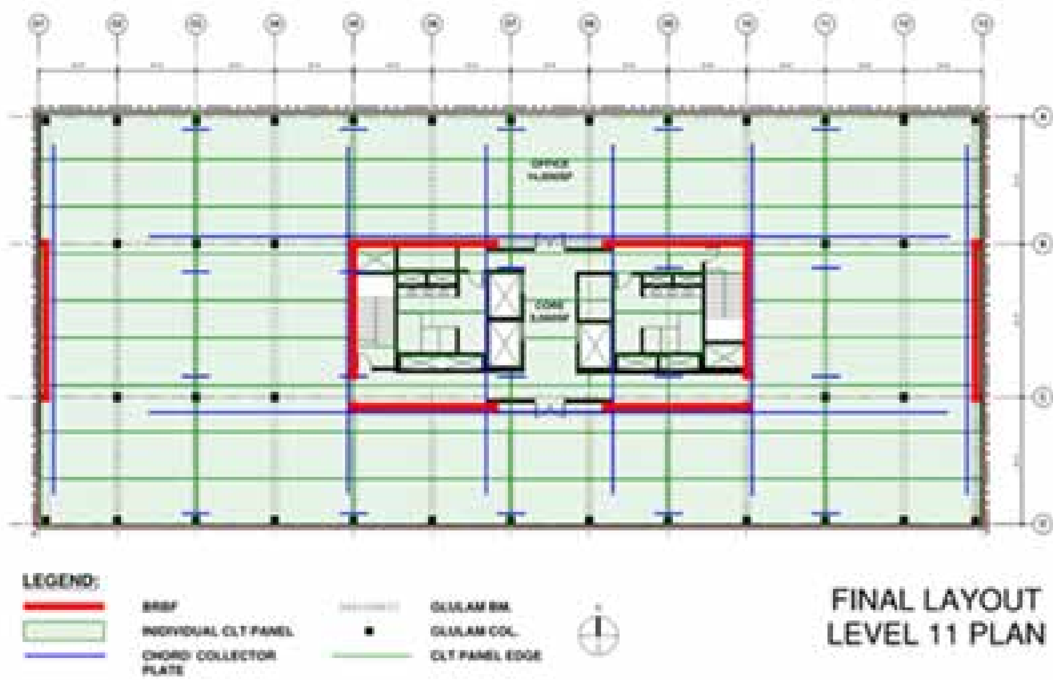
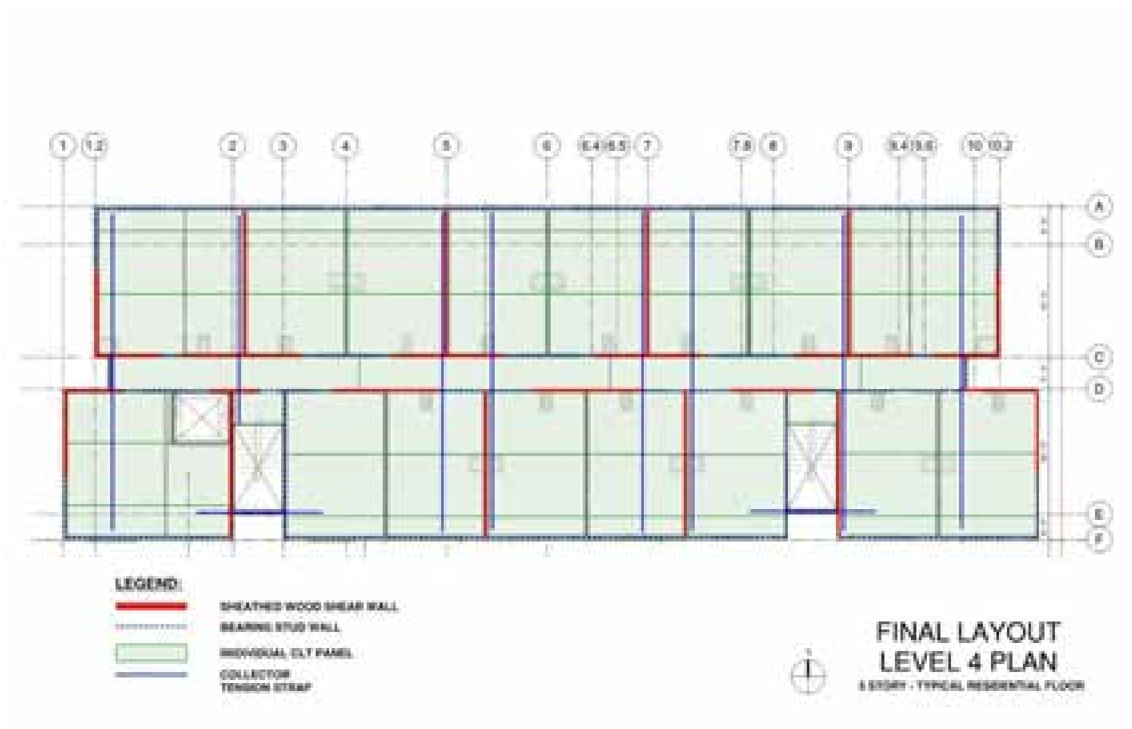
WoodWorks CLT Diaphragm Guideline with Examples

