MTC SOLUTIONS

Structural Screw Connection Design Guide

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Carbon 12

Portland, Oregon

Courtesy of Andrew Poque

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Mass Timber Hardware Specialist

At MTC Solutions, our core focus is to supply structural hardware for modern mass timber applications in commercial, industrial, and residential projects. We are proud to partner with leading industry experts, providing solutions and tools to design code-compliant buildings that are pushing the boundaries of the North American construction industry.

Our in-house team of mass timber specialists support professionals in designing connections that are tailored to the specific needs of each project, resulting in truly innovative and cost-efficient solutions. We are recognized as experts, moving the industry forward with tested and proven solutions.

Expertise

We provide the knowledge and tools to help our customers build cutting-edge and code-compliant mass timber projects while pushing the boundaries of the North American construction industry.

Commitment

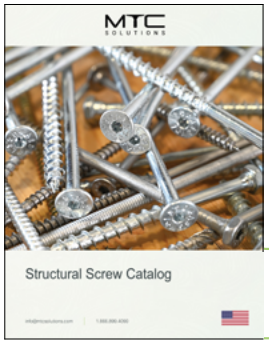
We are dedicated to making your project a success, from design and installation support to delivering high quality products with speed and accuracy.

North American Tailored Products

We partner with leading research facilities across North America to ensure our products are tested and customized to fit the unique needs of the market, from seismic considerations to solutions for large post and beam structures in various climates.

Find Your Connection Solution

MTC Solutions provide the right tools to design code-compliant buildings, educating the mass timber industry on connection solutions.



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Fall Arrest

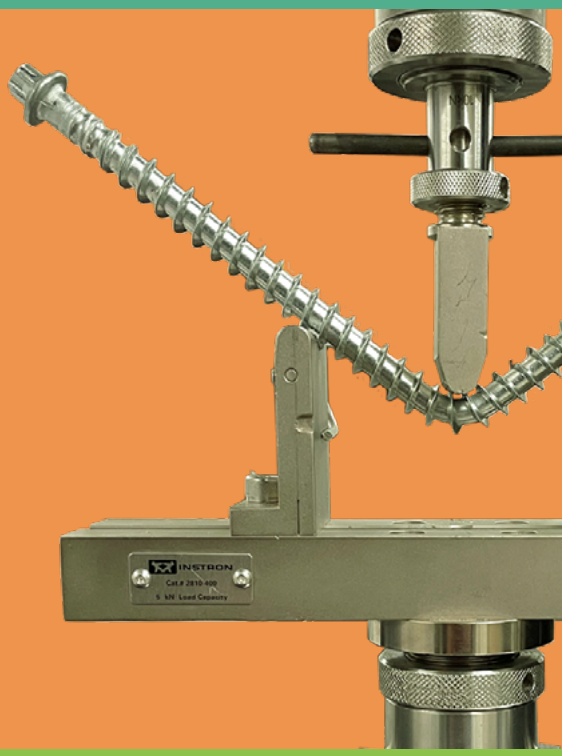
WHO ARE WE?

YOUR MASS TIMBER HARDWARE SUPPLIER

Rely on our distribution team to deliver your North American projects with speed and accuracy.

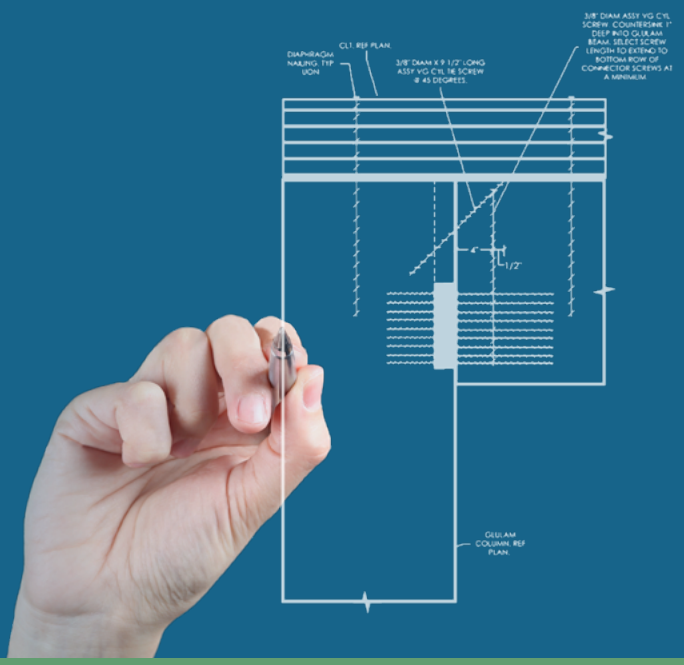
LEADING WITH INNOVATION & RESEARCH

We are leading the mass timber industry with cutting edge connection solutions and partnering with renowned research facilities.



WE MAKE YOU THE EXPERT

Learn about the right solutions for your projects and Mass Timber connections with our technical resources & support team!



CONNECTIONS DESIGN SUPPORT

Reach out to the technical team for design support, from early design stages to ongoing iterative changes. We help find the most efficient connection solutions.

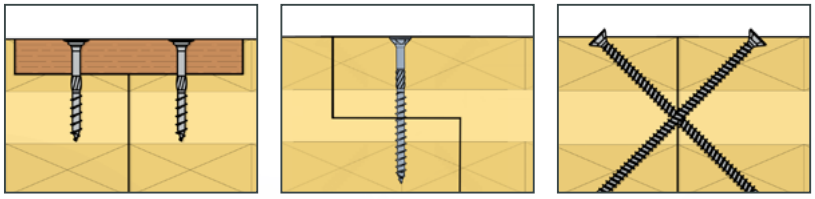
MANUFACTURERS' HELP DESK

Use our comprehensive & practical resources to find the most cost-effective solutions for your structural elements.

TESTED & PROVEN SOLUTIONS

Count on MTC Solutions' 10+ years of expertise, providing tested & proven ICC approved solutions, support, and resources.

General Information



Panel to Panel Connections

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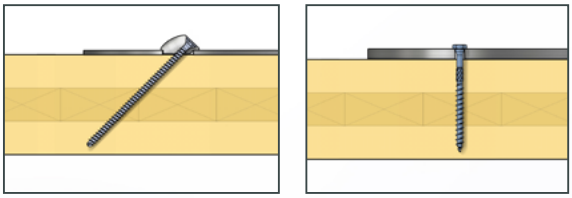

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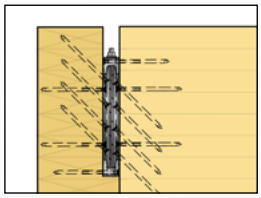

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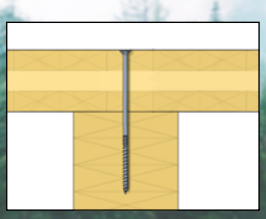

Panel to Beam Connections

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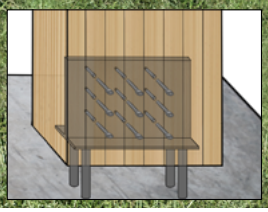

Self-Drilling Dowel Connections

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Connector Design Guide

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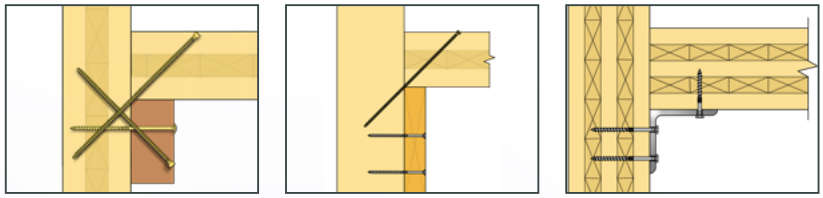

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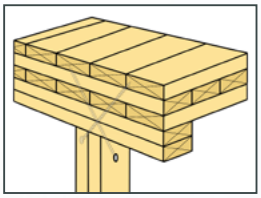

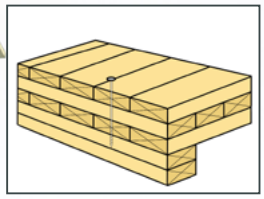

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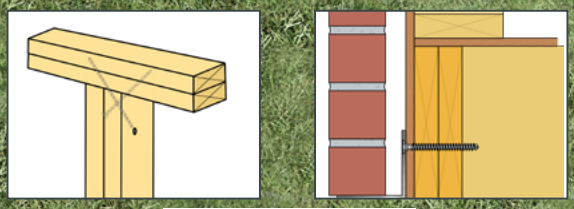

Wall Connections

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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.

AVAILABLE IN MULTIPLE SIZES

TESTED IN NORTH AMERICA

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 EVALUATION SERVICE
ICC-ESR-3178
ICC-ESR-3179

CCMC
13677-R

ISO 50001

ETA

Information about Mass Timber

Wood Failure Modes and Reinforcing Solutions

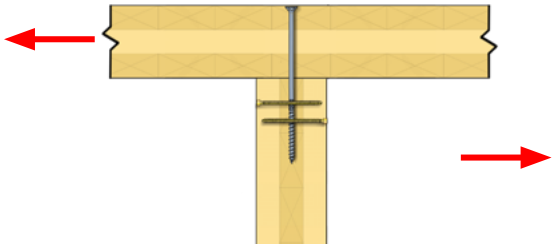
The high withdrawal resistance and tensile strength of fully threaded self-tapping screws can be used in many ways to compensate for low strength loading directions in timber or CLT. Some common failure modes and reinforcing solutions are explained below.

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.

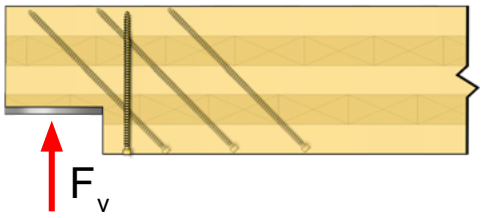
Notches at the tension face of bending members can also overstress the CLT members. In many cases, fully threaded fasteners can be designed to transfer the tensile load components, preventing accidental brittle failure modes.

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.

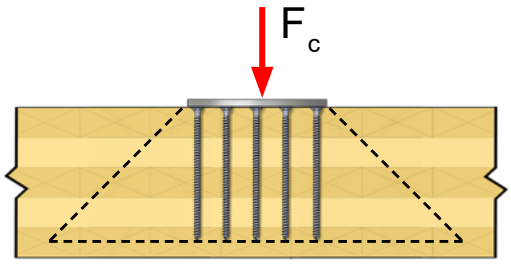
CLT can sometimes be limited by the relatively low rolling shear strength and stiffness of the crossing plies. Reducing the thickness of cross layers may mitigate this issues of low rolling shear strength and stiffness. Fully threaded screws can be used to reinforce the CLT against shear stresses activated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



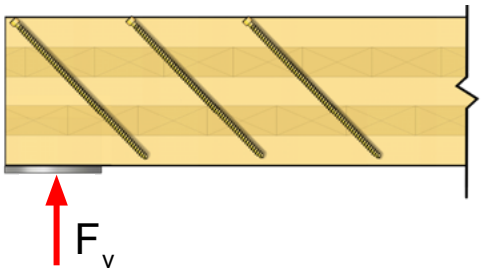
CLT floor to wall connection reinforcement to minimize risk of brittle failures



CLT notch reinforcement with a full thread screws



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



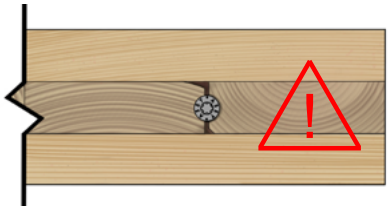
CLT rolling shear reinforcement using inclined full thread screws

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 J_E = 0.67 is assigned to reference withdrawal design values, as per CSA O86-19 Clause 12.6.6.1.

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.



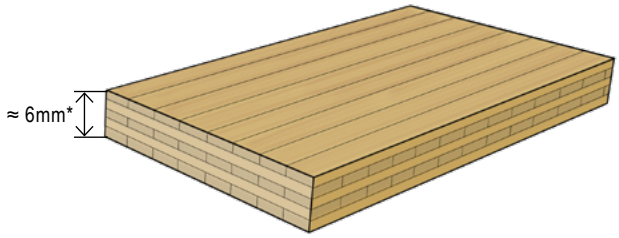
Screw Installed in a Gap in the Narrow Edge

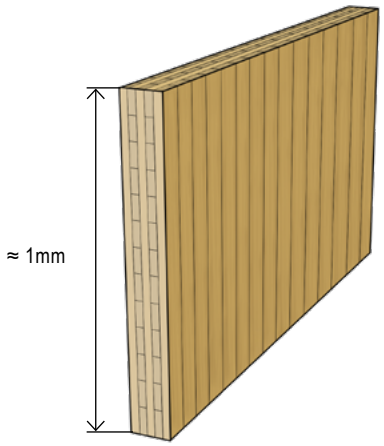
Screw Installed in the Narrow Edge

Swelling and Shrinkage of CLT

According to Clause 8.3.2 of CSA O86-19, cross-laminated 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.





Notes:

1. For a 105mm 3 ply S.P.F.panel to a 300mm S.P.F. panel, swelling and shrinkage may vary from ≈ 4mm to ≈ 12mm.

* 6mm is for a 175mm 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 Factored Resistances presented in this document have been estimated following applicable provisions in the CSA O86-19 or derived from testing following the Canadian Construction Materials Centre (CCMC) 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

Factored Resistances
Fastener(s) reference strength in the loading directions applicable to the connection
(See page 15)

Panel & Joint Configuration				Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	N'//		105	VG Cyl 6 x 140	123	141	25

Relative Density (G)
The assigned relative density of the material used for the calculations are the following:


S-P-F
G = 0.42


Douglas Fir
G = 0.49

Tables Color Code
The colors represents the diameter of the fastener used in the connection:

- 6mm screw
- 8mm screw
- 10mm screw
- 12mm screw

Dimensions
Dimensions and spacing requirements are shown in millimeters [mm], except if otherwise specified.

Connection Resistance Calculation

$N_r = N' \cdot n_F \cdot n_R \cdot K'$ $P_{rw} = P' \cdot n_F \cdot n_R \cdot K'$

N_r or P_{rw} Factored lateral strength or withdrawal resistance of a connection

N' or P' Factored lateral strength or withdrawal resistance ($N'_{//}$, $N'_{m,\perp}$, $N'_{s,\perp}$, $N'_{\perp}$ or P') given in the provided design tables or calculated in accordance with CSA O86-19 clause 12.6

n_F Number of effective fasteners in a row

n_R Number of rows in a connection

K' The adjustment factors for the connection, composed of: K_D ; K_{SF} ; K_T ; J_G ; J_{PL} ; J_E

The J_X factor for CLT is included in the calculation of the factored resistances.

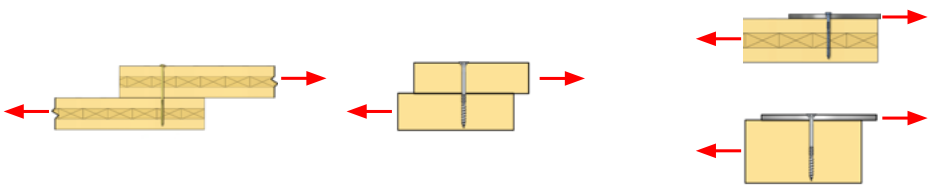
Connection Design

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

Wood-to-Wood | Steel-to-Wood

$N'_{\parallel}$ - Parallel to Grain Loading

Connection with all wood members loaded parallel to grain.

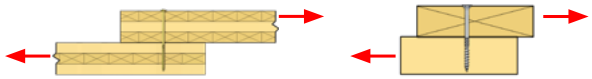


$N'_{m,\perp}$ - Parallel to Grain Loading of Side Member

Connection with main member loaded perpendicular to grain and side member loaded parallel to grain.

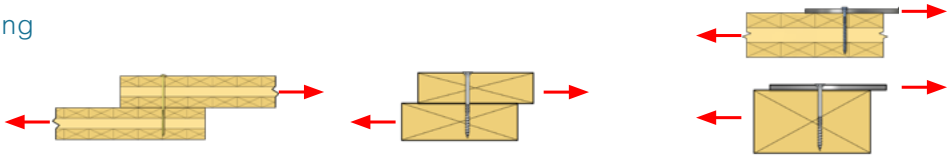
$N'_{s,\perp}$ - Parallel to Grain Loading of Main Member

Connection with main member loaded parallel to grain and side member loaded perpendicular to grain.



$N'_{\perp}$ - Perpendicular to Grain Loading

Connection with all wood members loaded perpendicular to grain.

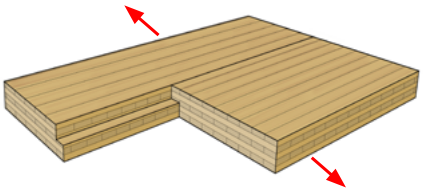


P' - Withdrawal Loading

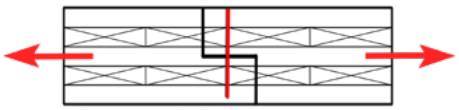
Connection with self-tapping screw loaded in withdrawal through one or two wood members. Factored withdrawal resistances in the provided tables is the minimum of the withdrawal, tensile and the head-pull through capacity of the fastener. Other failure modes remain responsibility of the qualified designer.

