



CLT Diaphragm Design: New Code Provisions and Design Examples

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Architect Hacker, Photo: Structurlam

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Course Description

The use of cross-laminated timber (CLT) as structural floor and roof panels has seen incredible growth in the US over the past decade. However, its use as part of a seismic and wind force-resisting system—either as a diaphragm or shear wall—has not been codified to date. This has resulted in designing CLT diaphragms through alternative means or using a structural topping, such as a layer of wood structural panels or concrete, as the diaphragm. This webinar will introduce new provisions for CLT diaphragm design, in the American Wood Council's 2021 Special Design Provisions for Wind and Seismic (SDPWS), which will be the code-referenced standard to provide guidance on CLT diaphragms. Following a discussion of the new SDPWS provisions, CLT diaphragm detailing options and design examples will be presented in order to apply practical design techniques and discuss structural detailing challenges and solutions.

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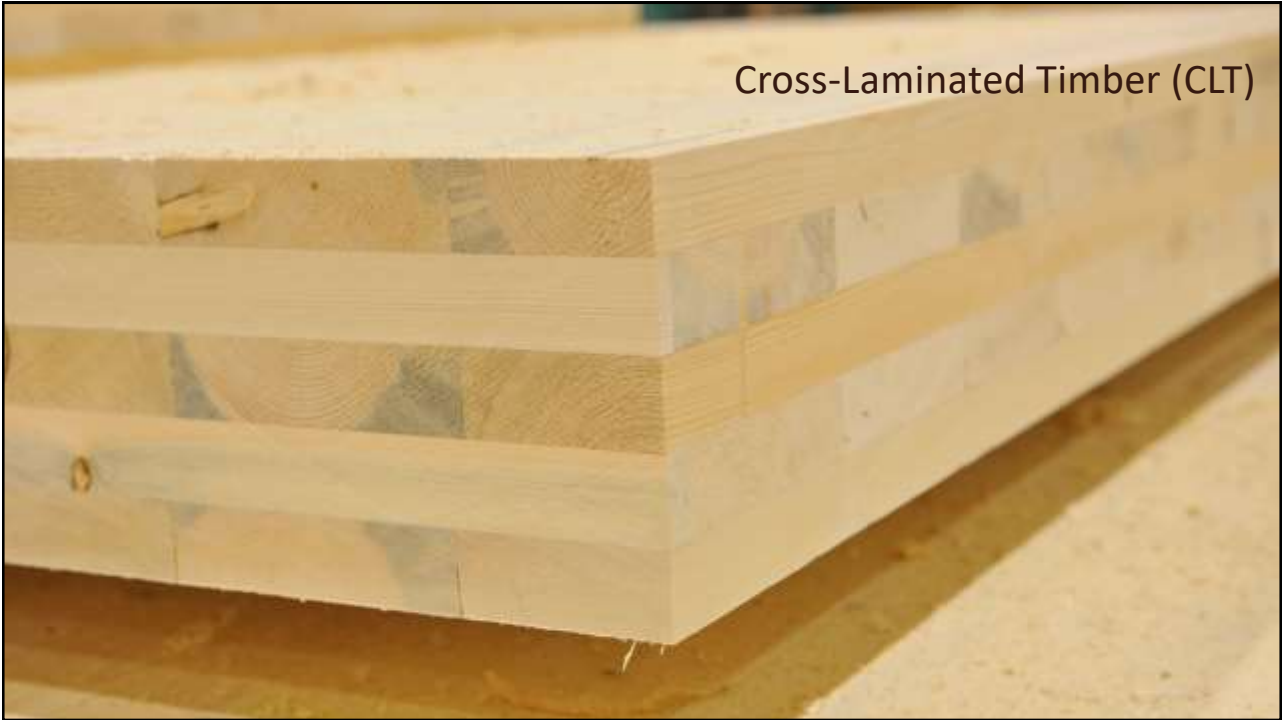


Learning Objectives

- Develop an understanding of structural design challenges as it pertains to designing CLT while meeting the intent of the code.
- Discuss new provisions contained in the 2021 SDPWS related to the design of CLT diaphragms.
- Examine common panel to panel detailing options in CLT diaphragms to understand the impact of detailing on the relative strength, stiffness, costs and constructability.
- Describe some detailing challenges and solutions for chord and collector conditions in CLT diaphragms.

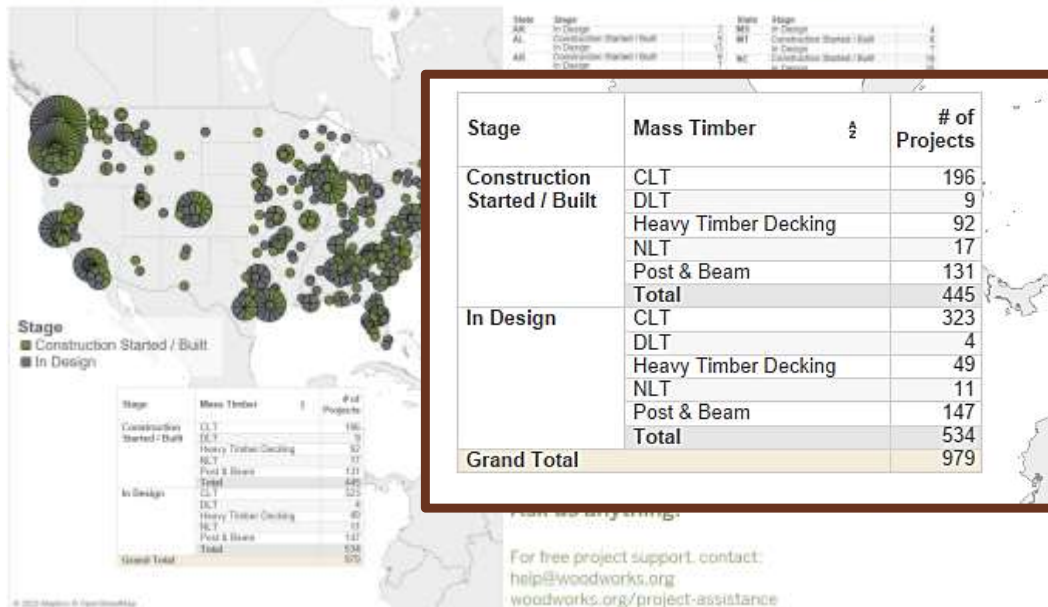
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Cross-Laminated Timber (CLT)



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Mass Timber Projects In Design and Constructed in the US (September 2020)



<https://www.woodworks.org/publications-media/building-trends-mass-timber/>

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Cheney Park Apartments
CLT floor on Panelized
Light Frame Walls



Photo Credit: WoodWorks



Photo Credit: WoodWorks

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Barracuda Condos
Madison WI



Photo Credit: WoodWorks

Public Library
Brentwood CA



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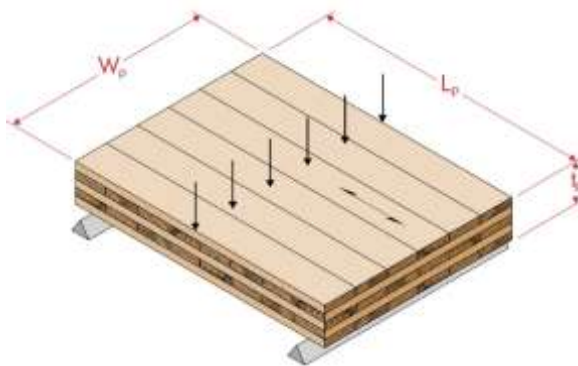
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CLT Building Code Acceptance

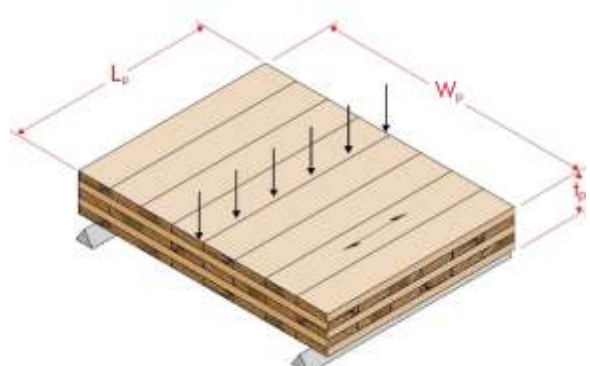


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FLATWISE Panel Loading



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

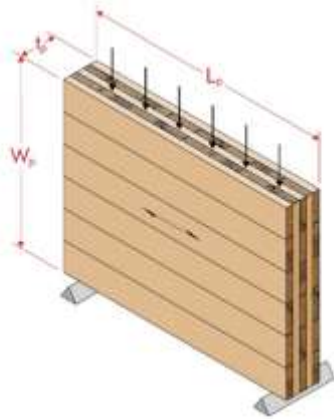


Span in **MINOR** Strength Direction
 "Perpendicular" Direction
 Use subscript '90' in Notation

