

Structural Mass Timber Fastening Design Guide



www.mtcsolutions.com



Disclaimer

The information in this document is for general information purposes. While we aim to keep the information provided in this document complete, accurate and in line with state-of-the-art design methods, we cannot make warranties of any kind.

Images and drawings provided are for reference only and cannot be applied to all conditions that may occur on site. Any reliance you place on such information is therefore strictly at your own risk. In no event will we assume liability for any loss or damage including and without limitation, indirect or consequential loss or damage, or any loss or damage whatsoever arising from loss of profits arising out of, or in connection with the use of the system. Through the use of the document and system you are able to derive other loading cases which are outside of our control. The inclusion of the system or the implied use of the document to other applications is outside of our responsibility.

Published on June 10th, 2021, Copyright © 2021 by MTC Solutions. All rights reserved.

This document or any portion thereof may not be reproduced or used in any manner whatsoever without the expressed written permission of the publisher. This document expires on December 31st 2021.



TABLE OF CONTENTS

GENERAL INFORMATION	8
INFORMATION ABOUT MASS TIMBER	
Withdrawal Design in Narrow Panel Edge	13
Swelling and Shrinkage of CLT	13
HOW TO USE THIS GUIDE	
About this Guide	
Design Table Guidelines	
Adjusted Design Value Calculation (Z')	
Connection Design	
GENERAL NOTES TO THE DESIGNER	
Values Determined by Testing	17
TYPICAL PANEL TO PANEL CONNECTIONS	19
CLT Butt Joint Connection in Shear	20
CLT Lap Joint Connection in Shear	22
CLT Lap Joint Notch Reinforcement	
CLT Lap Joint with Inclined Screws	
CLT Lap Joint with Inclined Screws in Shear	
CLT Surface Spline Connection in Shear	
NLT Butt Joint Connection in Shear	34
PANEL TO BEAM CONNECTIONS	
CLT Panel to Beam Connection in Shear	
CLT Floor to Beam Connection	
CLT Panel to Beam Connection with Inclined Screws	
NLT Panel to Beam Connection in Shear	
NLT Panel to Beam Connection with Inclined Screws	
CLT Panel to Steel Beam Connection NLT Panel to Steel Beam Connection	
POST TO BEAM CONNECTIONS	
Post to Beam Connection - Bearing	
Beam to Jack Stud Connection	
Wood Beam to Steel Column - Shear Screws	
Wood Beam to Steel Column - Inclined Screws Beam Bearing Straps - Shear Screws	
Beam Bearing Straps - Inclined Screws	
Wood Beam to Steel Column - Bottom Plate	
Housed CLT Floor Unlift Connections	

LEDGER CONNECTIONS	65 66 70
FLOOR TO WALL CONNECTIONS	74 75 77
WALL CONNECTIONS	80
STEEL TO WOOD CONNECTIONS CLT Panel with Steel Side Plate in Shear. CLT and Steel Plate with Inclined Screws Steel Beam to Wood Connection	86 88
DETAILING SECTIONGeometry Requirements	
HARDWARE ASSY Ecofast ASSY SK ASSY Kombi ASSY VG CSK ASSY VG Cyl Bits - AW Drive	96 98 100 101 103
45° Washer	104



MTC Solutions is a supplier of connection solutions for modern mass timber applications in commercial, industrial, and residential projects. MTC Solutions is proud to work with the most innovative partners on cutting-edge projects across North America.

INDUSTRY EXPERT



We provide the support necessary to design efficient connection solutions with our team of in-house experienced design professionals.



We deliver hardware solutions where and when you need them with a logistics chain stretching from Alaska to Florida.



We conduct exhaustive research, partnering with leading North American research facilities to push innovation in mass timber connection solutions.

PROVEN SOLUTION



We have supplied hardware to thousands of Mass Timber and Heavy Timber projects in North America over the past decade.



We provide the right tools to **design code-compliant buildings**, such as detailed design guides and ICC-ES approvals for our hardware.





General Information

General Information	8 - 11

How to Use This Guide	12 - 18

Connections

Panel to Panel Connections	19 - 35
----------------------------	---------

Panel to Beam Connections	
---------------------------	--

Post to Beam Connections	52 - 63
--------------------------	---------

Ledger Connections	64 - 73

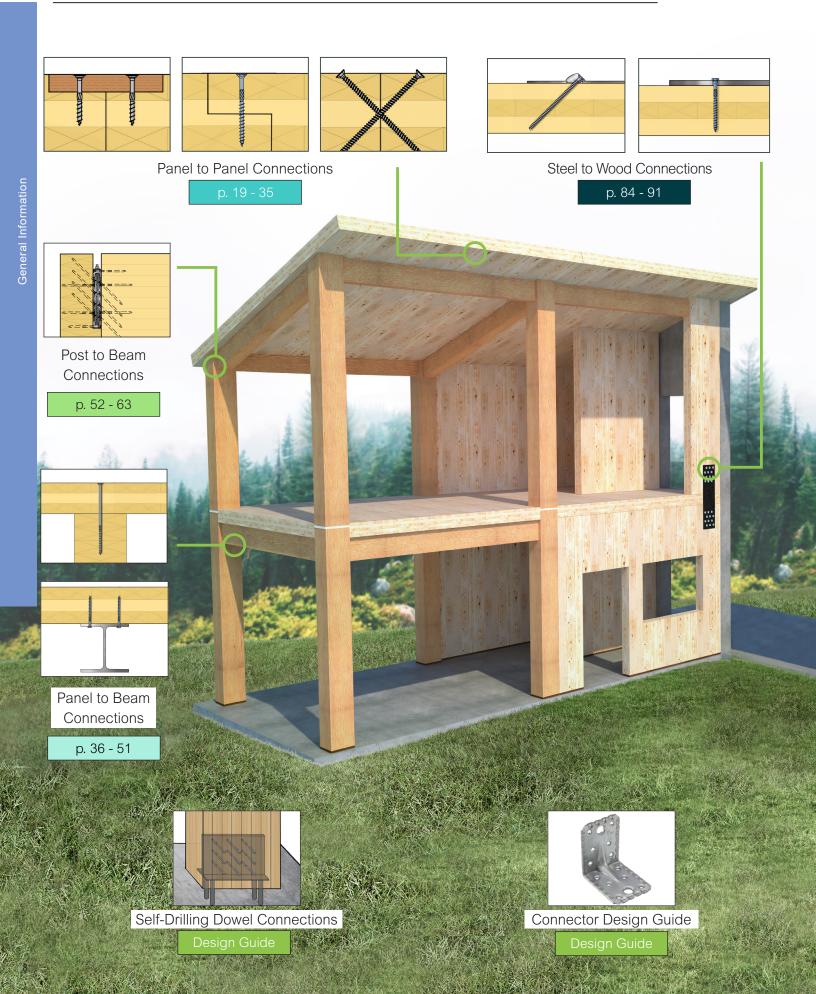
Detailing Section

Geometi	ን Ի	Requirements
---------	-----	--------------

Hardware	96 - 104

92 - 95

General Information



The Structural Mass Timber Fastening Design Guide

This guide is the result of years of research in the North American mass timber market, industry partnerships and hands-on engineering experience. The solutions presented in this guide are found to be efficient and practical.

These solutions are achieved by using high quality hardware, evaluated through testing. This effort makes this guide the ultimate tool for designer to refer to.

Research and Testing

Designers can have peace of mind knowing that the values listed in this guide are confirmed through testing. Testing is conducted in collaboration with universities across North America using North American wood species that are readily available on the market. All testing follows applicable standards for the United States and Canada.



Certifications

Code-approved and reliable, ASSY fasteners were awarded with ICC-ESR approval in the US and by the Canadian Construction Materials Centre (CCMC) in Canada.

Our suppliers follow the strictest manufacturing processes and are under third party quality control by North American authorities. Our high-quality product comes with a commitment to high-quality service through our team of product consultants and technical advisors.





Fastener Line

Our self-tapping fasteners, constructed of hardened steel are engineered to fit the special needs of the North American mass timber market. Available in a wide variety of shapes and sizes, our fastener line provides viable mass timber connection solutions for all structural timber systems.









Engineered Head

Multiple head types available



Shank

Large selection of diameters and lengths available



Case Hardened Steel

Up to 3 times the bending yield strength of generic lag screws



Shank Cutter

Reduces torque during installation



Large Thread

Provides high withdrawal resistance



Self Tapping Tip

Eliminates the need for pre-drilling and provide easy installation

CERTIFICATIONS



ICC-ESR-3178 ICC-ESR-3179



ISO 50001



Information about Mass Timber

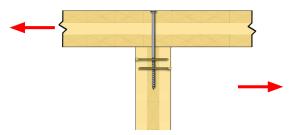
Wood Failure Modes and Reinforcing Solutions

The high withdrawal resistance and tensile strength of fully threaded self-tapping screws can be used in many ways to compensate for low strength loading directions in timber or CLT. Some common failure modes and reinforcing solutions are explained below.

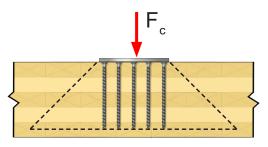
In conventional timber design, tensile stresses perpendicular to grain are generally avoided. North American design standards do not provide designers with capacities in this loading direction due to the brittle failures that occur. For CLT, perpendicular to grain tensile loading is a typical loading direction for fasteners installed on the narrow edge of CLT panels. In some cases, these fasteners have the capacity to over-stress the CLT if it is loaded out of plane.

Notches at the tension face of bending members can also overstress the CLT members. In many cases, fully threaded fasteners can be designed to transfer the tensile load components, preventing accidental brittle failure modes. Compressive stresses perpendicular to the grain typically do not cause brittle failure modes, however, timber strength in this direction is low. Designers can compensate for this low strength by using fully threaded screws and taking advantage of their high axial resistance. Compressive load components are transmitted into the panel through the screws, where the stresses are then diffused. Transferring the compressive loads through the screws increases the effective bearing area resulting in more effective force distribution.

CLT can sometimes be limited by the relatively low rolling shear strength and stiffness of the crossing plies. Reducing the thickness of cross layers may mitigate this issues of low rolling shear strength and stiffness. Fully threaded screws can be used to reinforce the CLT against shear stresses activated by panel bending as well as point loads.



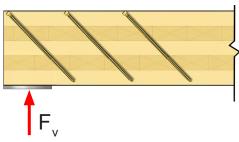
CLT floor to wall connection reinforcement to minimize risk of brittle failures



CLT bearing reinforcement with full thread screws to increase the virtual bearing area



CLT notch reinforcement with a full thread screws



CLT rolling shear reinforcement using inclined full thread screws

Withdrawal Design in Narrow Panel Edge

For fasteners installed on the narrow edge of the panel loaded in withdrawal, an end grain reduction factor of $C_{\rm eg} = 0.75$ is assigned to reference withdrawal design values, as per Clause 12.2.1.5 (exceptions may apply; see C12.2.1.5).

Designers should be mindful of the possibility of gaps on the narrow edge of CLT, as there is a risk they will run parallel to the screw axis. Long term loading of fasteners in withdrawal from the narrow edge of CLT is not recommended if the fastener is installed parallel to grain. Screws can be installed at an angle of 75° to the edge surface to counteract the presence of both end grain and gaps. Long length screws (at least 20D penetration) are recommended over short screws.



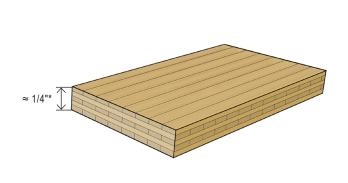
Screw Installed in a Gap in the Narrow Edge

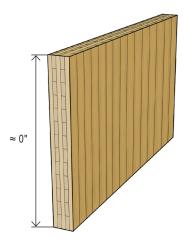


Screw Installed in the Narrow Edge

Swelling and Shrinkage of CLT

According to Clause 10.1.5 of NDS-2018, crosslaminated timber is specified for dry service conditions unless specifically permitted by the manufacturer. Nonetheless, there is a chance CLT panels may be exposed to the elements during construction. CLT is considered dimensionally stable, for the most part, against swelling and shrinking in-plane if changes in moisture occur. However, designers should consider the effects of swelling and shrinkage perpendicular to the panel plane, as this can affect connection integrity.





- For a 4-1/8" 3 ply S.P.F.panel to a 12" S.P.F. panel, swelling and shrinkage may vary from ≈ 1/16" to ≈ 1/2".
- * 1/4" is for a 6-7/8" 5 ply CLT panel.

How to Use this Guide

About this Guide

This connection design guide will help designers to get an overview of connection design with CLT in accordance with applicable design standards. State-of-the-art structural details are visualized in an easy-to-read table format.

All Reference Design Values presented in this document have been estimated following applicable provisions in the 2018 National Design Specification (NDS) for Wood Construction or derived from testing following ICC-ESR AC233 data analysis guideline.

Design Table Guidelines

CLT Loading Conditions

Summary figure of the CLT panels orientation and load direction (See page 15)



Panel Thickness (t)

The overall panel thickness is shown by "t". The thickness for each individual layer is also shown as "t_i"



Fastener Information

Description of the fastener applicable for the given connection parameters, including diameter and length



Reference Design Values

Fastener(s) reference strength in the loading directions applicable to the connection



	Panel & Joint Configuration				Reference Des	Minimum	
	Loading		Panel Thickness	Fastener Options	Standard Loading C _D =1.0	Short Term Loading $C_D = 1.6$	Spacing in a Row (S _P)
3 PLY	Z"	←	4-1/8"	VG Cyl 1/4" x 5-1/2"	123	197	1"

Specific Gravity (G)

The assigned specific gravity of the material used for the calculations are the following:







Douglas Fir G = 0.49

Tables Color Code

The colors represents the diameter of the fastener used in the connection:

- 1/4" screw
 - 5/16" screw
- 3/8" screw
- 1/2" screw

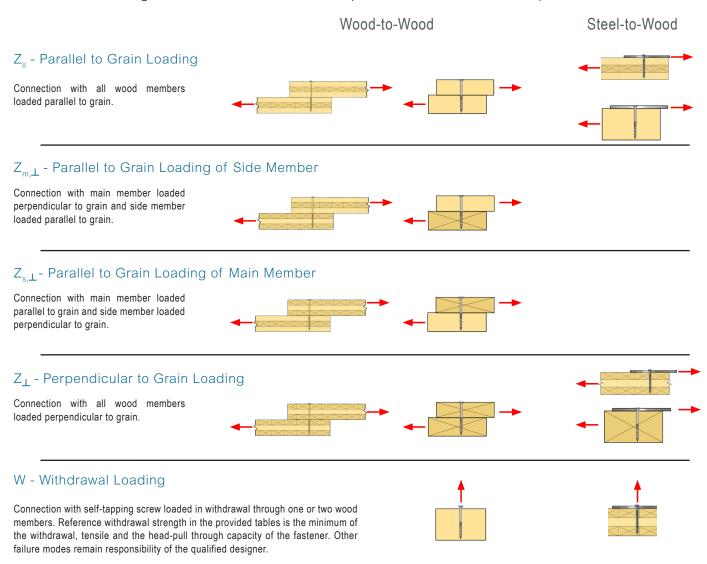
Adjusted Design Value Calculation (Z')

 $Z' = Z \cdot n_F \cdot n_R \cdot C'$

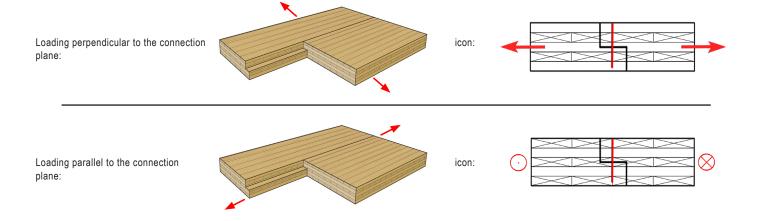
- Z Reference design value (Z_{\parallel} , $Z_{\text{m,\perp}}$, $Z_{\text{s,\perp}}$, Z_{\perp} , Z_{cal} , Z_{test} or W) given in the provided design tables or calculated in accordance with 12.3.1; NDS-2018
- n_F Number of effective fasteners in a row: $n_F = \max \{n^{0.9}; 0.9 \cdot n\}$
- n Number of screws acting together in a row
- n_R Number of rows in a connection
- C' The adjustment factors for the connection, composed of: C_D ; C_M ; C_t ; C_Δ ; C_{eq} ; C_{di} ; C_{tn} ; C_q

Connection Design

The load relation to grain orientation is based on the plie's orientation in the shear plane.



Load scenarios for different CLT connections are using icons as shown below:





- Reference design values presented in this design guide are based on the NDS-2018; ICC-ESR 3178-2018; ICC-ESR 3179-2019; and boundary conditions outlined in FTA-11/0190 unless noted otherwise.
- 2. For tested reference lateral design values (Z_{test}) determined by testing, all connection design must meet all relevant requirements of the General Notes for Reference Design Values (Z_{test}) section.
- All suggestions and details shown are to be treated as general and cannot be assumed to be valid for all construction requirements and specific site conditions.
- Connections must respect the geometry requirements as specified in the Detailing Section of this guide and the NDS.
- 5. Reference design values must be adjusted in accordance with all applicable adjustment factors of the NDS, Section 12.
- Maximum allowable drive in torque of the fasteners must be respected, see the Detailing Section, Table S.4.
- 7. Carbon steel ASSY screws are intended to be used in untreated wood under dry service conditions and temperatures below 100°F such that $C_{\rm M}$ =1.0 and $C_{\rm t}$ =1.0.
- 8. For standard term loading, load duration factor is $C_D=1$. For short term loading, load duration factor is $C_D=1.6$, as per 11.3.2; NDS-2018.
- For connection with inclined axially loaded screws, the listed reference design values are given along the line of the force. The vector has already been projected from the screw's axis to the shear plane of the connection.

- 10. Listed reference lateral design values (Z) apply to different timber species according to their respective specific gravities (G).
- 11. A pilot hole may be used to facilitate the installation of long self-tapping screws. Pilot holes of at least 3" (76mm) in depth should be used when screws are installed near the edge of the wood member or in the end grain. Pilot hole diameter must not exceed the minor diameter of the fastener.
- 12. The designer must ensure that all possible stress limits in the wood members, such as the shear capacity, the rolling shear capacity of the Cross Laminated Timber (CLT) or other material properties, are not exceeded, and continuous load path is assured.
- 13. A load bearing connection shall consist of at least two(2) ASSY screws.
- 14. For CLT connections, listed reference design values apply to CLT with G = 0.42 or higher.
- 15. In wood species sensitive to splitting, minimum geometry requirements may be required to be increased.
- 16. Example details do not show all required nails or other fasteners for clarity.
- 17. With approval from a design professional;

ASSY VG Cyl screws may be replaced with ASSY VG CSK

ASSY Ecofast screws may be replaced with ASSY SK screws.





Values Determined by Testing

When compared to testing, lateral design values determined by the yield equations presented in the NDS will lead to conservative design values for ASSY screw. Approval bodies, such as ICC-ES are providing guidelines to extract reference design values based on a database with controlled design parameters.

This CLT Connection Design Guide contains reference lateral design values determined by testing. These values are derived from testing of the configurations illustrated herein. Tested reference lateral design values ($Z_{\rm test}$) are based on a minimum factor of safety of 5.0, as per AC 233 clause 3.4.2. A slip modulus ($k_{\rm test}$) is included for the purpose of estimating joint displacement. Tested reference lateral design values ($Z_{\rm test}$) in this guide apply to the specific configurations tested only.

Utilising tested reference lateral design values ($Z_{\rm test}$) can result in more economical design and promotes installation and hardware cost savings.



Umass Design Building

Amherst, Massachusetts

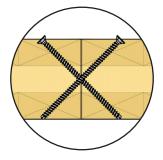


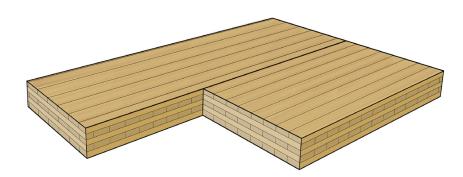
Typical Panel to Panel Connections

Floor-to-floor connections are mainly designed to transfer in-plane shear forces, with the panels acting as a diaphragm. Several joint types are used in construction, offering differences in application, price, capacity and ease of installation. In the following section, the three most common floor-to-floor joints are presented.

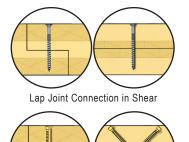
- The Butt joint is the simplest connection type from a fabrication point of view, as the panels are simply cut straight at the edges. It requires short machining time and less material is lost during production.
- Lap joints require more prefabrication than butt joints. For this, part of the panel width is removed when installed. Lap joints offer the largest variety of connection performances.
- **Spline joints** are similar to butt joints, but rather than installing the fastener at an incline, sections of the CLT are cut out to accept splines usually made from standard plywood.

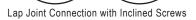
Butt Joint Connection

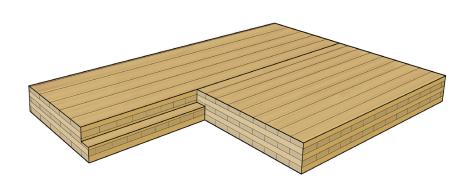




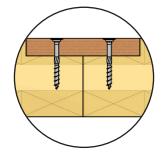
Lap Joint Connection

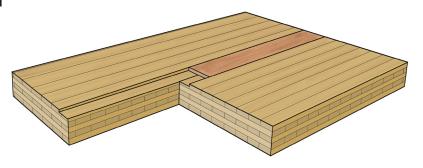






Surface Spline Connection



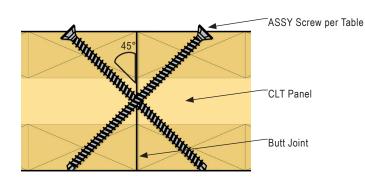


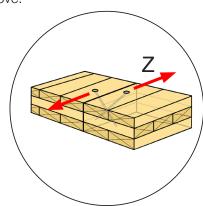
CLT Butt Joint Connection in Shear

The simple butt joint is one of the most cost effective methods of transferring in-plane shear between CLT panels because they only require square edge faces to be connected. Screws are installed at a 45° angle to the edge face, creating a mechanical connection at a depth of half the panel thickness.

Pre-drill jigs can be used to create short lead holes which help to assure consistent angle of installation between screws.

Due to minimum penetration requirements, butt joint connections can only be used for panel thicknesses of 4-1/8" and above.







Tested Connection

Table TPP.1, Tested Reference Lateral Design Values for CLT Butt Joints Loaded in Shear

Panel Cor	nfiguration						Referer	nce Design Valu	ı es [lbs]	
Туре	Panel Thickness				Tested Connection Geometry Specification Options	Calculated Standard Loading C _D =1.0	Tested Standard Loading C _D =1.0	Tested Short Term Loading C _D =1.6	Estimated Stiffness [in. / kips]	
	(t)	(a _L)	(t/2)	(S _P)			Z _{II}	Z _{// test}		K test
3 PLY (SPF)	4-1/8"	3"	2"	2-1/2"		VG CSK 5/16" x 5-1/2"	123	306	490	0.26

Notes:

- Tested reference design values apply to a single fastener, conforming to the connection geometry and loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Tested reference lateral design values (Z_{lest}) presented apply to the specific configurations tested only.
- Screws are installed at a 45° angle to the surface of the panel, intersecting the joint at 1/2 the panel thickness, such that the screws are loaded perpendicular to their longitudinal axis.
- 6. CLT panels ply thickness tested were 1-3/8 [35 mm].
- Testing was done with loading parallel-to-grain at the shear plane unless noted otherwise.