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

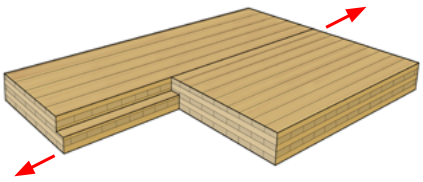
Loading perpendicular to the connection plane:



Icon:



Loading parallel to the connection plane:



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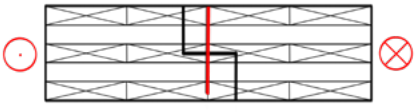


General Notes To The Designer

1. Factored resistances presented in this design guide are based on CSA O86, CCMC 13677-R 2020, and boundary conditions outlined in ETA-11/0190 unless noted otherwise.
2. 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.
3. Connections must respect the geometry requirements as specified in the Detailing Section of this guide and CSA O86.
4. Factored resistances must be factored in accordance with all applicable adjustment factors of CSA O86-19, Clause 12.6.
5. Maximum factored drive in torque of the fasteners must be respected, see the Detailing Section, Table S.4.
6. Carbon steel ASSY screws are intended to be used in untreated wood under dry service conditions and temperatures below 100°F such that K_{SF}=1.0 and K_T=1.0.
7. For standard term loading, load duration factor is K_D=1. For short term loading, load duration factor is K_D=1.15, as per CSA O86-19 clause 5.3.2.
8. Listed factored resistance apply to different timber species according to their respective relative densities (G).
9. For connection with inclined axially loaded screws, the listed factored resistances 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. 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.
11. 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.
12. A load bearing connection shall consist of at least two (2) ASSY screws.
13. For CLT connections, listed factored resistances apply to CLT with G = 0.42 or higher.
14. Wood species should be assumed to be SPF with G = 0.42 if not otherwise specified.
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. Dimensions and spacing requirements are shown in millimeters [mm], except if otherwise specified.
18. 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.

Origine Tower

Quebec City, Quebec

Umass Design Building

Amherst, Massachusetts

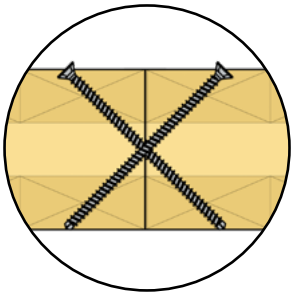
Courtesy of Alex Schreyer

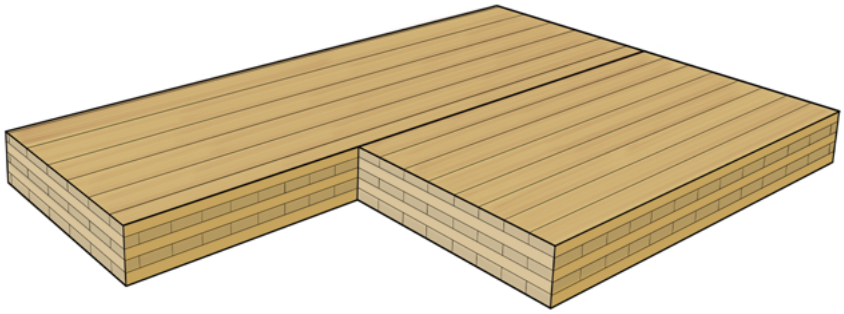
Typical Panel to Panel Connections

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.

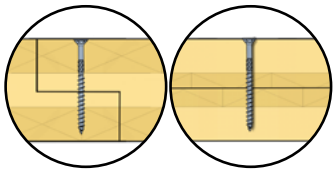
- **The Butt joint** is the simplest connection type from a fabrication point of view, as the panels are simply cut straight at the edges. It requires short machining time and less material is lost during production.
- **Lap joints** require more prefabrication than butt joints. For this, part of the 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

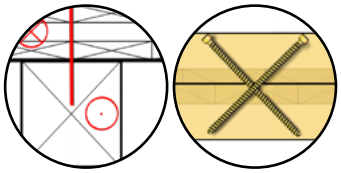




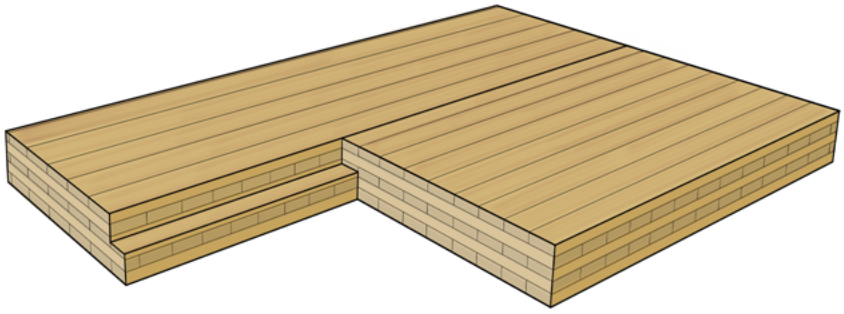
Lap Joint Connection



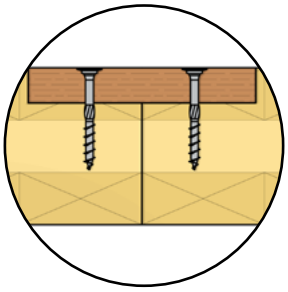
Lap Joint Connection in Shear

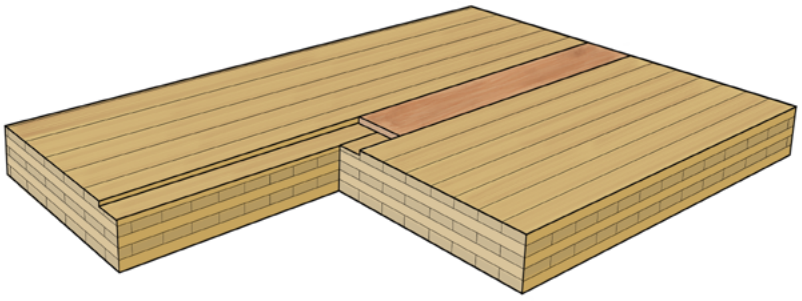


Lap Joint Connection with Inclined Screws



Surface Spline Connection



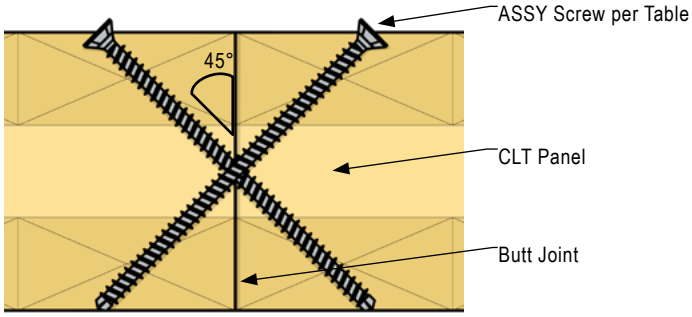


CLT Butt Joint Connection in Shear

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 105mm and above.



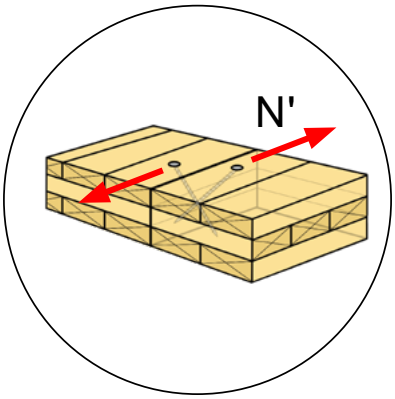


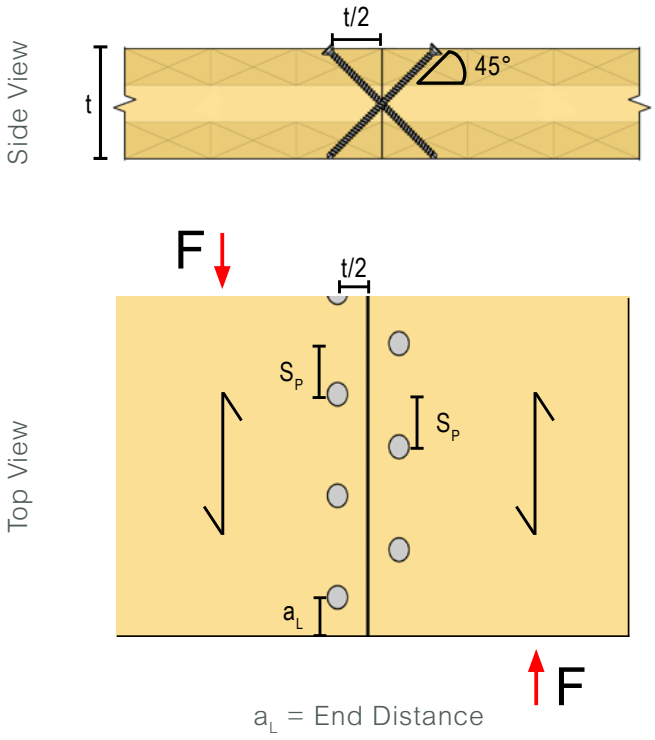
Table PP.1.1, Factored Resistances for CLT Butt Joints Loaded in Shear

Panel & Joint Configuration				Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$		105	VG Cyl 6 x 140	664	764	24
	$N'_{\perp}$				464	534	
5 PLY	$N'_{//}$		139	VG CSK 8 x 180	1169	1344	32
			175	VG CSK 8 x 220	1169	1344	32
				VG CSK 10 x 220	1721	1979	40
	$N'_{\perp}$		139	VG CSK 8 x 180	798	918	32
			175	VG CSK 8 x 220	817	940	32
				VG CSK 10 x 220	1160	1334	40

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be installed at a 45° angle intersecting the shear plane at half the panel thickness. The angle between force and fastener axis is 90°.
6. End grain factor (J_E = 0.67) is not included in the Factored Resistance because test have shown that the Factored Resistance presented are already conservative.
7. $N'_{//}$ Angle between loading direction and wood grain in the shear plane Θ = 0°.
   $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane Θ = 90°.

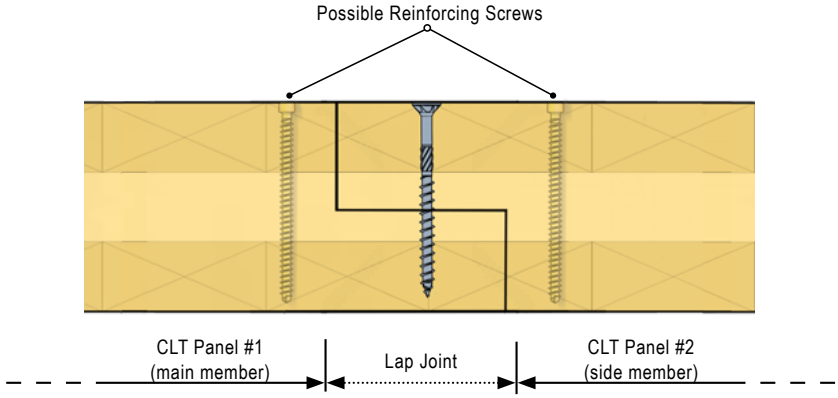
Geometry Requirements



a_L = End Distance

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.



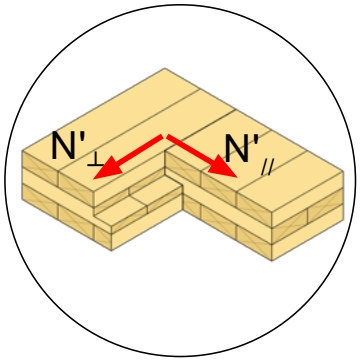
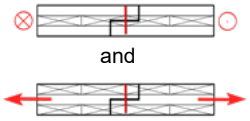
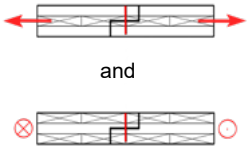


Table PP.2.1, Factored Resistances for CLT Lap Joints Loaded in Shear

Panel & Joint Configuration				Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
	$N'_{//}$		105	Eco 6 x 90	669	769	24
			105	Eco 8 x 100	973	1119	32
	$N'_{\perp}$		105	Eco 6 x 90	352	405	24
			105	Eco 8 x 100	476	547	32

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. 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.
6. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at half the panel thickness.
7. The angle between force and fastener axis is 90°.
8. Factored lateral resistance may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
9. $N'_{//}$ Angle between loading direction and wood grain in the shear plane ϴ = 0°.
   $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane ϴ = 90°.

Geometry Requirements

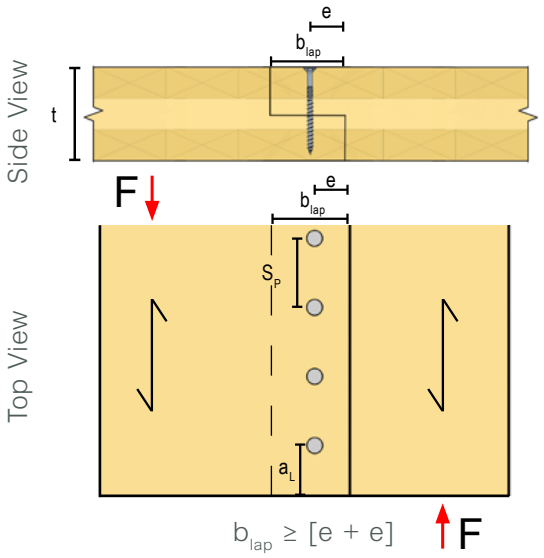
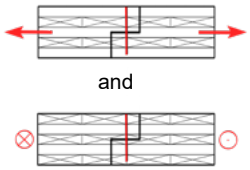
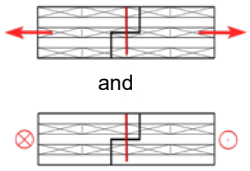
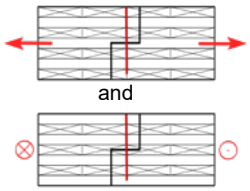
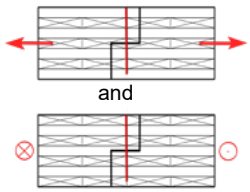


Table PP.2.2, Factored Resistances for CLT Lap Joints Loaded in Shear

Panel & Joint Configuration				Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
5 PLY	$N'_{//}$		132	Eco 6 x 120	887	1020	24
			139	Eco 6 x 120	869	999	
			175	Eco 8 x 160	1567	1802	32
				Eco 10 x 160	2104	2420	40
	$N'_{\perp}$		132	Eco 6 x 120	532	612	24
			139	Eco 6 x 120	518	596	
			175	Eco 8 x 160	921	1059	32
				Eco 10 x 160	1111	1278	40
7 PLY	$N'_{//}$		191	Eco 8 x 180	1567	1802	32
				Eco 10 x 180	2285	2628	40
			221	Eco 8 x 200	1567	1802	32
				Eco 10 x 200	2308	2654	40
			244	Eco 8 x 220	1567	1802	32
				Eco 10 x 220	2308	2654	40
	$N'_{\perp}$		191	Eco 8 x 180	1012	1164	32
				Eco 10 x 180	1259	1448	40
			221	Eco 8 x 200	1043	1199	32
				Eco 10 x 200	1397	1607	40
			244	Eco 8 x 220	1091	1255	32
				Eco 10 x 220	1457	1676	40

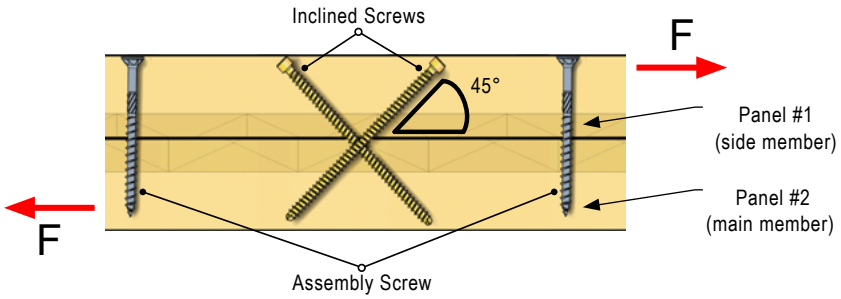
Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. 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.
6. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at half the panel thickness.
7. The angle between force and fastener axis is 90°.
8. Factored lateral resistancemay be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
9. $N'_{//}$ Angle between loading direction and wood grain in the shear plane $\Theta = 0°$.
   $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane $\Theta = 90°$.

CLT Lap Joint with Inclined Screws

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.

Factored resistances 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.



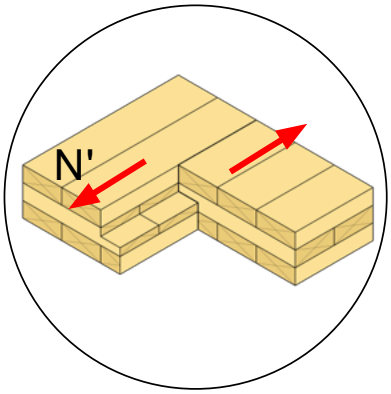


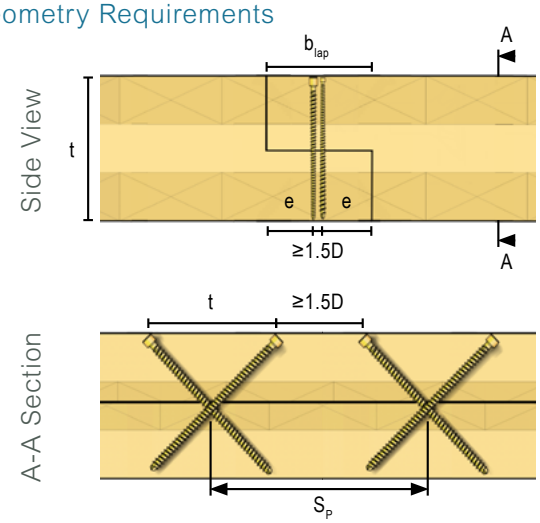
Table PP.3.1, Factored Resistances for CLT Lap Joints with Inclined Screw Crosses

Panel & Joint Configuration				Fastener Options	Factored Resistance per Screw Cross [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$		105	VG Cyl 6 x 140	3,160	3,640	42
	$N'_{\perp}$				3,330	3,830	

Notes:

1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. 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.
6. Factored resistances require the fasteners to be 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. Factored lateral resistance only apply to parallel loading along the panel joint.
9. 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.
10. The upper limit of the factored withdrawal resistance is set by the factored tensile strength of fastener, no further increase are allowed. WYW
11. $N'_{//}$ Factored resistance per screw cross in tension with panel joint along major span direction of CLT panel.
    $N'_{\perp}$ Factored resistance per screw cross in tension with panel joint along minor span direction of CLT panel.