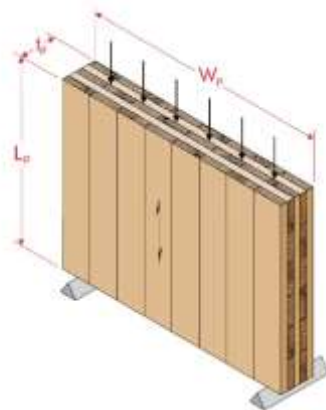
Reference & Source: ANSI/APA PRG 320

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EDGEWISE Panel Loading



Span in **MAJOR** Strength Direction

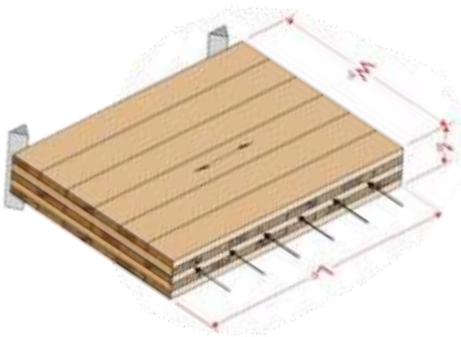


Span in **MINOR** Strength Direction

Reference & Source: ANSI/APA PRG 320

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EDGEWISE Panel Loading



Span in **MAJOR** Strength Direction



Span in **MINOR** Strength Direction

Reference & Source: ANSI/APA PRG 320

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CLT Seismic Design

CLT Seismic Force Resisting Systems **Not** addressed In



ASCE/SEI 7-10 or 7-16



SDPWS 2015

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CLT in In-Plane (Edgewise) Strength

TABLE 3—REFERENCE DESIGN VALUES FOR IN-PLANE SHEAR OF THE STRUCTURAL CROSSLAM® CLT PANELS¹

CLT LAYOUT ²	CLT PANEL THICKNESS DESIGNATION	FACE LAMINATION ORIENTATION ³ (psi)		FACE LAMINATION ORIENTATION ³ (lb/ft of width)	
		v^4	Δ^4	v^4	Δ^4
V2MT	98 V	175 ⁵	235 ⁵	8,200 ⁷	11,000 ⁷
	169 V	175 ⁵	235 ⁵	14,000 ⁷	18,800 ⁷
	239 V	175 ⁵	235 ⁵	19,800 ⁷	26,600 ⁷
	309 V	175 ⁵	235 ⁵	25,600 ⁷	34,300 ⁷
V2MT.1	109V	195	290	9,700	14,400
	179V	270	290 ⁷	22,400	24,000 ⁷
	249V	270 ⁷	290 ⁷	31,300 ⁷	33,600 ⁷
	319V	270 ⁷	290 ⁷	40,200 ⁷	43,200 ⁷

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

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 > 9 kips / ft in-plane shear capacity

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

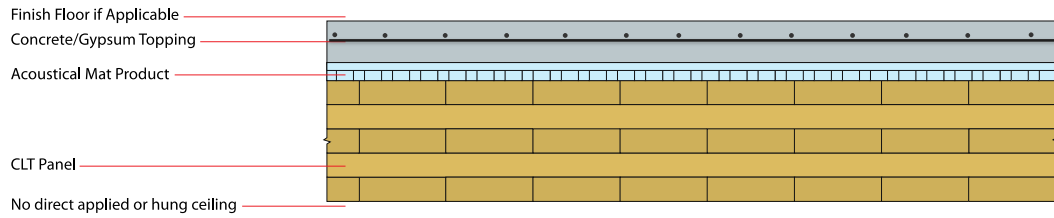
Major Strength Direction		Minor Strength Direction	
$F_{v,0.05}^{(10)}$ (psi)	$G_{0.05} \text{ lb/ft}^2$ (10^3 lb/ft^2)	$F_{v,0.05}^{(10)}$ (psi)	$G_{0.05} \text{ lb/ft}^2$ (10^3 lb/ft^2)
155 ⁽¹⁰⁾	1.36	190 ⁽¹⁰⁾	1.36
155	1.52	190 ⁽¹⁰⁾	1.52
155	1.79	190	1.79
185 ⁽¹¹⁾	2.23	215 ⁽¹¹⁾	2.23
145	2.39	190 ⁽¹⁰⁾	2.39
185 ⁽¹¹⁾	2.44	215 ⁽¹¹⁾	2.44
185	2.99	215	2.99
155 ⁽¹¹⁾	3.37	215 ⁽¹¹⁾	3.37
185 ⁽¹¹⁾	3.64	215 ⁽¹¹⁾	3.64
185 ⁽¹¹⁾	3.75	215 ⁽¹¹⁾	3.75
185 ⁽¹¹⁾	4.18	215 ⁽¹¹⁾	4.18
185 ⁽¹¹⁾	4.18	215 ⁽¹¹⁾	4.18
155 ⁽¹¹⁾	4.56	215 ⁽¹¹⁾	4.56
185 ⁽¹¹⁾	5.38	215 ⁽¹¹⁾	5.38

Source: APA Product Report PR-L306

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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.

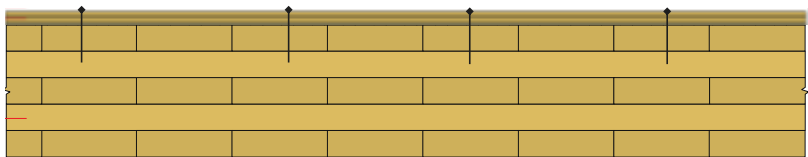
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Diaphragm Strategies with Horizontal CLT

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

WSP as diaphragm

CLT Panel as
laminated decking



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?

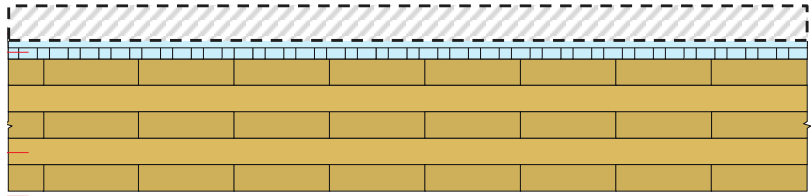
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Diaphragm Strategies with Horizontal CLT

Option 2: CLT as a Diaphragm via Engineering Principles

Topping and Flooring
as needed

CLT Panel as
Diaphragm



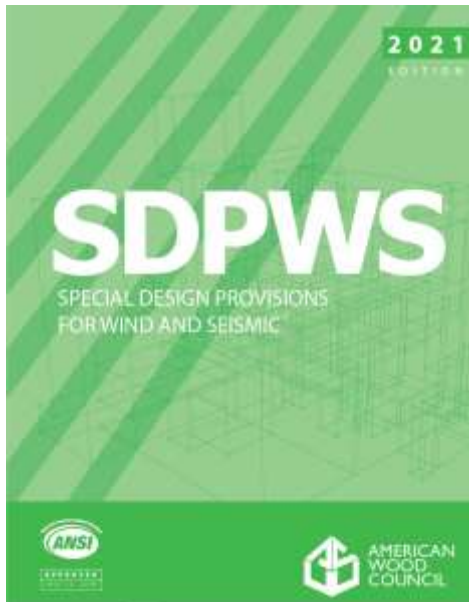
CLT Diaphragms not Recognized in IBC 2018 and
Reference Standards.
Guidance documents and Precedents Available.

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> Special Design Provisions for Wind & Seismic 2021 Update

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2021 Special Design Provisions for Wind and Seismic



- Referenced in 2021 International Building Code
- CLT diaphragm provisions in Section 4.5

Target minimum nominal unit shear capacity of 2.8 times ASD unit shear capacity for seismic

- ✓ Nominal unit shear capacity based on dowel-type fasteners with Z value controlled by Mode III_s or IV yield per NDS
- ✓ Wood elements, steel parts and chord splice connections designed for increased forces to meet the minimum strength objective

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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 analysis shows otherwise, does not exceed the maximum permissible deflection limit of attached and detaching or separating elements. Permissible deflections shall be those deflections that will permit the diaphragm and any attached elements to maintain their overall integrity and continue to support their prescribed loads as determined by the applicable building code in standard.

4.5.2 Definition

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

4.5.3 Unit Shear Capacity

CLT diaphragms shall be designed to 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 of the dowel-type fastener connections used to transfer diaphragm shear forces, as calculated per 4.1.4, times 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 ϕZ^* , where Z^* is Z multiplied by all applicable NDS adjustment factors except C_d , C_{ix} , C_{it} , and C_{ix} shall be controlled by Mode III_s or Mode IV for

more yielding in accordance with NDS 12.1.1.

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 prescribed seismic and wind design loads, respectively.
2. Where dowel-type fasteners are used in chord splice connections and the connection is controlled by Mode III_s 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 elements other than wood or steel shall be designed using provisions in NDS 1.4.

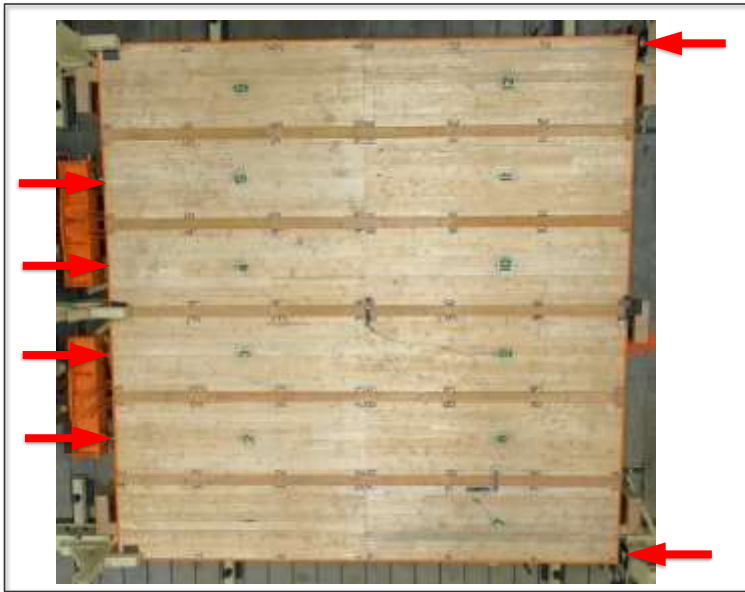
- Unit shear capacity based on dowel-type fastener connections
- Fastener Z value controlled by Mode III_s or IV per NDS
- Wood elements, steel parts and chord splice connections designed for 2.0 times forces induced from design loads

Exceptions:

- 1) Wood elements and chord splice connections for wind (1.5 times)
- 2) Mode III_s or IV dowels in chord splice connections (1.5 times for seismic, 1.0 times for wind)

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24' x 24' CLT Diaphragm Test with Plywood Spline



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2021 Special Design Provisions for Wind and Seismic

4.1.4 Shear Capacities

4.1.4.1 For seismic design of diaphragms and shear walls, the ASD allowable shear capacity shall be determined by dividing the nominal shear capacity in 4.1.2 by the ASD reduction factor of 2.8 and the LRFD factored shear resistance shall be determined by multiplying the nominal shear capacity by a resistance factor, ϕ , of 0.50. No further increases shall be permitted.