Tested Connection Geometry Requirements

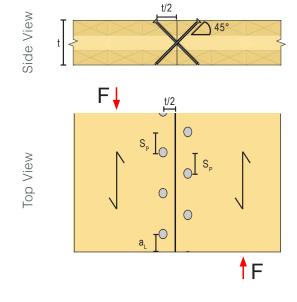
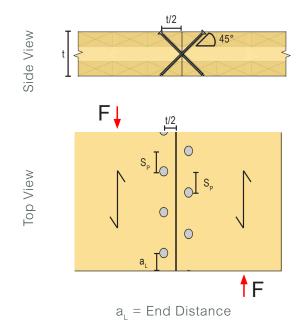


Table PP.1.1, Reference Lateral Design Values for CLT Butt Joints Loaded in Shear

	Pa	anel & Joint Configuration	ì		Reference Des	ign Values [lbs]	Minimum	
		Loading	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)	
3 PLY	Z"	⊗	- 4-1/8"	VG Cyl	123	197	1"	
3 Р	\mathbf{Z}_{\perp}	⊗ ○ ○	4-1/0	1/4" x 5-1/2"	125	197	1	
				5-1/2"	VG CSK 5/16" x 7-1/8"	190	304	1-1/4"
	Z ,,	⊗ • • • • • • • • • • • • • • • • • • •	6-7/8"	VG CSK 5/16" x 8-5/8"	190	304	1-1/4"	
PLY			0-7/0	VG CSK 3/8" x 8-5/8"	251	402	1-1/2"	
5 P			5-1/2"	VG CSK 5/16" x 7-1/8"	152	243	1-1/4"	
	\mathbf{Z}_{\perp}	⊗	6-7/8"	VG CSK 5/16" x 8-5/8"	152	243	1-1/4"	
			0-7/8"	VG CSK 3/8" x 8-5/8"	201	322	1-1/2"	

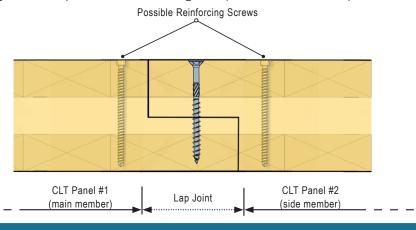
- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- 5. Fasteners are installed at a 45° angle intersecting the shear plane at half the panel thickness.
- 6. The angle between force and fastener axis is 90° .
- Adjustment for narrow edge loading of CLT (C_{eg}) shall be considered, following NDS-2018 clause 12.5.2.
- Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.

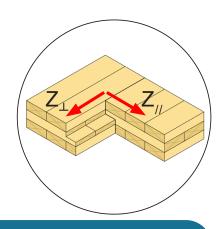
Geometry Requirements



CLT Lap Joint Connection in Shear

The lap joint is a common panel-to-panel connection employed with CLT panels, largely due to ease of installation Reinforcing screws can be considered to strengthen the panel across the grain (similar to notch reinforcement) where out of plane load transfer is anticipated across the joint. As with any lateral connection design with CLT, the grain direction at the shear plane is used as a base of reference.







Tested Connection

Table TPP.2, Tested Reference Lateral Design Values for CLT Lap Joints Loaded in Shear

Panel Cor	nfiguration						Referen	ues [lbs]		
Туре	Panel Thickness	Tested Connection Geometry Specification		Fastener Options	Calculated Standard Loading C _D =1.0	Tested Standard Loading C _D =1.0	Tested Short Term Loading C _D =1.6	Estimated Stiffness [in. / kips]		
	(t)	(a _L)	(e)	(b _{lap})	(S _P)		Z _{II}	Z _{// test}		K test
3 PLY (SPF)	4-1/8"	3"	1-5/8"	3-1/8"	2-1/2"	Eco 5/16" x 3-1/2"	183	288	461	0.14
5 PLY	6.7/0"	6"	1-1/4"	2-5/8"	6"	Eco 1/4" x 6-1/4"	185	341 [*]	546*	0.14
(SPF)	6-7/8"	3"	1-5/8"	3-1/8"	2-1/2"	Eco 5/16" x 6-1/4"	243	486	778	0.14

Notes:

- Tested reference design values apply to a single fastener, conforming to the connection geometry and loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.
- 5. Tested reference lateral design values (Z_{test}) presented apply to the specific configurations tested only.
- 6. CLT panels ply thickness tested were 1-3/8 [35 mm].
- Lap joint notch reinforcement may be required and remains responsibility of the designer.
- Testing was done with loading parallel-to-grain at the shear plane unless noted otherwise
 - *Testing was done with loading perpendicular-to-grain at the shear plane.

Tested Connection Geometry Requirements

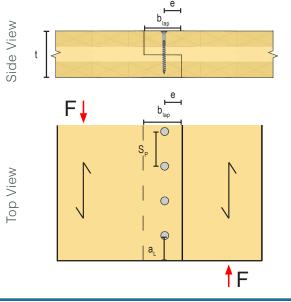


Table PP.2.1, Reference Lateral Design Values for CLT Lap Joints Loaded in Shear

P	anel & Joint Configuration			Reference Des	ign Values [lbs]	Minimum
	Loading	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _P)
7	and	4-1/8"	Eco 1/4" x 3-1/2"	153	245	1"
Z _{//}	⊗ • • • • • • • • • • • • • • • • • • •	4-1/8"	Eco 5/16" x 4"	209	334	1-1/4"
7	and	4-1/8"	Eco 1/4" x 3-1/2"	153	245	1"
Z_{\perp}	⊗ <u> </u>	4-1/8"	Eco 5/16" x 4"	167	267	1-1/4"

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.

- Fasteners are installed at a 90° angle intersecting the shear plane at half the panel thickness
- 7. The angle between force and fastener axis is 90°.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 9. Z_{\parallel} Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane $\Theta = 90^{\circ}$.

Geometry Requirements

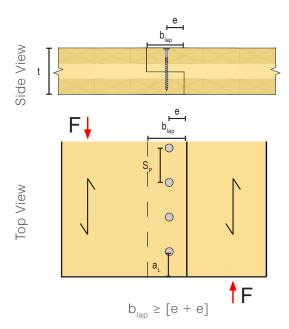


Table PP.2.2, Reference Lateral Design Values for CLT Lap Joints Loaded in Shear

	Pa	anel & Joint Configuration			Reference Des	ign Values [lbs]	Minimum
		Loading	Panel Thickness (t)	Fastener Options	Standard Loading $C_D = 1.0$	Short Term Loading C _D =1.6	Spacing in a Row (S _P)
			5-1/8" 5-1/2"	Eco 1/4" x 4-3/4"	185	296	1"
	Z ,,	and	6-7/8"	Eco 5/16" x 6-1/4"	243	389	1-1/4"
5 PLY		⊗	0-770	Eco 3/8" x 6-1/4"	354	566	1-1/2"
5 P		+	5-1/8" 5-1/2"	Eco 1/4" x 4-3/4"	185	296	1"
	Z _{//}	and	6-7/8"	Eco 5/16" x 6-1/4"	194	310	1-1/4"
		⊗	0-776	Eco 3/8" x 6-1/4"	244	390	1-1/2"
		and	7-1/2"	Eco 5/16" x 7-1/8"	243	389	1-1/4"
			1-1/2	Eco 3/8" x 7-1/8"	366	586	1-1/2"
	7		8-5/8"	Eco 5/16" x 7-7/8"	243	389	1-1/4"
	Z _{//}			Eco 3/8" x 7-7/8"	366	586	1-1/2"
			9-5/8"	Eco 5/16" x 8-5/8"	243	389	1-1/4"
7 PLY			3-3/0	Eco 3/8" x 8-5/8"	366	586	1-1/2"
7 F			7-1/2"	Eco 5/16" x 7-1/8"	194	310	1-1/4"
			7-1/2	Eco 3/8" x 7-1/8"	244	390	1-1/2"
	\mathbf{Z}_{\perp}	and	8-5/8"	Eco 5/16" x 7-7/8"	194	310	1-1/4"
	4 1	allu	0-0/0	Eco 3/8" x 7-7/8"	244	390	1-1/2"
		⊗	9-5/8"	Eco 5/16" x 8-5/8"	194	310	1-1/4"
		3-3/0	Eco 3/8" x 8-5/8"	244	390	1-1/2"	

- 1. Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.

- Fasteners are installed at a 90° angle intersecting the shear plane at half the panel thickness.
- 7. The angle between force and fastener axis is 90°.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.

CLT Lap Joint Notch Reinforcement

Floor to floor connections are typically designed to transfer in-plane diaphragm forces acting parallel to the line of the joint. Design of the floor system will typically minimize vertical load transfer caused by out-of-plane forces.

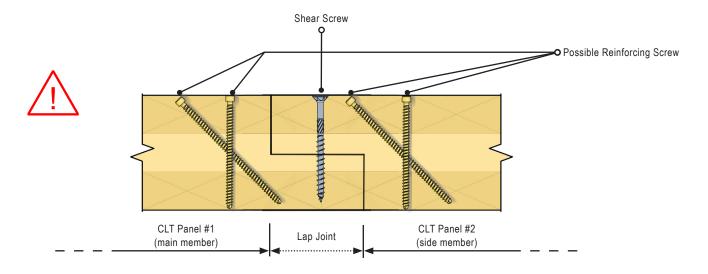
Coding standards, including the NDS-2018, do not provide directives for notches on the tension side of CLT panels. Therefore, there are no fully developed procedures outlining the unique material characteristics, stress distribution patterns and crack propagation path along the unglued lamella edges within the CLT.

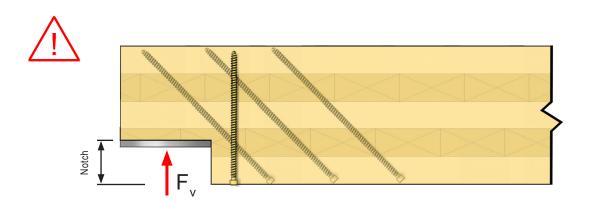
Designers are asked to be more conservative when designing notches with out of plane loading or to avoid them whenever possible.

Reinforcing notched members with fully threaded selftapping fasteners may prevent brittle failure mode through the screws high axial capacity.

For Glued Laminated Timber, notches shall not exceed the lesser of 1/10 of the beam depth or 3" as per 5.4.5.1; NDS-2018.

CLT Lap joint connections are two notched members connected together

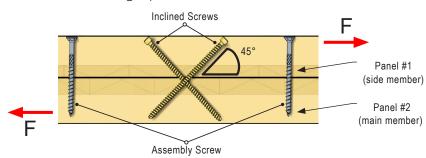




CLT Lap Joint with Inclined Screws

Similar to butt joints, a mechanical connection can be made across a lap joint using screws inclined at a 45° angle. Inclined screws tend to produce stiffer connections with higher loading capacities. Short pilot holes may be pre-drilled with the help of drill jigs to ensure consistent angle placement.

Reference design values provided below refer to the case of forces acting parallel to the line of joint. Generally, all other characteristics of the lap joint loaded in shear apply.



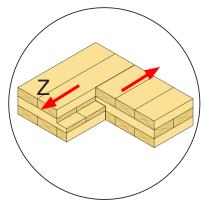


Table PP.3.1, Reference Design Values for CLT Lap Joints with Inclined Screw Crosses

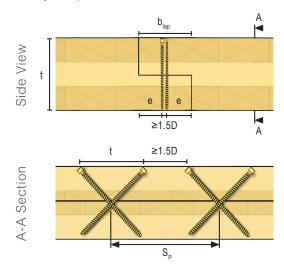
	Pa	anel & Joint Configuration	1		Reference D per Screw	Minimum	
	Loading Pa			Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
ΓΥ	Z ,,	⊗	4-1/8"	VG Cyl	511	818	- 1-1/2"
3 Р	\mathbf{Z}_{\perp}	⊗	4-1/8	1/4" x 5-1/2"	524	838	

Notes:

- Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.

- Fasteners are installed at a 45° angle intersecting the shear plane at half the panel thickness.
- 7. The angle between force and fastener axis is 45°.
- 8. Reference lateral design values only apply to parallel loading along the panel joint.
- Due to stiffness differences, assembly screws may not be assumed to take any load. They
 are only there to facilitate installation and insure a tight fit panel joint.
- The upper limit of the adjusted withdrawal resistance is set by the allowable fastener tensile strength, no further increase are allowed.
- Z_{II} Reference lateral design value per screw cross in tension with panel joint along major span direction of CLT panel.
 - $Z_{\!\scriptscriptstyle \perp} \qquad \text{Reference lateral design value per screw cross in tension with panel joint along } \\ \\ \text{minor span direction of CLT panel}.$

Geometry Requirements



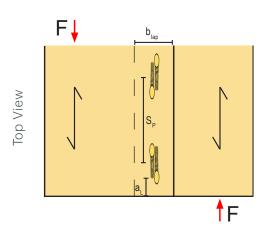


Table PP.3.2, Reference Design Values for CLT Lap Joints with Inclined Screw Crosses

	P	anel & Joint Configuration	1			esign Values Cross [lbs]	Minimum
		Loading	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _P)
			5-1/2"	VG CSK 5/16" x 7-1/8"	798	1,277	1-7/8"
	Z"	⊗	0.7/0"	VG CSK 5/16" x 8-5/8"	970	1,552	1-7/8"
PLY			6-7/8"	VG CSK 3/8" x 8-5/8"	1,067	1,707	2-1/4"
5 P			5-1/2"	VG CSK 5/16" x 7-1/8"	843	1,349	1-7/8"
	\mathbf{Z}_{\perp}	⊗	6-7/8"	VG CSK 5/16" x 8-5/8"	951	1,552	1-7/8"
			0-170	VG CSK 3/8" x 8-5/8"	1,043	1,669	2-1/4"
		8	7-1/2"	VG CSK 5/16" x 10-1/4"	1,250	2,000	1-7/8"
				VG CSK 3/8" x 10-1/4"	1,379	2,206	2-1/4"
	_		8-5/8"	VG CSK 5/16" x 10-1/4"	1,055	1,688	1-7/8"
	Z"			VG CSK 3/8" x 10-1/4"	1,158	1,853	2-1/4"
				VG CSK 5/16" x 11-7/8"	1,343	2,149	1-7/8"
PLY			9-5/8"	VG CSK 3/8" x 11-7/8"	1,480	2,368	2-1/4"
7 P			7-1/2"	VG CSK 5/16" x 10-1/4"	1,326	2,122	1-7/8"
			7-1/2	VG CSK 3/8" x 10-1/4"	1,462	2,339	2-1/4"
	7		8-5/8"	VG CSK 5/16" x 10-1/4"	1,059	1,694	1-7/8"
	Z _⊥		0-3/0	VG CSK 3/8" x 10-1/4"	1,165	1,864	2-1/4"
			9-5/8"	VG CSK 5/16" x 11-7/8"	1,306	2,090	1-7/8"
			3-J/O	VG CSK 3/8" x 11-7/8"	1,442	2,307	2-1/4"

- Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.
- Fasteners are installed at a 45° angle intersecting the shear plane at half the panel thickness.

- The angle between force and fastener axis is 45°.
- 8. Reference lateral design values only apply to parallel loading along the panel joint.
- Due to stiffness differences, assembly screws may not be assumed to take any load. They
 are only there to facilitate installation and insure a tight fit panel joint.
- The upper limit of the adjusted withdrawal resistance is set by the allowable fastener tensile strength, no further increase are allowed.
- Z_{II} Reference lateral design value per screw cross in tension with panel joint along major span direction of CLT panel.
 - Z_{\perp} Reference lateral design value per screw cross in tension with panel joint along minor span direction of CLT panel.

CLT Lap Joint with Inclined Screws in Shear

Loading parallel to the panel joint will result in the screws being loaded by a force component along the axis. The lateral reference design value is calculated according to the lateral component of the withdrawal or tensile strength of the fastener.

Loading perpendicular to the panel joint of an inclined screw application in a lap joint will result in the screw being loaded perpendicular to the axis. In this case, connection strength is calculated in accordance with the Yield Limit Equations in NDS.

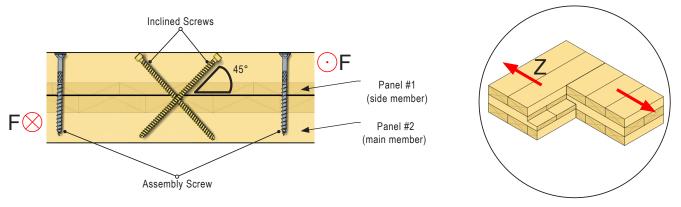
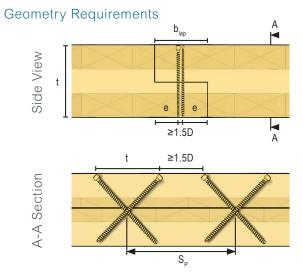


Table PP.4.1, Reference Design Values for CLT Lap Joints with Inclined Screw Crosses

	Panel & Joint Configuration	n		Reference D	Minimum		
Loading Panel Thickness (t)			Fastener Options	Standard Loading $C_D = 1.0$ Short Term Loading $C_D = 1.6$		Spacing in a Row (S _P)	
3 PLY			Eco 1/4" x 5-1/2"	123	194	1-1/2"	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Due to stiffness differences, assembly screws may not be assumed to take any load. They are only there to facilitate installation and insure a tight fit panel joint.

- It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.
- Fasteners are installed at a 45° angle intersecting the shear plane at half the panel thickness.
- 8. The angle between force and fastener axis is 90°.
- Reference lateral design values only apply to perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 10. Z_{II} Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.



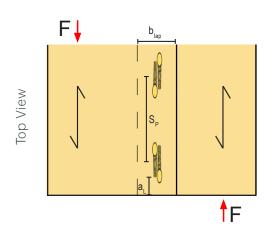


Table PP.4.2, Reference Design Values for CLT Lap Joints with Inclined Screw Crosses

	P	anel & Joint Configuration	1	·		esign Values os]	Minimum
		Loading	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
			5-1/2"	VG CSK 5/16" x 7-1/8"	190	304	1-7/8"
	Z"	←	C 7/0"	VG CSK 5/16" x 8-5/8"	190	304	1-7/8"
PLY			6-7/8"	VG CSK 3/8" x 8-5/8"	251	402	2-1/4"
5 P			5-1/2"	VG CSK 5/16" x 7-1/8"	152	243	1-7/8"
	Z _⊥		C 7/0"	VG CSK 5/16" x 8-5/8"	152	243	1-7/8"
			6-7/8"	VG CSK 3/8" x 8-5/8"	201	322	2-1/4"
			7-1/2"	VG CSK 5/16" x 10-1/4"	190	304	1-7/8"
				VG CSK 3/8" x 10-1/4"	251	402	2-1/4"
	_		8-5/8"	VG CSK 5/16" x 10-1/4"	190	304	1-7/8"
	Z _"			VG CSK 3/8" x 10-1/4"	251	402	2-1/4"
			0.5/01	VG CSK 5/16" x 11-7/8"	190	304	1-7/8"
PLY			9-5/8"	VG CSK 3/8" x 11-7/8"	251	402	2-1/4"
7 P			7.4/0"	VG CSK 5/16" x 10-1/4"	152	243	1-7/8"
			7-1/2"	VG CSK 3/8" x 10-1/4"	201	322	2-1/4"
	7		0.5/0"	VG CSK 5/16" x 10-1/4"	152	243	1-7/8"
	Z _⊥		8-5/8"	VG CSK 3/8" x 10-1/4"	201	322	2-1/4"
			0.5/00	VG CSK 5/16" x 11-7/8"	152	243	1-7/8"
			9-5/8"	VG CSK 3/8" x 11-7/8"	201	322	2-1/4"

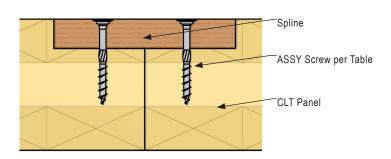
- 1. Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- It is recommended that panel-to-panel CLT lap joint connections be reinforced if potential loads may occure in a direction promoting CLT notch failures.

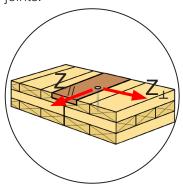
- Due to stiffness differences, assembly screws may not be assumed to take any load. They are only there to facilitate installation and insure a tight fit panel joint.
- Fasteners are installed at a 45° angle intersecting the shear plane at half the panel thickness.
- 8. The angle between force and fastener axis is 90°.
- Reference lateral design values only apply to perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 10. $Z_{_{||}}$ Angle between loading direction and wood grain in the shear plane Θ = 0°.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.

CLT Surface Spline Connection in Shear

Surface spline connections are made using standard plywood placed into a routed section on the panel surface across the joint. Spline connections require

additional machining compared to butt joints, although there is less material loss in terms of panel thickness compared to half-lap joints.







Tested Connection

Table TPP.5, Tested Reference Lateral Design Values for CLT Surface Spline Joints Loaded in Shear

Panel	& Spline	Configu	ration							Reference	ce Design Va	lues [lbs]			
	Thickr	iesses	Spline	Tested Connection Geometry Specification					Fastener	Calculated Standard	Tested Standard	Tested Short Term	Estimated Stiffness		
Panel Type	Panel	Spline	Width	Ged	metry S	респіса	uon	Options				Loading C _D =1.0	Loading C _D =1.0	Loading C _D =1.6	[in. / kips]
	(t)	(S _T)	(S _w)	(a _L)	(e)	(S _Q)	(S _P)			Z _{//}	Z,	test	K _{test}		
3 PLY (SPF)	4-1/8"	3/4"	3-3/8"	2-3/8"	7/8"	1-5/8"	4-3/4"		Eco 5/16" x 3-1/8"	172	292	467	0.17		
3 PLY (D. Fir)	4-1/8"	1"	11"	6"	2-3/4"	5-1/2"	6"		Eco 3/8" x 4"	269	387	619	0.2		
5 PLY	6-7/8"	3/4"	5-1/2"	6"	1-3/8"	2-3/4"	6"		Eco 1/4" x 6-1/4"	134	198	317	0.3		
(SPF)	0-1/0	1"	5-1/2"	6"	1-3/8"	2-3/4"	6"		Eco 5/16" x 6-1/4"	243	444	710	0.17		

Notes:

- Tested reference design values apply to a single fastener, conforming to the connection geometry and loading configuration described for that design value.
- 2. Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Tested reference lateral design values (Z_{best}) presented apply to the specific configurations tested only.
- 5. Testing was done with fasteners installed in pair, one screw in each CLT panel in order to transmit the load through the spline connection.
- CLT panels ply thickness tested were 1-3/8 [35 mm].
- It is recommended to stagger the screws across the line of the joint, as illustrated in the Tested Connection Geometry Specification on this page.

Tested Connection Geometry Requirements

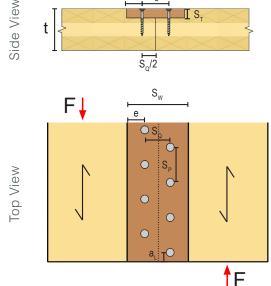


Table PP.5.1, Reference Lateral Design Values for CLT Surface Spline Joints Loaded in Shear

		Panel & Spline Config	uration			Reference Des	sign Values [lbs]	Minimum
		Loading	Spline Thickness	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
				3-1/8"	Eco 1/4" x 2-3/4	4"		
			1/2"	3-3/8"	Eco	130*	208*	
				4-1/8"	1/4" x 3-1/3	3"		1-3/4"
				3-1/8"	Eco 1/4" x 2-3/-	1"	214	1-5/4
	Z _{//}	and	3/4"	3-3/8"	Eco 1/4" x 3-1/3	134		
			3/4	4-1/8"	Eco 1/4" x 3-1/3	3"		
				4-1/0	Eco 5/16" x 3-1/	2" 172	275	2-1/4"
			1"	4-1/8"	Eco 1/4" x 3-1/3	3" 143	229	1-3/4"
PLY				4-1/0	Eco 5/16" x 3-1/	2" 178	285	2-1/4"
3 P				3-1/8"	Eco 1/4" x 2-3/4	4"	208*	
			1/2"	3-3/8"	Eco	130*		
				4-1/8"	1/4" x 3-1/8	3"		1-3/4"
		←		3-1/8"	Eco 1/4" x 2-3/4	1"		1-3/4
	Z ⊥ and 3/4"	and	3///"	3-3/8"	Eco 1/4" x 3-1/3	134	214	
			J/4	4-1/8"	Eco 1/4" x 3-1/3	3"		
				4-1/0	Eco 5/16" x 3-1/	2" 138	221	2-1/4"
			1"	4-1/8"	Eco 1/4" x 3-1/5	143	229	1-3/4"
		'	4-1/0	Eco 5/16" x 3-1/	2" 143	229	2-1/4"	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode IIIs
 or IV except if otherwise identified with an asterisk (*) in which case the failure mode is
 not IIIs or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 4. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- The angle between force and fastener axis is 90°.