Geometry Requirements



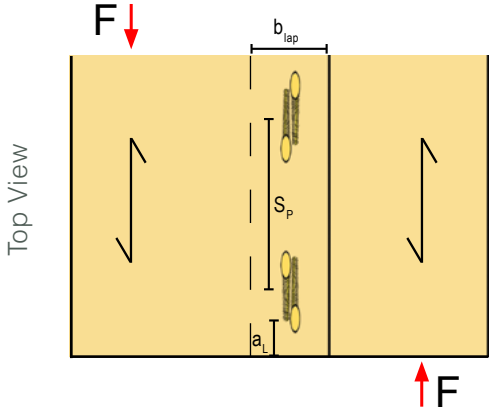
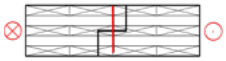
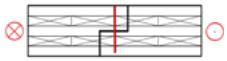
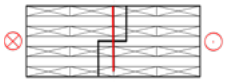
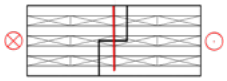


Table PP.3.2, Factored Resistances for CLT Lap Joints with Inclined Screw Crosses

Panel & Joint Configuration				Fastener Options	Factored Resistance per Screw Cross [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
5 PLY	$N'_{//}$		139	VG CSK 8 x 180	5,100	5,870	56
			175	VG CSK 8 x 220	6,260	7,200	56
				VG CSK 10 x 220	7,630	8,770	70
	$N'_{\perp}$		139	VG CSK 8 x 180	5,520	6,350	56
			175	VG CSK 8 x 220	6,460	7,430	56
				VG CSK 10 x 220	7,870	9,050	70
7 PLY	$N'_{//}$		191	VG CSK 8 x 260	8,130	9,350	56
				VG CSK 10 x 260	9,950	11,450	70
			220	VG CSK 8 x 260	6,840	7,870	56
				VG CSK 10 x 260	8,350	9,600	70
			244	VG CSK 8 x 300	8,470	9,740	56
				VG CSK 10 x 300	10,370	11,930	70
	$N'_{\perp}$		191	VG CSK 8 x 260	8,730	10,040	56
				VG CSK 10 x 260	10,690	12,300	70
			220	VG CSK 8 x 260	7,130	8,200	56
				VG CSK 10 x 260	8,700	10,000	70
			244	VG CSK 8 x 300	8,660	9,950	56
				VG CSK 10 x 300	10,600	12,190	70

Notes:

1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. 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.
6. Factored resistances require the fasteners to be 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. Factored lateral resistance only apply to parallel loading along the panel joint.
9. 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.
10. The upper limit of the factored withdrawal resistance is set by the factored tensile strength of fastener, no further increase are allowed.
11. $N'_{//}$ Factored resistance per screw cross in tension with panel joint along major span direction of CLT panel.
    $N'_{\perp}$ Factored resistance per screw cross in tension with panel joint along minor span direction of CLT panel.

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.

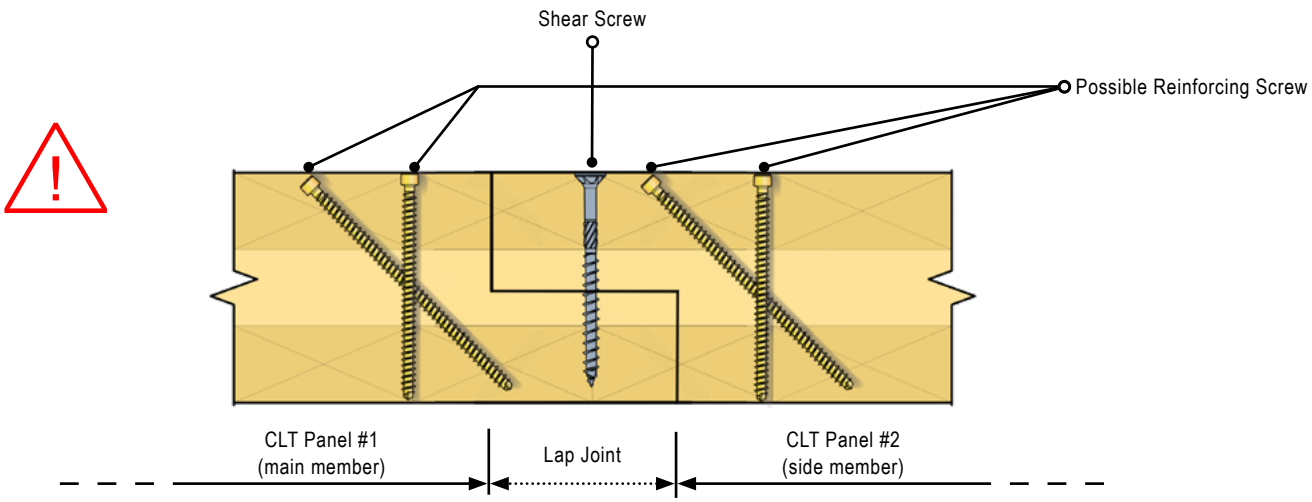
Coding standards, including the CSA O86, do not provide directives for notches on the tension side of CLT panels. Therefore, there are no fully developed procedures outlining the unique material characteristics, stress distribution patterns and crack propagation path along the unglued lamella edges within the CLT.

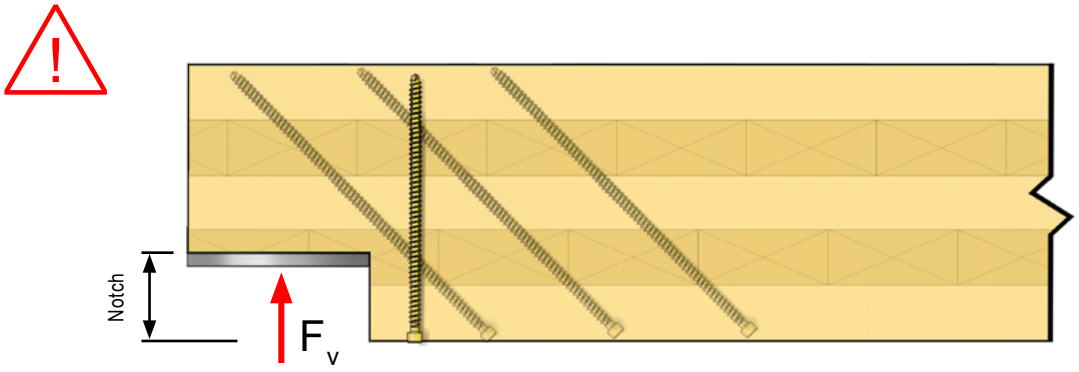
Designers are asked to be more conservative when designing notches with out of plane loading or to avoid them whenever possible.

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

For Glued Laminated Timber, notches shall not exceed 1/4 of the beam depth as per 7.5.7.5; CSA O86 2019.

CLT Lap joint connections are two notched members connected together



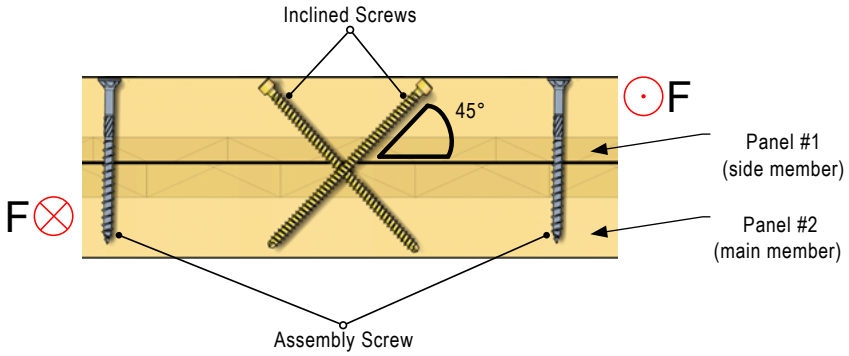


Brock Commons

Vancouver, British Columbia

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 factored lateral resistances 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 CSA O86-19 Clause 12.6.5.



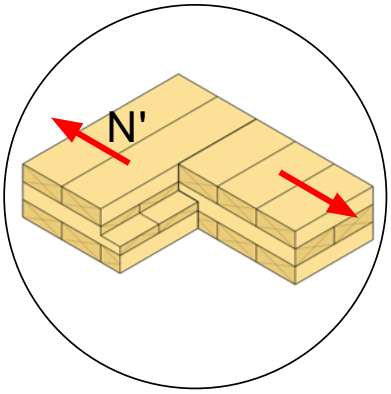


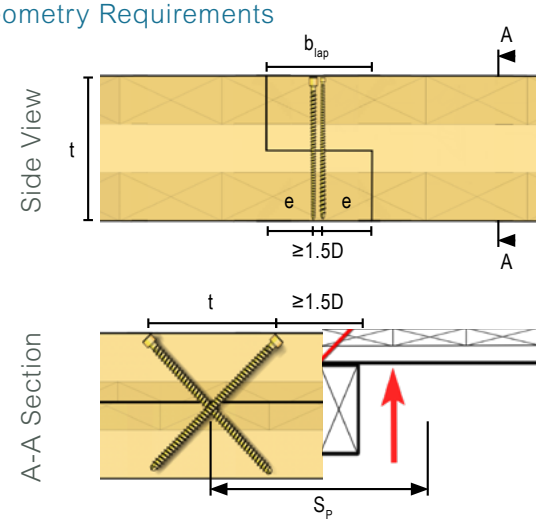
Table PP.4.1, Factored Resistances for CLT Lap Joints with Inclined Screw Crosses

Panel & Joint Configuration			Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading		Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$	105	VG cyl 6 x 140	664	764	42
	$N'_{\perp}$			464	534	

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. 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.
6. 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.
7. Factored resistances require the fasteners to be installed at a 45° angle intersecting the shear plane at half the panel thickness.
8. The angle between force and fastener axis is 90°.
9. Factored lateral resistance only apply to perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
10. $N'_{//}$ Angle between loading direction and wood grain in the shear plane $\Theta = 0°$.
    $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane $\Theta = 90°$.

Geometry Requirements



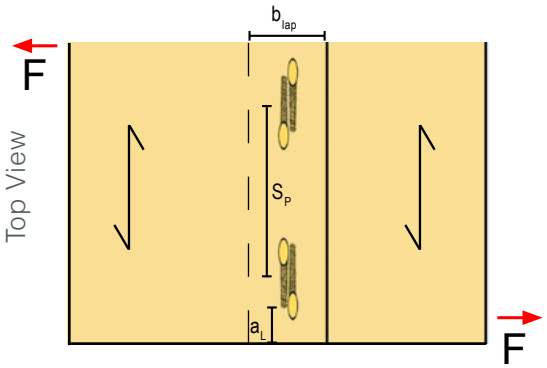
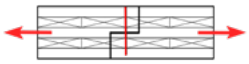
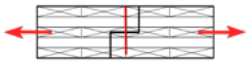
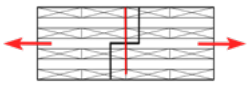
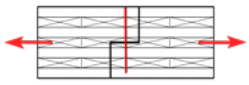


Table PP.4.2, Factored Resistances for CLT Lap Joints with Inclined Screw Crosses

Panel & Joint Configuration			Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading		Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
5 PLY	$N'_{//}$ 	139	VG CSK 8 x 180	1,169	1,344	56
		175	VG CSK 8 x 220	1,169	1,344	56
			VG CSK 10 x 220	1,721	1,979	70
	$N'_{\perp}$ 	139	VG CSK 8 x 180	798	918	56
		175	VG CSK 8 x 220	817	940	56
			VG CSK 10 x 220	1,160	1,334	70
7 PLY	$N'_{//}$ 	190	VG CSK 8 x 260	1,169	1,344	56
			VG CSK 10 x 260	1,721	1,979	70
		221	VG CSK 8 x 260	1,169	1,344	56
			VG CSK 10 x 260	1,721	1,979	70
		244	VG CSK 8 x 300	1,169	1,344	56
			VG CSK 10 x 300	1,721	1,979	70
	$N'_{\perp}$ 	190	VG CSK 8 x 260	817	940	56
			VG CSK 10 x 260	1,203	1,383	70
		221	VG CSK 8 x 260	817	940	56
			VG CSK 10 x 260	1,203	1,383	70
		244	VG CSK 8 x 300	817	940	56
			VG CSK 10 x 300	1,203	1,383	70

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. 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.
6. 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.
7. Factored resistances require the fasteners to be installed at a 45° angle intersecting the shear plane at half the panel thickness.
8. The angle between force and fastener axis is 90°.
9. Factored lateral resistance only apply to perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
10. $N'_{//}$ Angle between loading direction and wood grain in the shear plane $\Theta = 0°$.
    $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane $\Theta = 90°$.

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.

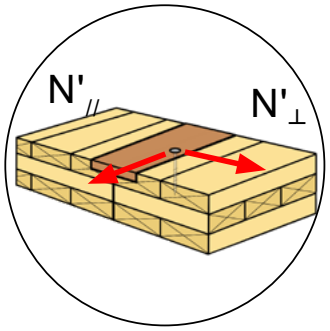
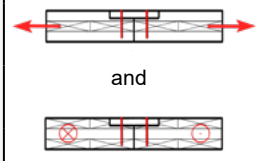
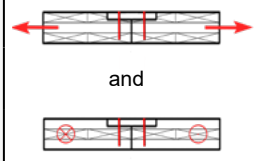
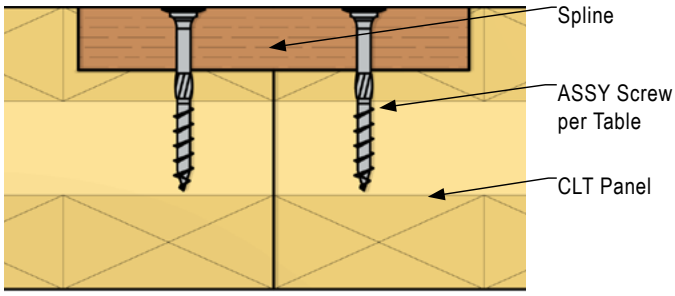


Table PP.5.1, Factored Resistances for CLT Surface Spline Joints Loaded in Shear

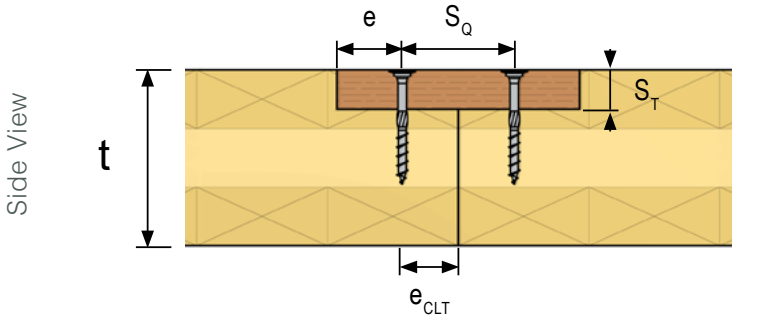
Panel & Spline Configuration					Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Spline Thickness	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$		12.7	87	Eco 6 x 80	590	679	42
				105				
			19.1	79	Eco 6 x 70	631	726	
				87	Eco 6 x 80	657	756	
				105	Eco 6 x 80			
					Eco 8 x 90	1042	1198	56
			25.4	105	Eco 6 x 80	724	833	42
					Eco 8 x 90	1051	1209	56
	$N'_{\perp}$		12.7	87	Eco 6 x 80	421	484	42
				105				
			19.1	79	Eco 6 x 70	412	474	
				87	Eco 6 x 80	458	527	
				105	Eco 6 x 80			
					Eco 8 x 90	644	741	56
			25.4	105	Eco 6 x 80	496	570	42
					Eco 8 x 90	693	797	56

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be installed at a 90° angle, intersecting the shear plane in the CLT panel at a depth equal to the spline thickness.
6. The angle between force and fastener axis is 90°.
7. Factored lateral resistance may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
8. $N'_{//}$ Angle between loading direction and wood grain in the shear plane $\Theta = 0°$.
   $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane $\Theta = 90°$.