4.1.4.2 For wind design of diaphragms and shear walls, the ASD allowable shear capacity shall be determined by dividing the nominal shear capacity in 4.1.2 by the ASD reduction factor of 2.0 and the LRFD factored shear resistance shall be determined by multiplying the nominal shear capacity by a resistance factor, ϕ , of 0.80. No further increases shall be permitted.

- 4.5.4...Nominal shear capacity for dowel-type fastener connections:

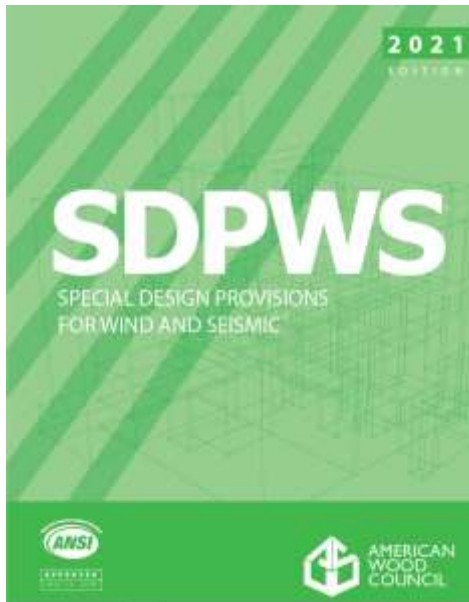
$$= 4.5Z^*$$

Where Z^* is Z multiplied by all applicable adjustment factors except C_D , K_F , ϕ , λ

- 4.1.4.1 Seismic Design
 - ASD: Nominal/2.8
 - LRFD: (Nominal)(0.5)
- 4.1.4.2 Wind Design
 - ASD: Nominal/2.0
 - LRFD: (Nominal)(0.8)

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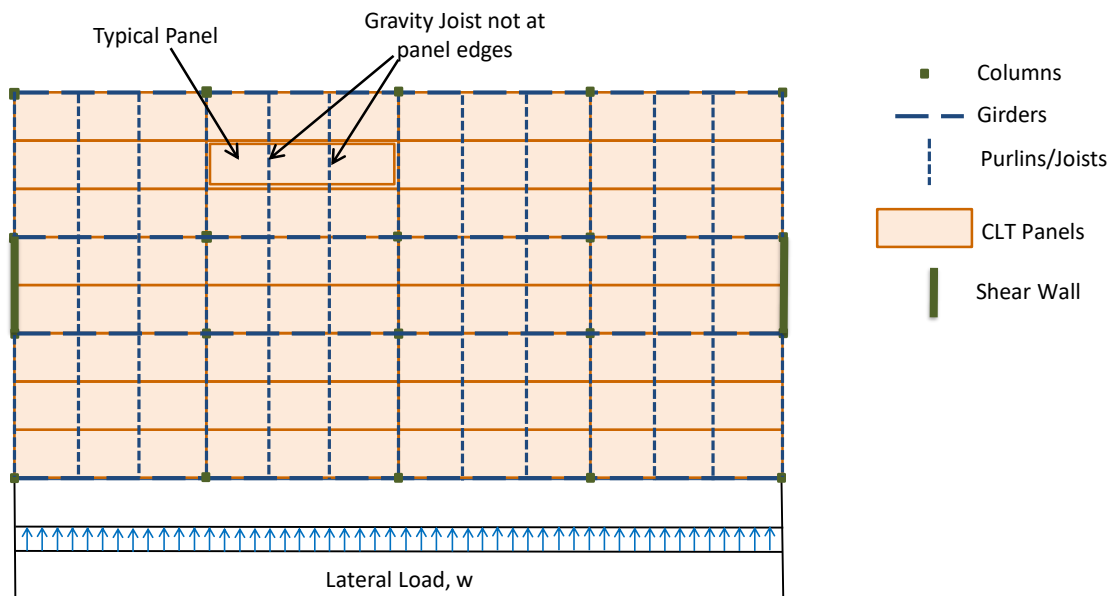
2021 Special Design Provisions for Wind and Seismic



- Free view at [AWC.org](https://www.awc.org)

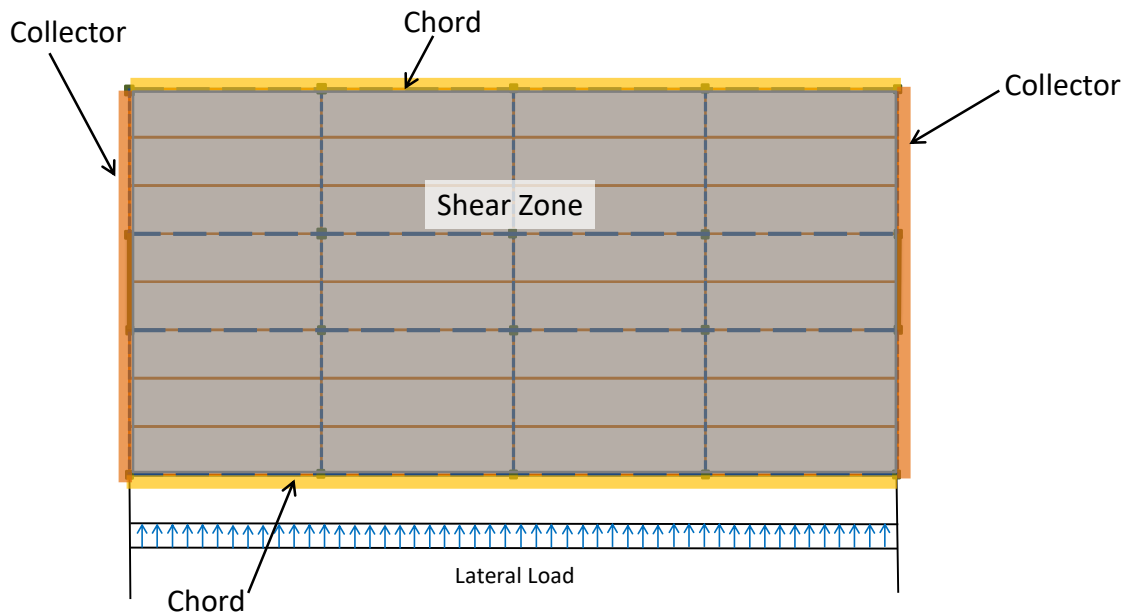
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Generic Mass Timber Floor System



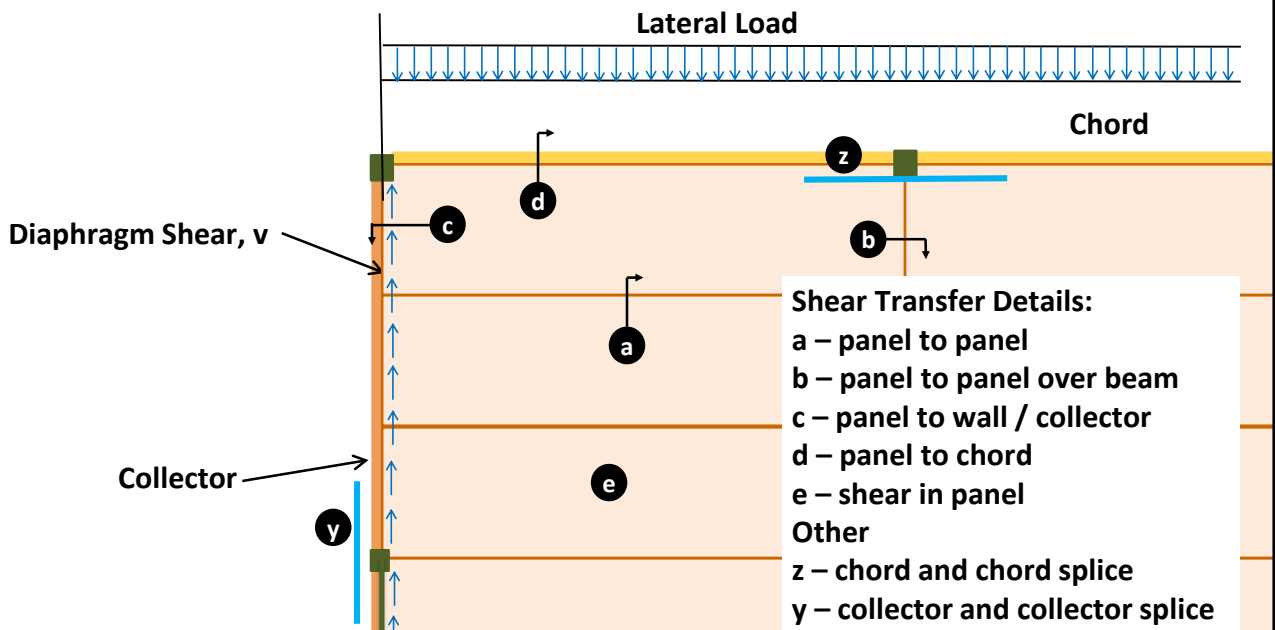
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Example CLT Diaphragm Design