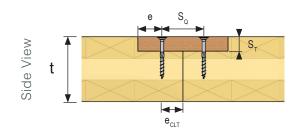
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle, intersecting the shear plane in the CLT panel at a depth equal to the spline thickness.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 9. Z_{\parallel} Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.

Table PP.5.2, Reference Lateral Design Values for CLT Surface Spline Joints Loaded in Shear

		Panel & Spline Config	uration				Reference Des	ign Values [lbs]	Minimum
		Loading	Spline Thickness	Panel Thickness (t)		Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
				5-1/8"					
			3/4"	5-1/2"		Eco 5/16" x 4-3/4"	172	275	
		*		6-7/8"					2-1/4"
	Z ,,	and		5-1/8"		Eco 5/16" x 4-3/4"			2-1/4
			1"	5-1/2"			178	285	
				6-7/8"		Eco 5/16" x 4-3/4"			
5 PLY	<u>ک</u>			0-776		Eco 3/8" x 4-3/4"	269	430	2-5/8"
5 P				5-1/8"					
			3/4"	5-1/2"		Eco 5/16" x 4-3/4"	138	221	
				6-7/8"					2-1/4"
	Z	and		5-1/8"		Eco			2-1/4
			1"	5-1/2"		5/16" x 4-3/4"	143	229	
			1"	0.7/0"		Eco 5/16" x 4-3/4"			
				6-7/8"		Eco 3/8" x 4-3/4"	197	315	2-5/8"

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode IIIs
 or IV except if otherwise identified with an asterisk (*) in which case the failure mode is
 not IIIs or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 5. The angle between force and fastener axis is 90°.

Geometry Requirements



- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle, intersecting the shear plane in the CLT panel at a depth equal to the spline thickness.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 9. $Z_{_{II}}$ Angle between loading direction and wood grain in the shear plane Θ = 0°.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.

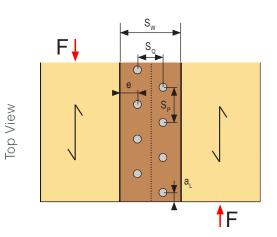


Table PP.5.3, Reference Lateral Design Values for CLT Surface Spline Joints Loaded in Shear

		Panel & Spline Config	uration			Reference Des	ign Values [lbs]	Minimum
		Loading	Spline Thickness	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _P)
				7-1/2"	F			
			3/4"	8-5/8"	Eco 5/16" x 5-1/2"	172	275	2-1/4"
				9-5/8"				
				7-1/2"	VG CSK 5/16" x 5-1/2"	178	285	2-1/4"
	_		1"	7-1/2	VG CSK 3/8" x 5-1/2"	269	430	2-5/8"
	Z _{//}	and		8-5/8" 9-5/8"	VG CSK 5/16" x 5-1/2"	178	285	2-1/4"
			'		VG CSK 3/8" x 5-1/2"	269	430	2-5/8"
					VG CSK 5/16" x 5-1/2"	178	285	2-1/4"
PLY				9-5/6	VG CSK 3/8" x 5-1/2"	269	430	2-5/8"
7 F				7-1/2"	Foo			
			3/4"	8-5/8"	Eco 5/16" x 5-1/2"	138	221	2-1/4"
				9-5/8"				
				7-1/2"	VG CSK 5/16" x 5-1/2"	143	229	2-1/4"
				7 1/2	VG CSK 3/8" x 5-1/2"	197	315	2-5/8"
	Z	and	1"	8-5/8"	VG CSK 5/16" x 5-1/2"	143	229	2-1/4"
			'	0-3/0	VG CSK 3/8" x 5-1/2"	197	315	2-5/8"
				0.5/0"	VG CSK 5/16" x 5-1/2"	143	229	2-1/4"
				9-5/8"	VG CSK 3/8" x 5-1/2"	197	315	2-5/8"

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode IIIs
 or IV except if otherwise identified with an asterisk (*) in which case the failure mode is
 not IIIs or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 5. The angle between force and fastener axis is 90°.

- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle, intersecting the shear plane in the CLT panel at a depth equal to the spline thickness.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 9. Z_{\parallel} Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.
 - Z_{\perp} Angle between loading direction and wood grain in the shear plane Θ = 90°.

NLT Butt Joint Connection in Shear

The simple butt joint is one of the most cost-effective methods of transferring in-plane shear between NLT or DLT panels. The screws are installed at a 45° angle to the edge face, creating a mechanical connection at a depth of half the panel thickness.

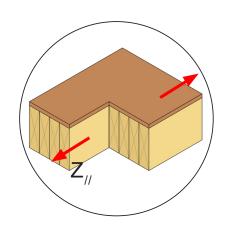


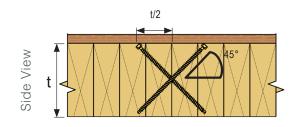
Table PP.6.1, Reference Lateral Design Values for NLT Butt Joints Loaded in Shear

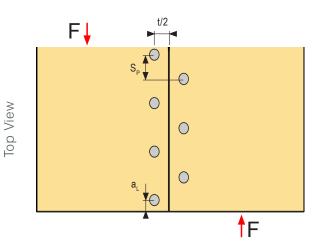
NLT Panel & Joint Configuration				Reference Design Values [lbs]		Minimum
	Loading Panel Thickness (t)		Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _P)
NLT	Z _{II}	3-1/2"	VG Cyl 1/4" x 4-3/4"	123	197	1-3/4"
		5-1/2"	VG Cyl 1/4" x 5-1/2"			
		7-1/4"	VG Cyl 1/4" x 7-1/8"			
		9-1/4"	VG CSK 5/16" x 9-1/2"	190	305	2-3/16"

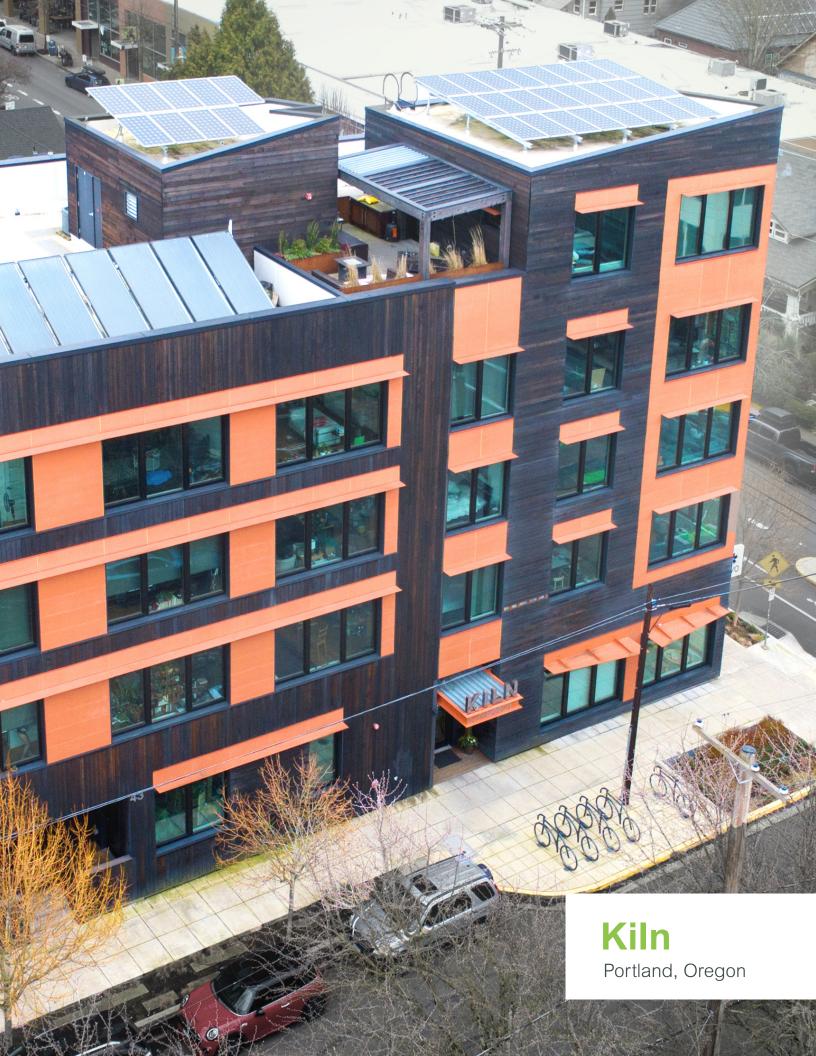
Notes:

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- 5. Fasteners are installed at a 45° angle, intersecting the shear plane in the NLT panel at a depth equal to the spline thickness.
- 6. The angle between force and fastener axis is 90°.
- 7. Z_{II} Angle between loading direction and wood grain in the shear plane $\Theta = 0^{\circ}$.

Geometry Requirements





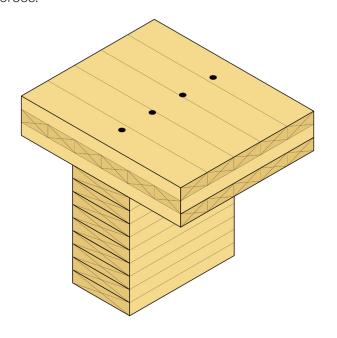


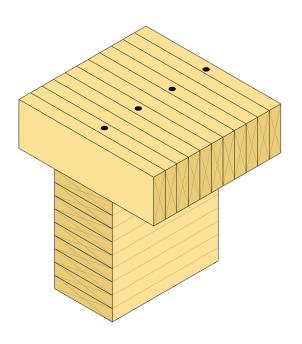


Panel to Beam Connections

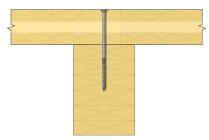
For post and beam structures, diaphragm forces are often transferred to collector elements such as beams, which then transfer the forces to the lateral load resisting system on the way down to the foundation. Floor to beam connections often benefit from the high strength and stiffness of fully threaded inclined screws or screw crosses to transfer these high magnitude forces.

Floor to beam connections can also maximize the effective bending stiffness of the two elements through composite action. Inclined fully threaded screws or screw crosses minimize slip at the interface, thereby maximizing connection efficiency with regards to composite effects.

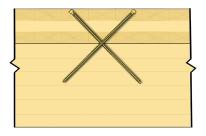




Typical Panel to Glulam Beam Connections

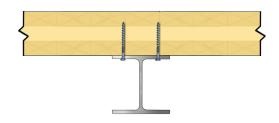


CLT panel to Glulam beam connection with a fastener in shear, see page 38 for details.

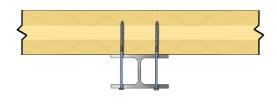


Connection with inclined fasteners arranged in a screw cross, see page 44 for details.

Typical Panel to Steel Beam Connections



CLT deep H-beam connection using shear screws, see Steel to Wood Connections Section.

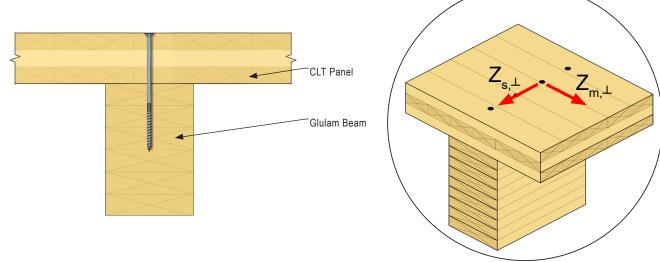


CLT shallow H-beam connection using shear screws, see Steel to Wood Connections Section.

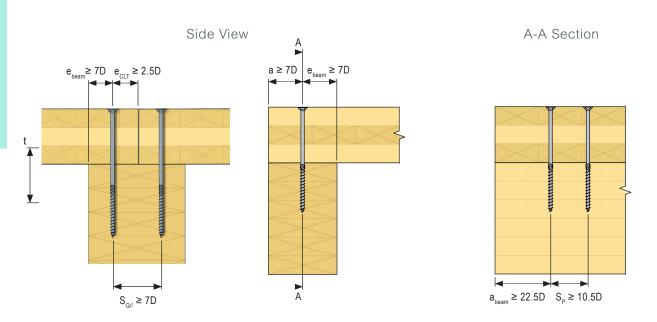
CLT Panel to Beam Connection in Shear

Partially threaded screws can be used to transfer shear forces and close the gap between two elements when connecting CLT diaphragms.

Four possible connection configurations, based on the angle to grain relationship, are tabulated on the following pages. If the CLT panel or the beam is expected to shrink, screws should be countersunk enough so that they do not push into the concrete slap on top of the CLT panel.



Geometry Requirements*



Notes:

1. *Minimum geometry requirements for S.P.F. panels and D.Fir glulam beams.

Table PB.1.1, Reference Lateral Design Values for CLT Panel to Beam Connections in Shear

		CLT Panel & Beam Config	juration			Reference Des	ign Values [lbs]	Minimum
		Loading	Beam Type	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
				3-1/8"	Eco	198	317	2-5/8"
	7			3-3/8"	1/4" x 6-1/4"	.00	01.	2 0/0
	Z _{//}			4-1/8"	Eco 1/4" x 7-7/8"	198	317	2-5/8"
				4-1/0	Eco 5/16" x 7-7/8"	259	414	3-3/8"
>	$\mathbf{Z}_{\!\scriptscriptstyle \perp}$		D-Fir (0.49)	3-1/8"	Eco	198	317	2-5/8"
3 PLY	or Z _{m,⊥}			3-3/8"	1/4" x 6-1/4"	130	317	2-3/0
	or				Eco 1/4" x 7-7/8"	198	317	2-5/8"
	Z _{s,} ⊥	-		4-1/8"	Eco 5/16" x 7-7/8"	207	331	3-3/8"

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode Ills
 or IV except if otherwise identified with an asterisk (*) in which case the failure mode is
 not Ills or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.

- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting beam.
- 7. The angle between force and fastener axis is 90°.
- 8. The main member is assumed as a glulam member with G = 0.49.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 10. $Z_{_{II}}$ Main member and side member loaded parallel to grain Θ = 0°.
 - $Z_{m,\perp}$ Main member loaded perpendicular to grain (Θ = 90°); side member loaded parallel to grain (Θ = 0°); Θ = 90° with regards to $K_{\rm e}$.
 - $$\begin{split} Z_{_{S}\perp} &\quad \text{Main member loaded parallel to grain } (\Theta=0^\circ); \text{ side member loaded} \\ &\quad \text{perpendicular to grain } (\Theta=90^\circ); \Theta=90^\circ \text{ with regards to } K_{_{\!\Theta}}. \end{split}$$
 - Z_{\perp} Main member and side member loaded perpendicular to grain Θ = 90°.

Table PB.1.2, Reference Lateral Design Values for CLT Panel to Beam Connections in Shear

		CLT Panel & Beam Config	guration			Reference Des	ign Values [lbs]	Minimum
		Loading	Beam Type	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
				5-1/8"	Eco	250	444	2.2/0"
	7			5-1/2"	5/16" x 9-1/2"	259	414	3-3/8"
	Z ,,			6.7/0"	Eco 5/16" x 11-7/8"	259	414	3-3/8"
				6-7/8"	Eco 3/8" x 11-7/8"	380	608	4"
				5-1/8"	Eco	207	331	3-3/8"
	7			5-1/2"	5/16" x 9-1/2"	_3.	301	3-3/6
	Z _{m,⊥}			6-7/8"	Eco 5/16" x 11-7/8"	207	331	3-3/8"
5 PLY			D-Fir	0-776	Eco 3/8" x 11-7/8"	282	451	4"
5 P			(0.49)	5-1/8"	Eco	207	331	3-3/8"
	7			5-1/2"	5/16" x 9-1/2"	201	331	3-3/6
	$\mathbf{Z}_{\mathrm{s},\!\perp}$			6-7/8"	Eco 5/16" x 11-7/8"	207	331	3-3/8"
				0-776	Eco 3/8" x 11-7/8"	273	451	4"
				5-1/8"	Eco	207	331	3-3/8"
	7	*		5-1/2"	5/16" x 9-1/2"	201	331	J-J/O
	$\mathbf{Z}_{\!\scriptscriptstyle \perp}$	→		6-7/8"	Eco 5/16" x 11-7/8"	207	331	3-3/8"
			0-1/0	Eco 3/8" x 11-7/8"	257	451	4"	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode IIIs
 or IV except if otherwise identified with an asterisk (*) in which case the failure mode is
 not IIIs or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.

- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting beam.
- 7. The angle between force and fastener axis is 90°.
- 8. The main member is assumed as a glulam member with G = 0.49.
- Reference lateral design values may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
- 10. Z_{ij} Main member and side member loaded parallel to grain $\Theta = 0^{\circ}$.
 - $Z_{m,\perp}$ Main member loaded perpendicular to grain (Θ = 90°); side member loaded parallel to grain (Θ = 0°); Θ = 90° with regards to K_a .
 - $Z_{s,\perp}$ Main member loaded parallel to grain (Θ = 0°); side member loaded perpendicular to grain (Θ = 90°); Θ = 90° with regards to K_{s} .
 - Z_{\perp} Main member and side member loaded perpendicular to grain Θ = 90°.

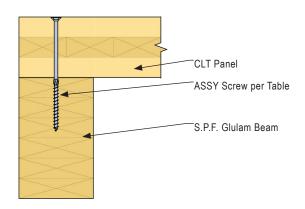
Table PB.1.3, Reference Lateral Design Values for CLT Panel to Beam Connections in Shear

Loading Panel Thickness Fastner Options Standard Loading Short Term Loading Short			CLT Panel & Beam Config	guration			Reference Des	ign Values [lbs]	Minimum
7-1/2" Sife'x 11-7/8" 259 414 3-3/8" Eco 3/8" x 11-7/8" 380 608 4" Eco 3/8" x 11-7/8" 207 331 3-3/8" Eco 3/8" x 11-7/8" 282 411 4" 4" Eco 3/8" x 11-7/8" 273 451 4" Eco 5/16" x 11-7/8" 273 451 4" Eco 3/8" x 11-7/8" 257 437 4"			Loading		Thickness			Short Term Loading C _D =1.6	Spacing in a Row
Z					7.4/0"		259	414	3-3/8"
Signature Sign					7-1/2"		380	608	4"
Z		7			9 5/9"		259	414	3-3/8"
Z SK SK SK SK SK SK SK		Z	0		0-3/0		380	608	4"
Total Sk 1/2" x 15-3/4" 5-46 874 5-1/4" 5-1					9-5/8"		380	608	4"
7-1/2" S/16" x 11-7/8" 207 331 3-3/8"					3 0/0		546	874	5-1/4"
Z m, L Z m Z m, L Z m Z m Z m Z m Z m Z m Z m Z					7-1/2"		207	331	3-3/8"
Solution					. 1/2		282	411	4"
D-Fir		7 .			8-5/8"		207	331	3-3/8"
D-Fir 9-5/8" SK 389 573 5-1/4" 4"		- m,⊥	→		2 0,2		282	411	4"
D-Fir (0.49) Z s, L Comparison of the compar					9-5/8"		282	411	4"
7-1/2"	7			D-Fir	0 0/0		399	573	5-1/4"
Z _{s,⊥}				(0.49)	7-1/2"		207	331	3-3/8"
Z _{s,1} 8-5/8" 8-5/8" 5/16" x 13-3/8" Eco 3/8" x 14-1/4" 9-5/8" Eco 3/8" x 15" SK 1/2" x 15-3/4" Eco 5/16" x 11-7/8" 207 331 3-3/8" 451 4" 4" Eco 3/8" x 15" 273 451 4" Eco 3/8" x 11-7/8" 207 331 3-3/8" 7-1/2" Eco 3/8" x 11-7/8" 257 437 4" Eco 3/8" x 14-1/4" 257 437 4" Eco 3/8" x 15" SK 257 437 4"							273	451	4"
SK 11-7/8" 273 451 4"		7 .			8_5/8"		207	331	3-3/8"
3/8" x 15" 2/3 451 4 SK 1/2" x 15-3/4" 384 638 5-1/4" FECO 5/16" x 11-7/8" 207 331 3-3/8" ECO 3/8" x 11-7/8" 257 437 4" FECO 3/8" x 13-3/8" 207 331 3-3/8" FECO 3/8" x 11-7/8" 257 437 4" FECO 3/8" x 14-1/4" 257 437 4" FECO 3/8" x 14-1/4" 257 437 4" FECO 3/8" x 15" 257 437 4" FECO 3/8" x 15" 257 437 4" FECO 3/8" x 15" 257 437 4"		- s, [⊥]					273	451	4"
SK 1/2" x 15-3/4" 384 638 5-1/4"					9-5/8"		273	451	4"
7-1/2"					0 0/0		384	638	5-1/4"
Eco 3/8" x 11-7/8" 257 437 4" Eco 5/16" x 13-3/8" 207 331 3-3/8" Eco 3/8" x 14-1/4" 257 437 4" Eco 3/8" x 14-1/4" 257 437 4" Eco 3/8" x 15" 257 437 4" SK 359 572 574 573 5 144"					7-1/2"		207	331	3-3/8"
Eco 3/8" x 14-1/4" 257 437 4" Eco 3/8" x 14-1/4" 257 437 4" Eco 3/8" x 15" 257 437 4"					,2		257	437	4"
9-5/8" SK 257 437 4" SK 257 437 4" SK 259 573		7			8-5/8"		207	331	3-3/8"
9-5/8" 3/8" x 15" 257 437 4" SK 259 573 5 1/4"		- 1			0 0/0		257	437	4"
SK 250 572 5 44"					0.5/0"		257	437	4"
					9-3/0	SK 1/2" x 15-3/4"	358	573	5-1/4"

See notes under Table PB.1.2, page 40.

CLT Floor to Beam Connection

CLT floor panels can also be fastened to supporting timber beams below with partially threaded selftapping screws installed from the top surface of the panel in order to transfer shear and uplift forces.



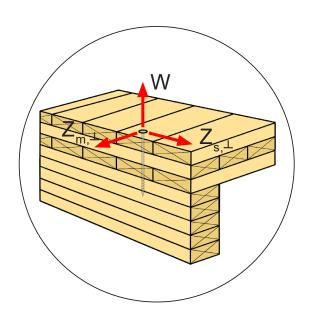


Table PB.3.1, Reference Design Values for CLT Floor to Beam Connection

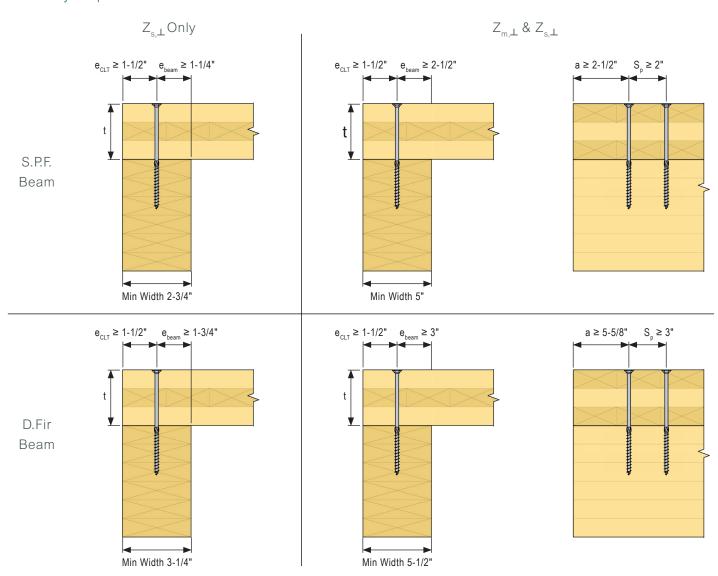
CL	Γ Panel & Beam	Configuration		Re	ference Des	ign Values [l	bs]
	Beam Type	Panel Thickness (t)	Fastener Options	Z _{m,} _	Z _{s,} ⊥	W _{ECO}	W _{sk}
		3-1/8"	Eco / SK				
3 PLY	SPF (0.42)	3-3/8"	1/4" x 6-1/4"	185	185	141	274
	, ,	4-1/8"	Eco / SK 1/4" x 7-1/8"				
		5-1/8"	Eco / SK 1/4" x 7-1/8"	157	157		
5 PLY	SPF (0.42)	5-1/2"	Eco / SK 1/4" x 8-5/8"	185	185	141	274
	, ,	6-7/8"	Eco / SK 1/4" x 10-1/4"	100	105		

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the adjacent figures (page 43) and the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting beam.
- 6. Short term loading ($C_p = 1.6$) can be applied to $Z_{m,\perp}$ and $Z_{s,\perp}$.
- 7. $Z_{m,\perp}$ Main member loaded perpendicular to grain (Θ = 90°); side member loaded parallel to grain (Θ = 0°); Θ = 90° with regards to K_{Φ} .
 - $Z_{s,\perp}$ Main member loaded parallel to grain (Θ = 0°); side member loaded perpendicular to grain (Θ = 90°); Θ = 90° with regards to K_a.