Geometry Requirements



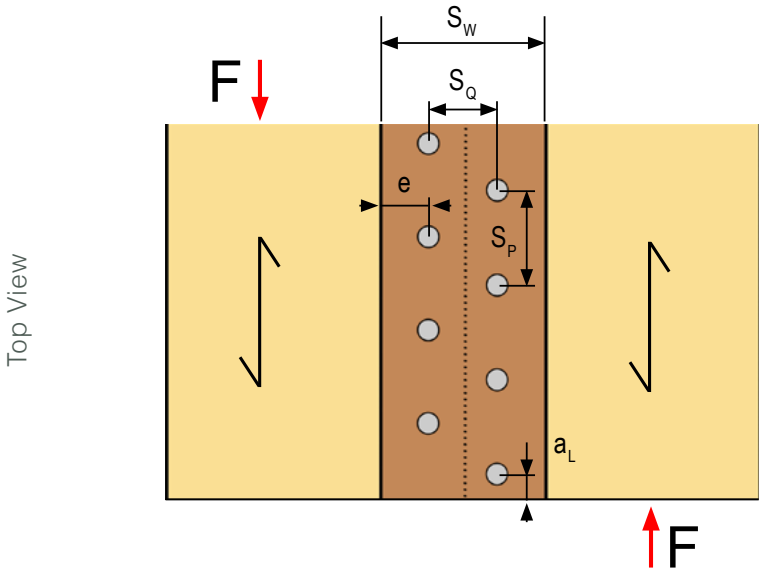
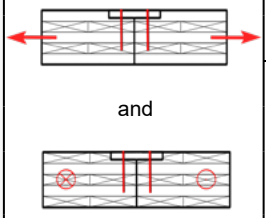
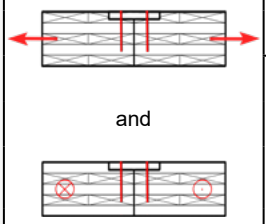


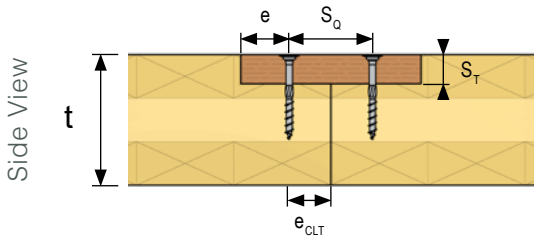
Table PP.5.2, Factored Resistances for CLT Surface Spline Joints Loaded in Shear

Panel & Spline Configuration					Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Spline Thickness	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
5 PLY	$N'_{//}$		19.1	133	Eco 8 x 120	1066	1226	56
				139				
				175				
			25.4	133	Eco 8 x 120	1153	1326	
				139				
				175	Eco 8 x 120			
					Eco 10 x 120	1612	1854	70
	$N'_{\perp}$		19.1	133	Eco 8 x 120	825	949	56
				139				
				175				
			25.4	133	Eco 8 x 120	874	1005	
				139				
				175	Eco 8 x 120			
					Eco 10 x 120	1054	1212	70

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fastener 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. Factored resistances require the fasteners to be installed at a 90° angle, intersecting the shear plane in the CLT panel at a depth equal to the spline thickness.
6. The angle between force and fastener axis is 90°.
7. Factored lateral resistance may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
8. $N'_{//}$ Angle between loading direction and wood grain in the shear plane ϴ = 0°.
   $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane ϴ = 90°.

Geometry Requirements



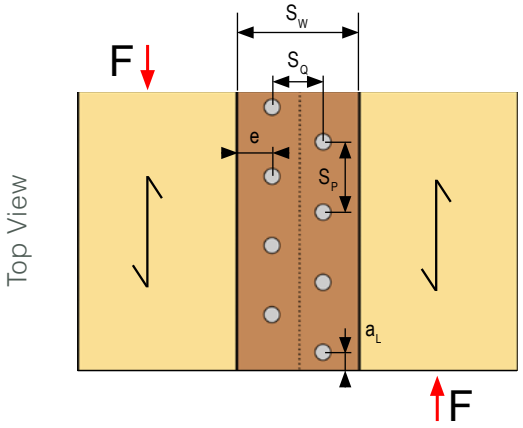
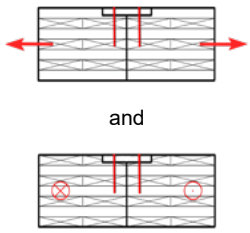
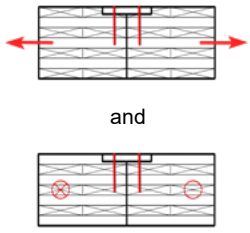


Table PP.5.3, Factored Resistances for CLT Surface Spline Joints Loaded in Shear

Panel & Spline Configuration					Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Spline Thickness	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
7 PLY	$N'_{//}$		19.1	191	Eco 8 x 140	1066	1226	56
				221				
				244				
			25.4	191	Eco 8 x 140	1153	1326	56
					Eco 10 x 140	1612	1854	70
				221	Eco 8 x 140	1153	1326	56
					Eco 10 x 140	1612	1854	70
				244	Eco 8 x 140	1153	1326	56
					Eco 10 x 140	1612	1854	70
	$N'_{\perp}$		19.1	191	Eco 8 x 140	908	1044	56
				221				
				244				
			25.4	191	Eco 8 x 140	995	1144	56
					Eco 10 x 140	1203	1383	70
				221	Eco 8 x 140	995	1144	56
					Eco 10 x 140	1203	1383	70
				244	Eco 8 x 140	995	1144	56
					Eco 10 x 140	1203	1383	70

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be installed at a 90° angle, intersecting the shear plane in the CLT panel at a depth equal to the spline thickness.
6. The angle between force and fastener axis is 90°.
7. Factored lateral resistance may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
8. $N'_{//}$ Angle between loading direction and wood grain in the shear plane $\Theta = 0°$.
   $N'_{\perp}$ Angle between loading direction and wood grain in the shear plane $\Theta = 90°$.

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.

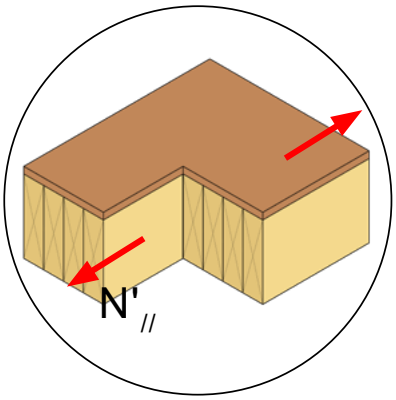
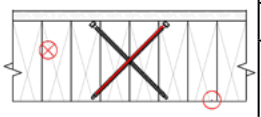


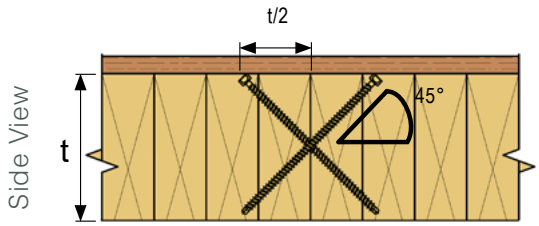
Table PP.6.1, Factored Resistances for NLT Butt Joints Loaded in Shear

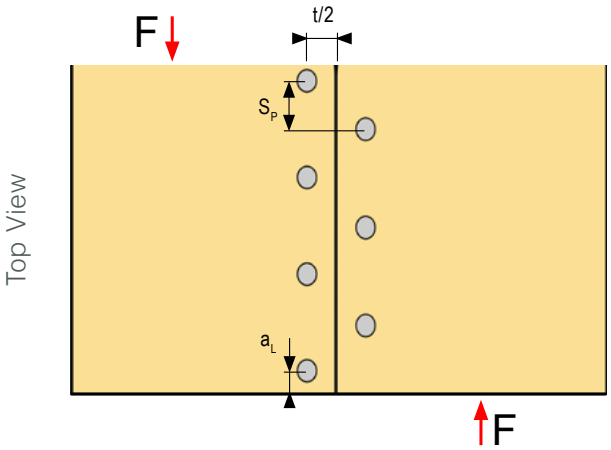
NLT Panel & Joint Configuration				Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Panel Thickness (t)		Standard Loading C_D =1.0	Short Term Loading C_D =1.15	
NLT	N'//		89	VG Cyl 6 x 140	700	805	45
			140		672	773	
			185	VG Cyl 6 x 180	700	805	
			235	VG CSK 8 x 240	1232	1417	60

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be 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. N'_{II} Angle between loading direction and wood grain in the shear plane Θ = 0°.

Geometry Requirements





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First Tech Credit Union

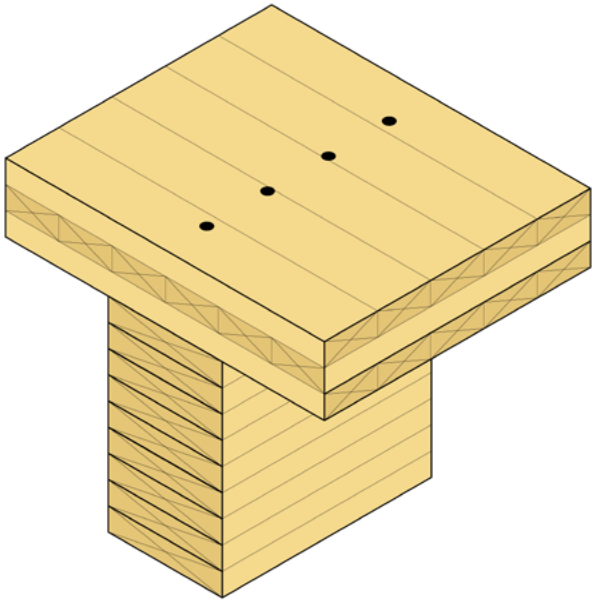
Hillsboro, Oregon

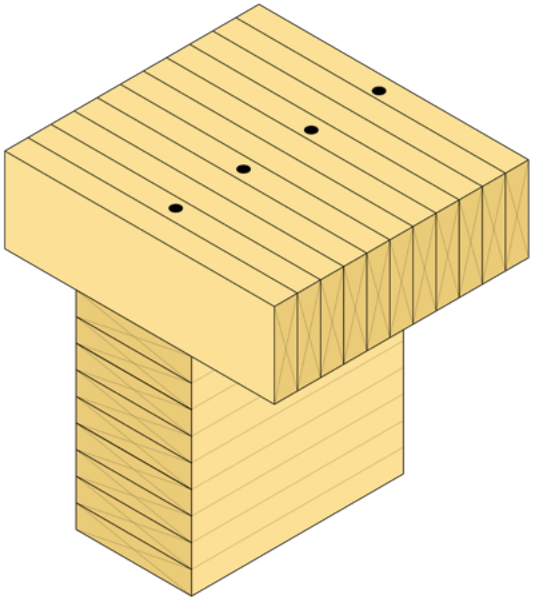
Courtesy of Oregon Forest Resources Institute

Panel to Beam Connections

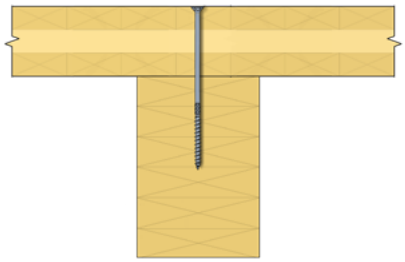
For post and beam structures, diaphragm forces are often transferred to collector elements such as beams, which then transfer the forces to the lateral load resisting system on the way down to the foundation. Floor to beam connections often benefit from the high strength and stiffness of fully threaded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

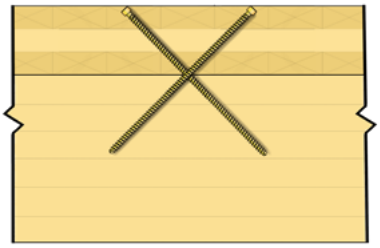




Typical Panel to Glulam Beam Connections

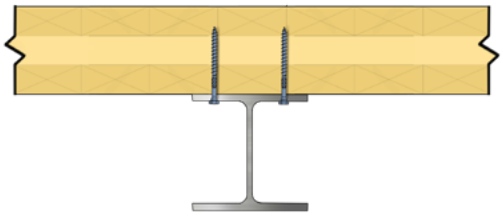


CLT panel to Glulam beam connection with a fastener in shear, see page 38 for details.

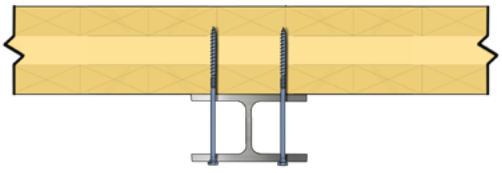


Connection with inclined fasteners arranged in a screw cross, see page 44 for details.

Typical Panel to Steel Beam Connections



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



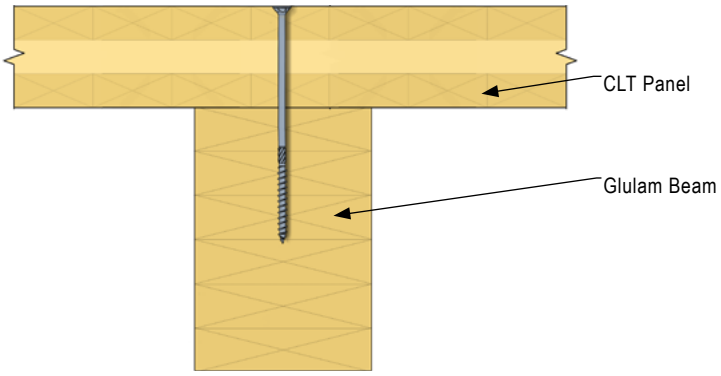
CLT shallow H-beam connection using shear screws, see Steel to Wood Connections Section.

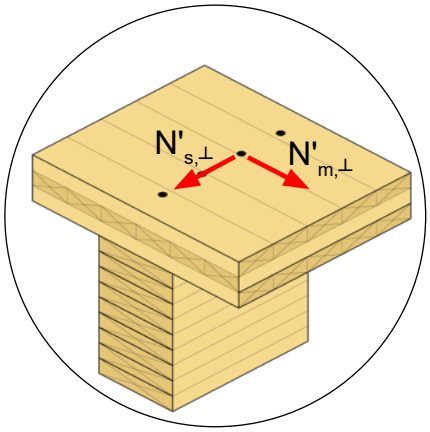
CLT Panel to Beam Connection in Shear

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.

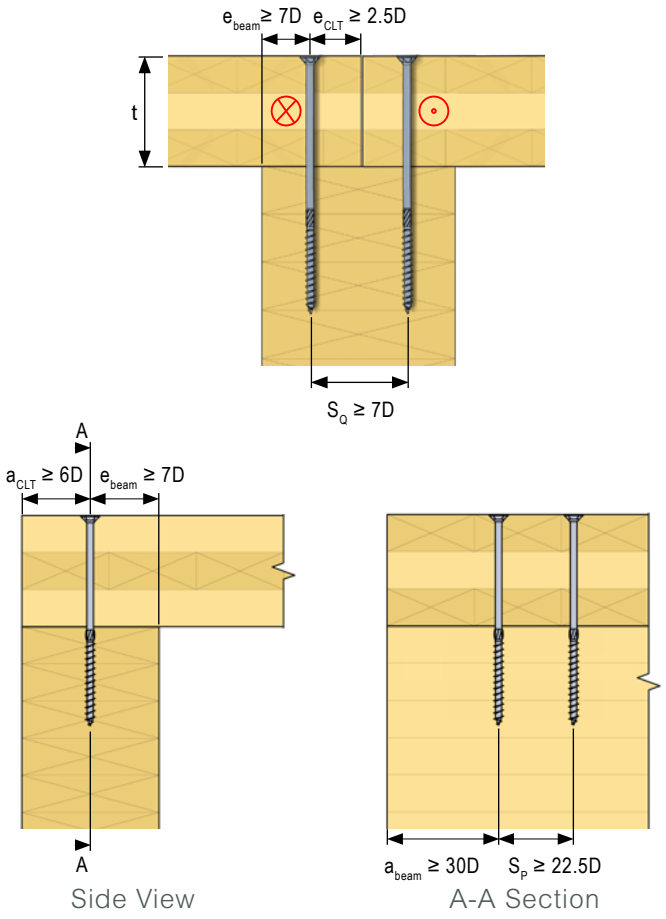
If the CLT panel or the beam is expected to shrink, screws should be countersunk enough so that they do not push into the concrete slap on top of the CLT panel.



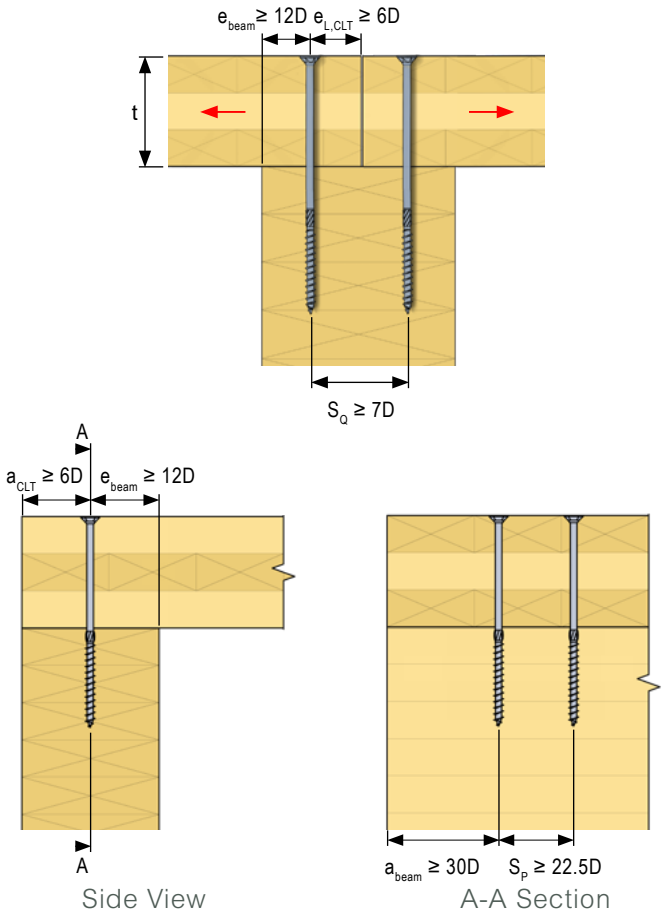


Geometry Requirements

$N'_{//}$ & $N'_{s,\perp}$

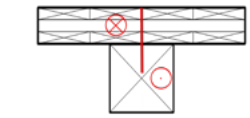
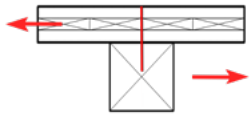
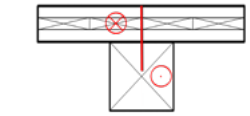
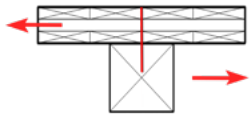


$N'_{m,\perp}$ & $N'_{\perp}$



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

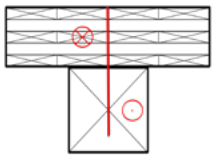
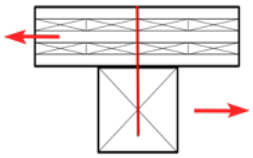
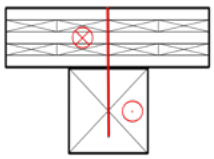
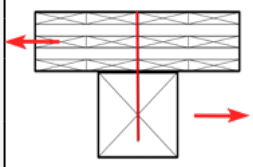
Table PB.1.1, Factored Resistances for CLT Panel to Beam Connections in Shear

CLT Panel & Beam Configuration					Fastener Options		Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Beam Type	Panel Thickness (t)			Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$		D-Fir (0.49)	79		Eco 6 x 160	940	1080	135
				87					
				105		Eco 6 x 200	940	1080	135
						Eco 8 x 200	1660	1910	180
	$N'_{m,\perp}$			79		Eco 6 x 160	760	870	135
				87					
				105		Eco 6 x 200	760	870	135
						Eco 8 x 200	1340	1540	180
	$N'_{s,\perp}$			79		Eco 6 x 160	720	830	135
				87		Eco 6 x 160	690	790	
				105		Eco 6 x 200	750	860	135
						Eco 8 x 200	1190	1370	180
	$N'_{\perp}$			79		Eco 6 x 160	640	740	135
				87					
				105		Eco 6 x 200	640	740	135
						Eco 8 x 200	1225	1410	180

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting beam.
6. The angle between force and fastener axis is 90°.
7. The main member is assumed as a glulam member with G = 0.49.
8. Factored lateral resistance may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
9. $N'_{//}$ Main member and side member loaded parallel to grain ϴ = 0°.
   $N'_{m,\perp}$ Main member loaded perpendicular to grain (ϴ = 90°); side member loaded parallel to grain (ϴ = 0°).
   $N'_{s,\perp}$ Main member loaded parallel to grain (ϴ = 0°); side member loaded perpendicular to grain (ϴ = 90°).
   $N'_{\perp}$ Main member and side member loaded perpendicular to grain ϴ = 90°.