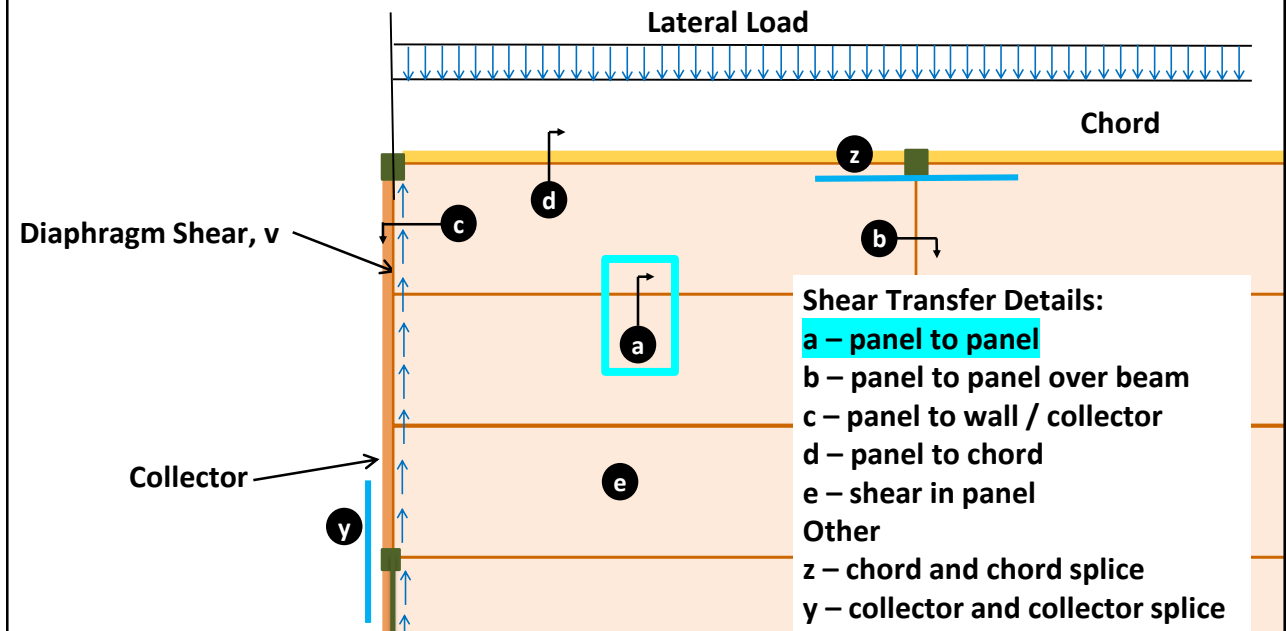
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Example CLT Diaphragm Design



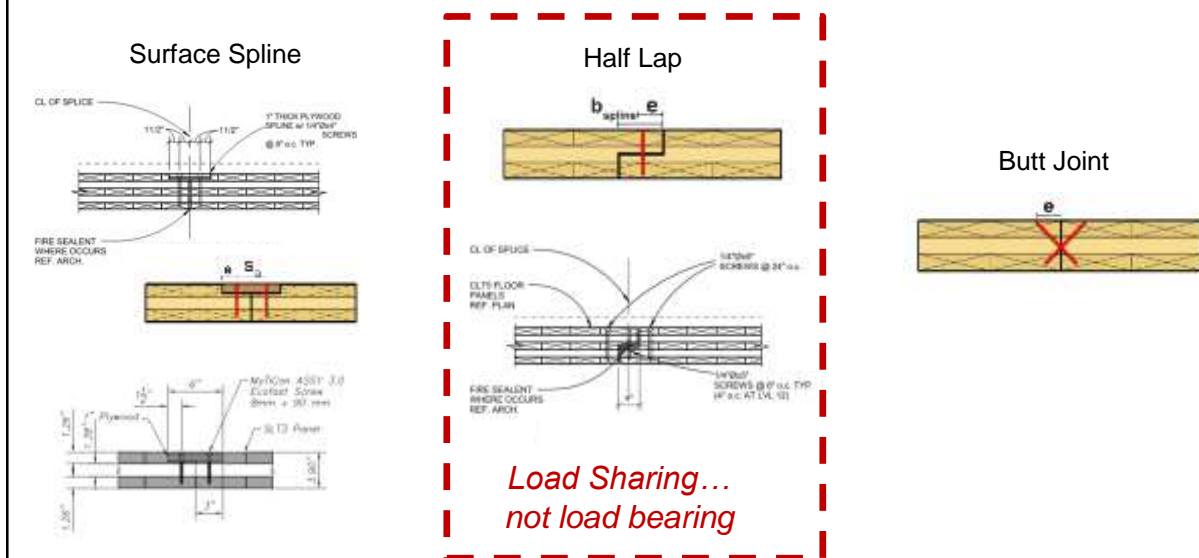
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Example CLT Diaphragm Design



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Panel to Panel Connection Styles

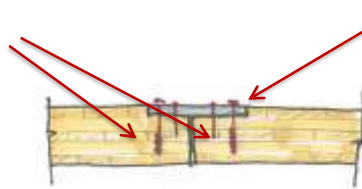


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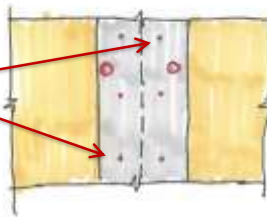
An Efficient Panel to Panel Connection

Self-Tapping Screws
as "erection bolts"
@ 18" – 24" o.c

5 ½" to 6" plywood
strip ¾" or 1" Thick



Nails at spacing
required for shear
transfer



Graphics: ASPECT Structural Engineers

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Connection Styles



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Fastener Vendor Design Support



Surface Splines

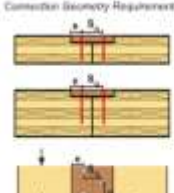
Table 1. Surface Spline Reference Design Values

CLT Grade	Spline Thickness	Dimensions			Spline Depth for 4800 Series (inches)	Reference Design Values		
		a	b	c		$F_{v, \text{Stud}}$	$F_{v, \text{Stud}}$	$F_{v, \text{Stud}}$
5-ply 2080	3/4"	10/16"	1/2"	3/4"	10/16" x 1/2"	175	0.3	100
5-ply 2080	3/4"	1/2"	1/4"	1/2"	1/2" x 1/4"	150	0.3	100
5-ply 2080	3/4"	3/4"	1/2"	1/2"	3/4" x 1/2"	175	0.3	100
5-ply 2080	1/2"	1/2"	1/4"	1/2"	1/2" x 1/4"	150	0.3	100
5-ply 2080	3/4"	1/2"	1/2"	1/2"	1/2" x 1/2"	175	0.3	100

Notes:

- Take 1 inch reference design values valid for reference design values in the table for a single 4800 Series spline fastener as shown in the connection geometry and loading conditions described on this page.
- It is recommended to stagger the splines across the face of the panel, as illustrated in the table.
- Control reference lateral design values only apply to the 4800 Series and 4800 Series.
- Fastener must be installed in panel face to face to work against water to prevent the fastener from splitting.
- CLT panel ply thickness are assumed to be 1/2" (12 mm).
- Control reference lateral design values given correspond to load duration factor $C_D = 1.0$. Reference design values may be adjusted for a different load duration factor C_D .
- Control reference lateral design values are valid for dry service conditions ($C_M = 1.0$).

Connection Geometry Requirements






Table 1. Reference allowable load and edge modulus for NDS Timber Screws (NDS24000E and NDS24000R) for CLT surface spline fastening with 1-1/8-in. APA rated Sural-4-Kor wood structural panel, single surface splines.

CLT Wood Species Combination	Allowable load per Fastener (lb)	Fastener edge modulus (in./ft)
SPF	375	0.15
SYP	375	0.15
SPF-S	375	0.15

Notes:

- Allowable loads are given at $C_u = 1.0$ and may be increased up to $C_u = 1.6$ as permitted by the building code.
- Applicable adjustments shall be applied following the ANSI/APA NDS-13 or NDS-18.
- Design values are applicable for all grain orientation combinations of major strength directions in the CLT and the wood structural panel spline and grades of CLT for the species combinations listed.
- Designer is responsible to check shear capacity of spline shear through the thickness and edge shear.