Table PB.3.2, Reference Design Values for CLT Floor to Beam Connection

CLI	Γ Panel & Beam	Configuration			Re	ference Des	ign Values [l	bs]
	Beam Type	Panel Thickness (t)	Fastene Options		Z _{m,⊥}	Z _{s,} ⊥	W _{ECO}	W _{sk}
(3-1/8"	Eco / S	SK				
3 PLY	D-Fir (0.49)	3-3/8"	1/4" x 6-1	1/4"	198	198	141	274
	, ,	4-1/8"	Eco / S 1/4" x 7-					
		5-1/8"	Eco / S 1/4" x 7-1		195	195		
5 PLY	D-Fir (0.49)	5-1/2"	Eco / S 1/4" x 8-5		100	198	141	274
3	, ,,,	6-7/8"	Eco / S 1/4" x 10-		198	190		

See notes under table PB.3.1, page 42.



CLT Panel to Beam Connection with Inclined Screws

Inclined, fully threaded screws can be used in place of screws loaded perpendicular to the screw axis for shear connections wherever greater stiffness and higher capacity is required. The use of screw crosses ensures equal capacity in alternating loading directions. Partially threaded screws can be installed in advance of the inclined screws for assembly purposes. The partially threaded screws serve to close the gap between the elements and hold them together tightly until the load transmitting inclined screws are installed.

Reference design values refer to one screw cross (two fully threaded screws). The shear capacity of assembly screws must not be accounted for.

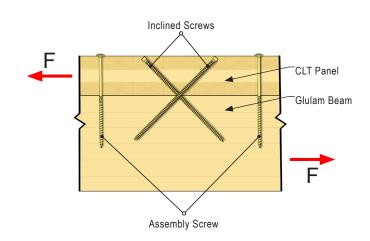


Table PB.2.1, Reference Design Values for CLT Panel to Beam Connection Inclined Screws

		CLT Panel & Joint Config	uration		Fastener		esign Values Cross [lbs]	Minimum Spacing
		Loading	Beam Type	Panel Thickness (t)	Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	in a Row (S _P)
				3-1/8"	VG CSK 5/16" x 8-5/8"	1,171	1,873	4-3/4"
	7		D-Fir	3-3/8"	VG CSK 5/16" x 9-1/2"	1,283	2,031	4-3/4"
	Z"		(0.49)	4-1/8"	VG CSK 5/16" x 11-7/8"	1,582	2,259*	4-3/4"
7					VG CSK 3/8" x 11-7/8"	1,769	2,830	5-5/8"
3 P				3-1/8"	VG CSK 5/16" x 8-5/8"	1,171	1,873	4-3/4"
	7		D-Fir	3-3/8"	VG CSK 5/16" x 9-1/2"	1,308	2,050	4-3/4"
	\mathbf{Z}_{\perp}		(0.49)	4.4/0"	VG CSK 5/16" x 11-7/8"	1,666	2,259*	4-3/4"
				4-1/8"	VG CSK 3/8" x 11-7/8"	1,862	2,932	5-5/8"

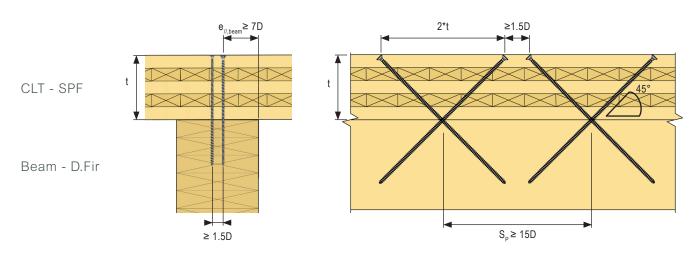
- Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the adjacent figures (page 45) and the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of the CLT panel and supporting beam.

- 6. The angle between force and fastener axis is 45°.
- 7. The main member is assumed as a glulam member with G = 0.49.
- Reference lateral design values only apply to parallel loading along the span direction of the glulam.
- The upper limit of the adjusted withdrawal resistance is set by the allowable fastener tensile strength, no further increase allowed.
- 10. $Z_{_{\parallel}}$ Reference lateral design value per screw cross with CLT main member loaded along the major span direction.
 - Z_⊥ Reference lateral design value per screw cross with CLT main member loaded along the minor span direction.

Table PB.2.2, Reference Design Values for CLT Panel to Beam Connection Inclined Screws

		CLT Panel & Joint Config	juration		Fastener		esign Values Cross [lbs]	Minimum Spacing
		Loading	Beam Type	Panel Thickness (t)	Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	in a Row (S _P)
				5-1/8"	VG Cyl 5/16" x 15"	2,016	2,259*	4-3/4"
	7		D-Fir	5-1/2"	VG Cyl 5/16" x 15"	2,038	2,259*	4-3/4"
	Z _{//}	→	(0.49)	6-7/8"	VG Cyl 5/16" x 19"	2,259*	2,259*	4-3/4"
PLY				0-776	VG CSK 3/8" x 19"	2,932	3,246*	5-5/8"
5 P				5-1/8"	VG Cyl 5/16" x 15"	2,046	2,259*	4-3/4"
	7		D-Fir	5-1/2"	VG Cyl 5/16" x 15"	2,050	2,259*	4-3/4"
	Z		(0.49)	6-7/8"	VG Cyl 5/16" x 19"	2,259*	2,259*	4-3/4"
					VG CSK 3/8" x 19"	2,953	3,246*	5-5/8"
				7-1/2"	VG Cyl 5/16" x 20-7/8"	2,259*	2,259*	4-3/4"
	Z _{//}			7-1/2	VG CSK 3/8" x 20-7/8"	3,036	3,246*	5-5/8"
PLY	or		D-Fir (0.49)	0.5/08	VG Cyl 5/16" x 22-7/8"	2,259*	2,259*	4-3/4"
7	\mathbf{Z}_{\perp}		(0.40)	8-5/8" -	VG CSK 3/8" x 22-7/8"	0.040*	0.040*	5.5(0)
		-		9-5/8"	VG CSK 3/8" x 25-5/8"	3,246*	3,246*	5-5/8"

See notes under Table PB.2.1, page 44.



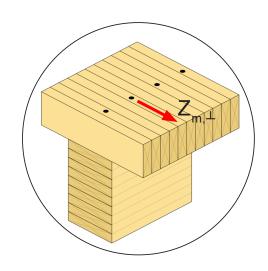
NLT Panel to Beam Connection in Shear

Table PB.4, Reference Lateral Design Values for NLT Panel to Beam Connections in Shear

		NLT Panel & Beam Config	guration			Reference Des	ign Values [lbs]	Minimum
	I Oading		Beam Type	Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _P)
				3-1/2"	Eco 1/4" x 7-7/8"			
	Z _{m,} _		D-Fir (0.49)	5-1/2"	Eco 1/4" x 10-1/4"	198	316	3"
NFT				7-1/4"	Eco 1/4" x 11-7/8"			
				9-1/4"	Eco 5/16" x 14-1/4"	207	332	3-3/8"
				11-1/4"	Eco 5/16" x 15-3/4"	201	332	3-3/6

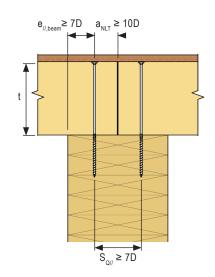
Notes:

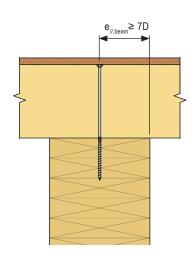
- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the NLT panel and supporting beam.
- The angle between force and fastener axis is 90°.
- 7. The main member is assumed as a glulam member with G = 0.49.
- 8. $Z_{m,\perp}$ Main member loaded perpendicular to grain (Θ = 90°); side member loaded parallel to grain (Θ = 0°); Θ = 90° with regards to K_G.
 - $Z_{s\perp}$ Main member loaded parallel to grain (Θ = 0°); side member loaded perpendicular to grain (Θ = 90°); Θ = 90° with regards to K_{Θ} .



NLT - SPF

Beam - D.Fir





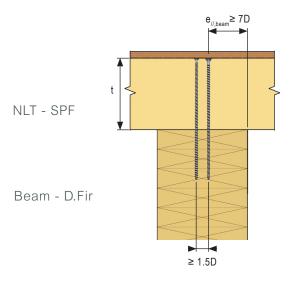
NLT Panel to Beam Connection with Inclined Screws

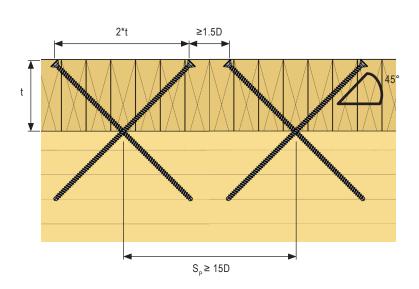
Table PB.5, Reference Lateral Design Values for NLT Panel to Beam Connections with Inclined Screws

		NLT Panel & Beam Confiç	guration			Reference D per Screw	Minimum	
	Loading			Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
					VG CSK 5/16" x 9-1/2"	1,274	2,023	
NLT	7	← \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	D-Fir	5-1/2"	VG Cyl 5/16" x 14-1/4"	1,851		4-3/4"
Z	Z _″	—————————————————————————————————————	(0.49)	7-1/4"	VG Cyl 5/16" x 17"	1,934	2,259*	4-3/4
		7		9-1/4"	VG Cyl 5/16" x 20-7/8"	2,128		

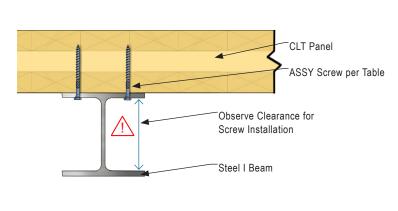
Notes:

- 1. Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- 5. Fasteners are installed at a 45° angle intersecting the shear plane at the interface of the NLT panel and supporting beam.
- 6. The angle between force and fastener axis is 45°.
- 7. The main member is assumed as a glulam member with G = 0.49.
- Reference lateral design values only apply to parallel loading along the span direction of the glulam and with the screws installed perpendicular-to-grain in the NLT.
- * The upper limit of the adjusted withdrawal resistance is set by the allowable fastener tensile strength, no further increase allowed.





CLT Panel to Steel Beam Connection



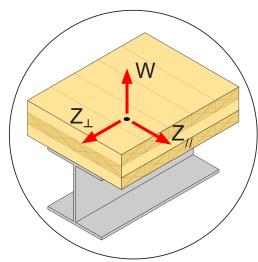


Table PB.6.1, Reference Lateral Design Values for CLT Steel Beam Connections

	C	CLT Panel & Steel Beam C	onfiguration			Reference Des	ign Values [lbs]
	Loading Panel Thickness (t)				Fastener Options	Z	w
			3-1/8"	3/16"		279	
	Z _″	•	to	1/4"	Kombi 5/16" x 3-1/8"	312	
PLY			4-1/8"	1/2"		323*	358
3 P			3-1/8"	3/16"		223	336
	\mathbf{Z}_{\perp}		to	1/4"	Kombi 5/16" x 3-1/8"	249	
			4-1/8"	1/2"		258*	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode IIIs
 or IV except if otherwise identified with an asterisk (*) in which case the failure mode is
 not IIIs or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting steel beam.

- The angle between force and fastener axis is 90°.
- The side member is assumed as ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 10. Z_{\parallel} Main member loaded parallel to grain. ($\Theta = 0^{\circ}$)
 - Z_{\perp} Main member loaded perpendicular to grain. ($\Theta = 90^{\circ}$)
 - W Screws loaded in withdrawal.

Table W.5.2, Steel Plate Pre-Drilling Diameter

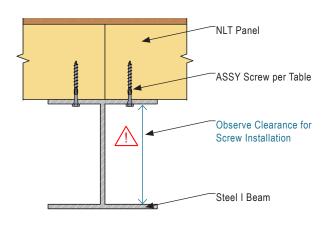
Screw Nominal Diameter	Steel Plate Hole Diameter
in.	in.
1/4"	9/32"
5/16"	3/8"
3/8"	7/16"
1/2"	17/32"

Table PB.6.2, Reference Lateral Design Values for CLT Steel Side Plate Connections

	C	CLT Panel & Steel Beam C	onfiguration			Reference Des	ign Values [lbs]	
		Loading	Panel Thickness (t)	Steel Thickness	Fastener Options	z	w	
					Kombi 5/16" x 3-1/8"	279	358	
				2/40"	Kombi 3/8" x 4-3/4"	394	652	
				3/16"	Kombi 1/2" x 4-3/4"	540	007	
a					Kombi 1/2" x 5-1/2"	542	667	
PLY or More			5-1/2"		Kombi 5/16" x 3-1/8"	312	358	
or	Z ,,	or	to	1/4"	Kombi 3/8" x 4-3/4"	430	652	
5 PL			9-5/8"	1/4	Kombi 1/2" x 4-3/4"	F.7.F	007	
4)		***			Kombi 1/2" x 5-1/2"	575	667	
					Kombi 3/8" x 4-3/4"	505	652	
				1/2"	Kombi 1/2" x 4-3/4"	713*	007	
					Kombi 1/2" x 5-1/2"	725	667	
					Kombi 5/16" x 3-1/8"	223	358	
					Kombi 3/8" x 4-3/4"	267	652	
				3/16"	Kombi 1/2" x 4-3/4"	050	007	
					Kombi 1/2" x 5-1/2"	356	667	
More			5-1/2"		Kombi 5/16" x 3-1/8"	249	358	
PLY or	Z	or	to	4 / 4"	Kombi 3/8" x 4-3/4"	292	652	
5 PL			9-5/8"	1/4"	Kombi 1/2" x 4-3/4"	378*	667	
ω.		<u> </u>			Kombi 1/2" x 5-1/2"	379	667	
					Kombi 3/8" x 4-3/4"	339	652	
				1/2"	Kombi 1/2" x 4-3/4"	439*	607	
					Kombi 1/2" x 5-1/2"	472	667	

See notes under Table PB.6.1, page 48.

NLT Panel to Steel Beam Connection



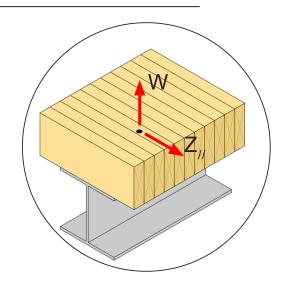


Table PB.7.1, Reference Lateral Design Values for NLT to Steel Beam Connections

N	NLT Panel & Steel Beam Configuration					Reference Design Values [lbs]			
Loa	ading	Panel Thickness (t)	Steel Thickness		Fastener Options	Z	w		
		3-1/2"	3/16"		Kombi 5/16" x 3-1/8"	279			
NLT	Z ,,	to	1/4"			312	358		
	"	5-1/2"	1/2"			323			

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the NLT panel and supporting steel beam.

- 6. The angle between force and fastener axis is 90°.
- The side member is assumed as ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 9. $Z_{_{II}}$ Main member loaded parallel to grain. (Θ = 0°)
 - Z_{\perp} Main member loaded perpendicular to grain. (Θ = 90°)
 - W Screws loaded in withdrawal.

Table PB.7.3, Steel Plate Pre-Drilling Hole Size Diameter

Screw Nominal Diameter	Steel Plate Hole Diameter
in.	in.
1/4"	9/32"
5/16"	3/8"
3/8"	7/16"
1/2"	17/32"

Table PB.7.2, Reference Lateral Design Values for NLT to Steel Beam Connections

NLT Panel & Steel Beam Configuration			onfiguration		Reference Design Values [lbs]			
Lo	ading	Panel Thickness (t)	Steel Thickness	Fastener Options	Z	w		
NLT	Z"	5-1/2" to 11-1/4"	3/16"	Kombi 5/16" x 3-1/8"	279	358		

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- 5. Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the NLT panel and supporting steel beam.

- The angle between force and fastener axis is 90°.
- 7. The side member is assumed as ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- 8. Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 9. Z_{\parallel} Main member loaded parallel to grain. ($\Theta = 0^{\circ}$)
 - Z_{\perp} Main member loaded perpendicular to grain. (Θ = 90°)
 - W Screws loaded in withdrawal.

Post to Beam Connections



Beam Hanger Systems

The beam hanger systems are pre-engineered solutions for easily connecting post to beam or girder to beam members in mass timber structures. High loads are supported with simple and fast installation, making the beam hanger systems one of the most cost-effective mass-timber connecting solutions on the market.





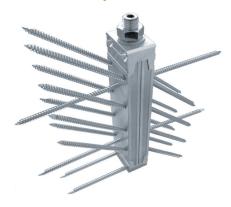
GIGANT System



RICON S VS System



MEGANT System



Engineered for Mass Timber

Optimizing post and beam framing systems



Easy to Install

Simple drop-in assembly accelerates the construction process



Versatile

Can be installed on steel, concrete and wood



Certified Fire Rated

Full scale fully loaded fire tested in America



Inter-Story Drift Performance Tested

Used in seismic zones



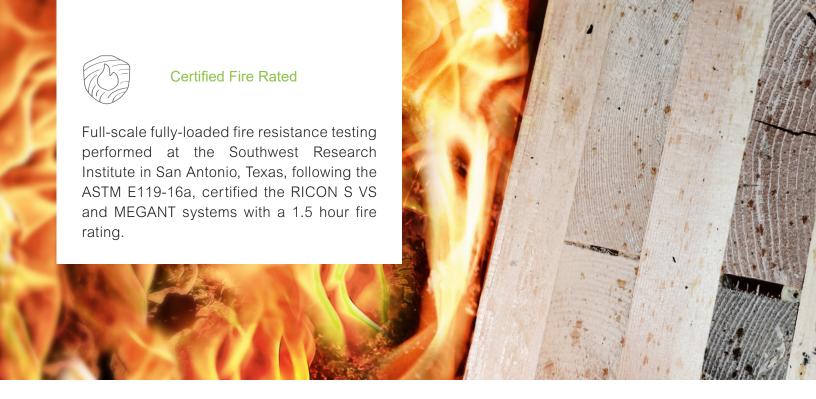
Moisture Content Variation Tested

Dry-Wet-Dry & Wet-Wet-dry configurations tested

CERTIFICATIONS

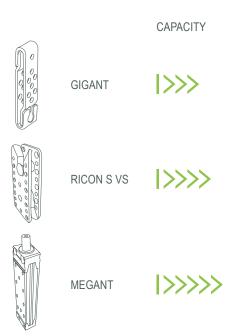
ISO 50001 for the Fasteners





Pre-designed

Our detailed Beam Hanger Design Guide provides tabulated design values and precise installation instructions for each of our Beam Hanger Systems, reducing the engineering & detailing time needed to successfully complete a project.



Notes: For more information please consult our **Beam Hanger Design Guide**.

MTC Beam Hanger Design Guide contains tabulated design values, detailed explanations for fire rating and skewed connections, installation instruction and the full range of our products.

Easy to Install

Beam Hanger Systems can be pre-installed in a controlled shop environment, offering the following benefits:

- Accelerated construction time
- Fewer power tools
- Reduced on-site labor
- Reduces risk of injury and error

High Architectural Value

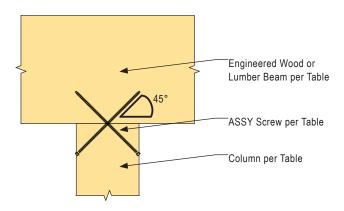
The standardized and complete beam hanger system, includes detailed routing procedures, allowing for a repetitive and precise installation while offering an architecturally appealing clean wood appearance.



Post to Beam Connection - Bearing

As an alternative to pre-engineered steel connectors, both fully threaded and partially threaded self-tapping screws can connect beams to posts in bearing connections. Post to beam connections are capable of resisting longitudinal and transverse lateral loads, as

well as uplift forces. Either for temporary or permanent work, self-tapping screws are an efficient alternative for post to beam connections and can easily be concealed if required.



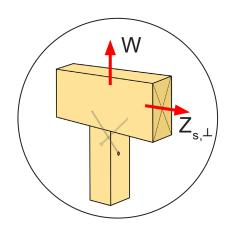
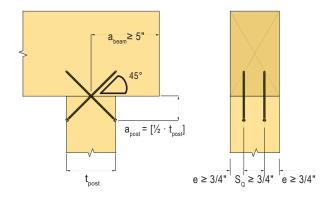


Table PT.1, Reference Design Values for Beam to Post Connection (Bearing)

	to Post Config				Defense Basins		
Loading	Beam Type	Colum Size		Fastener Options	Reference Design Values per Screw Cross [lbs]		
				VG Cyl 1/4" x 6-1/4"	390		
	SPF	6 x 6"		VG Cyl 1/4" x 7-1/8"	551		
	Sawn Lumber & Glulam			VG Cyl 1/4" x 7-7/8"	689		
	(0.42)	8 x 8"		VG Cyl 1/4" x 7-1/8"	220		
		0 X 0		VG Cyl 1/4" x 7-7/8"	428		
				VG Cyl 1/4" x 6-1/4"	465		
W	5.5	6 x 6"		VG Cyl 1/4" x 7-1/8"	593		
or	D-Fir (0.49)			VG Cyl 1/4" x 7-7/8"	718		
${f Z}_{{f s},\!oldsymbol{f \perp}}$		8 x 8"		VG Cyl 1/4" x 7-1/8"	283		
Ξ,		0 X 0		VG Cyl 1/4" x 7-7/8"	511		
				VG Cyl 1/4" x 6-1/4"	419		
				6 x 6"		VG Cyl 1/4" x 7-1/8"	593
	(0.50)			VG Cyl 1/4" x 7-7/8"	718		
	(0.30)	9 v 9"		VG Cyl 1/4" x 7-1/8"	238		
		8 x 8"		VG Cyl 1/4" x 7-7/8"	461		

Notes

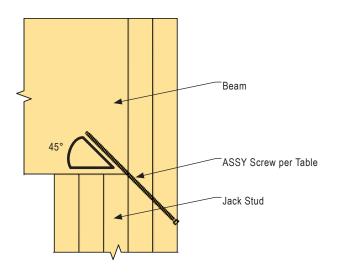
- Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed in a screw cross configuration, intersecting the shear plane at the interface of the post and the beam.
- 6. The angle between force and fastener axis is 45°.
- Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.



Beam to Jack Stud Connection

Fully threaded self-tapping screws installed at a 45° angle are an efficient and simple way to connect headers to jack and king studs. Single or double screws can be installed to resist uplift forces as well

as lateral loads along the length of the header. A comparable nailed or premanufactured connection would require a considerable additional amount of work in order to obtain the same capacities.



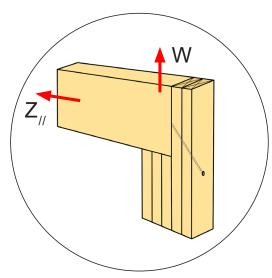


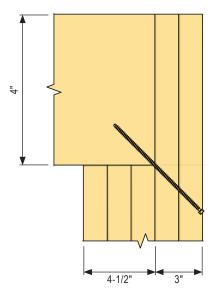
Table PT.2, Reference Design Values for Beam to Jack Stud Connection

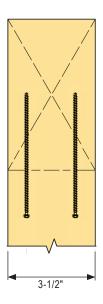
Beam to J	ack Stud Con	nfiguration											
Loading	Jack Stud	Beam Type	Options		Reference Design Values [lbs]								
		SPF		VG Cyl 1/4" x 6-1/4"	180								
		Sawn Lumber & Glulam		VG Cyl 1/4" x 7-1/8"	270								
w		(0.42)		VG Cyl 1/4" x 7-7/8"	347								
or	Double 2"	D-Fir (0.49)						VG Cyl 1/4" x 6-1/4"	215				
or	Lumber			VG Cyl 1/4" x 7-1/8"	322								
Z _{//}		(0.40)		VG Cyl 1/4" x 7-7/8"	387								
												VG Cyl 1/4" x 6-1/4"	194
		EWP (0.50)		VG Cyl 1/4" x 7-1/8"	290								
		(3.33)		VG Cyl 1/4" x 7-7/8"	373								

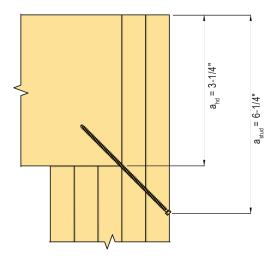
Note

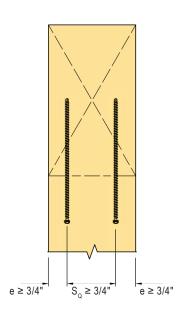
- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- 5. Fasteners to be installed at a 45° angle intersecting the shear plane at the interface of the post and the beam.
- Sawn Lumber studs with multiple plies must be independently fasten to each other as per the applicable design codes or standards.
- Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.