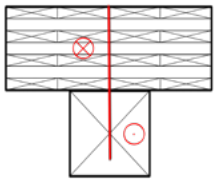
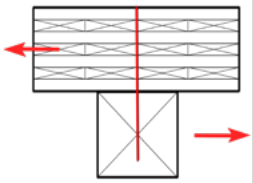
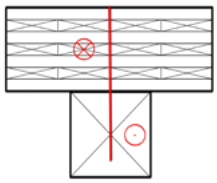
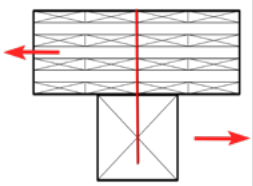
Table PB.1.2, Factored Resistances for CLT Panel to Beam Connections in Shear

CLT Panel & Beam Configuration					Fastener Options		Factored Resistance [N]		Minimum Spacing in a Row (S_P)
	Loading		Beam Type	Panel Thickness (t)			Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
5 PLY	$N'_{//}$		D-Fir (0.49)	133		Eco 8 x 240	1660	1910	180
				139					
				175		Eco 8 x 300	1660	1910	180
						Eco 10 x 300	2450	2820	225
	$N'_{m,\perp}$			133		Eco 8 x 240	1340	1540	180
				139					
				175		Eco 8 x 300	1340	1540	180
						Eco 10 x 300	1970	2270	225
	$N'_{s,\perp}$			133		Eco 8 x 240	1260	1450	180
				139			1220	1400	
				175		Eco 8 x 300	1320	1520	180
						Eco 10 x 300	1830	2100	225
	$N'_{\perp}$			133		Eco 8 x 240	1140	1310	180
				139			1130	1300	
				175		Eco 8 x 300	1140	1310	180
						Eco 10 x 300	1670	1920	225

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and are only valid for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fasterner 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. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting beam.
6. The angle between force and fastener axis is 90°.
7. The main member is assumed as a glulam member with G = 0.49.
8. Factored lateral resistance may be applied to parallel and perpendicular loading towards the panel joint considering grain directions and minimum spacing requirements.
9. $N'_{//}$ Main member and side member loaded parallel to grain ϴ = 0°.
   $N'_{m,\perp}$ Main member loaded perpendicular to grain (ϴ = 90°); side member loaded parallel to grain (ϴ = 0°).
   $N'_{s,\perp}$ Main member loaded parallel to grain (ϴ = 0°); side member loaded perpendicular to grain (ϴ = 90°).
   $N'_{\perp}$ Main member and side member loaded perpendicular to grain ϴ = 90°.

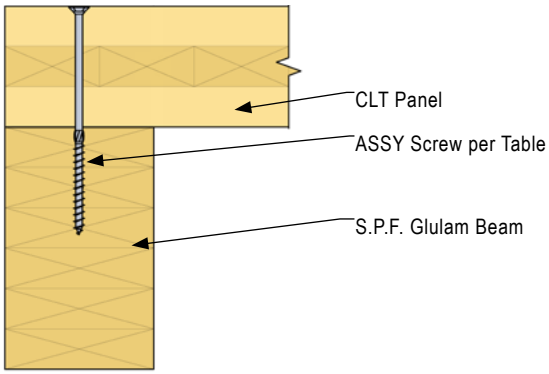
Table PB.1.3, Factored Resistances for CLT Panel to Beam Connections in Shear

CLT Panel & Beam Configuration					Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Beam Type	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
7 PLY	$N'_{//}$		D-Fir (0.49)	191	Eco 8 x 300	1660	1910	180
					Eco 10 x 300	2450	2820	225
				221	Eco 8 x 340	1660	1910	180
					Eco 10 x 360	2450	2820	225
				244	Eco 10 x 380	2450	2820	225
					SK 12 x 400	3490	4010	270
	$N'_{m,\perp}$			191	Eco 8 x 300	1340	1540	180
					Eco 10 x 300	1970	2270	225
				221	Eco 8 x 340	1340	1540	180
					Eco 10 x 360	1970	2270	225
				244	Eco 10 x 380	1970	2270	225
					SK 12 x 400	2800	3220	270
	$N'_{s,\perp}$			191	Eco 8 x 300	1270	1460	180
					Eco 10 x 300	1710	1970	225
				221	Eco 8 x 340	1320	1520	180
					Eco 10 x 360	1930	2220	225
				244	Eco 10 x 380	1900	2190	225
					SK 12 x 400	2580	2970	270
	$N'_{\perp}$			191	Eco 8 x 300	1140	1310	180
					Eco 10 x 300	1570	1810	225
				221	Eco 8 x 340	1140	1310	180
					Eco 10 x 360	1670	1920	225
				244	Eco 10 x 380	1670	1920	225
					SK 12 x 400	2380	2740	270

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 self-tapping screws installed from the top surface of the panel in order to transfer shear and uplift forces.



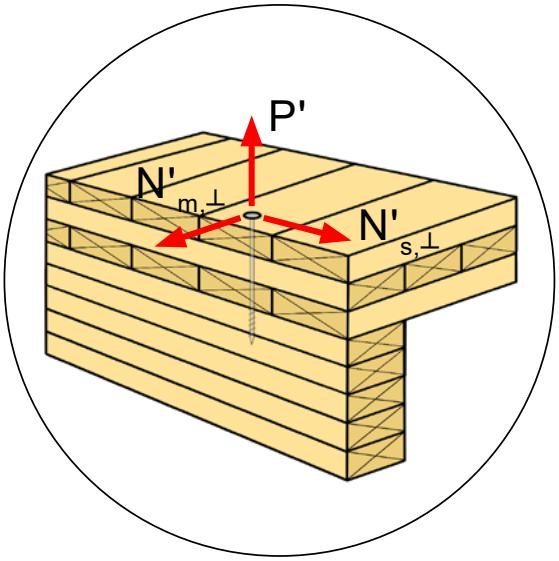


Table PB.3.1, Factored Resistances for CLT Floor to Beam Connection

CLT Panel & Beam Configuration			Fastener Options	Factored Resistance [N]			
	Beam Type	Panel Thickness (t)		$N'_{m,\perp}$	$N'_{s,\perp}$	P'_{ECO}	P'_{SK}
3 PLY	SPF (0.42)	79	Eco / SK 6 x 160	719	715	1320	2170
		87			683		
		105	Eco / SK 6 x 180		687		
5 PLY	SPF (0.42)	130	Eco / SK 6 x 200	719	664	1320	2170
		140	Eco / SK 6 x 220		711		
		175	Eco / SK 6 x 260		731		

Notes:

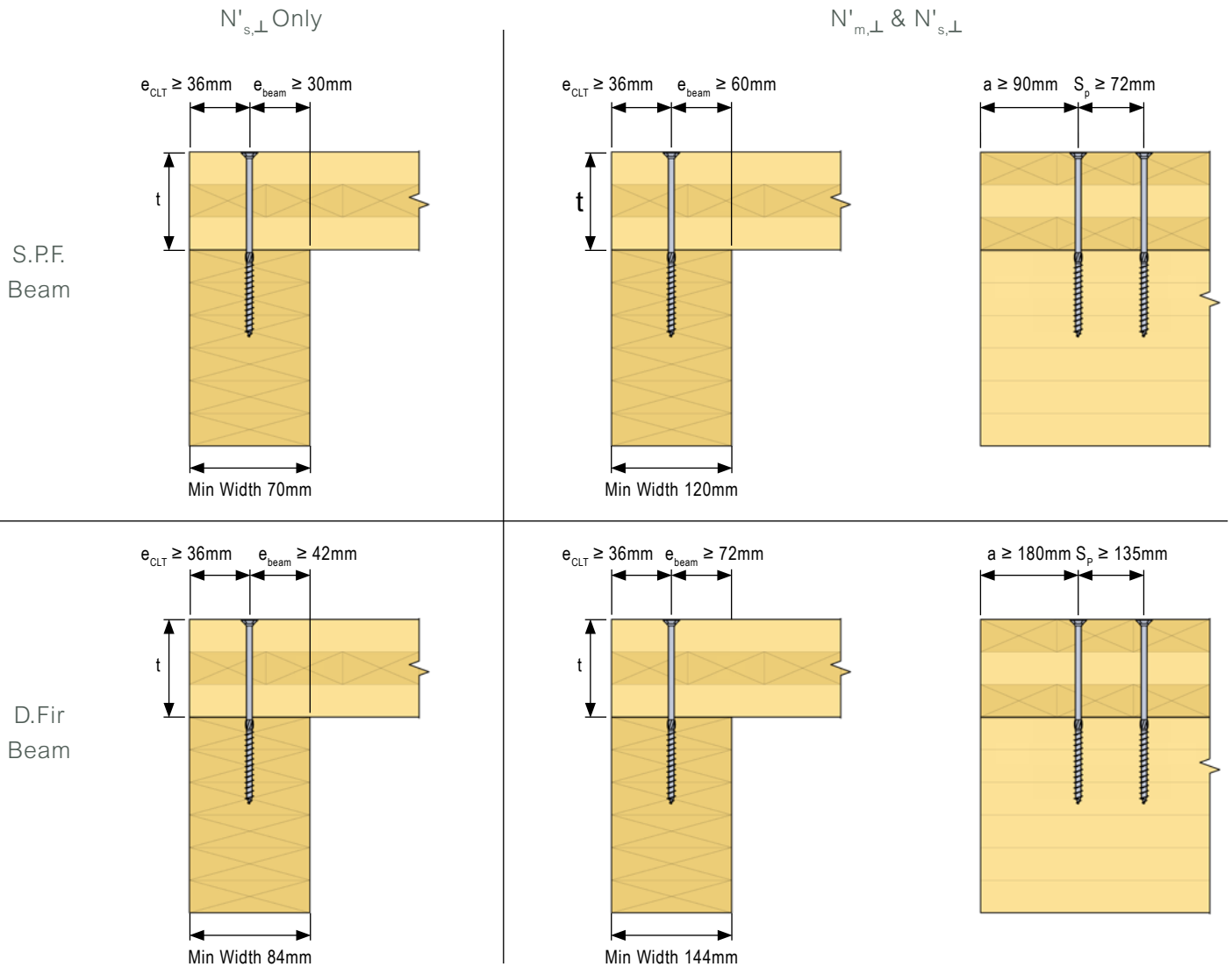
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fasterner 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.
5. 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 (K_D = 1.15) can be applied to $N'_{m,\perp}$ and $N'_{s,\perp}$.
7. $N'_{m,\perp}$ Main member loaded perpendicular to grain (Θ = 90°); side member loaded parallel to grain (Θ = 0°).
   $N'_{s,\perp}$ Main member loaded parallel to grain (Θ = 0°); side member loaded perpendicular to grain (Θ = 90°).

Table PB.3.2, Factored Resistances for CLT Floor to Beam Connection

CLT Panel & Beam Configuration			Fastener Options	Factored Resistance [N]			
	Beam Type	Panel Thickness (t)		$N'_{m,\perp}$	$N'_{s,\perp}$	P'_{ECO}	P'_{SK}
3 PLY	D-Fir (0.49)	79	Eco / SK 6 x 160	756	724	1320	2560
		87			691		
		105	Eco / SK 6 x 180		696		
5 PLY	D-Fir (0.49)	130	Eco / SK 6 x 200	756	672	1320	2560
		140	Eco / SK 6 x 220		719		
		175	Eco / SK 6 x 260		742		

See notes under table PB.3.1, page 42.

Geometry Requirements



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.

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

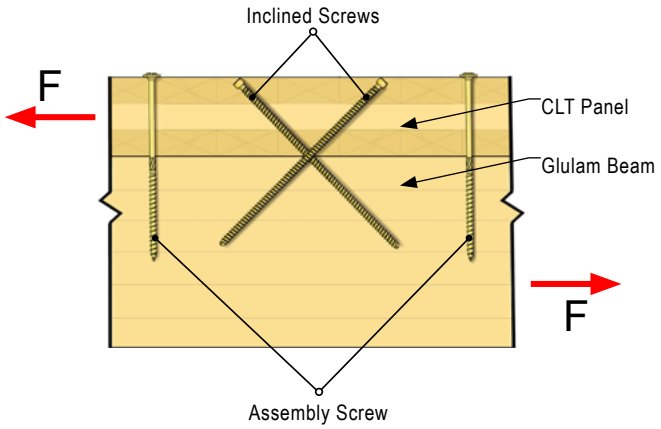
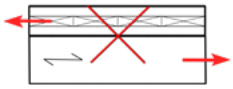
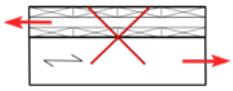


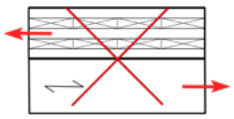
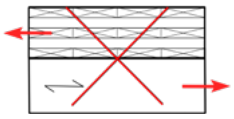
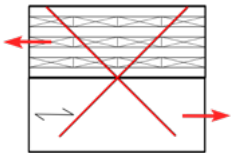
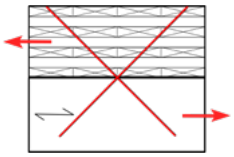
Table PB.2.1, Factored Resistances for CLT Panel to Beam Connection Inclined Screws Crosses

CLT Panel & Joint Configuration					Fastener Options	Factored Resistance per Screw Cross [N]		Minimum Spacing in a Row (S_P)
Loading			Beam Type	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$		D-Fir (0.49)	79	VG CSK 8 x 220	7,890	9,070	256
				87	VG CSK 8 x 240	8,440	9,710	256
				105	VG CSK 8 x 300	10,410	11,970	256
					VG CSK 10 x 300	12,970	14,910	320
	$N'_{\perp}$		D-Fir (0.49)	79	VG CSK 8 x 220	8,290	9,530	256
				87	VG CSK 8 x 240	9,270	10,660	256
				105	VG CSK 8 x 300	10,960	12,600	256
					VG CSK 10 x 300	13,650	15,700	320

Notes:

1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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.
5. 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 shear plane and fastener axis is 45°.
7. The main member is assumed to be a glulam member with G = 0.49.
8. Factored Lateral Resistance only apply to parallel loading along the span direction of the glulam.
9. The upper limit of the factored withdrawal resistance may be set by the factored tensile strength of fastener, no further increase allowed.
10. $N'_{X//}$ Factored resistance per screw cross with CLT main member loaded along the major span direction.
    $N'_{X\perp}$ Factored resistance per screw cross with CLT main member loaded along the minor span direction.