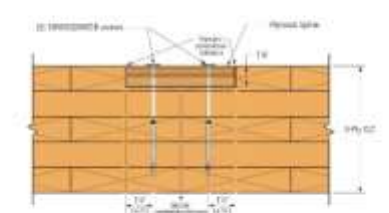
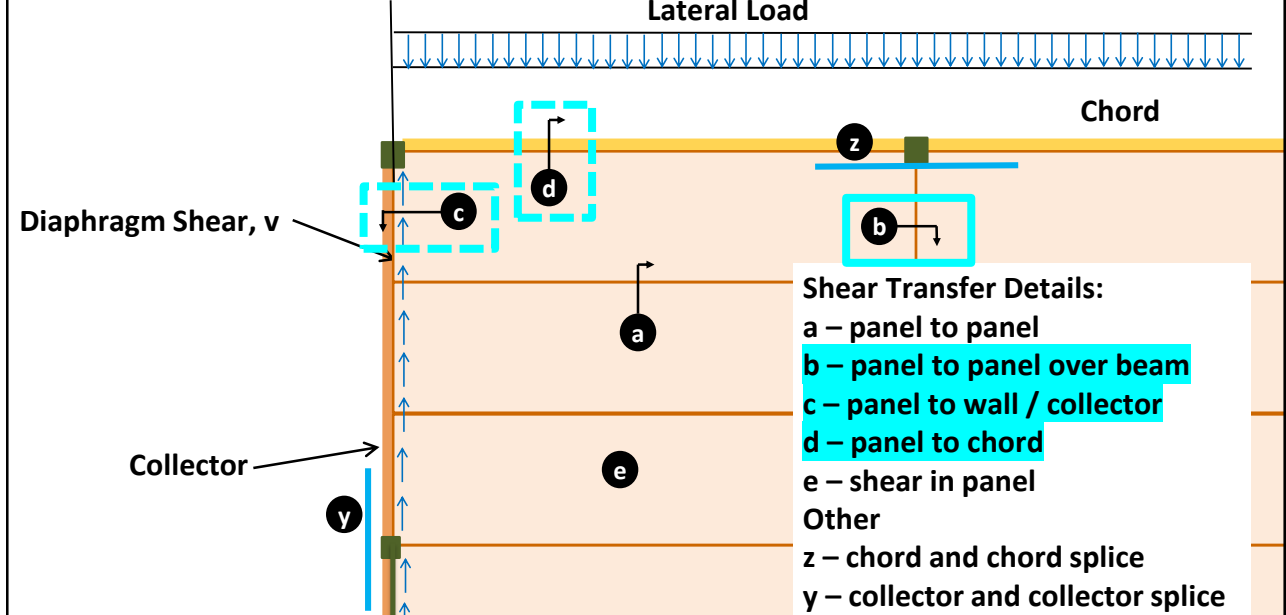


Figure 1: Typical end elevation - Single surface spline with 5-ply CLT panels, 1-1/8-in. spline (plywood) chords, 6-in. x 6-in., and 6-in. NDS Timber screws (NDS24000R).

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Example CLT Diaphragm Design



Lateral Load

Chord

Diaphragm Shear, v

Collector

Shear Transfer Details:

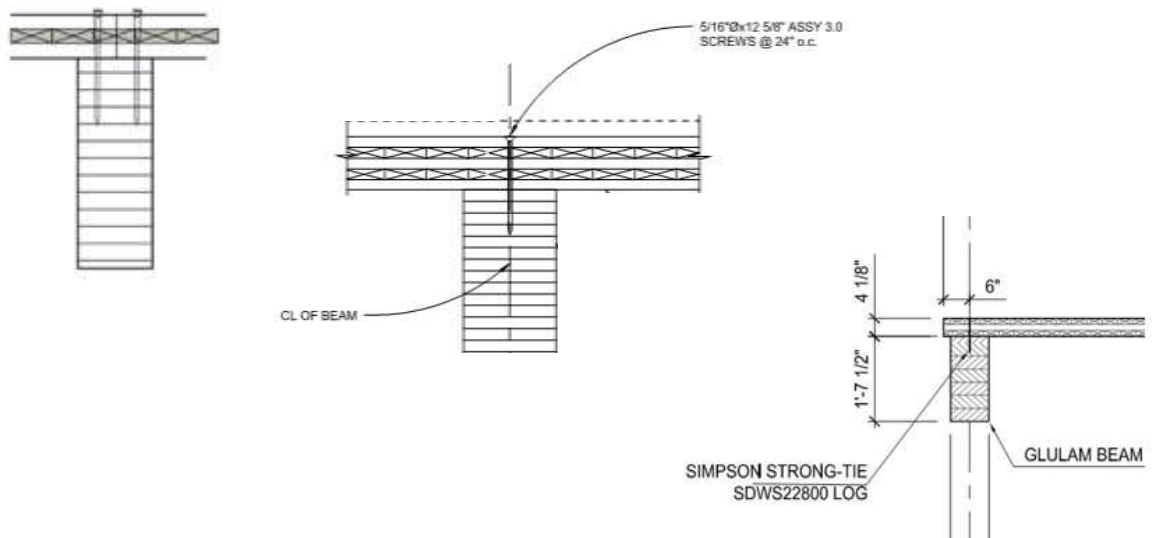
- a – panel to panel
- b – panel to panel over beam
- c – panel to wall / collector
- d – panel to chord
- e – shear in panel

Other

- z – chord and chord splice
- y – collector and collector splice

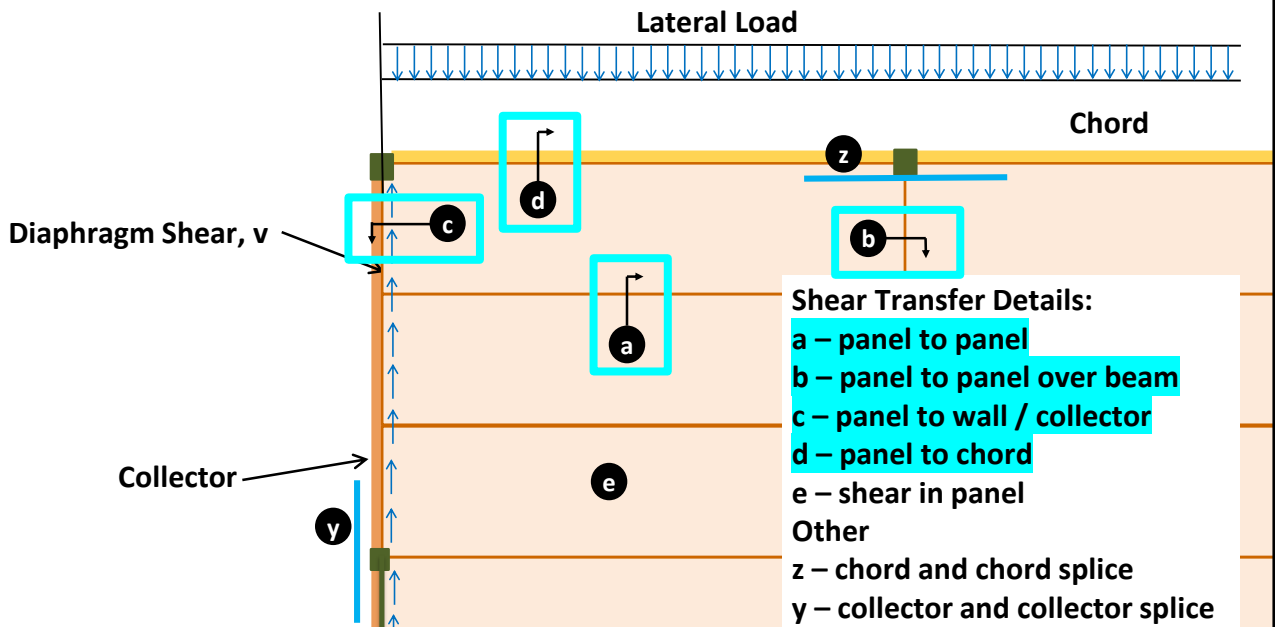
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Panel to Beam Connection Styles



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CLT Diaphragm Shear Transfer Connections



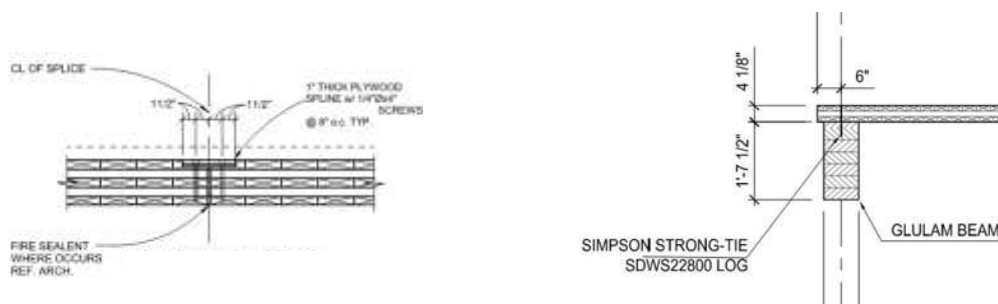
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CLT Diaphragm Shear Connection Design

CLT Diaphragm Shear Capacity

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

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

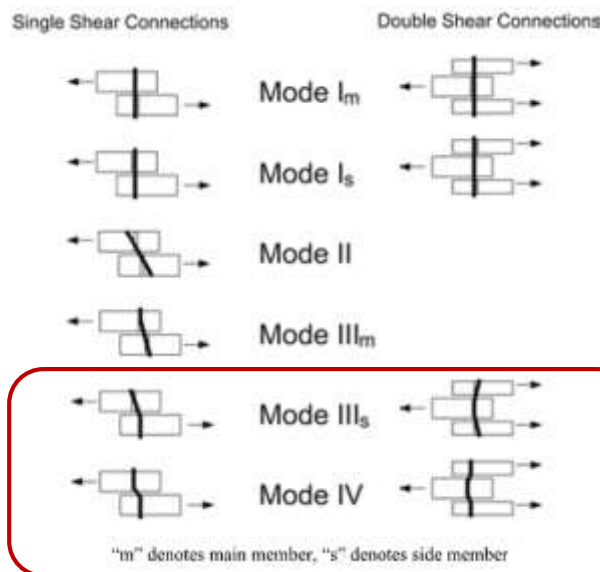


SDPWS 2021 Section 4.5.3

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Connection Yield Modes Per the NDS