Minimum Timber Requirements

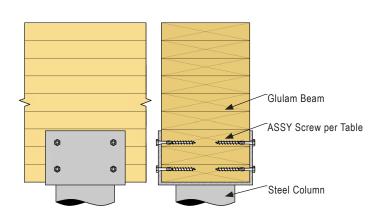








Wood Beam to Steel Column - Shear Screws



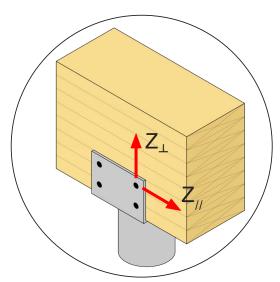


Table PT.3, Reference Design Values for Steel Column

	& Steel ifiguration		_ ,		e Design ues
Beam	Steel		Fastener Options	[lk	os]
Туре	Thickness			Z"	Z _⊥
			Kombi 5/16" x 2-3/8"	264	211
	1/4"		Kombi 5/16" x 3-1/8"	312	249
			Kombi 5/16" x 4"	312	249
epr.			Kombi 5/16" x 2-3/8"	265	212
SPF	1/2"		Kombi 5/16" x 3-1/8"	323	259
(0.42)			Kombi 5/16" x 4"	337	269
	3/4"		Kombi 5/16" x 2-3/8"	250	200
			Kombi 5/16" x 3-1/8"	302	241
			Kombi 5/16" x 4"	337	269
			Kombi 5/16" x 2-3/8"	326	261
	1/4"		Kombi 5/16" x 3-1/8"	252	202
			Kombi 5/16" x 4"	353	282
EMD			Kombi 5/16" x 2-3/8"	323	258
EWP	1/2"		Kombi 5/16" x 3-1/8"	200	200
(0.50)			Kombi 5/16" x 4"	386	309
			Kombi 5/16" x 2-3/8"	300	240
	3/4"		Kombi 5/16" x 3-1/8"	377	302
			Kombi 5/16" x 4"	386	309

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
- Steel members must be pre-drilled prior to the installation of the fasteners.
 The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 7. The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- 8. Z_{II} Main member loaded parallel to grain (Θ = 0°).
 - Z_{\perp} Main member loaded perpendicular to grain ($\Theta = 90^{\circ}$).

Wood Beam to Steel Column - Inclined Screws

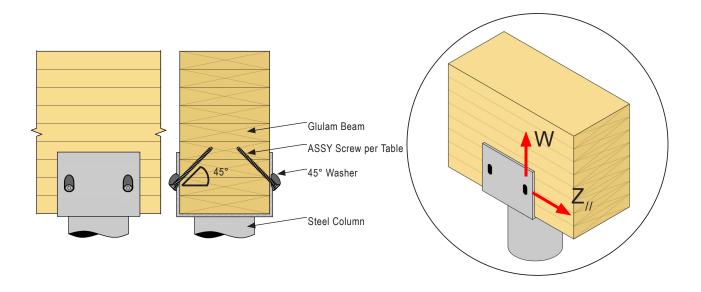
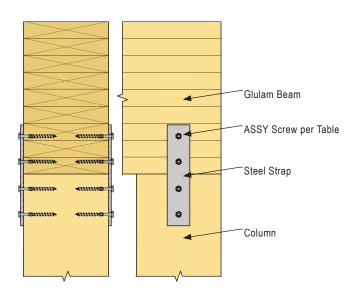


Table PT.4.1, Reference Design Values for Steel Column with Inclined Screws

	& Steel nfiguration	Fastener	Val	e Design ues
Beam Type	Steel Thickness	Options		os]
.,,,,			W	Z"
		VG CSK 5/16" x 4-3/4"	553	
	1/4"	VG CSK 5/16" x 5-1/2"	665	
		VG CSK 5/16" x 6-1/4"	778	
0.05		VG CSK 5/16" x 4-3/4"	534	
SPF	3/8"	VG CSK 5/16" x 5-1/2"	646	264
(0.42)		VG CSK 5/16" x 6-1/4"	759	
		VG CSK 5/16" x 4-3/4"	506	
	9/16"	VG CSK 5/16" x 5-1/2"	618	
		VG CSK 5/16" x 6-1/4"	731	
		VG CSK 5/16" x 4-3/4"	467	
	1/4"	VG CSK 5/16" x 5-1/2"	562	
		VG CSK 5/16" x 6-1/4"	657	
EMD		VG CSK 5/16" x 4-3/4"	451	
EWP	3/8"	VG CSK 5/16" x 5-1/2"	546	308
(0.50)		VG CSK 5/16" x 6-1/4"	641	
		VG CSK 5/16" x 4-3/4"	427	
	9/16"	VG CSK 5/16" x 5-1/2"	522	
		VG CSK 5/16" x 6-1/4"	617	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
- Steel members must be pre-drilled prior to the installation of the fasteners.
 The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- For more information on how to predrill a steel plate with MTC Solutions 45° washer, please refer to the detailing section of this guide, page 104.
- 9. Z_{\parallel} Main member loaded parallel to grain ($\Theta = 0^{\circ}$).

Beam Bearing Straps - Shear Screws



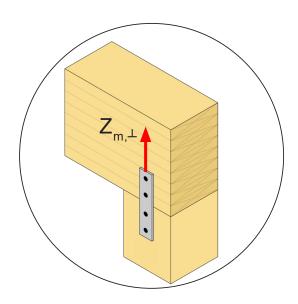
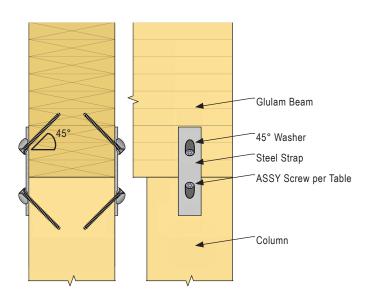


Table PT.5, Reference Design Values for Beam Bearing Straps

	& Steel nfiguration		Reference Design Values
Beam	Steel	Fastener Options	[lbs]
Type	Thickness		Z _{m,} _
		Kombi 5/16" x 2-3/8"	211
	1/4"	Kombi 5/16" x 3-1/8"	249
		Kombi 5/16" x 4"	249
SPF		Kombi 5/16" x 2-3/8"	212
(0.42)	1/2"	Kombi 5/16" x 3-1/8"	259
(0.42)		Kombi 5/16" x 4"	269
	3/4"	Kombi 5/16" x 2-3/8"	200
		Kombi 5/16" x 3-1/8"	241
		Kombi 5/16" x 4"	269
		Kombi 5/16" x 2-3/8"	261
	1/4"	Kombi 5/16" x 3-1/8"	282
		Kombi 5/16" x 4"	202
EWP		Kombi 5/16" x 2-3/8"	258
	1/2"	Kombi 5/16" x 3-1/8"	309
(0.50)		Kombi 5/16" x 4"	309
		Kombi 5/16" x 2-3/8"	240
	3/4"	Kombi 5/16" x 3-1/8"	302
		Kombi 5/16" x 4"	309

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
- Steel members must be pre-drilled prior to the installation of the fasteners.
 The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 7. The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- 8. $Z_{m,\perp}$ Main member loaded perpendicular to grain ($\Theta = 90^{\circ}$); side member loaded parallel to grain ($\Theta = 0^{\circ}$); $\Theta = 90^{\circ}$ with regards to K_{o} .

Beam Bearing Straps - Inclined Screws



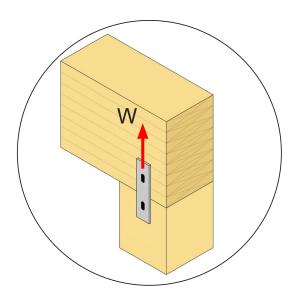
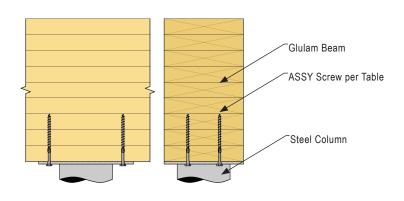


Table PT.6.1, Reference Design Values for Beam Bearing Straps with Inclined Screws

	& Steel nfiguration Steel			Reference Design Values
Beam			Fastener Options with 45° Washers	[lbs]
Туре	Thickness			W
			VG CSK 5/16" x 4-3/4"	553
	1/4"		VG CSK 5/16" x 5-1/2"	665
			VG CSK 5/16" x 6-1/4"	778
SPF			VG CSK 5/16" x 4-3/4"	534
	3/8"		VG CSK 5/16" x 5-1/2"	646
(0.42)			VG CSK 5/16" x 6-1/4"	759
	9/16"		VG CSK 5/16" x 4-3/4"	506
			VG CSK 5/16" x 5-1/2"	618
			VG CSK 5/16" x 6-1/4"	731
			VG CSK 5/16" x 4-3/4"	467
	1/4"		VG CSK 5/16" x 5-1/2"	562
			VG CSK 5/16" x 6-1/4"	657
EMD			VG CSK 5/16" x 4-3/4"	451
EWP	3/8"		VG CSK 5/16" x 5-1/2"	546
(0.50)			VG CSK 5/16" x 6-1/4"	641
			VG CSK 5/16" x 4-3/4"	427
	9/16"		VG CSK 5/16" x 5-1/2"	522
			VG CSK 5/16" x 6-1/4"	617

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
- Steel members must be pre-drilled prior to the installation of the fasteners.
 The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- For more information on how to predrill a steel plate with MTC Solutions 45° washer, please refer to the detailing section of this guide, page 104.

Wood Beam to Steel Column - Bottom Plate



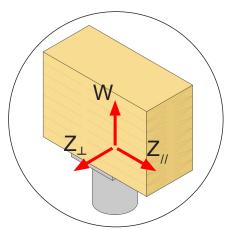
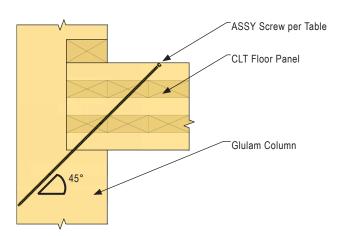


Table PT.7, Reference Design Values for Steel Column - Bottom Plate

	& Steel nfiguration			Referen	ce Desigr	ı Values	
Beam	Steel		Fastener Options		[lbs]		
Type	Thickness			Z"	\mathbf{Z}_{\perp}	w	
			Kombi 5/16" x 2-3/8"	264	211	252	
	1/4"		Kombi 5/16" x 3-1/8"	240	249	358	
			Kombi 5/16" x 4"	312	249	437	
SPF			Kombi 5/16" x 2-3/8"	265	212	252	
	1/2"		Kombi 5/16" x 3-1/8"	323	259	358	
(0.42)			Kombi 5/16" x 4"	337	269	437	
	3/4"			Kombi 5/16" x 2-3/8"	250	200	252
			Kombi 5/16" x 3-1/8"	302	241	358	
			Kombi 5/16" x 4"	337	269	437	
			Kombi 5/16" x 2-3/8"	326	261	213	
	1/4"		Kombi 5/16" x 3-1/8"	353		302	
			Kombi 5/16" x 4"	353	282	369	
EWP			Kombi 5/16" x 2-3/8"	323	258	213	
(0.50)	1/2"		Kombi 5/16" x 3-1/8"	386	309	302	
(0.50)			Kombi 5/16" x 4"	300	308	369	
			Kombi 5/16" x 2-3/8"	300	240	213	
	3/4"		Kombi 5/16" x 3-1/8"	377	302	302	
			Kombi 5/16" x 4"	386	309	369	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge,
 end distance requirements for ASSY screws, as specified in the
 Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 7. The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_e = 87,000 psi for steel is used in the yield limit equations.
- 8. Z_{\parallel} Main member loaded parallel to grain ($\Theta = 0^{\circ}$).
 - Z_{\perp} Main member loaded perpendicular to grain (Θ = 90°).

Housed CLT Floor Uplift Connections



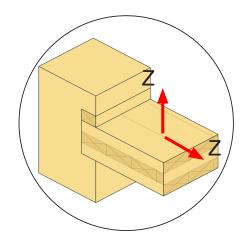


Table PT.8, Reference Lateral Design Values for Housed CLT Floor Uplift Connections; 45° Inclined Screws

Panel Configuration			Reference Des	Reference Design Values [lbs]			
Lo	Loading Panel Thickness		Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6		
		3-1/8"	VG CSK 5/16" x 7-7/8"	436	698		
	Z"	3-3/8"	VG CSK 5/16" x 8-5/8"	467	747		
۲		4-1/8"	VG CSK 5/16" x 11"	665	1,064		
3 PLY		3-1/8"	VG CSK 5/16" x 7-7/8"	439	702		
	\mathbf{Z}_{\perp}	3-3/8"	VG CSK 5/16" x 8-5/8"	501	802		
		4-1/8"	VG CSK 5/16" x 11"	686	1,098		
	7	5-1/2"	VG Cyl 5/16" x 14-1/4"	838	1,255*		
₹	Z"	6-7/8"	VG CSK 3/8" x 17"	1,064	1,702		
5 PLY	_	5-1/2"	VG Cyl 5/16" x 14-1/4"	890	1,255*		
	Z _⊥	6-7/8"	VG CSK 3/8" x 17"	1,085	1,736		
		7-1/2"	VG CSK 3/8" x 19"	1,202			
	Z"	8-5/8"	VG CSK 3/8" x 22-7/8"	1,572	1,803*		
۲		9-5/8"	VG CSK 3/8" x 25-5/8"	1,803*	1		
7 PLY		7-1/2"	VG CSK 3/8" x 19"	1,289			
	\mathbf{Z}_{\perp}	Z _⊥ 8-5/8" VG CSK 3/8" x 22-7/8"		1,607	1,803*		
		9-5/8"	VG CSK 3/8" x 25-5/8"	1,803*			

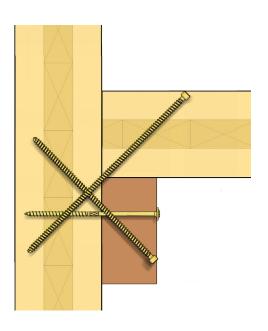
- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of CLT floor, wall and ledger. Fasteners must penetrate the whole thickness of the CLT floor panel (t).
- 6. The angle between force and fastener axis is 45°.
- Reference lateral design values may be applied to uplift and horizontal tension loading towards the panel joint.
- Adjustment for narrow edge loading of CLT (C_{eg})
 may be neglected as corresponding withdrawal
 resistances are already multiplied by the angle to
 grain reduction factor R_a. (12.2.1.5; NDS-2018)
- Z_{II} Main member loaded along the major CLT span direction; side member loaded along the major CLT span direction.
 - $\rm Z_{\perp}$ Main member loaded along the major CLT span direction; side member loaded along the minor CLT span direction.

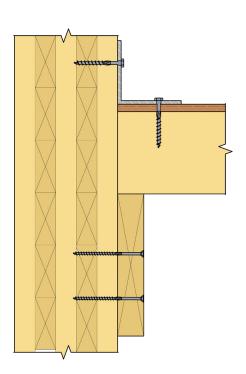
Ledger Connections

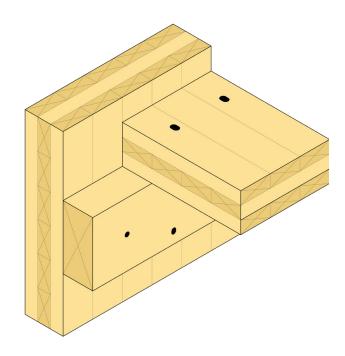
A typical detail used for balloon framing is the structural ledger. Most ledgers for construction with CLT are made from engineered wood products such as LVL, PSL, OSL and LSL. Steel ledgers are also an option. For most applications, connections will exhibit perpendicular-to-grain loading in the side member while parallel-to-grain loading in the CLT wall or main member. Materials typically show different

specific gravities, which has to be considered in design. Connections with fasteners acting in shear are typically ductile and show lower capacities than fasteners installed at an angle.

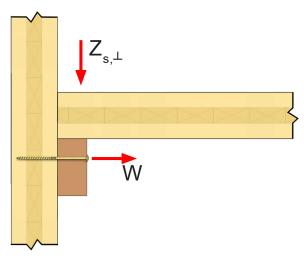
For steel angle connections, see the Steel to Wood Connections Section.







CLT Ledger Connection - 90° Shear Screws Only



90° Shear Screws Only

Table LG.1.1, Reference Lateral Design Values for Wall to Ledger Connections; 90° Shear Screws Only

		CLT Panel & Ledger Con			Referenc	e Design			
	Loading		Ledger Panel Thickness			Fastener Options	Values [lbs]		
			Thickness	(t)			Z	w	
.У			1-3/4"	≥ 3-1/8"		Eco 1/4" x 4-3/4"	199	262	
7 PLY							Eco 5/16" x 8-5/8"	209	327
to	$\mathbf{Z}_{s,\!\perp}$		3-1/2"	≥ 5-1/8"	Eco 3/8" x 8-5/8"			500	
PLY					Eco 3/8" x 10-1/4"	285	509		
3			5-1/4"	≥ 5-1/8"		SK 1/2" x 10-1/4"	402	939	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of EWP and CLT.
- 6. The angle between force and fastener axis is 90°.
- The side member, assumed as Engineered Wood Products, must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.
- 3. $Z_{s\perp}$ Main member loaded parallel to grain ($\Theta=0^{\circ}$); side member loaded perpendicular to grain ($\Theta=90^{\circ}$); $\Theta=90^{\circ}$ with regards to K_a.

Complete CLT Ledger Connection

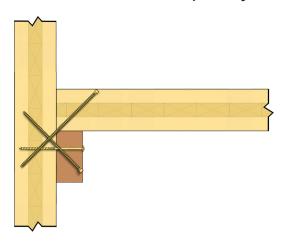
An option for connecting the ledger to the CLT wall element is through the use of inclined fully threaded screws. Connection strength and stiffness is assumed to come entirely from the inclined screws.

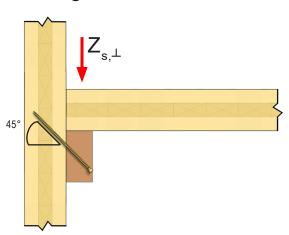
Shear screws installed at 90° angle are used during installation to ensure proper placement and tight connection between side and main member, and to

provide ductility to this critical connection. The shear screws can also reduce the eccentricity created by the inclined screws.

For design purposes, capacities of shear and inclined fasteners may not be combined, as both systems have different inherent stiffnesses.

Part.a - Downward Capacity of Complete Ledger Connection





Complete Ledger Connection

45° Inclined Screws

Table LG.2.1, Reference Design Values for CLT Wall to Ledger Connections; 45° Inclined Screws

		CLT Panel & Ledger Con						
		Loading	Ledger Thickness	Panel Thickness (t)	Fastener Options		Reference Design Values [lbs]	
PLY	7		1-3/4"	≥ 3-1/8"	5	VG CSK 5/16" x 6-1/4"	313	
3 F	Z _{s,} ⊥		1-3/4"	≥ 4-1/8"	;	VG CSK 3/8" x 7-1/8"	369	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of EWP and CLT.
- 6. The angle between force and fastener axis is 45°.
- The side member, assumed as Engineered Wood Products, must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.
- 8. Reference lateral design values only apply to parallel (gravity shear) loading.
- 9. Z_s Reference lateral design value per screw loaded primarily in tension.

Table LG.2.2, Reference Design Values for CLT Wall to Ledger Connections; 45° Inclined Screws Only

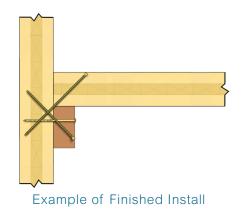
		CLT Panel & Ledger Con	figuration			
		Loading	Ledger Thickness (t)		Fastener Options	Reference Design Values [lbs]
			1-3/4"	≥ 5-1/8"	VG CSK 5/16" x 6-1/4"	313
			1-5/4	≥ 6-7/8"	VG CSK 3/8" x 7-1/8"	369
5 PLY	_		3-1/2"	≥ 5-1/8"	VG CSK 5/16" x 11"	627
8 51				≥ 5-1/8"	VG CSK 3/8" x 11"	739
	$\mathbf{Z}_{s,\!\perp}$		5-1/4"	≥ 5-1/8"	VG CSK 5/16" x 14-1/4"	877
7 PLY				≥ 5-1/8"	VG CSK 3/8" x 14-1/4"	972
				≥ 6-7/8"	VG CSK 5/16" x 15"	940
				≥ 6-7/8"	VG CSK 3/8" x 15"	1108

See notes under Table LG.2, page 66.

Part.b - Uplift Capacity of Complete Ledger Connection

In order to secure floor panels resting on a ledger, toe screws are usually used to prevent uplift or lateral movement during construction or throughout the lifetime of a building. When using fully threaded self-tapping fasteners, capacities in both horizontal and

vertical directions can be determined with the axial resistance of the fastener. Toe screws are typically installed at a 45° angle. If any tolerance gaps between the CLT wall and floor panel are present, reference lateral design values shall be reduced accordingly.



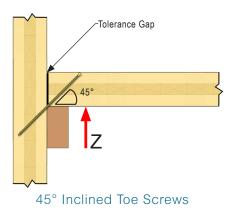


Table LG.3.1, Reference Design Values for CLT Wall to Ledger Connections; 45° Inclined Toe Screws

	CLT	Panel & Ledger Configurat	tion		Reference Design Values [lbs]			
	Loading		Loading Panel Thickness (t)		Standard Loading [C _D =1.0]	Short Term Loading [C _D =1.6]		
	Z _{II}	1	3-1/8"	VG CSK 5/16" x 7-7/8"	436	698		
PLY			3-3/8"	VG CSK 5/16" x 8-5/8"	467	747		
			4-1/8"	VG CSK 5/16" x 11"	665	1,064		
3 P	Z _⊥	↑	3-1/8"	VG CSK 5/16" x 7-7/8"	439	702		
			3-3/8"	VG CSK 5/16" x 8-5/8"	501	802		
			4-1/8"	VG CSK 5/16" x 11"	686	1,098		

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of CLT floor and wall.

- 6. The angle between force and fastener axis is 45°.
- Reference lateral design values may be applied to uplift and horizontal tension loading towards the panel joint.
- Adjustment for narrow edge loading of CLT (C_{eg}) may be neglected as corresponding withdrawal resistances are already multiplied by the angle to grain reduction factor R_o. (12.2.1.5: NDS-2018)
- * The upper limit of the adjusted withdrawal resistance is set by the allowable fastener tensile strength, no further increase allowed.
- 10. Z_{\parallel} Main member loaded along the major CLT span direction; side member loaded along the major CLT span direction..
 - $\rm Z_{\perp}$ $\,$ Main member loaded along the major CLT span direction; side member loaded along the minor CLT span direction.

Table LG.3.2, Reference Design Values for CLT Wall to Ledger Connections; Uplift 45° Inclined Screws Only

	CLT	Panel & Ledger Configurat	tion			Reference Design Values [lbs]			
	Loading			Fastener Options		Standard Loading [C _D =1.0]	Short Term Loading [C _D =1.6]		
ĹY	7		5-1/2"		VG Cyl 5/16" x 14-1/4"	838	1,255*		
	Z _{//}	1 T	6-7/8"		VG CSK 3/8" x 17"	1,064	1,702		
5 PLY	\mathbf{Z}_{\perp}	1	5-1/2"		VG Cyl 5/16" x 14-1/4"	838	1,255*		
			6-7/8"		VG CSK 3/8" x 17"	1,064	1,702		
	Z _{II}	1	7-1/2"		VG CSK 3/8" x 19"	1,202			
			8-5/8"		VG CSK 3/8" x 22-7/8"	1,572	1,803*		
ιΥ			9-5/8"		VG CSK 3/8" x 25-5/8"	1,803*			
7 PLY		1	7-1/2"		VG CSK 3/8" x 19"	1,289			
	\mathbf{Z}_{\perp}		8-5/8"		VG CSK 3/8" x 22-7/8"	1,607	1,803*		
			9-5/8"		VG CSK 3/8" x 25-5/8"	1,803*			

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 45° angle intersecting the shear plane at the interface of CLT floor and wall.