Table PB.2.2, Factored Resistances for CLT Panel to Beam Connection Inclined Screws Crosses

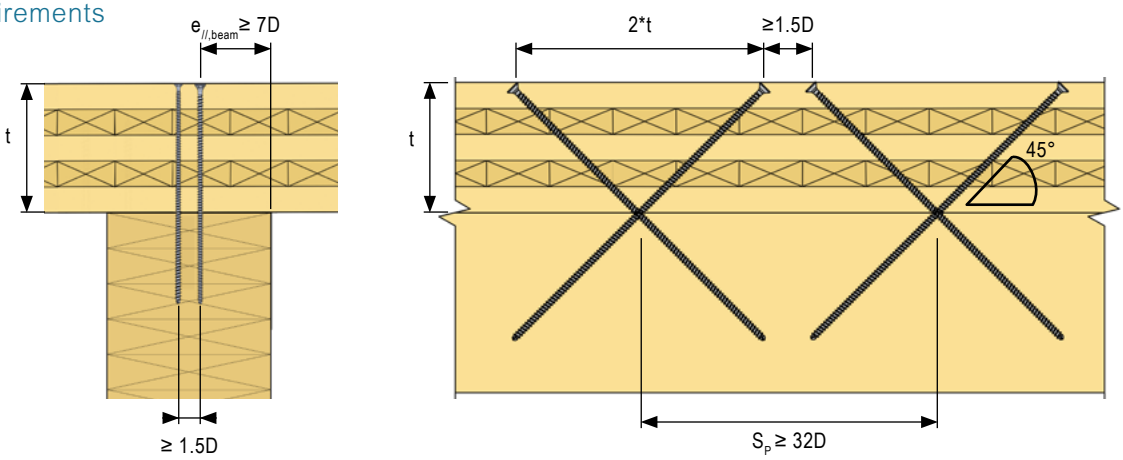
CLT Panel & Joint Configuration					Fastener Options	Factored Resistance per Screw Cross [N]		Minimum Spacing in a Row (S_P)
	Loading		Beam Type	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
5 PLY	$N'_{//}$		D-Fir (0.49)	133	VG Cyl 8 x 380	13,320	15,310	256
				139	VG Cyl 8 x 380	13,600	15,640	256
				175	VG Cyl 8 x 480	17,320	18,630	256
					VG Cyl 10 x 480	21,780	23,420	320
	$N'_{\perp}$		D-Fir (0.49)	133	VG Cyl 8 x 380	13,700	15,760	256
				139	VG Cyl 8 x 380	14,710	16,910	256
				175	VG Cyl 8 x 480	17,590	18,950	256
					VG Cyl 10 x 480	22,120	23,810	320
7 PLY	$N'_{//}$		D-Fir (0.49)	191	VG Cyl 8 x 530	17,930	19,240	256
					VG CSK 10 x 530	22,540	24,290	320
				221	VG Cyl 8 x 580	19,240	19,240	256
					VG CSK 10 x 650	24,440	24,440	320
				244	VG CSK 10 x 650			
	$N'_{\perp}$		D-Fir (0.49)	191	VG Cyl 8 x 530	18,620	19,240	256
					VG CSK 10 x 530	23,410	24,440	320
				221	VG Cyl 8 x 580	19,240	19,240	256
					VG CSK 10 x 580	24,440	24,440	320
				244	VG CSK 10 x 650			

See notes under Table PB.2.1, page 44.

Geometry Requirements

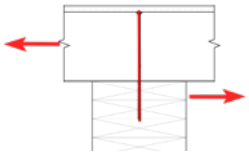
CLT - SPF

Beam - D.Fir



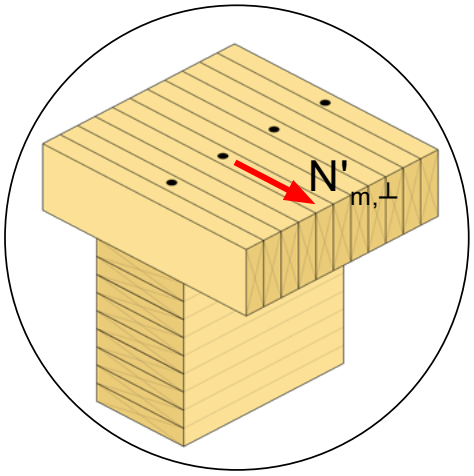
NLT Panel to Beam Connection in Shear

Table PB.4, Factored Resistances for NLT Panel to Beam Connections in Shear

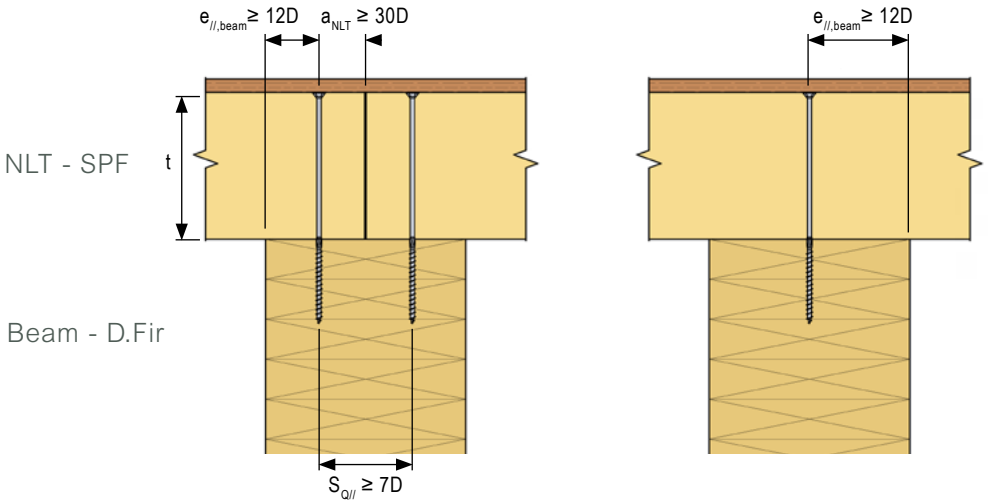
NLT Panel & Beam Configuration					Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading			Beam Type	Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
NLT	$N'_{m,\perp}$		D-Fir (0.49)	89	Eco 6 x 200	770	890	135
				140	Eco 6 x 260			
				185	Eco 6 x 300			
				235	Eco 8 x 360	1360	1560	180
				285	Eco 8 x 400			

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the NLT panel and supporting beam.
6. The angle between force and fastener axis is 90°.
7. The main member is assumed as a glulam member with G = 0.49.
8. $N'_{m,\perp}$ Main member loaded perpendicular to grain (ϴ = 90°); side member loaded parallel to grain (ϴ = 0°).
   $N'_{s,\perp}$ Main member loaded parallel to grain (ϴ = 0°); side member loaded perpendicular to grain (ϴ = 90°).

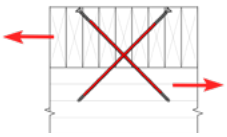


Geometry Requirements



NLT Panel to Beam Connection with Inclined Screws

Table PB.5, Factored Resistances for NLT Panel to Beam Connections with Inclined Screws Crosses

NLT Panel & Beam Configuration					Fastener Options		Factored Resistance per Screw Cross [N]		Minimum Spacing in a Row (S_P)
Loading			Beam Type	Panel Thickness (t)			Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
NLT	N'//		D-Fir (0.49)	89		VG CSK 8 x 240	9260	10650	256
				140		VG CSK 8 x 360	13560	15600	
				185		VG CSK 8 x 430	13990	16090	
				235		VG CSK 8 x 530	16550	18070	

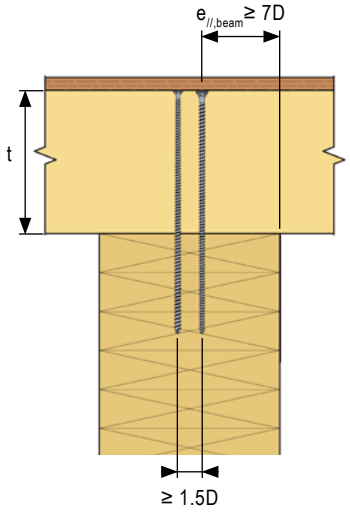
Notes:

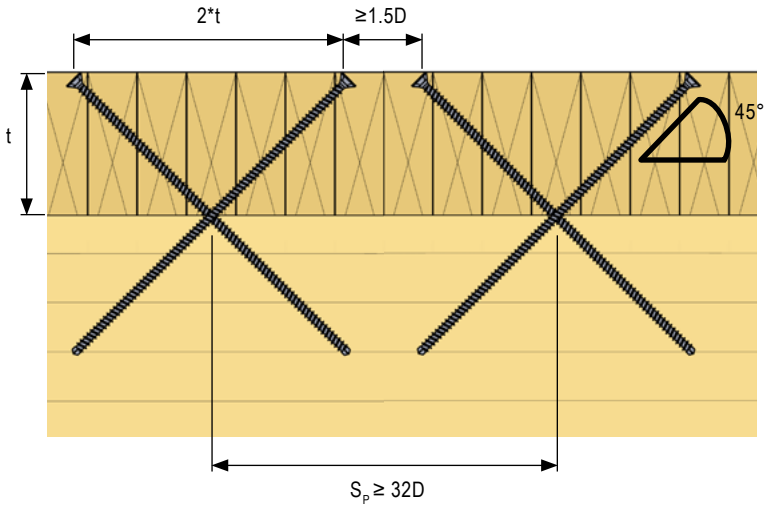
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fasterner 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. Factored resistances require the fasteners to be 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.
8. Factored Lateral Resistance only apply to parallel loading along the span direction of the glulam and with the screws installed perpendicular-to-grain in the NLT.
9. The upper limit of the factored withdrawal resistance may be set by the factored tensile strength of fastener, no further increase allowed.

Geometry Requirements

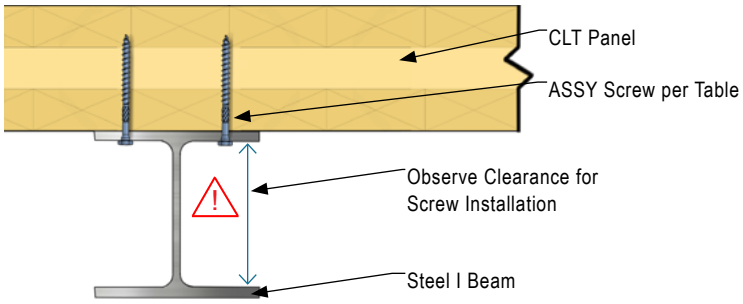
NLT - SPF

Beam - D.Fir





CLT Panel to Steel Beam Connection



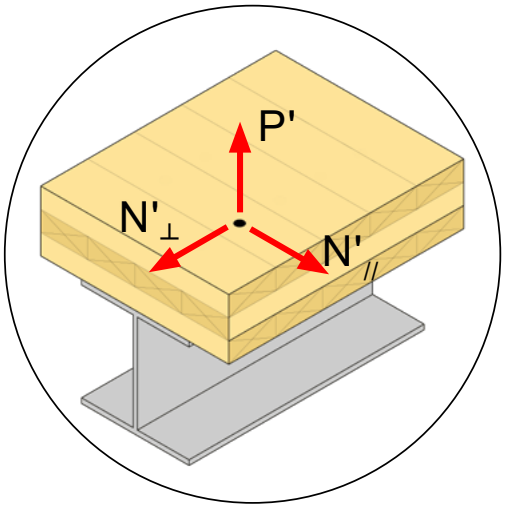
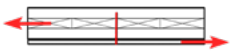
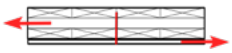


Table PB.6.1, Factored Resistances for CLT Steel Beam Connections

CLT Panel & Steel Beam Configuration					Fastener Options	Factored Resistance [N]	
Loading			Panel Thickness (t)	Steel Thickness		N'	P'
3 PLY	$N'_{//}$		87 to 105	4.76	Kombi 8 x 80	2203	2615
				6.35			
				12.7			
	$N'_{\perp}$		87 to 105	4.76	Kombi 8 x 80	1545	
				6.35			
				12.7			

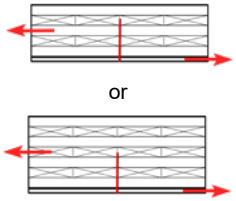
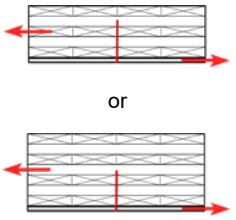
Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the CLT panel and supporting steel beam.
6. 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 CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
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. $N'_{||}$ Main member loaded parallel to grain. ($\Theta = 0°$)
   $N'_{\perp}$ Main member loaded perpendicular to grain. ($\Theta = 90°$)
   P' Screws loaded in withdrawal.

Table W.5.2, Steel Plate Pre-Drilling Diameter

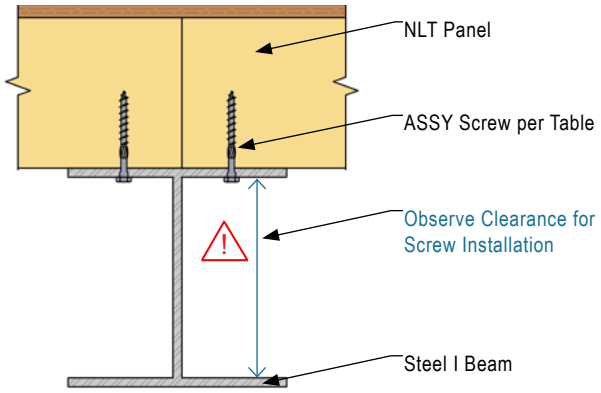
Screw Nominal Diameter	Steel Plate Hole Diameter
in. [mm]	in. [mm]
1/4" [6]	**9/32" [7]**
5/16" [8]	**3/8" [9]**
3/8" [10]	**7/16" [11]**
1/2" [12]	**17/32" [13]**

Table PB.6.2, Factored Resistances for CLT Steel Side Plate Connections

CLT Panel & Steel Beam Configuration					Fastener Options	Factored Resistance [N]	
Loading			Panel Thickness (t)	Steel Thickness		N'	P'
5 PLY or More	$N'_{//}$		139 to 244	4.76	Kombi 8 x 80	2203	2615
					Kombi 10 x 120	3247	5309
					Kombi 12x 120	4622	6067
					Kombi 12 x 140		
				6.35	Kombi 8 x 80	2203	2615
					Kombi 10 x 120	3247	5309
					Kombi 12x 120	4622	6067
					Kombi 12 x 140		
				12.7	Kombi 10 x 120	3247	5309
					Kombi 12x 120	4622	6067
					Kombi 12 x 140		
	$N'_{\perp}$		139 to 244	4.76	Kombi 8 x 80	1545	2615
					Kombi 10 x 120	2276	5309
					Kombi 12x 120	3241	6067
					Kombi 12 x 140		
				6.35	Kombi 8 x 80	1545	2615
					Kombi 10 x 120	2276	5309
					Kombi 12x 120	3241	6067
					Kombi 12 x 140		
				12.7	Kombi 10 x 120	2276	5309
					Kombi 12x 120	3241	6067
					Kombi 12 x 140		

See notes under Table PB.6.1, page 48.

NLT Panel to Steel Beam Connection



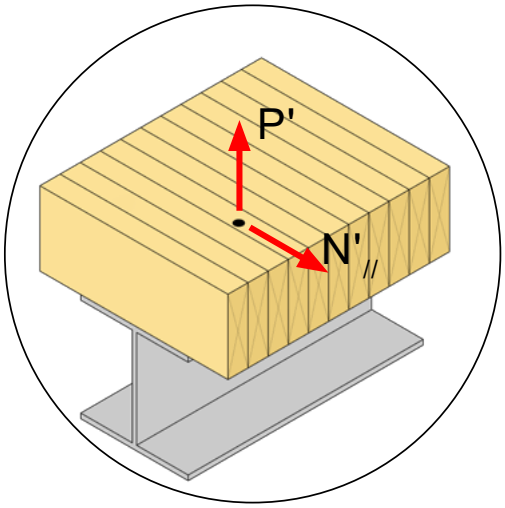


Table PB.7.1, Factored Resistances for NLT to Steel Beam Connections

NLT Panel & Steel Beam Configuration				Fastener Options	Factored Resistance [N]	
Loading		Panel Thickness (t)	Steel Thickness		N'	P'
NLT	$N'_{//}$	89 to 139	4.76	Kombi 8 x 80	2320	2560
			6.35			
			12.7			

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
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.
8. The side member is assumed as ASTM A36 grade steel or higher. In accordance with CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
9. 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. $N'_{||}$ Main member loaded parallel to grain. ($\Theta = 0°$)
    $N'_{\perp}$ Main member loaded perpendicular to grain. ($\Theta = 90°$)
    P' Screws loaded in withdrawal.

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

Screw Nominal Diameter	Steel Plate Hole Diameter
in. [mm]	in. [mm]
1/4" [6]	**9/32" [7]**
5/16" [8]	**3/8" [9]**
3/8" [10]	**7/16" [11]**
1/2" [12]	**17/32" [13]**

Table PB.7.2, Factored Resistances for NLT to Steel Beam Connections

NLT Panel & Steel Beam Configuration				Fastener Options		Factored Resistance [N]	
Loading		Panel Thickness (t)	Steel Thickness			N'	P'
NLT	$N'_{//}$	139 to 285	4.76		Kombi 8 x 80	2320	2560
					Kombi 10 x 120	3420	5320
			6.35		Kombi 8 x 80	2320	2560
					Kombi 10 x 120	3420	5320
			12.7		Kombi 10 x 120	3420	5320

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
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.
8. The side member is assumed as ASTM A36 grade steel or higher. In accordance with CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
9. 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. $N'_{||}$ Main member loaded parallel to grain. ($\Theta = 0°$)
    $N'_{\perp}$ Main member loaded perpendicular to grain. ($\Theta = 90°$)
    P' 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.

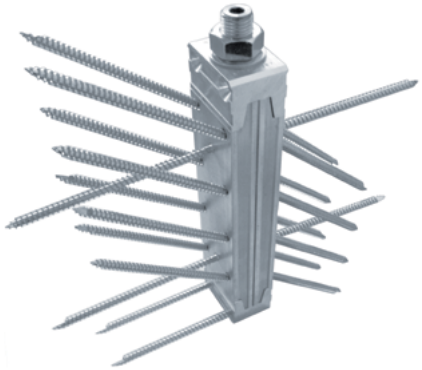
AVAILABLE IN MULTIPLE SIZES

TESTED IN NORTH AMERICA

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

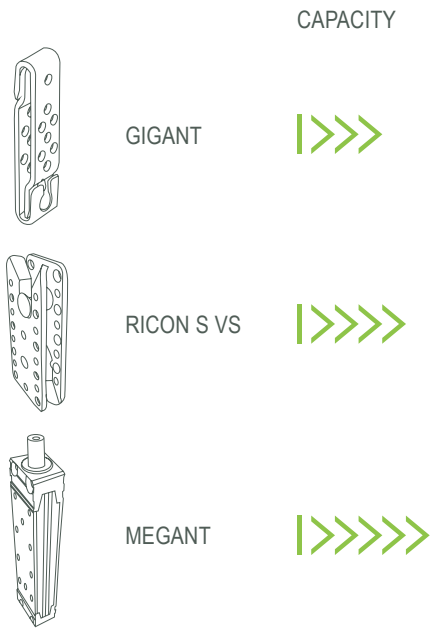
ETA

Certified Fire Rated

Full-scale fully-loaded fire resistance testing performed at the Southwest Research Institute in San Antonio, Texas, following the ASTM E119-16a, certified the RICON S VS and MEGANT systems with a 1.5 hour fire rating.