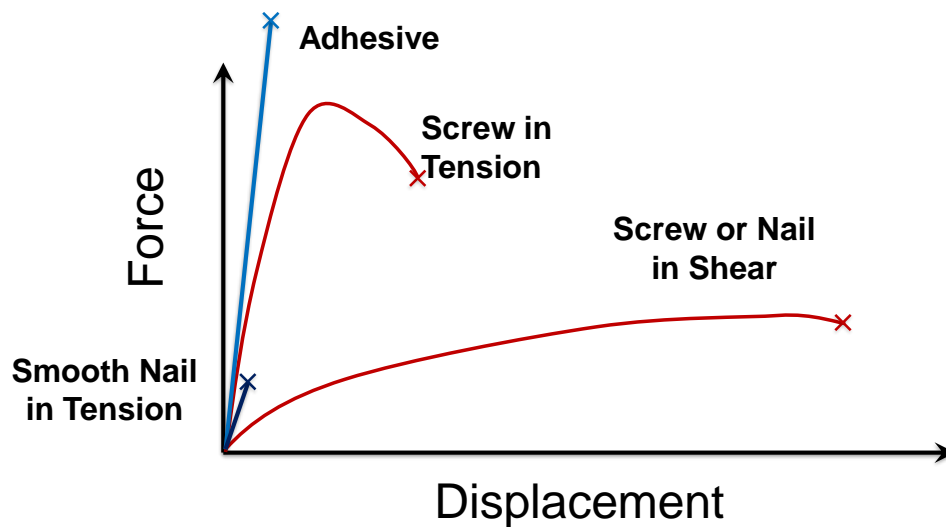
CLT Diaphragm Shear Capacity



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Conceptual Fastener Behavior

CLT Diaphragm
Shear Capacity

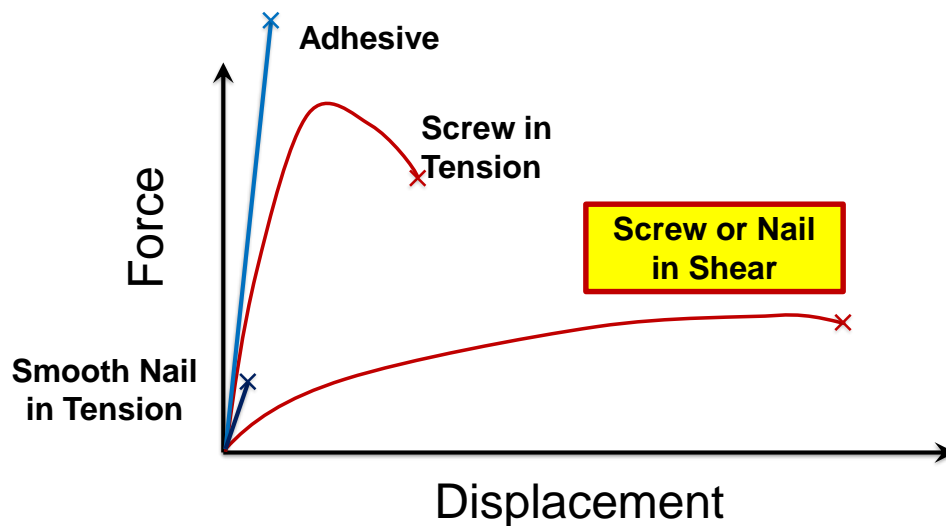


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Conceptual Fastener Behavior

CLT Diaphragm
Shear Capacity

Well behaved seismic systems have ductile failure modes.



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CLT Diaphragm Shear Connection Design

CLT Diaphragm Shear Capacity

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 , $\lambda = 1.0$

SDPWS 2021 Section 4.5.4(1) and NDS Table 11.3.1

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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 ¹	Penetration Depth Factor ³	End Grain Factor ²	Metal Side Plate Factor ³	Diaphragm Factor ²	Toe-Nail Factor ²	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	1.0	C _A	-	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

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CLT Diaphragm Shear Connection Design

CLT Diaphragm Shear Capacity

Fastener with regular spacing, S , nominal unit shear connection capacity is:

$$v_n = Z_n/S = 4.5 Z^*/S$$

Required unit shear strength \leq Design unit shear capacity

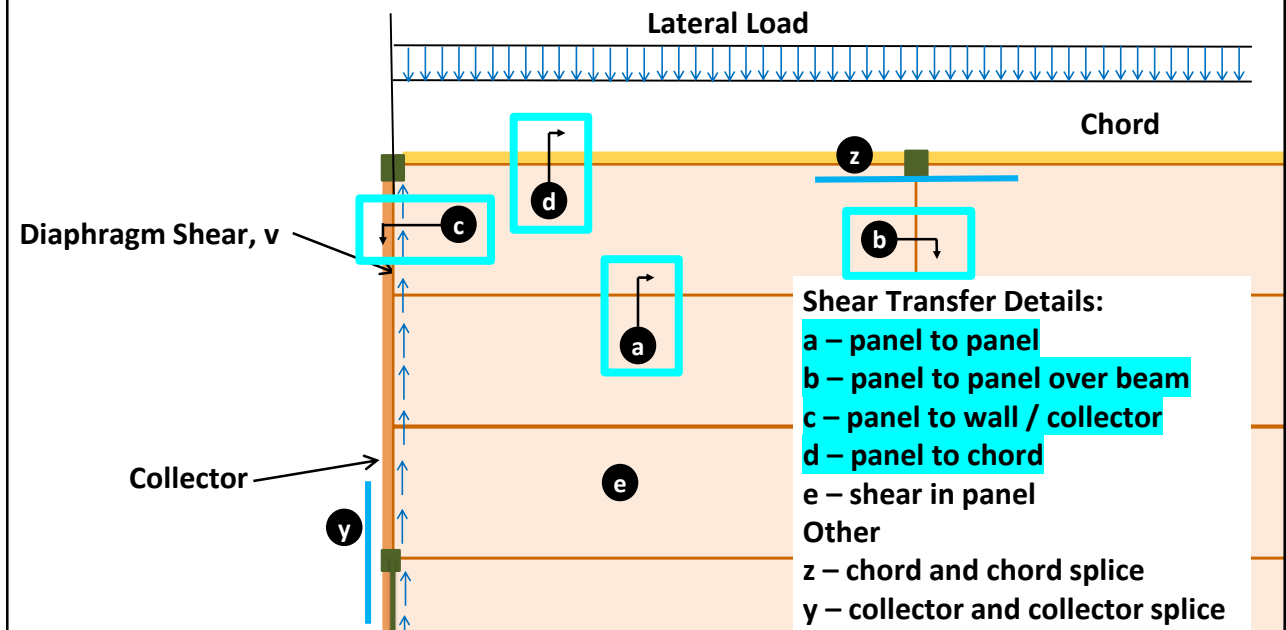
ASD $v = v_{ASD} \leq \frac{v_n}{RF}$ $RF = 2.8 \text{ (seismic)}$
 $= 2.0 \text{ (wind)}$

LRFD $v = v_u \leq \phi v_n$ $\phi = 0.5 \text{ (seismic)}$
 $= 0.8 \text{ (wind)}$

SDPWS 2021 Section 4.1.4 and 4.5.4(1)

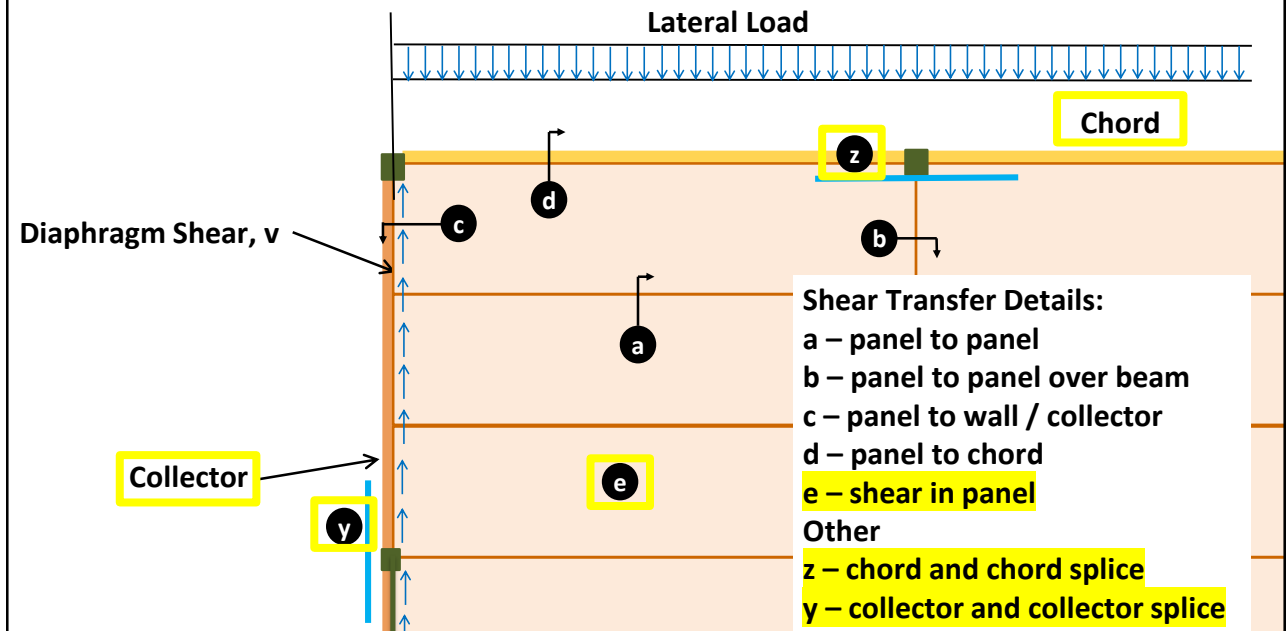
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CLT Diaphragm Shear Transfer Connections