- 6. The angle between force and fastener axis is 45°.
- Reference lateral design values may be applied to uplift and horizontal tension loading towards the panel joint.
- 8. Adjustment for narrow edge loading of CLT ($C_{\rm eg}$) may be neglected as corresponding withdrawal resistances are already multiplied by the angle to grain reduction factor $R_{\rm a}$. (12.2.1.5; NDS-2018)
- * The upper limit of the adjusted withdrawal resistance is set by the allowable fastener tensile strength, no further increase allowed.
- 10. Z_{II} Main member loaded along the major CLT span direction; side member loaded along the major CLT span direction.
 - Z_{\perp} Main member loaded along the major CLT span direction; side member loaded along the minor CLT span direction..

Ledger Board to Rim Joist Connection

Single and double ledger boards can be fastened to floor rim joists through structural sheathing with partially threaded self-tapping screws.

The connection presented below can be easily implement for both new construction and additions to existing structures.

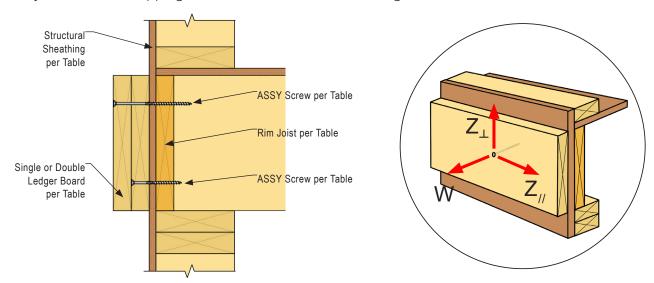


Table LG.6.1, Reference Design Values for Ledger Board to Rim Joist Connection

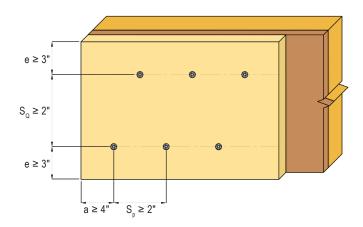
	Ledger Configuration						Re	Reference Design Values [lbs]					
	Туре	Thickness	Ledger Board	Rim Joist		Fastener Options	Z"	Z ⊥	W _{ECO}	W _{sk}			
			1-1/4" EWP	1-1/4" EWP		Eco / SK 1/4" x 3-1/2"	1	86	187				
			1-1/4 EVVP	2" Lumber		Eco / SK 1/4" x 3-1/2"	1	86	237				
		1/2"	2" Lumber	1-1/4" EWP		Eco / SK 1/4" x 3-1/2"	1	171		218			
			2 Lumber	2" Lumber		Eco / SK 1/4" x 3-1/2"	171		163	237			
	0 0 10		1-3/4" EWP	1-1/4" EWP		Eco / SK 1/4" x 4-3/4"	198		18	37			
SPF				2" Lumber		Eco / SK 1/4" x 4-3/4"	1	199		37			
S	G = 0.42		2-1/2" EWP	1-1/4" EWP		Eco / SK 1/4" x 5-1/2"	1	198		37			
				2" Lumber		Eco / SK 1/4" x 5-1/2"	1	199		37			
			Double 2" Lumber	1-1/4" EWP		Eco / SK 1/4" x 5-1/2"	185		156				
				2" Lumber		Eco / SK 1/4" x 5-1/2"	185		163	203			
			3-1/2" EWP	1-1/4" EWP		Eco / SK 1/4" x 6-1/4"	198		218				
				2" Lumber		Eco / SK 1/4" x 6-1/4"	1	99	262	338			

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of members.
- Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.
- Wall sheathing must be independently fastened to the rim joist backing as per the applicable design codes or standards.
- Double ledger boards must be independently fastened to each other as per the applicable design codes or standards.
- It is recommended that additional backing be provided whenever the screw protrudes behind the rim joist.

Table LG.6.2, Reference Design Values for Ledger Board to Rim Joist Connection

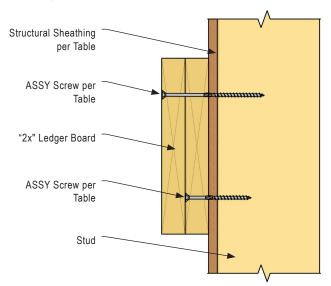
	Ledger Configuration						Re	Reference Design Values [lbs]					
	Туре	Thickness	Ledger Board	Rim Joist		Fastener Options	Z"	\mathbf{Z}_{\perp}	W _{ECO}	W _{sk}			
			1-1/4" EWP	1-1/4" EWP		Eco / SK 1/4" x 3-1/2"	198		187				
			1-1/4 EVVP	2" Lumber		Eco / SK 1/4" x 3-1/2"	1	186		37			
	Structural 1,	1/2"	2" Lumber	1-1/4" EWP		Eco / SK 1/4" x 3-1/2"	181		163	218			
p				2" Lumber		Eco / SK 1/4" x 3-1/2"	171		163	237			
000			1-3/4" EWP	1-1/4" EWP		Eco / SK 1/4" x 4-3/4"	217		187				
Plywood			1-3/4 EVVP	2" Lumber		Eco / SK 1/4" x 4-3/4"	199		237				
1	Grade		2-1/2" EWP	1-1/4" EWP		Eco / SK 1/4" x 5-1/2"	2	217		37			
OSB	G = 0.50			2" Lumber		Eco / SK 1/4" x 5-1/2"	1	199		37			
0			Double 2" Lumber	1-1/4" EWP		Eco / SK 1/4" x 5-1/2"	1	199		56			
				2" Lumber		Eco / SK 1/4" x 5-1/2"	1	85	163	203			
			0.4/08.514:-	1-1/4" EWP		Eco / SK 1/4" x 6-1/4"	2	17	2	18			
			3-1/2" EWP	2" Lumber		Eco / SK 1/4" x 6-1/4"	1	99	262	338			

See notes under table LG.6.1, page 70.



Ledger Board to Stud Wall Connection

Similar to rim joist connections, single and double ledger boards can be fastened to stud wall backing through structural sheathing with partially threaded self-tapping screws.



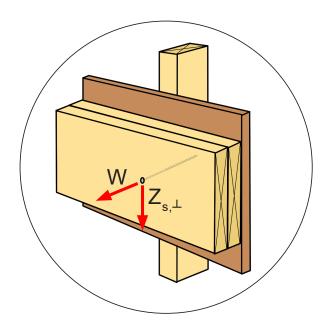
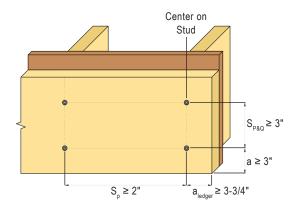


Table LG.7.1, Reference Design Values for Ledger Board to Stud Wall Connection

	Ledger	Configuratio	n			Reference Design Values [lbs]			
Thickness		Stud Type	Ledger Board	Fastener Options		${f Z}_{{ m s},\!\perp}$	W _{ECO}	W _{sk}	
	1/2"	2" Stud	1-1/4" EWP		Eco / SK 1/4" x 3-1/2"	186	262	296	
poo			2" Lumber			171	163	274	
Plywood			1-3/4" EWP		Eco / SK 1/4" x 4-3/4"	199	262	423	
_			2-1/2" EWP		Eco / SK 1/4" x 5-1/2"	185	262	423	
OSB			Double 2" Lumber		Eco / SK 1/4" x 6-1/4"	185	163	299	
			3-1/2" EWP		Eco / SK 1/4" x 6-1/4"	199	262	423	

Notes:

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of members.
- 6. Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.
- Wall sheathing must be independently fastened to the rim joist backing as per the applicable design codes or standards.
- Double ledger boards must be independently fastened to each other as per the applicable design codes or standards.



Specific Ledger to Stud Connection Design

Table LG.7.2, Adjusted Design Values for Ledger Board to Stud Wall Connection

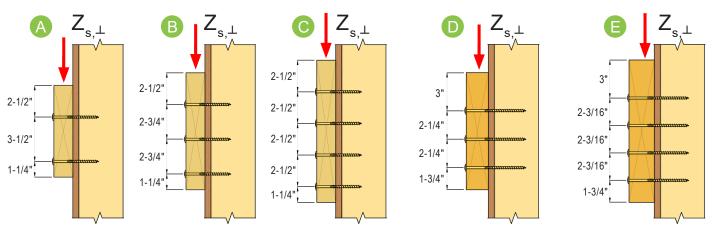
		Ledger Conf	figuration					Adjuste	d Design Val	ues [lbs]		
т	hickness	Stud Type	Ledger Board	Assembly		Fastener Options	Number of Effective Fastener in a Row (n _F)	${f Z}_{{ m s},\perp}$	W _{ECO}	W _{sk}		
			2 x 8" Lumber			Eco / SK 1/4" x 3-1/2"	2	319	304	550		
			Double 2 x 8" Lumber		Eco / SK 1/4" x 6-1/4"		2	345	304	552		
			2 x 10" Lumber	В		Eco / SK 1/4" x 3-1/2"	3	460	440	799		
poo			Double 2 x 10" Lumber			Eco / SK 1/4" x 6-1/4"	3	497	440	755		
Plywood	1/2"	2" Lumber	2 x 12" Lumber	C				Eco / SK 1/4" x 3-1/2"	4	596	587	1.065
_	1/2	2 Lumber	Double 2 x 12" Lumber			Eco / SK 1/4" x 6-1/4"	4	644	507	1,065		
OSB			1.75 x 9.25" EWP	D		Eco / SK 1/4" x 4-3/4"	3	525	707	4.407		
		3.5 x 9.25" EWP			Eco / SK 1/4" x 6-1/4"	3	535	707	1,107			
			1.75 x 11.31" EWP	B		Eco / SK 1/4" x 4-3/4"	4	604	943	1 501		
			3.5 x 11.31" EWP			Eco / SK 1/4" x 6-1/4"	4	694	943	1,521		

Notes:

- Adjusted design values apply to effective number fastener in a row (n_E), conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of members.

- Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition.
- 7. Wall sheathing must be independently fastened to the rim joist backing as per the applicable design codes or standards.
- Double ledger boards must be independently fastened to each other as per the applicable design codes or standards.
- 9. Adjusted design values include the factored resistance (Z or W) and effective number fastener in a row ($n_{\rm F}$).

Geometry Requirements



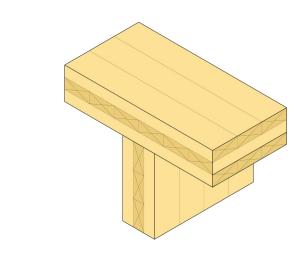
Note:

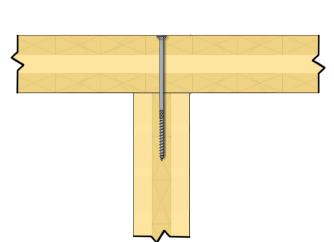
1. Minimum spacing requirements

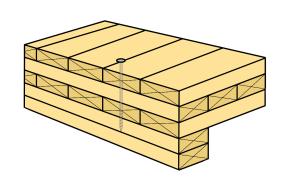
Floor to Wall Connections

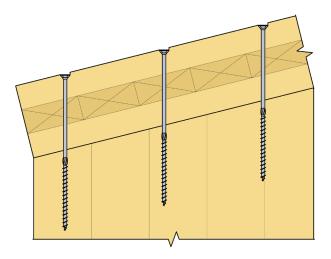
For CLT wall to floor connections, the designer should allocate special attention to ensure that minimum end and edge distance requirements for the narrow edge of CLT are satisfied.

Designers should also be aware that a three-ply or seven-ply CLT wall panel with its major span direction oriented vertically may accept the screw into the side grain of the middle ply, whereas a five-ply panel in the same orientation may accept the screw into the end grain of the middle ply. As lateral loading in the narrow panel face of CLT is generally considered as loading perpendicular to the grain for fasteners with D>1/4" (12.3.3.6; NDS-2018), only two loading scenarios are presented in that section.



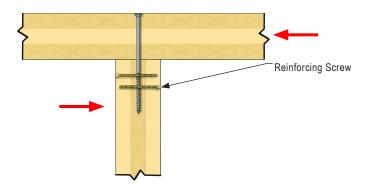






Reinforcement Possibilities

Out of plane shear loading in the narrow edge of CLT can result in reduced capacity due to splitting. Splitting risks may be reduced by installing fully threaded reinforcing screws.



CLT Floor to Wall Connections in Shear

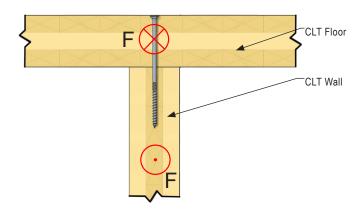


Table FW.1.1, Reference Lateral Design Values for CLT Floor to Wall Panel Connections Loaded in Shear

		Panel Configuration			Reference Des	ign Values [lbs]	Minimum
	Loading		Panel Thickness (t)	Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
	-		3-1/8"	Eco			
3 PLY	Z"		3-3/8"	1/4" x 6-1/4"	185	296	2-1/2"
3 F	\mathbf{Z}_{\perp}		4-1/8"	Eco 1/4" x 7-7/8"			
			4-1/0	Eco 5/16" x 7-7/8"	194	310	3-1/8"
			5-1/8"	Eco			
	7	8	5-1/2"	5/16" x 9-1/2"	194	310	3-1/8"
	Z _{//}		6-7/8"	Eco 5/16" x 11-7/8"			
PLY			0-7/8	Eco 3/8" x 11-7/8"	265	424	3-7/8"
5 P			5-1/8"	Eco		310	
	${f Z}_{oldsymbol{\perp}}$		5-1/2"	5/16" x 9-1/2"	194		3-1/8"
	4		6-7/8"	Eco 5/16" x 11-7/8"			
			0-770	Eco 3/8" x 11-7/8"	244	390	3-7/8"

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of both CLT members.
- Adjustment for narrow edge loading of CLT (C_{eg}=0.67) shall be applied for values listed for 3/8" and 1/2" diameter fasteners.
- 7. For loading perpendicular to the wall surface, effects of splitting shall be considered.
- 8. Z_{II} Main member loaded perpendicular to grain (Θ = 90°; narrow edge); side member loaded parallel to grain (Θ = 0°); Θ = 90° with regards to K_{Θ} .
 - Z_L Main member loaded perpendicular to grain (Θ = 90°; narrow edge); side member loaded perpendicular to grain (Θ = 90°); Θ = 90° with regards to K_a.

Table FW.1.2, Reference Lateral Design Values for CLT Panel to Wall Connections Loaded in Shear

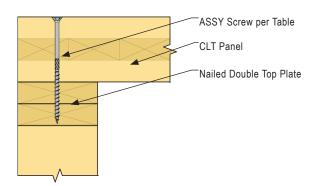
		Panel Configuration			Reference Des	ign Values [lbs]	Minimum
	Loading Panel Thickness (t)			Fastener Options	Standard Loading C _D =1.0	Short Term Loading C _D =1.6	Spacing in a Row (S _p)
			7-1/2"	Eco 5/16" x 11-7/8"	194	310	3-1/8"
			7-1/2	Eco 3/8" x 11-7/8"	265	424	3-7/8"
	Z,		8-5/8"	Eco 5/16" x 13-3/8"	194	310	3-1/8"
			0-5/0	Eco 3/8" x 14-1/4"	265	424	3-7/8"
		LIVI IVI IVI	9-5/8"	Eco 3/8" x 15"	200	424	3-7/0
PLY			9-5/6	SK 1/2" x 15-3/4"	374	598	5"
7 P			7-1/2"	Eco 5/16" x 11-7/8"	194	310	3-1/8"
			7-1/2	Eco 3/8" x 11-7/8"	244	390	3-7/8"
	7	⊗ > > > > > > > > > >	0.5/0"	Eco 5/16" x 13-3/8"	194	310	3-1/8"
	\mathbf{Z}_{\perp}		8-5/8"	Eco 3/8" x 14-1/4"	244	390	3-7/8"
		[] [] [] []	9-5/8"		244	390	3-1/0
			9-3/0	SK 1/2" x 15-3/4"	339	542	5"

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of both CLT members.

- 6. The angle between force and fastener axis is 90°.
- Adjustment for narrow edge loading of CLT (C_{eg}=0.67) shall be applied for values listed for 3/8" and 1/2" diameter fasteners.
- 8. For loading perpendicular to the wall surface, effects of splitting shall be considered.
- Main member loaded perpendicular to grain (Θ = 90°; narrow edge); side member loaded parallel to grain (Θ = 0°); Θ = 90° with regards to K_{Θ}.
 - Z_⊥ Main member loaded perpendicular to grain (Θ = 90°; narrow edge); side member loaded perpendicular to grain (Θ = 90°); Θ = 90° with regards to K_{Θ}.

CLT Floor to Top Plate Connection - Top Screwed

In hybrid structures made of light-frame walls and mass timber floor, an efficient option to connect CLT floor panels to load-bearing walls uses self-tapping screws installed from the top of the panel.



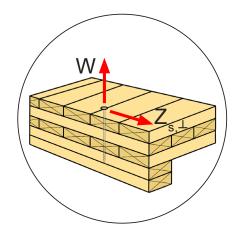


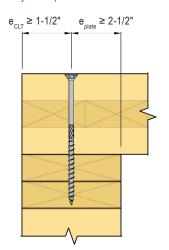
Table FW.2, Reference Design Values for CLT Floor to Top Plate Connection (Top)

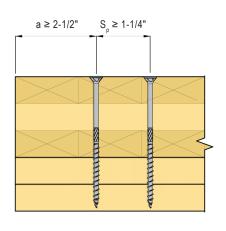
Pan	el & Top Wall C	Configuration			Reference Design Values [lbs]			
	Wall Top Plate	Panel Thickness (t)		Fastener Options	$\mathbf{Z}_{s,\!^\perp}$	W _{ECO}	W _{sk}	
_		3-1/8" Eco / SK 1/4" x 6-1/4"						
PLY	Double 2" Lumber	3-3/8"		Eco / SK 1/4" x 6-1/4"	185	163	299	
3		4-1/8"		Eco / SK 1/4" x 7-1/8"				
>		5-1/8"		Eco / SK 1/4" x 7-7/8"				
PLY	Double 2" Lumber	5-1/2"		Eco / SK 1/4" x 8-5/8"	185	163	299	
2		6-7/8"		Eco / SK 1/4" x 10-1/4"				

Notes:

- 1. Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the wall and floor members.
- Double top plates and built-up studs must be independently fasten to each other as per the applicable design codes or standards.

Geometry Requirements





CLT Floor to Top Plate Connection - Bottom Screwed

Self-tapping screws offer a quick to install, ductile connection between CLT floor panels and supporting light-frame walls below. Installing self-tapping screws through the double top plate is the most economic option due to shorter screw lengths compared to other alternatives.

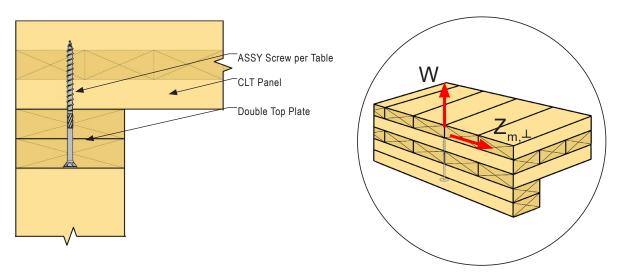


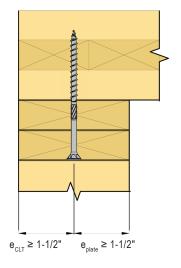
Table FW 3. Reference Design Values for CLT Floor to Top Plate Connection (Bottom)

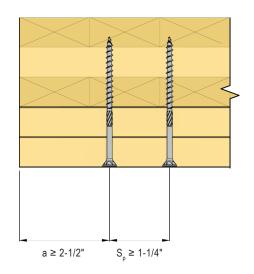
Pan	Panel & Top Wall Configuration				Reference Design Values [lbs]			
	Wall Top Plate	Panel Thickness (t)		Fastener Options	$\mathbf{Z}_{m,\!\perp}$	W _{ECO}	W _{sk}	
>		3-1/8"						
PLY	Double 2" Lumber	3-3/8"		Eco / SK 1/4" x 5-1/2"	185	163	299	
3		4-1/8"						

Notes:

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the wall and floor members.
- Double top plates and built-up studs must be independently fasten to each other as per the applicable design codes or standards.

Geometry Requirements





NLT Floor to Top Plate Connection - Inclined Screws

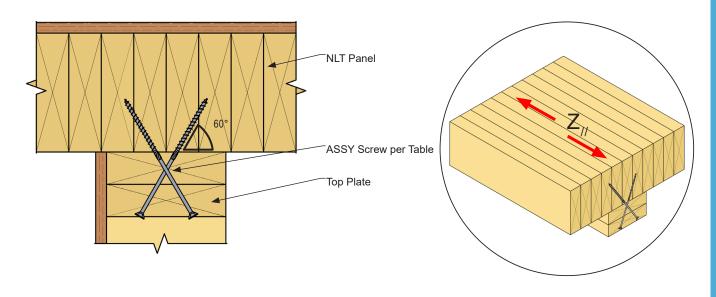


Table FW.9, Reference Design Values for Built-Up Stud to Top Plate Connections

Panel & 1	op Wall Configuration						
Loading	Buil-Up Top Plate		Fastener Options	Reference Design Values per Screw Cross [lbs]			
			Eco 1/4" x 4-3/4"	290			
	Double 2" Lumber		Eco 1/4" x 5-1/2"	270			
7			Eco 1/4" x 6-1/4"	370			
Z _{//}			Eco 1/4" x 7-1/8"	366			
	Triple 2" Lumber		Eco 1/4" x 7-7/8"	370			
			Eco 1/4" x 8-5/8"	370			

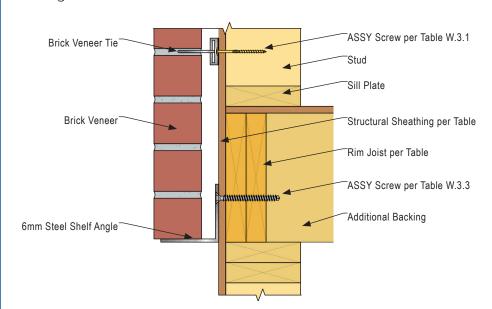
- Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 60° angle intersecting the shear plane at the interface wall and floor members.
- 6. The angle between force and fastener axis is 90°.
- 7. Sawn Lumber studs and plates with multiple plies must be independently fasten to each other as per the applicable design codes or standards.

Wall Connections

Brick Veneer to Wall Connection

Non-structural brick veneers are commonly supported laterally by proprietary steel connectors. These steel connectors can easily be installed with partially threaded self-tapping screws since they will tightly fasten the steel connector to the main structural framing.

By eliminating pre-drilling requirements fully-threaded self-tapping screws are a more efficient alternative to typical lag-bolt or through-bolt shelf-angle connections.



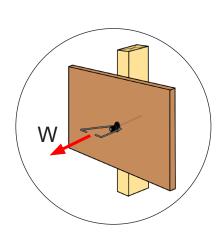


Table W.3.1, Reference Design Values for Brick Veneer Tie Connection

Sheating Configu	ration				Reference Design Values [lbs]
Туре	Thickness	Stud Backing	Tie Plate Thickness	Fastener Options	w
Plywood	3/8"	2"	40	Eco 1/4" x 2-3/8"	169
(G = 0.42)	1"	Lumber	16 ga	Eco 1/4" x 2-3/4"	186

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- The adjusted withdrawal design value shall not exceed the allowable tensile strength of the screw.
- 6. Refer to the brick veneer tie manufacturer for specific installation and design requirements.
- Wall sheathing must be independently fastened to the stud wall backing as per the applicable design codes or standards.
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.