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.



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.

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.

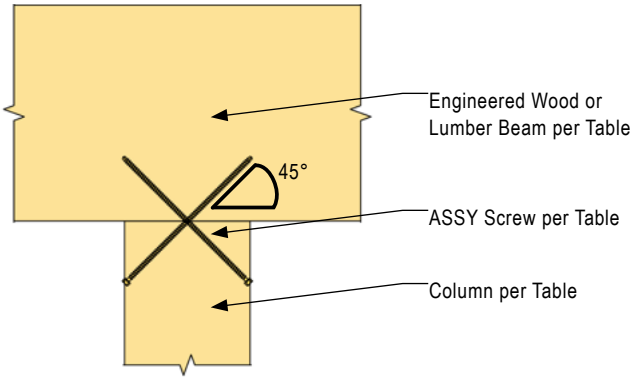
Carbon 12

Portland, Oregon

Courtesy of Andrew Poque

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.



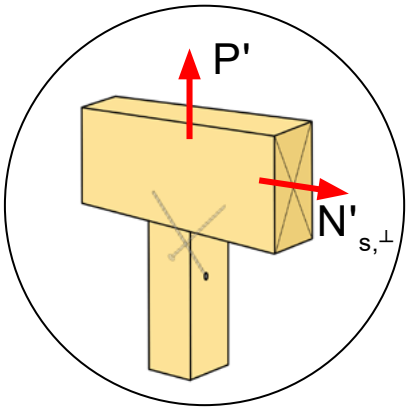


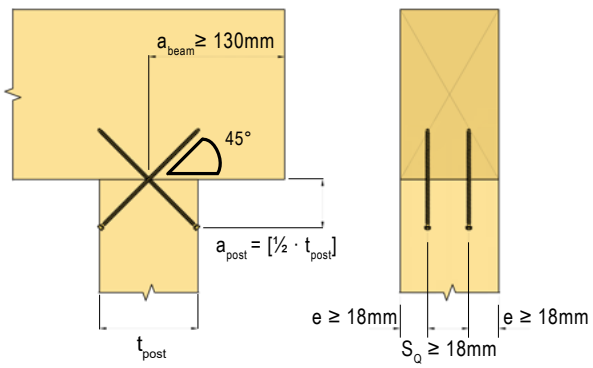
Table PT.1, Factored Resistances for Beam to Post Connection (Bearing)

Beam to Post Configuration			Fastener Options	Factored Resistance per Screw Cross [N]
Loading	**Beam Type**	**Colum Size**		
$N'_{s,\perp}$ or P'	SPF Sawn Lumber & Glulam (0.42)	140 x 140	VG Cyl 6 x 160	3070
			VG Cyl 6 x 180	4180
			VG Cyl 6 x 200	5300
		184 x 184	VG Cyl 6 x 180	2450
			VG Cyl 6 x 200	3560
	D-Fir (0.49)	140 x 140	VG Cyl 6 x 160	4000
			VG Cyl 6 x 180	5450
			VG Cyl 6 x 200	5520
		184 x 184	VG Cyl 6 x 180	3190
			VG Cyl 6 x 200	4650
	EWP (0.50)	140 x 140	VG Cyl 6 x 160	2330
			VG Cyl 6 x 180	3180
			VG Cyl 6 x 200	4030
		184 x 184	VG Cyl 6 x 180	1860
			VG Cyl 6 x 200	2710

Notes:

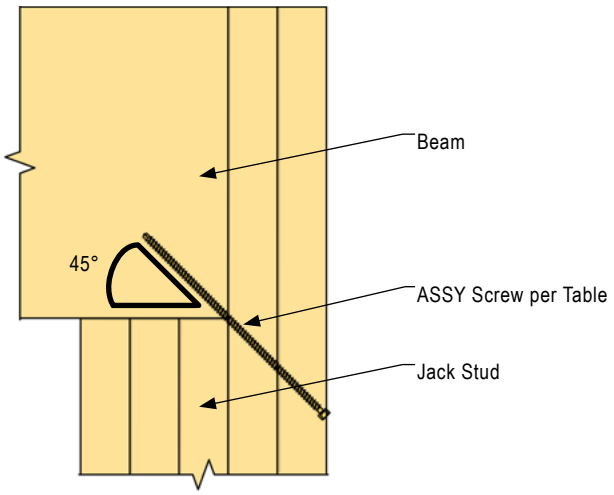
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fastener 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 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°.
7. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition.

Geometry Requirements



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.



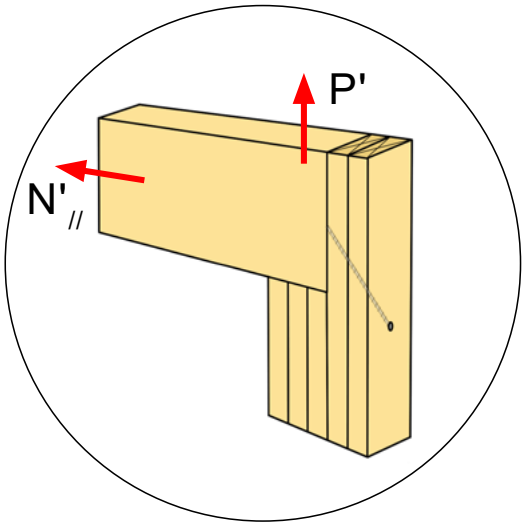


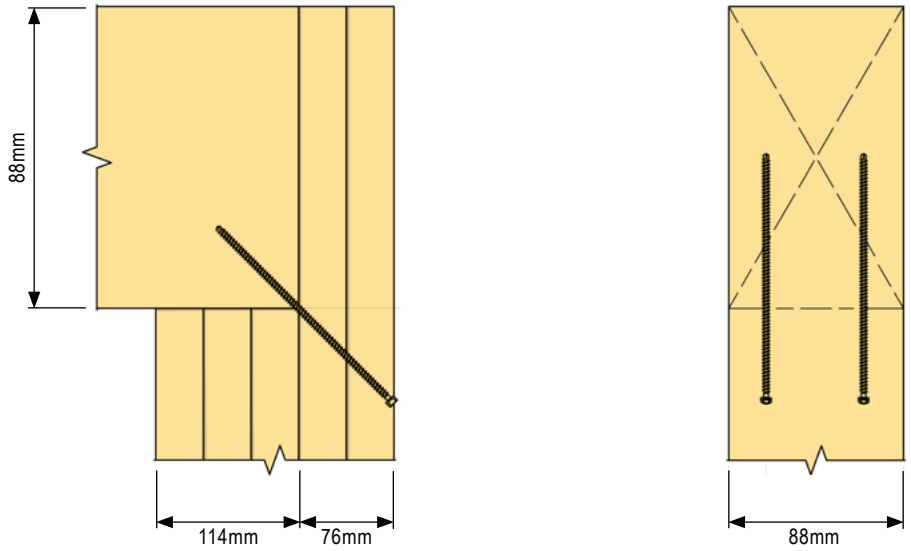
Table PT.2, Factored Resistances for Beam to Jack Stud Connection

Beam to Jack Stud Configuration			Fastener Options		Factored Resistance [N]
Loading	Jack Stud	Beam Type			
N'// or P'	Double 2" Lumber	SPF Sawn Lumber & Glulam (0.42)		VG Cyl 6 x 160	1300
				VG Cyl 6 x 180	1850
				VG Cyl 6 x 200	2410
		D-Fir (0.49)		VG Cyl 6 x 160	1690
				VG Cyl 6 x 180	2420
				VG Cyl 6 x 200	3000
		EWP (0.50)		VG Cyl 6 x 160	990
				VG Cyl 6 x 180	1410
				VG Cyl 6 x 200	1840

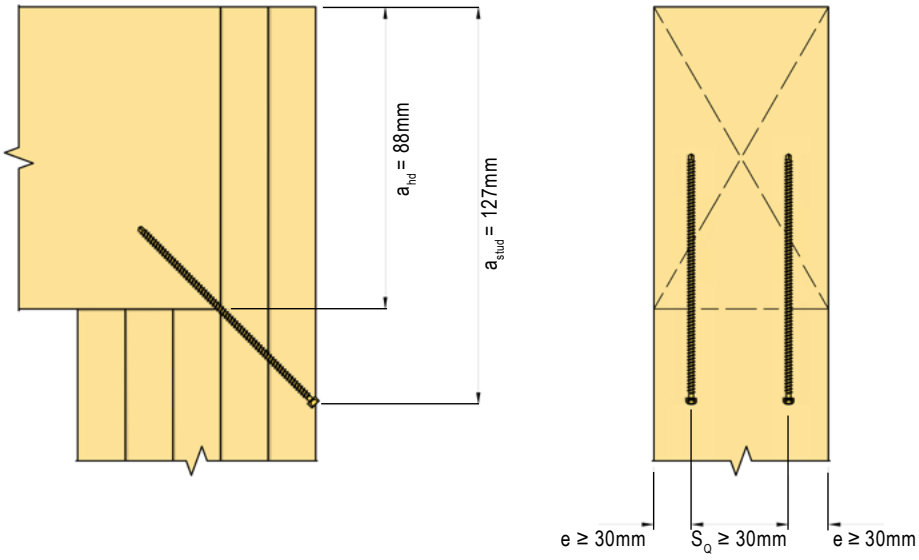
Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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.
6. Sawn Lumber studs with multiple plies must be independently fasten to each other as per the applicable design codes or standards.
7. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition.

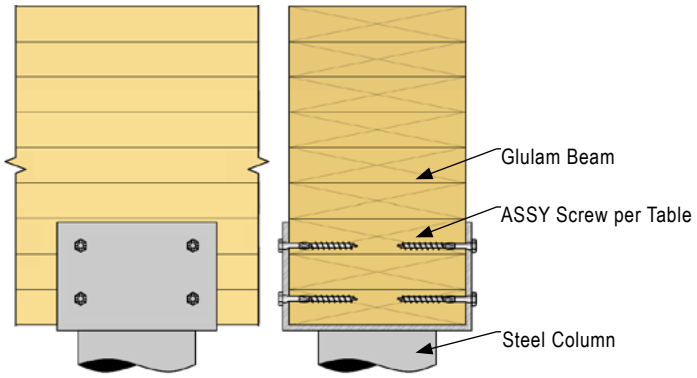
Minimum Timber Requirements



Geometry Requirements



Wood Beam to Steel Column - Shear Screws



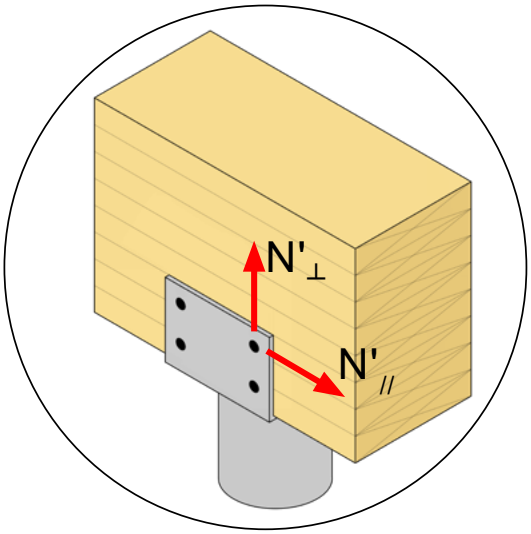


Table PT.3, Factored Resistances for Steel Column

Wood & Steel Beam Configuration		Fastener Options		Factored Resistance [N]	
Beam Type	Steel Thickness [mm]			$N'_{//}$	$N'_{\perp}$
SPF (0.42)	6.35		Kombi 8 x 60	2320	1390
			Kombi 8 x 80		1540
			Kombi 8 x 100		
	12.7		Kombi 8 x 60		1190
			Kombi 8 x 80		1540
			Kombi 8 x 100		
	19.1		Kombi 8 x 60	2270	1000
			Kombi 8 x 80	2320	1540
			Kombi 8 x 100		
EWP (0.50)	6.35		Kombi 8 x 60	2530	1660
			Kombi 8 x 80		1680
			Kombi 8 x 100		
	12.7		Kombi 8 x 60		1420
			Kombi 8 x 80		1680
			Kombi 8 x 100		
	19.1		Kombi 8 x 60		1190
			Kombi 8 x 80		1680
			Kombi 8 x 100		

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
6. 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 CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
8. $N'_{//}$ Main member loaded parallel to grain ($\Theta = 0°$).
   $N'_{\perp}$ Main member loaded perpendicular to grain ($\Theta = 90°$).

Wood Beam to Steel Column - Inclined Screws

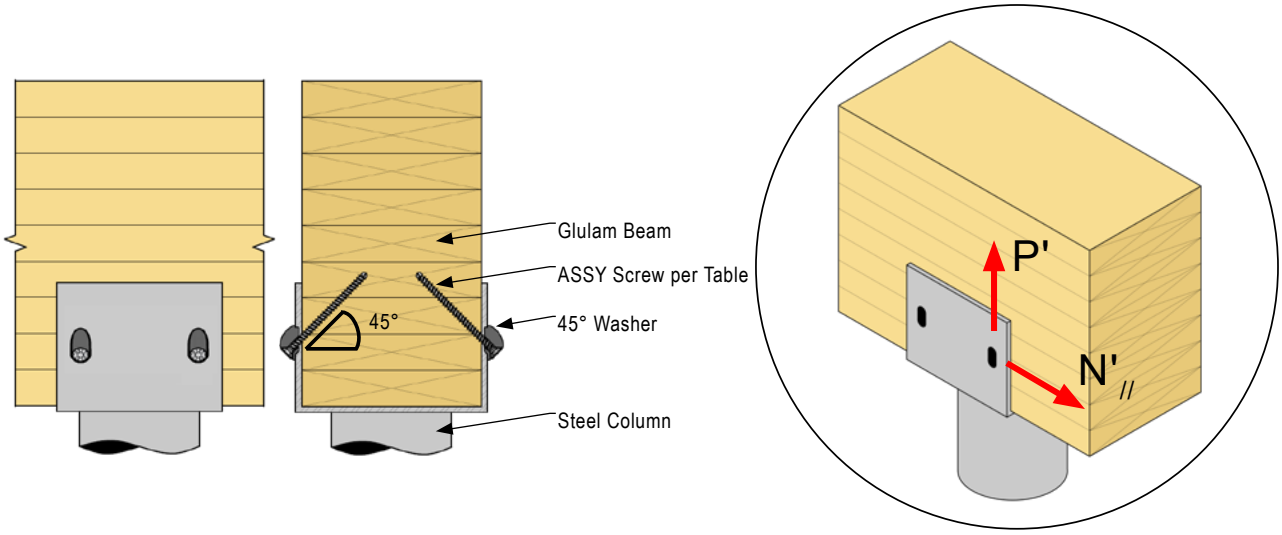


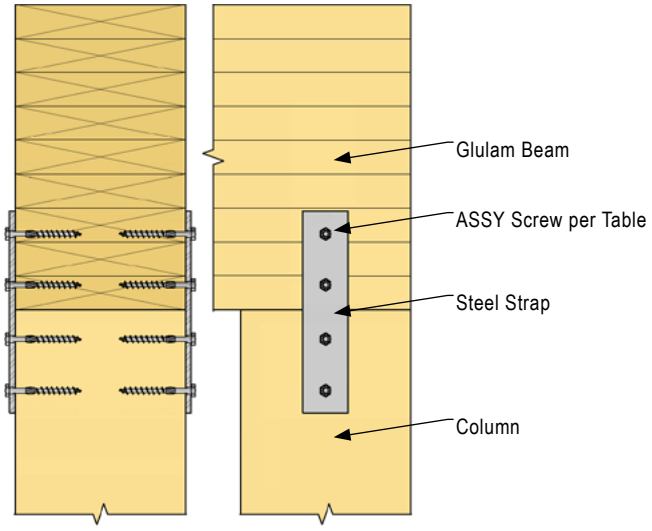
Table PT.4.1, Factored Resistances for Steel Column with Inclined Screws

Wood & Steel Beam Configuration		Fastener Options		Factored Resistance [N]	
Beam Type	Steel Thickness [mm]			P'	N'//
SPF (0.42)	6.35		VG CSK 8 x 120	3920	1730
			VG CSK 8 x 140	4780	
			VG CSK 8 x 160	5640	
	9.5		VG CSK 8 x 120	3700	
			VG CSK 8 x 140	4570	
			VG CSK 8 x 160	5430	
	14		VG CSK 8 x 120	3430	
			VG CSK 8 x 140	4290	
			VG CSK 8 x 160	5150	
EWP (0.50)	6.35		VG CSK 8 x 120	3020	1890
			VG CSK 8 x 140	3680	
			VG CSK 8 x 160	4350	
	9.5		VG CSK 8 x 120	2850	
			VG CSK 8 x 140	3520	
			VG CSK 8 x 160	4180	
	14		VG CSK 8 x 120	2640	
			VG CSK 8 x 140	3310	
			VG CSK 8 x 160	3970	

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 45° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
6. 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 CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
8. 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. $N'_{//}$ Main member loaded parallel to grain ($\Theta = 0°$).