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Other CLT Diaphragm Components



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Other CLT Diaphragm Components

Additional Design Requirements

Engineering goal: Design CLT panels, diaphragm chord members and chord splices such that diaphragm develops target shear capacity in ductile manner:

Approach 1: Capacity Based Design

Amplified nominal capacity of shear connections

$$\alpha \cdot v_n \leq v'$$

Design capacity of other components

SDPWS Approach

Approach 2: Overstrength Approach

Amplified applied wind or seismic forces

$$\gamma \cdot v \leq v'$$

Design capacity of other components

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Other CLT Diaphragm Components

Additional Design Requirements

Amplified Diaphragm Design Forces \leq Design Capacity

$$\gamma \cdot v \leq v'$$

v = wind or seismic force demand

v' = Adjusted capacity
calculated per the NDS

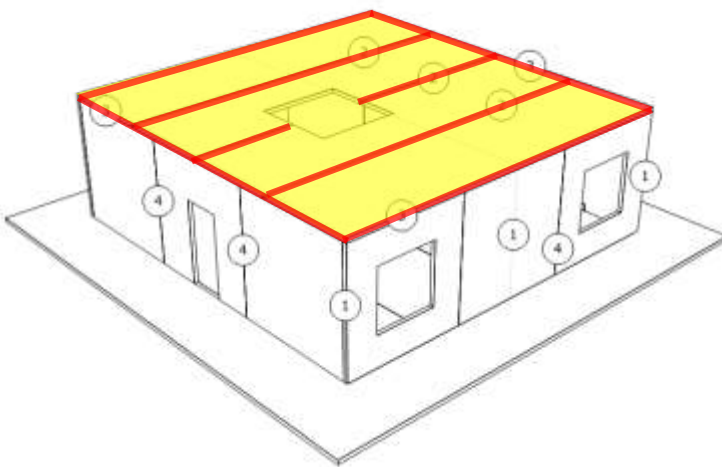
$\gamma =$

- 2.0 for wood and steel components, except:
- 1.5 wood members resisting wind loads
- 1.5 chord splice connections controlled by Mode IIIs or IV (seismic)
- 1.0 chord splices connections controlled by Mode IIIs or IV (wind)

See *SDPWS 2021 Section 4.5.4* for the full information

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CLT Diaphragms



Is the Diaphragm
Rigid or Flexible?

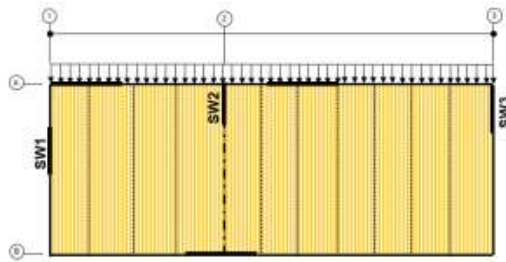
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Lateral Load Distribution using CLT Diaphragms

Option 1: Simplified Seismic Design

Regular structure, ≤ 3 stories & other limitations per ASCE 7 12.14

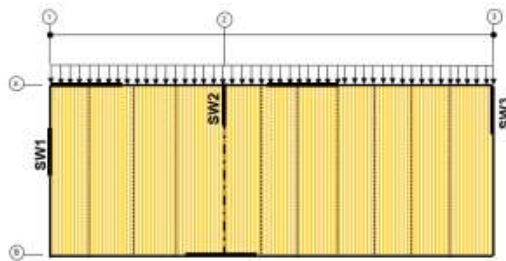
Can Assume Flexible if ASCE 7 12.14.1.1.8 met



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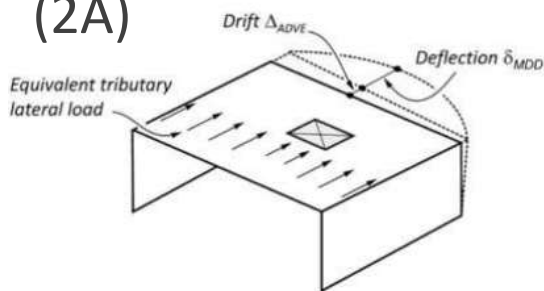
Lateral Load Distribution using CLT Diaphragms

Option 2: Idealize as Flexible (2A) or Rigid (2B) as Justified by Calculated Diaphragm Deflections



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(2A)



12.3.1.3 Calculated Flexible Diaphragm Condition. Diaphragms not satisfying the conditions of Sections 12.3.1.1 or 12.3.1.2 are permitted to be idealized as flexible provided:

$$\frac{\delta_{MDD}}{\Delta_{ADVE}} > 2 \quad (12.3-1)$$

where δ_{MDD} and Δ_{ADVE} are as shown in Fig. 12.3-1. The loading used in this calculation shall be that prescribed in Section 12.8.



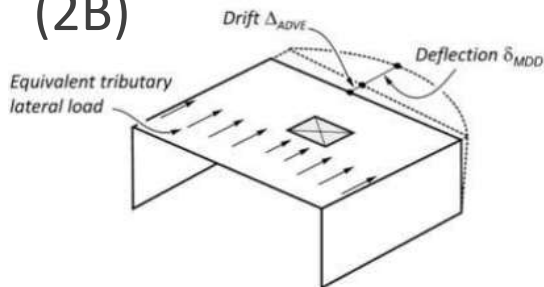
Flexible by Calculation

ASCE 7 12.3.1.3

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(2B)



IBC1604.4: A diaphragm is rigid for the purpose of distribution of story shear and torsional moment when the lateral deformation of the diaphragm **is less than** or equal to two times the average story drift.



Rigid by Calculation

IBC 1604.4

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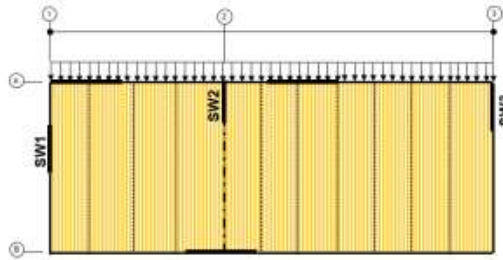
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Lateral Load Distribution using CLT Diaphragms

Option 3: Enveloped Diaphragm Design

Check both flexible and rigid diaphragm behavior (3A)

Or Check conservatively flexible and conservatively stiff semi-rigid behavior (3B)



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Lateral Load Distribution using CLT Diaphragms

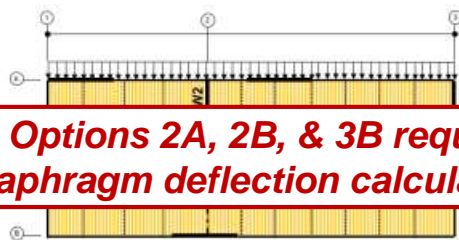
Option 1 – Simplified Seismic Method

Option 2A – Flexible by Calculation

Option 2B – Rigid by Calculation

Option 3A – Envelope (Flex & Rigid)

Option 3B – Envelope (Semi-rigid)



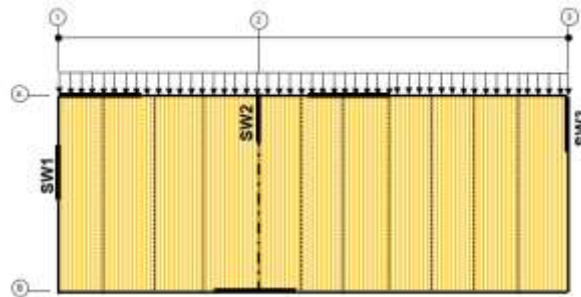
**Options 2A, 2B, & 3B require
diaphragm deflection calculations**

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CLT Diaphragm Deflection Requirements

SDPWS 2021 Section 4.5.2 Requirement:

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



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2015 White Paper on CLT Diaphragms

CROSS LAMINATED TIMBER

Horizontal Diaphragm Design Example

Our aim for this white paper is to provide a practical design method to determine the strength of a Cross Laminated Timber horizontal diaphragm and deflection due to lateral wind or seismic loads.

CLT HORIZONTAL DIAPHRAGM DESIGN

The design approach is based on compliance with engineered design of CLT in accordance with the 2015 International Building Code, reference standards, and other published information including literature.