Table W.3.2, Steel Plate Pre-Drilling Hole Diameter

Screw Nominal Diameter	Steel Plate Hole Diameter
in.	in.
1/4"	9/32"
3/8"	7/16"
1/2"	17/32"

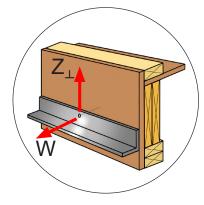


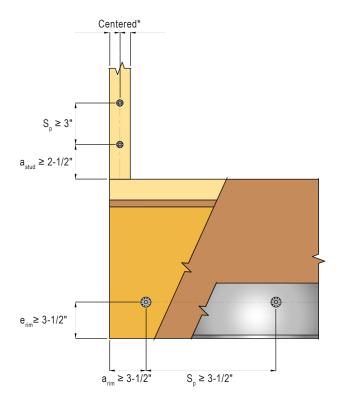
Table W.3.3, Refence Design Values for Brick Veneer Shelf Angle Connection

Shea	ating Configu	ration						Reference Des	ign Values [lbs]
Туре		Thickness	Steel Thickness	Rim Joist	Additional Backing		Fastener Options	\mathbf{Z}_{\perp}	w
					4.4/47.514/5		VG CSK 3/8" x 4"	319	554
				1-1/4" EWP	1-1/4" EWP		VG CSK 1/2" x 4-3/4"	275	596
Plywood	G = (0.49)	1/2"	1/4"	1-1/4 EVVF	1-3/4" EWP		VG CSK 3/8" x 4"	319	554
Plyw	0 = (0.43)	1/2	174		1-3/4 EVVF		VG CSK 1/2" x 4-3/4"	307 319	708
				2" Lumber	2" Lumber		VG CSK 3/8" x 4"		622
				Z Lumber	Z Lumber		VG CSK 1/2" x 4-3/4"	307	796
							VG CSK 3/8" x 4"	367	554
1)				1-1/4" EWP	1-1/4" EWP		VG CSK 1/2" x 4-3/4"	388	596
Plywood (Structural 1)	C = (0.50)	1/2"	1/4"	1-1/4 EVVP	1-3/4" EWP		VG CSK 3/8" x 4"	367	554
Plyw	G = (0.50)	1/2	1/4		1-3/4 EVVP		VG CSK 1/2" x 4-3/4"	388 708	708
S)				2" Lumber	2" Lumber		VG CSK 3/8" x 4"	367	622
				Z Lumber	Z LUIIIDEI		VG CSK 1/2" x 4-3/4"	388	796

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the wall and the steel angle.
- Reference design values apply to screws installed perpendicular to the grain of the main wood member.
- The adjusted withdrawal design value shall not exceed the allowable tensile strength of the screw.

- Shelf angle steel must conform to ASTM A36/A36M-14: Standard Specification for Carbon Structural Steel (or better).
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition shown above.
- Wall sheathing must be independently fastened to the rim joist as per the applicable design codes or standards.
- Rim joist backing must be independently fastened to the rim joist as per the applicable design codes or standards.
- It is recommended that additional backing be provided whenever the screw protrudes behind the rim joist.

Geometry Requirements

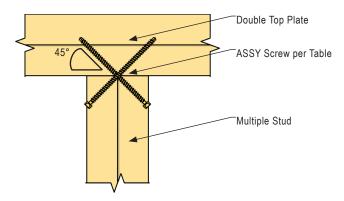


Notes:
1. * Fastener shall be installed centered on stud.

Top Plate to Stud Lateral Connection

In cases where double top plates need to be connected to built-up studs to transfer large shear or uplift loads,

inclined fully threaded self-tapping screws can be used for a stiff and strong connection.



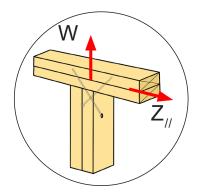


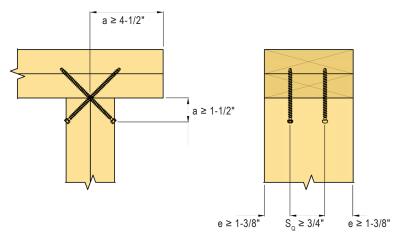
Table W.4.1, Reference Design Values for Built-Up Stud to Top Plate Connections

Top Plat	e & Stud Con	ifiguration		
Top Plate	Loading	Buil-Up Stud	Fastener Options	Reference Design Values [lbs]
_			VG Cyl 1/4" x 4-3/4"	417
	z,	Dbl. 2" Lumber	VG Cyl 1/4" x 5-1/2"	422
Double ' Lumber			VG Cyl 1/4" x 6-1/4"	422
Dou 2" Lu	or		VG Cyl 1/4" x 4-3/4"	259
2	W	Trip. 2" Lumber	VG Cyl 1/4" x 5-1/2"	424
			VG Cyl 1/4" x 6-1/4"	578

Notes:

- Reference design values apply to two fasteners in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 45° angle intersecting the shear plane at the interface of the studs and the top plate.
- 6. The angle between force and fastener axis is 45°.
- Sawn Lumber studs and plates with multiple plies must be independently fasten to each other as per the applicable design codes or standards.

Geometry Requirements

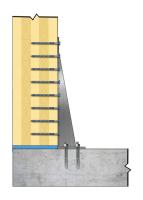




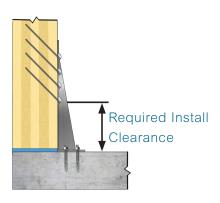
Steel to Wood Connections

Steel to CLT connections are a very common detail seen in modern mass timber construction, ranging from long collector straps fastened to the lateral load resisting core to high capacity hold down systems. Due to the high dowel bearing strength of steel, shear connections are typically stiffer than wood-to-wood installations but are limited by the bending yield strength of the fastener and wood embedment strength.

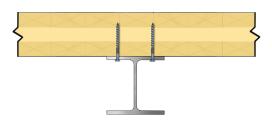
The possibility of using inclined screws, either with angled washers or reamed housing to accept the screw head offers high capacity options. The high connection strength of inclined screws thereby opens new doors toward innovative and economical design in modern mass timber structures. Due to the high axial stiffness of self-tapping fasteners, applications in moment resisting timber joints and collector plates for high overturning forces can be achieved with smaller numbers of screws, while providing high stiffness to the system.



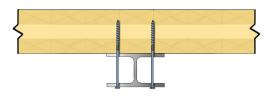
CLT wall hold down connection using shear screws, see page 86 for details.



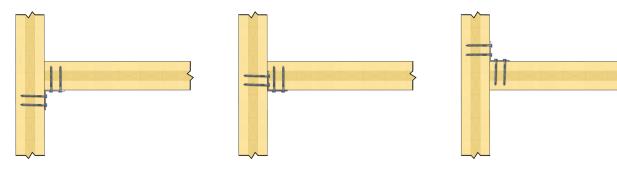
CLT wall hold down connection using inclined screws, see page 88 for details.



CLT deep H-beam connection using shear screws, see page 86 for details.



CLT wide H-beam connection using shear screws, see page 86 for details.



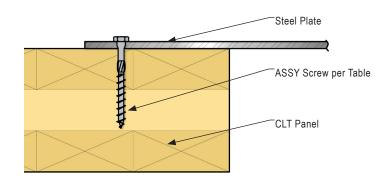
CLT floor to wall connections using angle brackets in different configurations, see page 86 for details on steel to wood connection.

CLT Panel with Steel Side Plate in Shear

The ASSY Kombi screw is engineered for steel to wood connections where the screw is loaded perpendicular to the screw axis.

and also provides a suitable bearing surface for the steel side plate.

The tapered shoulder of the Kombi head reduces slip



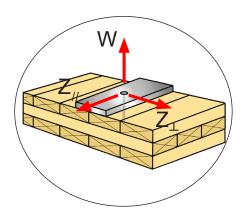


Table SC.1.1, Reference Lateral Design Values for CLT Steel Side Plate Connections

		CLT Panel & Steel Plate C	onfiguration				Reference Des	ign Values [lbs]
		Loading	Panel Thickness [t]	Steel Plate Thickness		Fastener Options	Z	w
			3-1/8"	3/16"		Kombi 5/16" x 3-1/8"	279	
	Z _{II}	to	1/4"		Kombi 5/16" x 3-1/8"	312		
PLY			4-1/8"	1/2"		Kombi 5/16" x 3-1/8"	323*	250
സ			3-1/8"	3/16"		Kombi 5/16" x 3-1/8"	223	358
	\mathbf{Z}_{\perp}		to	1/4"		Kombi 5/16" x 3-1/8"	249	
			4-1/8"	1/2"		Kombi 5/16" x 3-1/8"	259*	

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Reference lateral design values presented in the table above provide failure mode IIIs or IV except if otherwise identified with an asterisk (*) in which case the failure mode is not IIIs or IV.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed at a 90° angle intersecting the shear plane at the interface of steel side member and CLT.

- 7. The angle between force and fastener axis is 90°.
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_a = 87,000 psi for steel is used in the yield limit equations.
- 10. Z_{\parallel} Main member loaded parallel to grain ($\Theta = 0^{\circ}$).
 - Z₁ Main member loaded perpendicular to grain ($\Theta = 90^{\circ}$).
 - W Steel plate loaded in withdrawal.

Table SC.1.3, Steel Plate Pre-Drilling Hole Diameter

Screw Nominal Diameter	Steel Plate Hole Diameter
in.	in.
1/4"	9/32"
5/16"	3/8"
3/8"	7/16"
1/2"	17/32"

Table SC.1.2, Reference Lateral Design Values for CLT Steel Side Plate Connections

		CLT Panel & Steel Plate Co	onfiguration			Reference Des	i gn Values [lbs]
		Loading	Panel Thickness [t]	Steel Plate Thickness	Fastener Options	z	w
					Kombi 5/16" x 3-1/8"	279	358
					Kombi 3/8" x 4-3/4"	394	652
				3/16"	Kombi 1/2" x 4-3/4"	540	007
					Kombi 1/2" x 5-1/2"	542	667
			5-1/2"		Kombi 5/16" x 3-1/8"	312	358
	Z ,,		to	4 / 4 "	Kombi 3/8" x 4-3/4"	430	652
			9-5/8"	1/4"	Kombi 1/2" x 4-3/4"	F7F	007
					Kombi 1/2" x 5-1/2"	575	667
				1/2"	Kombi 3/8" x 4-3/4"	505	652
5 PLY					Kombi 1/2" x 4-3/4"	713*	007
8 5					Kombi 1/2" x 5-1/2"	725	- 667
					Kombi 5/16" x 3-1/8"	223	358
7 PLY				3/16"	Kombi 3/8" x 4-3/4"	267	652
					Kombi 1/2" x 4-3/4"	250	007
					Kombi 1/2" x 5-1/2"	356	667
			5-1/2"		Kombi 5/16" x 3-1/8"	249	358
	Z		to	1/4"	Kombi 3/8" x 4-3/4"	292	652
			9-5/8"	1/4	Kombi 1/2" x 4-3/4"	378*	667
					Kombi 1/2" x 5-1/2"	379	- 667
					Kombi 3/8" x 4-3/4"	339	652
				1/2"	Kombi 1/2" x 4-3/4"	439*	667
					Kombi 1/2" x 5-1/2"	472	- 667

See notes under Table Table SC.1.1, page 86.

CLT and Steel Plate with Inclined Screws

Steel to wood connections with inclined fasteners installed at a 45° angle usually offer higher connection strength and stiffness versus 90° shear screws. Tabulated values in this section incorporate the use of ASSY 45° wedge washers to provide bearing support in thin steel plates (although the use of thicker plates with reamed out holes is possible). When using wedge washers, ASSY 45° pre-drill jigs are used to establish 45° pilot holes at the correct location in the panels.

To reduce group tear-out failure modes and to activate the reinforcing effect of the crossing layers, screws should penetrate as many plies as possible. Inclined screws can transmit large tensile forces and connections must be accordingly detailed. Detailing must consider offsetting cross screws by 1.5D and overlapping of 4D when installing from opposite sides.

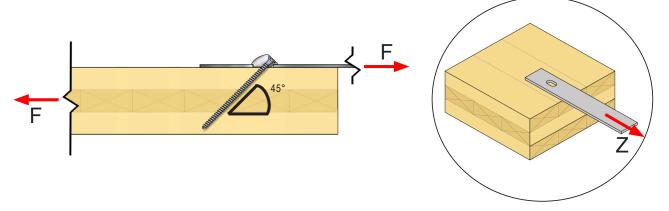


Table SC.2.1, Reference Lateral Design Values for CLT Steel Side Plate Connections

		CLT Panel & Steel Plate Co	onfiguration			
		Loading	Steel Plate Thickness	Panel Thickness (t)	Fastener Options	Reference Design Values [lbs]
			5/32"	≥ 3-3/8"	VG CSK 5/16" x 5-1/2"	532
	Z"		1/2"	≥ 4-1/8"	VG CSK 5/16" x 6-1/4"	649
PLY	n n		1/4" - 3/4"	≥ 4-1/8"	VG CSK 3/8" x 6-1/4"	634
ы П			5/32"	≥ 3-3/8"	VG CSK 5/16" x 5-1/2"	576
	$oldsymbol{Z}_{oldsymbol{\perp}}$		1/2"	≥ 4-1/8"	VG CSK 5/16" x 6-1/4"	667
			1/4" - 3/4"	≥ 4-1/8"	VG CSK 3/8" x 6-1/4"	639

- Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 4. Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners are installed with MTC Solutions 45° washer, intersecting the shear plane at the interface of steel side member and CLT.
- 6. The angle between force and fastener axis is 45°.

- 7. For ranges in steel plate thicknesses a design value is provided while assuring no through penetration of the fastener in the CLT panel with minimum steel plate thickness.
- The side member must be ASTM A36 grade steel or higher. In accordance with the NDS, a dowel bearing strength of F_a = 87,000 psi for steel is used in the yield limit equations.
- Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- 10. For more information on how to predrill a steel plate with MTC Solutions 45° washer, please refer to the detailing section of this guide, page 104.
- Z_{II} Reference lateral design value per screw in tension with loading direction along major span direction of CLT panel.
 - Z_{\perp} Reference lateral design value per screw in tension with loading direction along minor span direction of CLT panel.

Table SC.2.2, Reference Lateral Design Values for CLT Steel Side Plate Connections

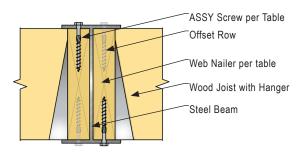
		CLT Panel & Steel Plate C	onfiguration			
		Loading	Steel Plate Thickness	Panel Thickness (t)	Fastener Options	Reference Design Values [lbs]
				≥ 5-1/8"	VG CSK 5/16" x 7-1/8"	777
			5/32" - 1/2"	≥ 5-1/2"	VG CSK 5/16" x 7-7/8"	857
	7		.,,_	≥ 6-7/8"	VG CSK 5/16" x 9-1/2"	1,109
	Z"			≥ 5-1/8"	VG CSK 3/8" x 7-1/8"	762
			1/4" - 3/4"	≥ 5-1/2"	VG CSK 3/8" x 7-7/8"	865
PLY				≥ 6-7/8"	VG CSK 3/8" x 9 -1/2"	1,137
5 F			5/00"	≥ 5-1/8"	VG CSK 5/16" x 7-1/8"	784
			5/32" - 1/2"	≥ 5-1/2"	VG CSK 5/16" x 7-7/8"	912
	\mathbf{Z}_{\perp}		172	≥ 6-7/8"	VG CSK 5/16" x 9-1/2"	1,113
	4		4/45	≥ 5-1/8"	VG CSK 3/8" x 7-1/8"	783
			1/4" - 3/4"	≥ 5-1/2"	VG CSK 3/8" x 7-7/8"	914
				≥ 6-7/8"	VG CSK 3/8" x 9-1/2"	1,147
				≥ 7-1/2"	VG CSK 3/8" x 10-1/4"	1,216
			1/4" - 3/4"	≥ 8-5/8"	VG CSK 3/8" x 12-5/8"	1,611
	Z ,,		3/4	≥ 9-5/8"	VG CSK 3/8" x 13-3/8"	1,730
			1/4"	≥ 7-1/2"	VG CSK 1/2" x 11"	1,326
PLY			- 1"	≥ 8-5/8"	VG CSK 1/2" x 11-7/8"	1,481
7 P				≥ 7-1/2"	VG CSK 3/8" x 10-1/4"	1,302
			1/4" - 3/4"	≥ 8-5/8"	VG CSK 3/8" x 12-5/8"	1,646
	Z ,,			≥ 9-5/8"	VG CSK 3/8" x 13-3/8"	1,743
			1/4"	≥ 7-1/2"	VG CSK 1/2" x 11"	1,411
			1"	≥ 8-5/8"	VG CSK 1/2" x 11-7/8"	1,544

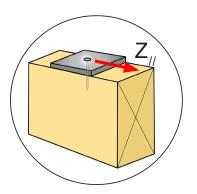
See notes under Table Table SC.2.1, page 88.

Steel Beam to Wood Connection

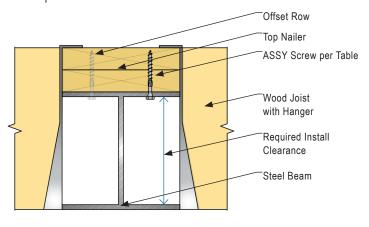
Timber joist members can be connected to structural steel I-beams by providing either web or top flange nailers that the joists can be attached to. Self-tapping screws can be installed to structurally connect nailers to the steel beam and be able to transfer in-plane lateral diaphragm forces.

Steel Beam to Web Nailer Connection





Steel Beam to Top Nailer Connection



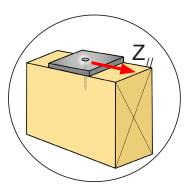


Table SC.3.1, Reference Design Values for Steel Beam to Web Nailer Connection

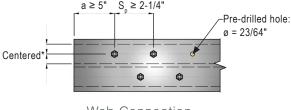
Ste	el Beam & Wo	ood Configura	tion		
Loading	Nailer S.G. Or E.S.G.	Nailer Thickness	Flange Thickness	Fastener Options	Reference Design Values [lbs]
			0.1"	Kombi 5/16" x 3-1/8"	228
			0.2"	Kombi 5/16" x 3-1/8"	246
	0.42	1-1/2"	0.3"	Kombi 5/16" x 3-1/8"	278
			0.4"	Kombi 5/16" x 3-1/8"	271
7			0.5"	Kombi 5/16" x 3-1/8"	265
Z _{//}		1-3/4"	0.1"	Kombi 5/16" x 3-1/8"	286
			0.2"	Kombi 5/16" x 3-1/8"	320
	0.5		0.3"	Kombi 5/16" x 3-1/8"	353
			0.4"	Kombi 5/16" x 3-1/8"	342
			0.5"	Kombi 5/16" x 3-1/8"	331

Notes:

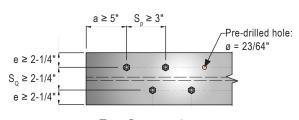
- 1. Reference design values apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
- Allowable loads listed are only valid for Allowable Stress Design in the USA and for listed ASSY screws.
- 3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Connector placement must respect the geometry requirements presented in the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
- Fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the steel and wood members.

- Reference design values apply to screws installed perpendicular to the grain direction of the main wood member.
- 7. Steel members must be pre-drilled prior to the installation of the fasteners. The designer must assure that all possible stress limits in the steel and wood are not exceeded.
- Steel beams must conform to ASTM A36/A36M-14: Standard Specification for Carbon Structural Steel (or better).
- Engineered Wood Products must have an Equivalent Specific Gravity (ESG) of 0.50 as per their respective ICC-ES Evaluation Report for the loading condition shown above.

Geometry Requirements



Web Connection



Top Connection

^{*} Fastener shall be installed centered on nailer.

Detailing Section

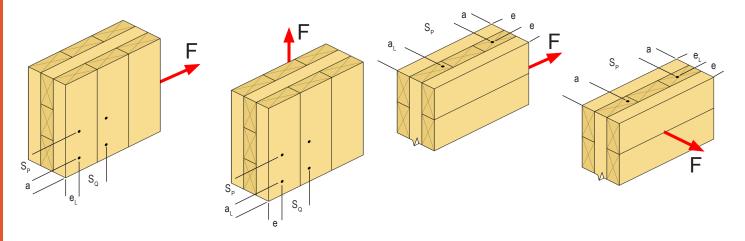
Geometry Requirements

Spacing and Edge Distance Requirements

Spacing and distance requirements ensure full fastener resistance can be developed. Self-tapping screws displace wood fiber as the screw is driven into the member, while pre-drilling removes wood fiber.

The spacing and edge distance requirements for self-tapping screws, vary when compared to other fasteners. If pre-drilling is implemented, the spacing and edge distance requirements as per NDS 2018 may apply.

Geometry Requirements in CLT for ASSY Screws Without Pre-Drilled Holes



Fasteners in Plane Surface

Fasteners in Narrow Edge

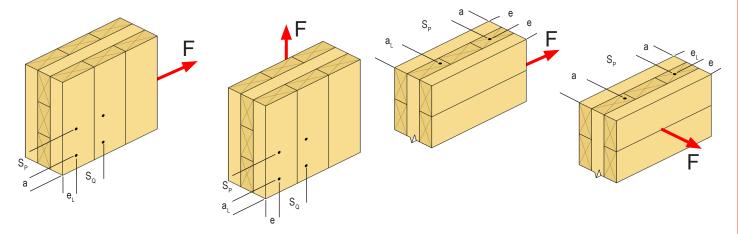
Table S.1.1, CLT Connection Geometry Requirements without Pre-drilling

CLT Plane	End Di	stance	Edge D	istance	Spacing Between Fas- teners in a Row	Spacing Between Rows	
	a	а	e _L e		S _P	S _Q	
Fastener In Plane Surface	6 D	6 D	6 D	6 D 2.5 D 4 D		2.5 D	
Fastener in Narrow Edge	12 D	7 D	6 D	3 D	10 D	4 D	

- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
- 3. Spacing, end and edge distance requirements in the above tables were veified in testing.
- 4. The listed values are applicable when the CLT panel tickness is at least 10-D.
- The minimum penetration depth of the screw into the narrow face of the panel should be equal to the maximum of the thread length and 10D.

Geometry Requirements in CLT for ASSY Scews With

Pre-Drilled Holes



Fasteners in Plane Surface

Fasteners in Narrow Edge

Table S.1.2, CLT Connection Geometry Requirements with Pre-drilled Holes, C_{Δ} =1.0

CLT Plane	End Di	stance	Edge D	istance	Spacing Between Fas- teners in a Row	Spacing Between Row	
	a	а	e L	е	S _P	S _Q	
Fastener In Plane Surface	7 D	4 D	4 D	3 D	4 D	4 D	
Fastener in Narrow Edge	7 D	4 D	3 D	3 D	4 D	4 D	

Notes:

- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
- Geometry requirements in CLT for ASSY scews with pre-drilled holes are taken from NDS 2018, clause 12.5.
- Full penatration length must be pre-drilled with a hole diameter according to the pre-drilling recommendations, presented in Table S.5.

Pre-Drilling Recommendations

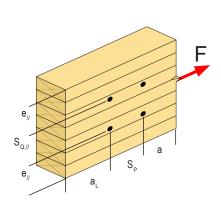
Table S.5, Pre-drilling hole diameter

Ma	jor Diameter	Softwood	Hardwood	Steel Plate
	[D]	[in.]	[in.]	[in.]
	1 / 4"	5 / 32"	5 / 32"	9 / 32"
	5 / 16"	3 / 16"	15 / 64"	23 / 64"
	3 / 8"	15 / 64"	17 / 64"	7 / 16"
	1 / 2"	17 / 64"	5 / 16"	33 / 64"

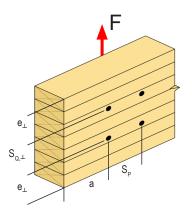
- 1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- 2. Consult a qualified design professional before pre-drilling.
- 3. Pre-drilled holes that exceed the diameters listed above may reduce the capacity of the screws.
- 4. Recommendations only applicable to ASSY screws.