Distributed Lateral System:

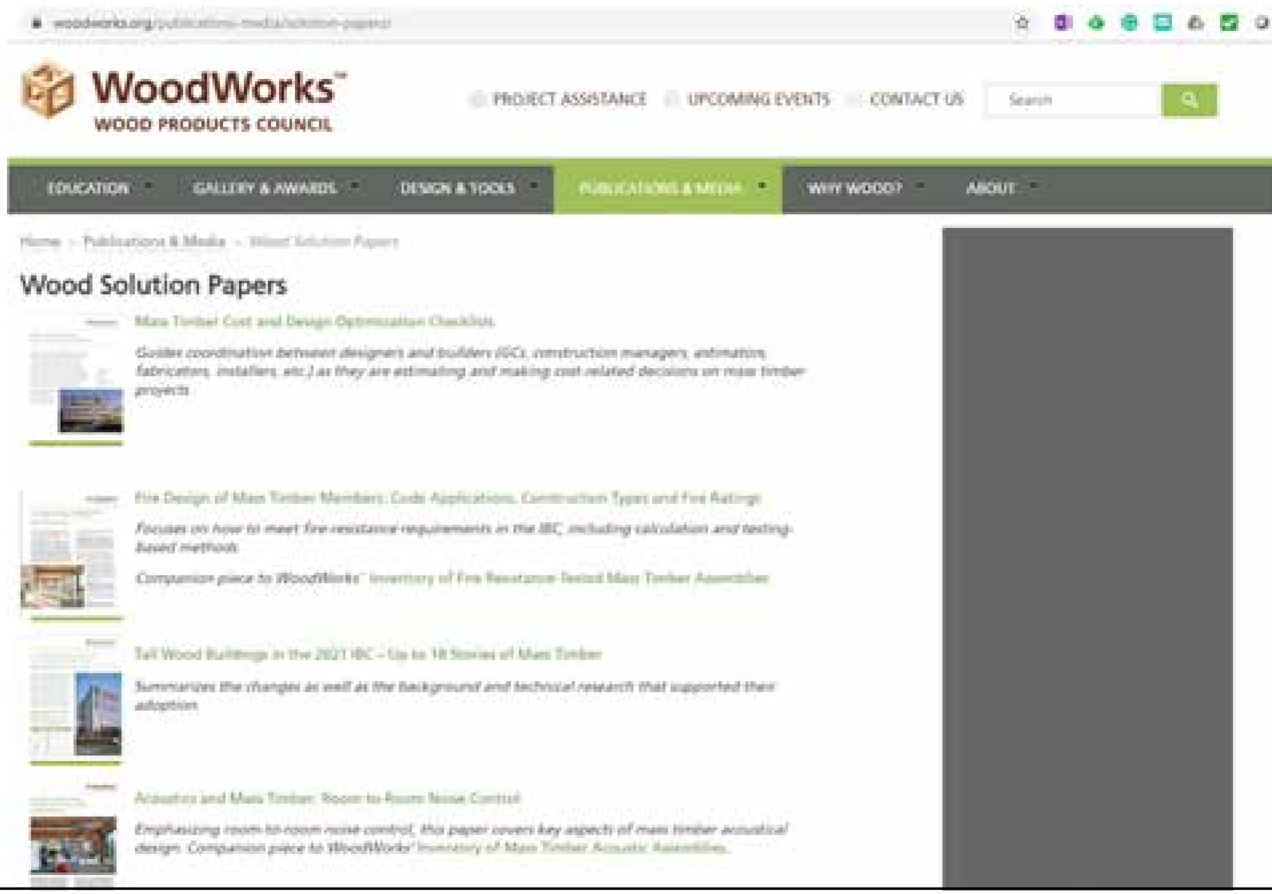


WoodWorks CLT Diaphragm Guideline with Examples

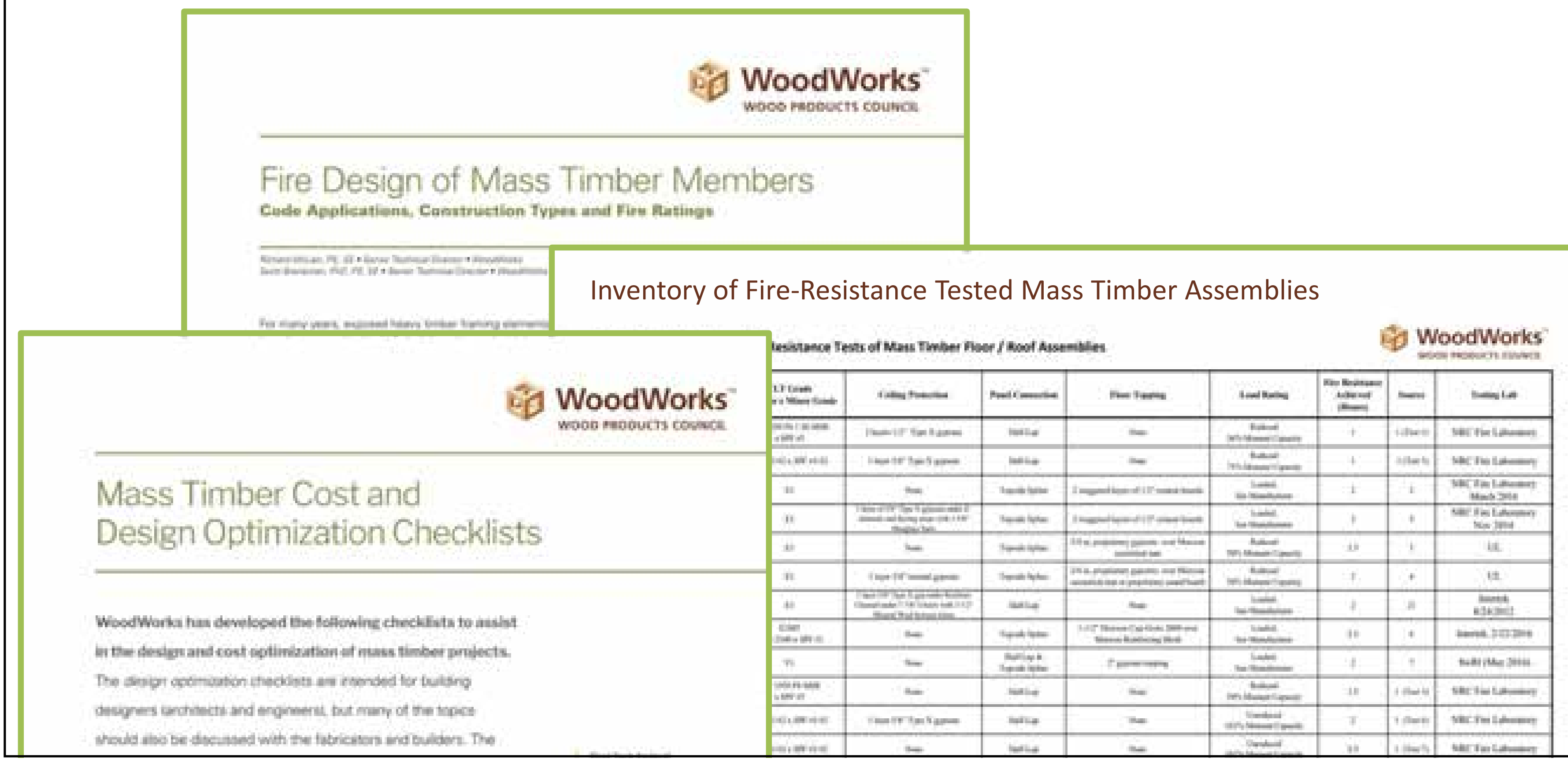
Light-Framed Shear Walls



Additional Resources – WoodWorks.org



Additional Resources – WoodWorks.org

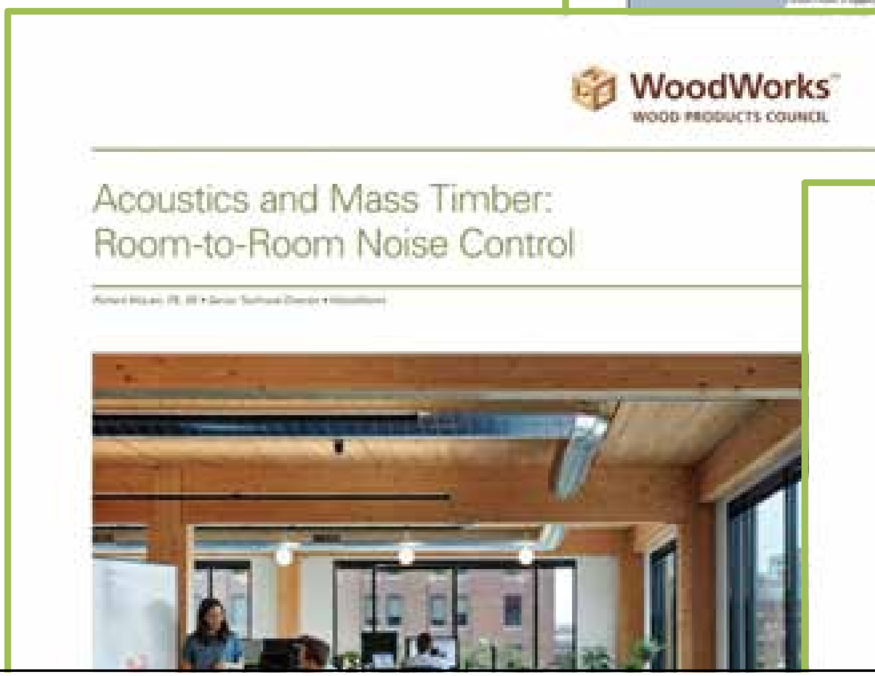


Additional Resources – WoodWorks.org

Inventory of Mass Timber Acoustic Assemblies


Table 1: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed

Acoustical Mat Product Between CLT and Topping	Finish Floor	STC	IIC	Source


WoodWorks
WOOD PRODUCTS COUNCIL

Acoustics and Mass Timber:
Room-to-Room Noise Control


WoodWorks
WOOD PRODUCTS COUNCIL

Tall Wood Buildings in the 2021 IBC
Up to 18 Stories of Mass Timber

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Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

WoodWorks – Wood Products Council
<enter your contact info here>

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