Applicable Building Code, reference standards, and sources:

- ICC, 2015 International Building Code
- ANSI/APA WDC-2015 National Design Specification (NDS) for Wood Construction with Commentary
- AISC SDPWS-2015 Special Design Provisions for Wind and Seismic
- ANSI/APA PRG 320 - 2012 Standard for Performance-rated Cross-laminated Timber
- FP Innovations, US CLT (Cross-Laminated Timber) Handbook 2013
- ASCE 7-10 Minimum Design Loads for Buildings and Other Structures
- AISC 360-10 Specification for Structural Steel Buildings
- APA Product Report PR-CLT4 - Chaired by Structurlam Products LP, February 20, 2014

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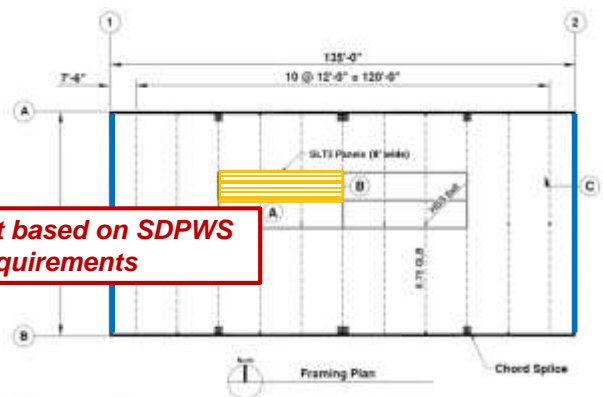
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Martin Pelt P.E., S.E.,
Martin Pelt Structural
Engineering
Sancho Martin, CA
mpelt@sancho martin.org

Published by: FP Innovations

Developed in 2015, not based on SDPWS 2021 design requirements



Available from structurlam.com

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2015 White Paper on CLT Diaphragms

- Design example following SDPWS 2015, US CLT Handbook
- Includes Modified 4-term wood panel sheathed diaphragm equation in SDPWS 2015

$$\delta_{dia} = \frac{5vL^3}{8EAW} + \frac{vL}{4G_v t_v} + \underbrace{CLe_n}_{\text{Connector Slip}} + \frac{\sum(x\Delta_c)}{2W}$$

Chord Flexure
Panel Shear
Connector Slip
Chord Slip

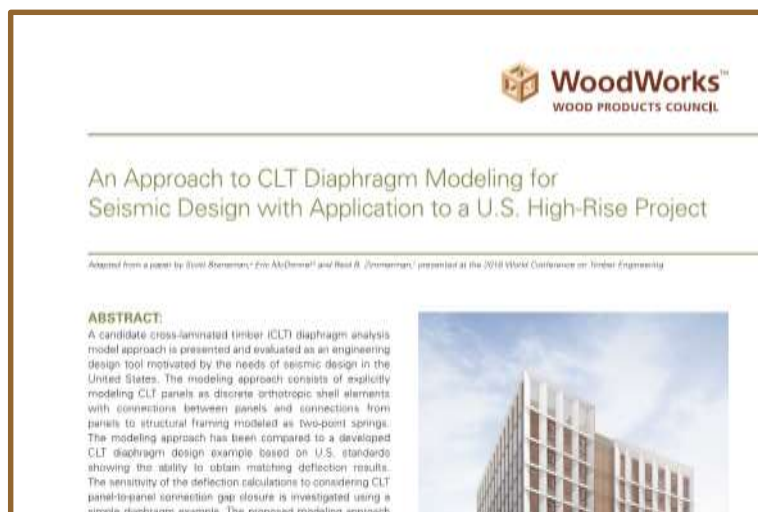
$$C = \frac{1}{2} \left(\frac{1}{P_L} + \frac{1}{P_W} \right)$$

P_L is panel length
 P_W is panel width
 e_n is connector slip at diaphragm edge

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WoodWorks Solutions Paper on CLT Modeling

<http://www.woodworks.org/wp-content/uploads/Approach-to-CLT-Diaphragm-Modeling-for-Seismic-WoodWorks-Jan-2017.pdf>



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WoodWorks CLT Diaphragm Guideline with Examples

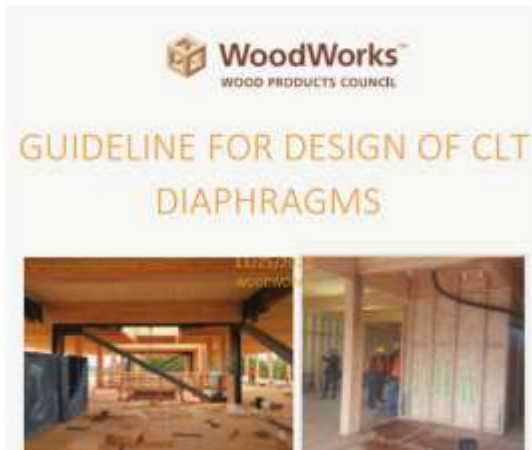
Under Development By:



Holmes Structures



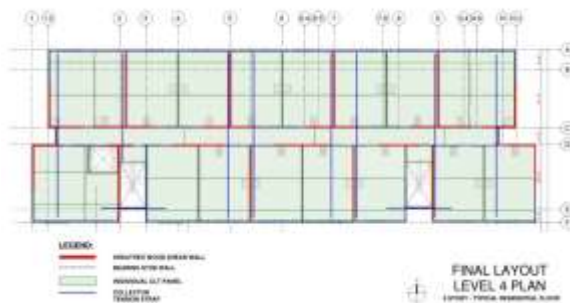
Funded By:



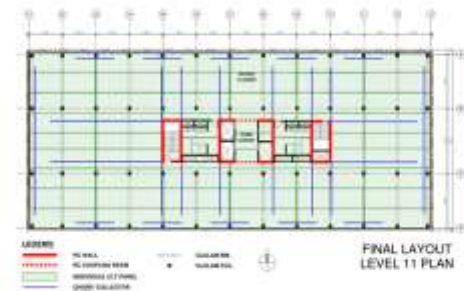
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WoodWorks CLT Diaphragm Guideline with Examples

3 Examples
High and Low Seismic & Wind



Example from Holmes Structures



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WoodWorks CLT Diaphragm Guideline with Examples

Design Tools

Spline Material	Fastener	Nominal Diaphragm Shear Connection Capacity vn = 4.5Z*, @ Spacing, S (plf)				
		12" O.C.	6" O.C.	4" O.C.	3" O.C.	2" O.C.
CLT SG = 0.36						
General Sheathing (23/32)	8d Common Nail	255	510	765	1020	1530
General Sheathing (23/32)	10d Common Nail	296	592	888	1184	1776
General Sheathing (23/32)	Screw Type 1	266	531	797	1062	1593
General Sheathing (23/32)	Screw Type 2	321	641	962	1283	1924
Struct 1 Sheathing (23/32)	8d Common Nail	311	623	934	1245	1867
Struct 1 Sheathing (23/32)	10d Common Nail	359	718	1077	1436	2154
Struct 1 Sheathing (23/32)	Screw Type 1	316	631	946	1261	1891
Struct 1 Sheathing (23/32)	Screw Type 2	385	771	1156	1541	2311
General Sheathing (7/8)	10d Common Nail	336	672	1008	1344	2016
General Sheathing (7/8)	16d Common Nail	379	758	1137	1516	2274
General Sheathing (7/8)	Screw Type 1	295	590	885	1180	1770
General Sheathing (7/8)	Screw Type 2	360	721	1081	1441	2162
Struct 1 Sheathing (7/8)	10d Common Nail	414	829	1243	1657	2486
Struct 1 Sheathing (7/8)	16d Common Nail	464	928	1392	1855	2783
Struct 1 Sheathing (7/8)	Screw Type 1	358	715	1073	1430	2145
Struct 1 Sheathing (7/8)	Screw Type 2	441	882	1323	1765	2647
General Sheathing (1 1/8)	10d Common Nail	405	810	1215	1620	2430
General Sheathing (1 1/8)	16d Common Nail	452	904	1357	1809	2714
General Sheathing (1 1/8)	Screw Type 1	347	695	1042	1390	2085
General Sheathing (1 1/8)	Screw Type 2	430	860	1290	1720	2581
Struct 1 Sheathing (1 1/8)	10d Common Nail	444	888	1332	1778	2664

Exp

$$\delta_{dia} = \frac{5v_n}{8E}$$

Available Early 2024

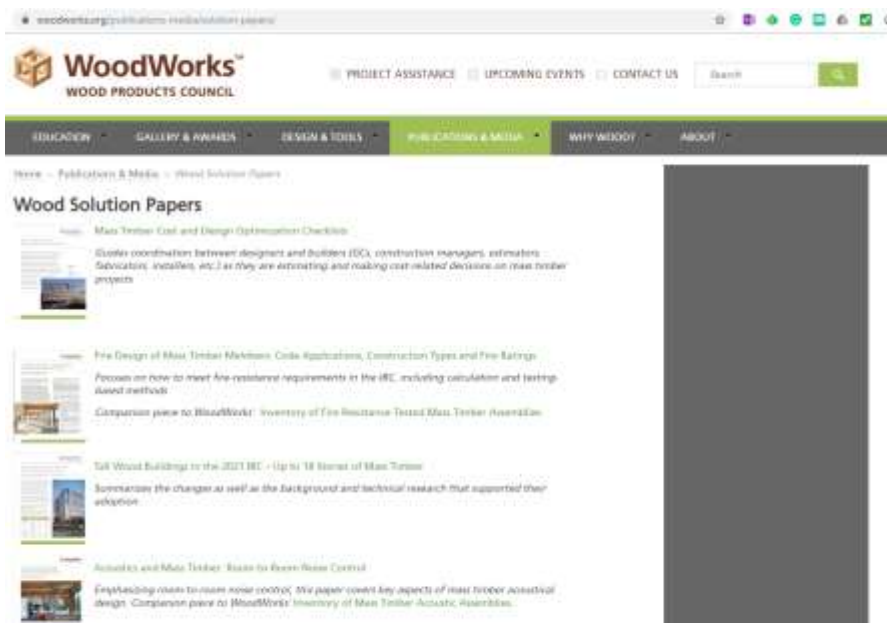
Expanded Deflection Estimates

$$\delta_{dia} = \frac{5vL^3W}{8EAd^2} + \frac{vL}{4G_v t_v} + \frac{L}{2} \left(\frac{e_{f\parallel}}{P_{\perp}} + \frac{e_{f\perp}}{P_{\parallel}} \right) + \frac{\sum(x\Delta_c)}{2d}$$

Available Early 2021

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Additional Resources – WoodWorks.org



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Questions?

This concludes The American Institute
of Architects Continuing Education
Systems Course

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