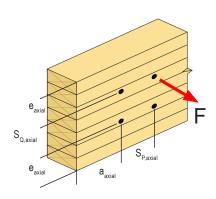
Geometry Requirements for ASSY Screws



Lateral loading parallel to grain



Lateral loading perpendicular to grain



Axial loading

Table S.2.1, Timber Connection Geometry Requirements without Pre-drilling

Fastener	Specific	End Distance		Е	dge Distand	e	Spacing Between Fasteners in a Row		Spacing Between Rows	
Thread Type	Gravity	a/a _L	a _{axial}	е "	e⊥	e axial	Sp	S p,axial	S QL / S Q//	S _{Q,axial}
	G ≤ 0.42	10 D	10 D	5 D	10 D	5 D	5 D	5 D	5 D	5 D
Partial Thread	0.42 < G ≤ 0.55	15 D	15 D	7 D	12 D	7 D	7 D	7 D	7 D	7 D
	D. Fir, G = 0.49	22.5 D	22.5 D	7 D	12 D	7 D	10.5 D	10.5 D	7 D	7 D
	G ≤ 0.42	7 D	5 D	3 D	7 D	3 D	7 D	5 D	5 D	2.5 D
Full Thread	0.42 < G ≤ 0.55	7 D	5 D	3 D	7 D	3 D	7 D	5 D	5 D	2.5 D
	D. Fir, G = 0.49	10.5 D	10.5 D	3 D	7 D	3 D	10.5 D	7.5 D	5 D	2.5 D

Notes:

- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
- 3. According to ICC-ESR-3178 and ICC-EDR-3179

- Tabulated values listed above must prevent splitting in wood. Shall splitting be observed a
 design professional must be consulted immediately.
- Within a row, fasteners may be staggered up to 2·D to further reduce the potential for splitting.

Table S.2.2, Timber Connection Geometry Requirements with Pre-drilled Holes, C₁=1.0

End Distance				Edge D	istance			Between s in a Row	Spacing Between Rows			
а	a _L	a _{axial}	е "	e⊥	e _{⊥, ∟}	e axial	S _p	S p,axial	Sq//	S _Q ⊥	S _{Q,axial}	
4 D	7 D *	4 D	3 D	4 D	4 D	3 D	4 D	4 D	3 D	5 D	4 D	

- All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
- Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
- Full penatration length must be pre-drilled with a hole diameter according to the pre-drilling recommendations, presented in Table S.5.
- 4. According to NDS 2018, section 12.5
- 5. Minimum fastener penetration 6·D.
- 6. * for softwood only

ASSY Allowable Fastener Tensile Strength

Table S.3, ASSY Allowable Tensile Strength

Ма	jor Diameter	ASSY Eco / Kombi / SK	ASSY VG CSK / VG CYL				
[D]		[lbs.]	[lbs.]				
	1 / 4"	1,150	1,165				
	5 / 16"	1,950	1,775				
	3 / 8"	2,780	2,550				
	1 / 2"	3,070	3,470				



Notes:

ASSY Adjusted Fastener Torsional Strength

Table S.4, ASSY Adjusted Torsional Strength

	Adjusted Torsional Strength [lbs. * ft.]									
Fastener Type	[D]									
	1 / 4"	5 / 16"	3 / 8"	1 / 2"	9 / 16"					
ASSY Eco / Kombi / SK	5.90	13.57	26.55	38.50	N/A					
ASSY VG CSK / VG CYL	5.90	13.57	26.55	44.25	67.85					

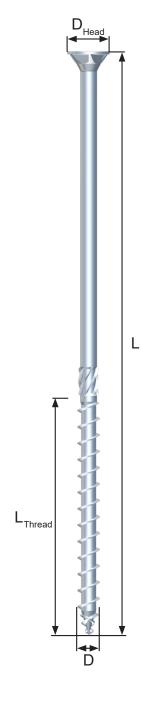
All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.

All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.

Hardware

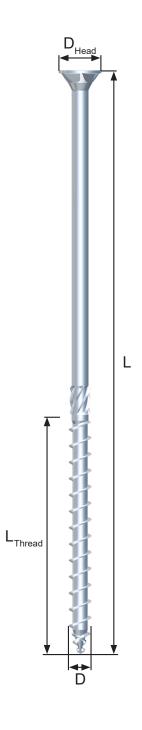
ASSY Ecofast

Item#	Box size		D	L		L _{Th}	read	D _{Head}		Bit
#	pieces		in.	in.	[mm]	in.	[mm]	in.		Dit
	-		[mm]				[]	[mm]		
110060060000100	200			2-1/8	[60]	1-1/2	[37]			
110060070000100	200			2-3/4	[70]	1-5/8	[42]			
110060080000100	100			3-1/8	[80]	2	[50]			
110060090000100	100			3-1/2	[90]	2	[50]			
110060100000100	100			4	[100]	2 3/8	[60]			
110060120000100	100		1/4	4-3/4	[120]	2-3/4	[70]	0.472		
110060140000100	100		[6]	5-1/2	[140]	2-3/4	[70]	[12]		AW 30
110060160000100	100			6-1/4	[160]	2-3/4	[70]			
110060180000100	100			7-1/8	[180]	2-3/4	[70]			
110060200000100	100			7-7/8	[200]	2-3/4	[70]			
110060220000100	100			8-5/8	[220]	2-3/4	[70]			
110060260000100	100			10 1/4	[260]	2 3/4	[70]			
110060300000100	100			11 7/8	[300]	2 3/4	[70]			
110080080000300	75			3 1/8	[80]	2	[50]			
110080090000300	75			3 1/2	[90]	2 3/8	[60]			
110080100000300	75	-		4	[100]	2 3/8	[60]			
110080120000300	75			4 3/4	[120]	3 1/8	[80]			
110080140000300	75			5 1/2	[140]	3 1/8	[80]			
110080160000300	75			6 1/4	[160]	3 1/8	[80]			
110080180000300	75			7 1/8	[180]	3 1/8	[80]			
110080200000300	75		5/16	7 7/8	[200]	3 1/8	[80]	0.591		AW 40
110080220000300	75		[8]	8 5/8	[220]	4	[100]	[15]		7 (0 0 40
110080240000300	75			9 1/2	[240]	4	[100]			
110080260000300	75			10 1/4	[260]	4	[100]			
110080280000300	75			11	[280]	4	[100]			
110080300000300	75			11 7/8	[300]	4	[100]			
110080340000300	100			13 3/8	[340]	4	[100]			
110080360000300	100			14 1/4	[360]	4	[100]			
110080400000300	100			15 3/4	[400]	4	[100]			



Notes: For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.

Item#	Box size	D		L		L Thread		D _{Head}		Dit	
#	nionon	in.		[mm]	in.	[mm]	in.		Bit		
#	pieces		[mm]	111.	[mm]	III.	[mm]	[mm]			
110100080000300	50			3 1/8	[80]	2	[50]				
110100100000300	50			4	[100]	2 3/8	[60]				
110100120000300	50			4 3/4	[120]	3 1/8	[80]				
110100140000300	50			5-1/2	[140]	3-1/8	[80]				
110100160000300	50				6-1/4	[160]	4	[100]			
110100180000300	50			7-1/8	[180]	4	[100]	0.700	ı		
110100200000300	50		3/8 [10]	7-7/8	[200]	4	[100]	0.728 [18.5]		AW 40	
110100220000300	50			8-5/8	[220]	4	[100]	[]			
110100260000300	50			10-1/4	[260]	4	[100]				
110100300000300	50			11-7/8	[300]	4	[100]				
110100360000300	50		14-1/4	[360]	4-3/4	[120]	1				
110100380000300	50		15	[380]	4 3/4	[120]					
110100400000300	50			15 3/4	[400]	4 3/4	[120]				

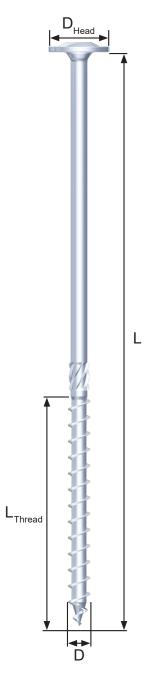


Notes:
1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.

ASSY SK

Item#	Box size	D L		L Thread		D _{Head}		Bit		
#	pieces		in.	in.	[mm]	in.	[mm]	in.		DIL
#	pieces		[mm]	111.	[IIIIII]	111.	[[[]]]	[mm]		
120060060000303	100			2-1/8	[60]	1-1/2	[37]			
120060070000303	100			2-3/4	[70]	1-5/8	[42]			
120060080000303	100			3-1/8	[80]	2	[50]			
120060090000303	100			3-1/2	[90]	2	[50]			
120060100000300	100			4	[100]	2 3/8	[60]			
120060120000300	100		414	4-3/4	[120]	2-3/4	[70]			
120060140000303	100		1/4 [6]	5-1/2	[140]	2-3/4	[70]	0.551 [14]		AW 30
120060160000303	100		[0]	6-1/4	[160]	2-3/4	[70]	[ייין		
120060180000303	100			7-1/8	[180]	2-3/4	[70]			
120060200000303	100			7-7/8	[200]	2-3/4	[70]			
120060220000303	100			8-5/8	[220]	2-3/4	[70]			
120060260000303	100			10 1/4	[260]	2 3/4	[70]	-		
120060300000303	100			11 7/8	[300]	2 3/4	[70]			

Item#	Box size	D	L		L _{Th}	read	D _{Head}	
#	pieces	in.	in.	[mm]	in.	[mm]	in.	Bit
		[mm]					[mm]	
120080080000303	50		3 1/8	[80]	2	[50]		
120080100000303	50		4	[100]	2 3/8	[60]		
120080120000300	50		4 3/4	[120]	3 1/8	[80]		
120080140000303	50		5 1/2	[140]	3 1/8	[80]		
120080160000303	50		6 1/4	[160]	3 1/8	[80]		
120080180000303	50		7 1/8	[180]	3 1/8	[80]		
120080200000303	50		7 7/8	[200]	3 1/8	[80]		
120080220000303	50		8 5/8	[220]	4	[100]		
120080240000303	50	5/16 [8]	9 1/2	[240]	4	[100]	0.870 [22.1]	AW 40
120080260000303	50	[0]	10 1/4	[260]	4	[100]	[22.1]	
120080280000303	50		11	[280]	4	[100]		
120080300000303	50		11 7/8	[300]	4	[100]		
120080320000303	50		12 5/8	[320]	4	[100]		
120080340000303	50		13 3/8	[340]	4	[100]		
120080400000303	50		15 3/4	[400]	4	[100]		
120080480000103	25		19	[480]	4	[100]]	
120080520000103	25		20 1/2	[520]	4	[100]		



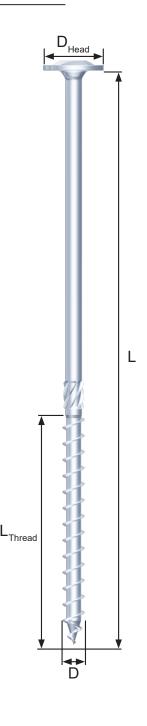
Notes:
1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.

Item#	Box size		D	L		L Thread		D_{Head}		Bit
#	pieces		in.	in.	[mm]	in.	[mm]	in.		Dit
#	pieces		[mm]	111.	[111111]		[[[]]]	[mm]		
120100100000303	50			4	[100]	2 3/8	[60]			
120100120000300	50			4 3/4	[120]	3 1/8	[80]			
120100140000303	50			5 1/2	[140]	3 1/8	[80]			
120100160000303	50			6 1/4	[160]	4	[100]			
120100180000303	50			7 1/8	[180]	4	[100]			
120100200000303	50			7 7/8	[200]	4	[100]			
120100220000303	50		3/8 [10]	8 5/8	[220]	4	[100]	0.992 [25.2]		AW 50
120100260000303	50		[10]	10 1/4	[260]	4	[100]	[23.2]		
120100300000303	50			11 7/8	[300]	4	[100]			
120100360000303	50			14 1/4	[360]	4 3/4	[120]			
120100380000303	50			15	[380]	4 3/4	[120]			
120100400000303	50			15 3/4	[400]	4 3/4	[120]]		
120100460000303	25			18 1/8	[460]	4 3/4	[120]			

Item#	Box size	D	L		L _{Th}	read	D _{Head}	D:t
#	nioooo	in.	in	[mm]	in.	[mm]	in.	Bit
#	pieces	[mm]	in.		111.	[mm]	[mm]	
120120020000300	25		7 7/8	[200]	4	[100]		
120120026000300	25		10 1/4	[260]	4 3/4	[120]		
120120040000300	25	1/2 [12]	15 3/4	[400]	5 3/4	[145]	1.157 [29.4]	AW 50
120120048000300	25	[12]	19	[480]	5 3/4	[145]	[29.4]	
120120052000300	25		20 1/2	[520]	5 3/4	[145]		

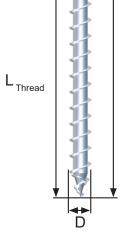


Notes:
1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.



ASSY Kombi

Item#	Box size	D	L		L _{Tr}	nread	D _{Head}	
#	pieces	in. [mm]	in.	[mm]	in.	[mm]	in. [mm]	Bit
130080060000103	75		2 3/8	[60]	1 1/2	[40]		
130080080000103	75		3 1/8	[80]	2	[50]		
130080100000103	75	5/16	4	[100]	2 3/8	[60]	0.472	AW 40 or
130080120000103	75	[8]	4 3/4	[120]	3 1/8	[80]	[12]	1/2 socket
130080160000103	75		6 1/4	[160]	3 1/8	[80]		
130080200000103	75		7 7/8	[200]	3 1/8	[80]		
130100060000103	50		2 3/8	[60]	2	[50]		
130100080000103	50		3 1/8	[80]	2	[50]		
130100100000103	50		4	[100]	2 3/8	[60]	0.591 [15]	
130100120000103	50	3/8	4 3/4	[120]	3 1/8	[80]		AW 40 or 19/32 socket
130100140000103	50	[[10]	5 1/2	[140]	3 1/8	[80]	[10]	10/02 30CKCt
130100160000103	50		6 1/4	[160]	4	[100]		
130100200000103	50		7 7/8	[200]	4	[100]		
130120080000103	50		3-1/8	[80]	2-3/4	[70]		
130120100000103	50		4	[100]	2 3/8	[60]		
130120120000103	50	1/2	4 3/4	[120]	3 1/8	[80]	0.669	AW 40 or
130120140000103	50	[12]	5 1/2	[140]	3 1/8	[80]	[17]	11/16 socket
130120160000103	50		6 1/4	[160]	5 3/4	[145]	5]	
130120200000103	50		7 7/8	[200]	4	[100]		



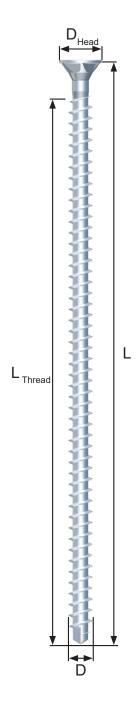
L

Notes:

1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.

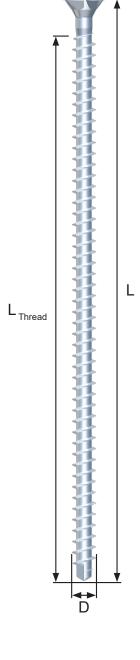
ASSY VG CSK

Item#	Box size		D) L		L _{Thre}	ead	D _{Head}	D.,
#	pieces		in.	in.	[mm]	in.	[mm]	in.	Bit
#	pieces		[mm]	111.	[IIIIIII]	111.	[mm]	[mm]	
140080080000102	75			3-1/8	[80]	2-1/2	[61]		
140080120000102	75			4-3/4	[120]	4	[103]		
140080140000100	75			5-1/2	[140]	4-7/8	[123]		
140080160000102	75			6-1/4	[160]	5-5/8	[143]		
140080180000102	75		F/40	7-1/8	[180]	6-3/8	[163]	0.504	
140080200000102	75		5/16 [8]	7-7/8	[200]	7-1/4	[183]	0.591 [15]	AW 40
140080220000102	75		[0]	8-5/8	[220]	8	[203]	[10]	
140080240000102	75			9-1/2	[240]	8-3/4	[223]		
140080260000102	75			10-1/4	[260]	9-5/8	[243]		
140080280000102	75			11	[280]	10-3/8	[263]		
140080300000102	75			11-7/8	[300]	11-1/8	[283]		
140100100000102	50			4	[100]	3	[77]		
140100160000102	50			6 1/4	[160]	5 3/4	[145]		
140100180000102	50			7 1/8	[180]	6 1/2	[165]		
140100200000102	50			7 7/8	[200]	7 1/4	[185]		
140100220000102	50			8 5/8	[220]	8 1/8	[205]		
140100240000102	50			9 1/2	[240]	8 7/8	[225]		
140100260000102	50			10 1/4	[260]	9 5/8	[245]		
140100300000102	50			11 7/8	[300]	11 1/4	[285]		
140100320000102	50		2.0	12 5/8	[320]	12	[305]		
140100340000102	50		3/8 [10]	13 3/8	[340]	12 3/4	[325]	0.728 [18.5]	AW 50
140100360000102	50		[10]	14 1/4	[360]	13 5/8	[345]	[10.0]	
140100400000102	50			15 3/4	[400]	15 1/8	[100]		
140100430000102	25			17	[430]	16 3/8	[415]		
140100480000102	25			19	[480]	18 1/4	[465]		
140100530000102	25			20 7/8	[530]	20 1/8	[512]		
140100580000102	25			22 7/8	[580]	22 1/8	[562]		
140100650000102	25			25 5/8	[650]	24 7/8	[632]		
140100750000102	25		-	29 1/2	[750]	28 7/8	[732]		
140100800000102	25			31 1/2	[800]	30 3/4	[782]		



Notes:
1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.

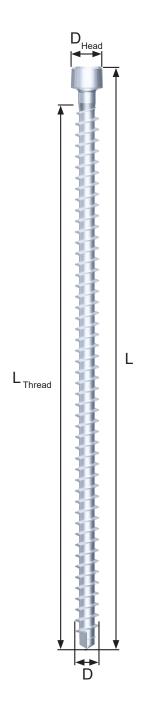
Item#	Box size		D	L		L _{Thre}	D _{Head}		D.;	
#	nioooo		in.	in.	[mm]	in.	[mm]	in.		Bit
#	pieces		[mm]	111.	[mm]	III.	[mm]	[mm]		
140120120000102	50			4 3/4	[120]	4 1/8	[105]			
140120140000100	50			5 1/2	[140]	4 7/8	[125]			
140120160000102	50			6 1/4	[160]	5 3/4	[145]			
140120200000102	50			7 7/8	[200]	7 1/4	[185]			
140120260000102	50		1/2	10 1/4	[260]	9 5/8	[245]	0.885		AW 50
140120280000102	50		[12]	11	[280]	10 4/9	[265]	[22.5]		AVV 50
140120300000102	50			11 7/8	[300]	11 1/4	[285]			
140120380000102	50			15	[380]	14 3/8	[365]			
140120480000102	50			19	[480]	18 1/4	[465]			
140120600000102	50			23 5/8	[600]	23	[585]			



Notes: 1. For more ASSY fastener options, visit the **MTC Solutions Website** at <u>mtcsolutions.com</u>.

ASSY VG Cyl

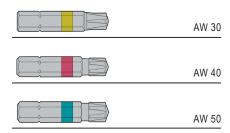
Item#	Box size		D	L		L _{Thr}	ead	D _{Head}		D.''
#	pieces		in.	in.	[mm]	in.	[mm]	in.		Bit
150060080000302	100		[mm]	3 1/8	1001	2 7/9	[72]	[mm]		
15006010000302	100			4	[80]	2 7/8 3 5/8	[73]			
150060100000302	100			4 3/4	[100]	4 1/2	[93] [113]			
150060120000302	100		1/4	5 1/2	[140]	5 1/4	[133]	0.323		AW 30
150060140000302	100		[6]	6 1/4	[160]	6	[153]	[8.2]		AVV 30
150060180000302	100			7 1/8	[180]	6 3/4	[173]			
150060200000302	100			7 7/8	[200]	7 5/8	[193]			
150080160000302	50			6 1/4	[160]	5 5/8	[144]			
150080180000302	50			7 1/8	[180]	6 1/2	[164]			
150080200000302	75			7 7/8	[200]	7 1/4	[184]			
150080220000302	75			8 5/8	[220]	8	[204]			
150080240000302	75			9 1/2	[240]	8 7/8	[224]			
150080260000302	75			10 1/4	[260]	9 5/8	[244]			
150080280000302	75			11	[280]	10 3/8	[264]			
150080300000302	75		5/16	11 7/8	[300]	11 1/8	[284]	0.394		AW 40
150080330000302	50		[8]	13	[330]	12 3/8	[314]	[10]		
150080360000302	50			14 1/4	[360]	13 1/2	[344]			
150080380000302	50			15	[380]	14 3/8	[364]			
150080430000302	25			17	[430]	16 1/4	[414]			
150080480000302	25			19	[480]	18 1/4	[464]			
150080530000302	25			20 7/8	[530]	20 1/4	[514]			
150080580000302	25			22 7/8	[580]	22 1/4	[564]			
150100180000302	50			7 1/8	[180]	6 1/2	[165]			
150100220000302	50			8 5/8	[220]	8 1/8	[205]			
150100260000302	50			10 1/4	[260]	9 5/8	[245]			
150100300000302	50			11 7/8	[300]	11 1/4	[280]			
150100340000302	50			13 3/8	[340]	12 3/4	[325]			
150100360000302	50			14 1/4	[360]	13 5/8	[345]			
150100400000302	50			15 3/4	[400]	15	[380]			
150100430000302	25		3/8 [10]	17	[430]	16 3/8	[415]	0.528 [13.4]		AW 50
150100480000302	25		[10]	19	[480]	18	[456]	[10.4]		
150100530000302	25			20 7/8	[530]	19 7/8	506]			
150100580000302	25			22 7/8	[580]	21 7/8	[556]			
150100650000302	25			25 5/8	[650]	24 5/8	[656]			
150100700000302	25			27 5/8	[700]	26 3/4	[680]			
150100750000302	25			29 1/2	[750]	28 5/8	[726]			
150100800000302	25			31 1/2	[800]	30 5/8	[780]			



^{1.} For more ASSY fastener options, visit the MTC Solutions Website at <u>mtcsolutions.com</u>.

Bits - AW Drive

AW Bits are engineered and patented for proper installation of all ASSY screws and offer exceptional fit and durability. They are available in three standard sizes.



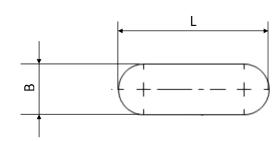
45° Washer

The 45° wedge washer is a cast-iron part suitable for use with all ASSY Countersunk head screw types. Use of the washer eliminates the need for inclined predrilled countersunk holes in steel plates and thus offers cost reductions by using standard machined elliptical holes and thinner steel plates. The possibility of setting a wood screw with its washer at a 45° angle enables engineers and designers to achieve high-performance connection systems.



Table W.1, 45° Washer Installation - Geometry Requirements

Screw Diameter	E	3	ı	-	Steel Plate Thickness			
	min	max	min max		min	max		
		i	n.					
		[m	nm]					
1 / 4"	0.394	0.433	1.26	1.299	0.157	0.591		
[8]	[10]	[11]	[32]	[33]	[4]	[15]		
5 / 16"	0.433	0.472	1.732	1.772	0.197	0.787		
[10]	[11]	[12]	[44]	[45]	[5]	[20]		
3 / 8"	0.512	0.551	1.969	2.008	0.236	0.934		
[12]	[13]	[14]	[50]	[51]	[6]	[25]		



Notes:

Drill recommendation

Use low rpm drill with high torque:

- 1/2 drill for 1/4" and 5/16" screws
- ¾ drill for 3/8" and 1/2" screws

Avoid use of impact drills, do not over-torque. Use AW drive bits for all ASSY screws.

Installation

- Do not stop drill during installation. ASSY screws shall be installed without stopping in one run.
- Use safety gear as required.
- Use drill with torque clutch when installing screws in steel-to-wood connections.



For coated steel plates the hole size needs to be oversized taking the thickness of the coating into account. Test
fitting of wedge washers into steel plate holes is required to assure required tolerances are in place.









info@mtcsolutions.com

1.866.899.4090

www.mtcsolutions.com