Beam Bearing Straps - Shear Screws



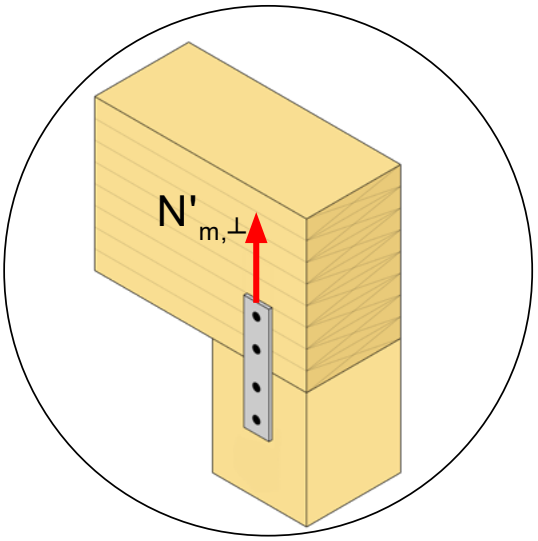


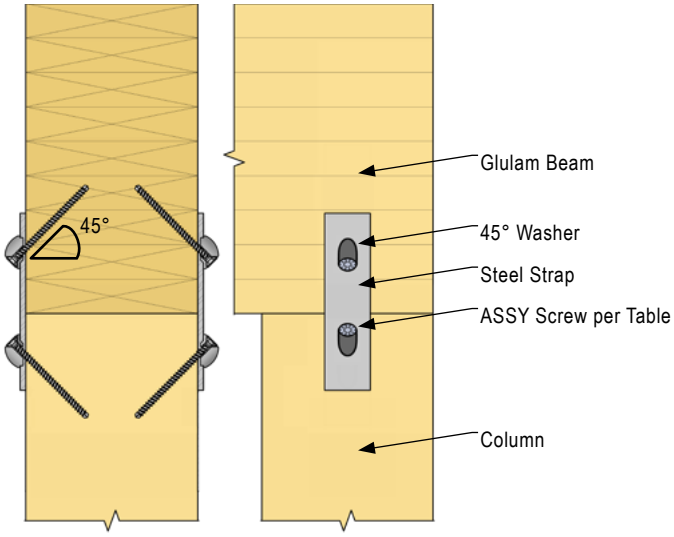
Table PT.5, Factored Resistances for Beam Bearing Straps

Wood & Steel Beam Configuration		Fastener Options	Factored Resistance [N]
Beam Type	Steel Thickness [mm]		$N'_{m,\perp}$
SPF (0.42)	6.35	Kombi 8 x 60	1390
		Kombi 8 x 80	1540
		Kombi 8 x 100	
	12.7	Kombi 8 x 60	1190
		Kombi 8 x 80	1540
		Kombi 8 x 100	
	19.1	Kombi 8 x 60	1000
		Kombi 8 x 80	1540
		Kombi 8 x 100	
EWP (0.50)	6.35	Kombi 8 x 60	1660
		Kombi 8 x 80	1680
		Kombi 8 x 100	
	12.7	Kombi 8 x 60	1420
		Kombi 8 x 80	1680
		Kombi 8 x 100	
	19.1	Kombi 8 x 60	1190
		Kombi 8 x 80	1680
		Kombi 8 x 100	

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
6. 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 CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
8. $N'_{m,\perp}$ Main member loaded perpendicular to grain ($\Theta = 90°$); side member loaded parallel to grain ($\Theta = 0°$).

Beam Bearing Straps - Inclined Screws



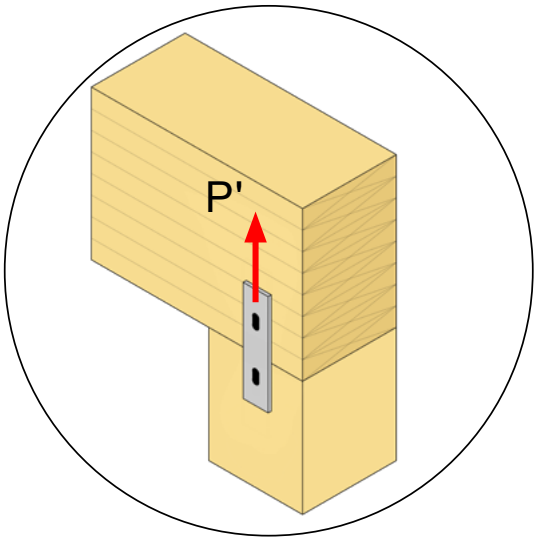


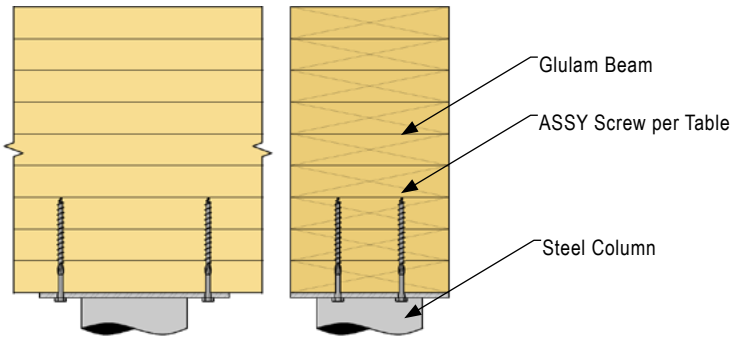
Table PT.6.1, Factored Resistances for Beam Bearing Straps with Inclined Screws

Wood & Steel Beam Configuration		Fastener Options with 45° Washers		Factored Resistance [N]
Beam Type	Steel Thickness [mm]			P'
SPF (0.42)	6.35		VG CSK 8 x 120	3920
			VG CSK 8 x 140	4780
			VG CSK 8 x 160	5640
	9.5		VG CSK 8 x 120	3700
			VG CSK 8 x 140	4570
			VG CSK 8 x 160	5430
	14		VG CSK 8 x 120	3430
			VG CSK 8 x 140	4290
			VG CSK 8 x 160	5150
EWP (0.50)	6.35		VG CSK 8 x 120	3020
			VG CSK 8 x 140	3680
			VG CSK 8 x 160	4350
	9.5		VG CSK 8 x 120	2850
			VG CSK 8 x 140	3520
			VG CSK 8 x 160	4180
	14		VG CSK 8 x 120	2640
			VG CSK 8 x 140	3310
			VG CSK 8 x 160	3970

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 45° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
6. 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 CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
8. 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



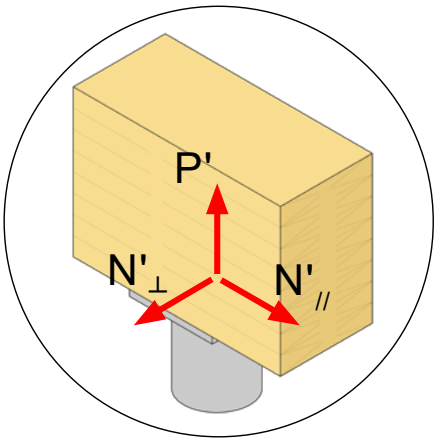


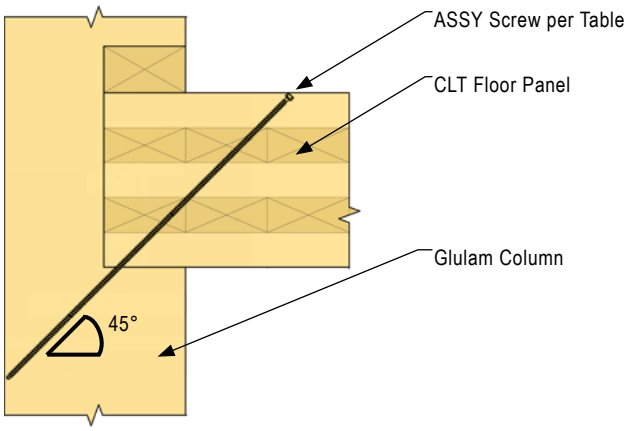
Table PT.7, Factored Resistances for Steel Column - Bottom Plate

Wood & Steel Beam Configuration		Fastener Options		Factored Resistance [N]		
Beam Type	Steel Thickness [mm]			$N'_{//}$	$N'_{\perp}$	P'
SPF (0.42)	6..35		Kombi 8 x 60	2320	1390	2070
			Kombi 8 x 80		1540	2680
			Kombi 8 x 100			3290
	12.7		Kombi 8 x 60		1190	1670
			Kombi 8 x 80		1540	2280
			Kombi 8 x 100			2890
	19.1		Kombi 8 x 60	2270	1000	1280
			Kombi 8 x 80	2320	1540	1890
			Kombi 8 x 100			2500
EWP (0.50)	6.35		Kombi 8 x 60	2530	1660	1600
			Kombi 8 x 80		1680	2070
			Kombi 8 x 100			2540
	12.7		Kombi 8 x 60		1420	1280
			Kombi 8 x 80		1680	1750
			Kombi 8 x 100			2220
	19.1		Kombi 8 x 60		1190	990
			Kombi 8 x 80		1680	1460
			Kombi 8 x 100			1930

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of the glulam beam and steel plate.
6. 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 CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
8. $N'_{//}$ Main member loaded parallel to grain ($\Theta = 0°$).
   $N'_{\perp}$ Main member loaded perpendicular to grain ($\Theta = 90°$).

Housed CLT Floor Uplift Connections



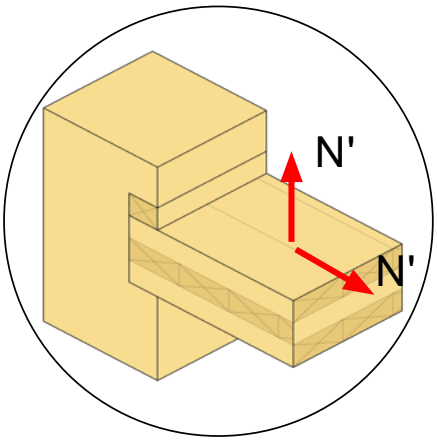


Table PT.8, Factored Resistances for Housed CLT Floor Uplift Connections; 45° Inclined Screws

Panel Configuration			Fastener Options		Factored Resistance [N]	
Loading		Panel Thickness (t)			Standard Loading K_D =1.0	Short Term Loading K_D =1.15
3 PLY	$N'_{//}$	79		VG CSK 8 x 200	3,010	3,460
		87		VG CSK 8 x 220	3,290	3,780
		105		VG CSK 8 x 280	4,720	5,420
	$N'_{\perp}$	79		VG CSK 8 x 200	3,010	3,460
		87		VG CSK 8 x 220	3,290	3,780
		105		VG CSK 8 x 280	4,720	5,420
5 PLY	$N'_{//}$	139		VG Cyl 8 x 360	5,790	6,660
		175		VG CSK 10 x 430	8,130	9,350
	$N'_{\perp}$	139		VG Cyl 8 x 360	5,790	6,660
		175		VG CSK 10 x 430	8,130	9,350
7 PLY	$N'_{//}$	191		VG CSK 10x 480	9,220	10,600
		220		VG CSK 10x 580	12,390	13,580
		245		VG CSK 10x 650	13,580	
	$N'_{\perp}$	191		VG CSK 10x 480	9,220	10,600
		220		VG CSK 10x 580	12,390	13,580
		245		VG CSK 10x 650	13,580	

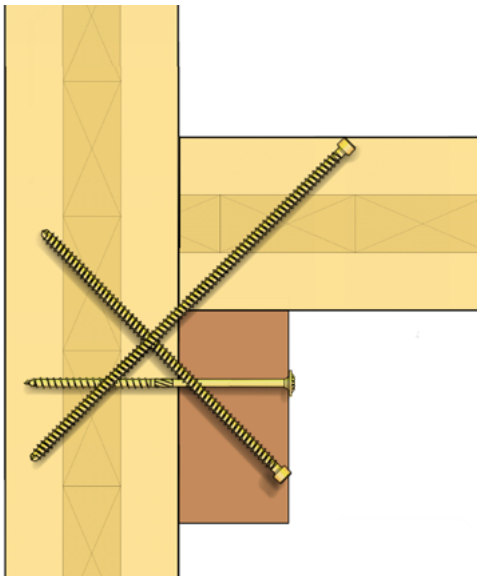
Notes:

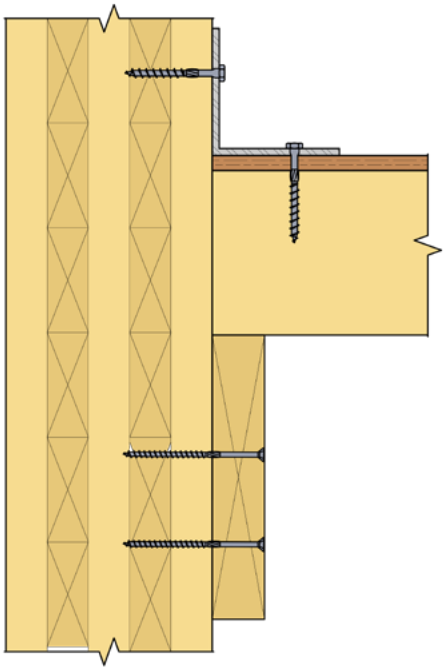
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
7. Factored Lateral Resistance may be applied to uplift and horizontal tension loading towards the panel joint.
8. Adjustment for end grain factor (J_E=0.67) in CLT may be neglected as corresponding withdrawal resistances are already multiplied by the angle to grain reduction factor Rα. (Clause 12.6.6; CSA O86-2019)
9. $N'_{//}$ Main member loaded along the major CLT span direction; side member loaded along the major CLT span direction.
   $N'_{\perp}$ Main member loaded along the major CLT span direction; side member loaded along the minor CLT span direction.

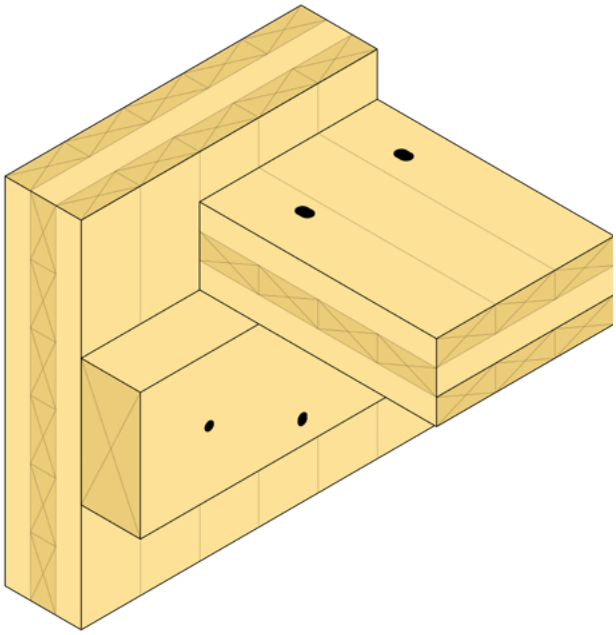
Ledger Connections

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.

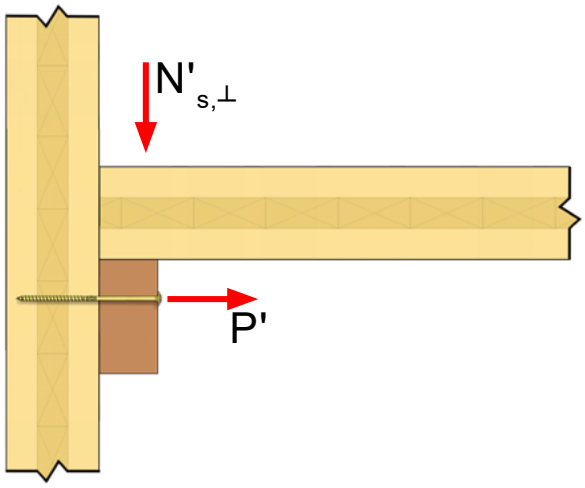
For steel angle connections, see the Steel to Wood Connections Section.





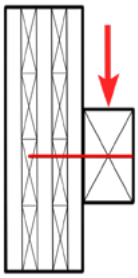


CLT Ledger Connection - 90° Shear Screws Only



90° Shear Screws Only

Table LG.1.1, Factored Resistances for Wall to Ledger Connections;
90° Shear Screws Only

CLT Panel & Ledger Configuration						Fastener Options	Factored Resistance [N]	
	Loading		Ledger Thickness	Panel Thickness (t)			N'	P'
3 PLY to 7 PLY	$N'_{s,\perp}$		44	≥ 79		Eco 6 x 120	600	2,170
			89	≥ 130		Eco 8 x 220	1,330	3,360
						Eco 10 x 220	1,900	3,990
			133	≥ 130		Eco 10 x 260	2,140	
						SK 12 x 260	2,580	8,850

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
7. The side member, assumed as Engineered Wood Products (EWP), must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition.
8. $N'_{s,\perp}$ Main member loaded parallel to grain (Θ = 0°); side member loaded perpendicular to grain (Θ = 90°).

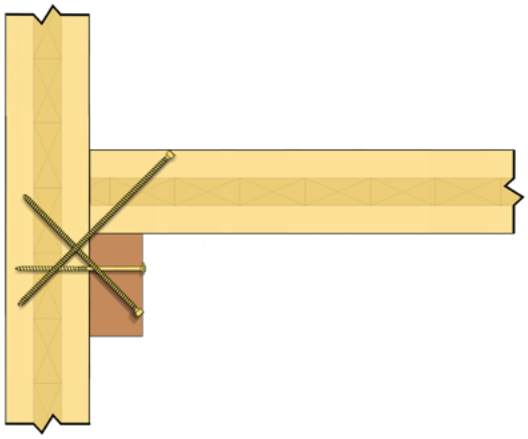
Complete CLT Ledger Connection

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.

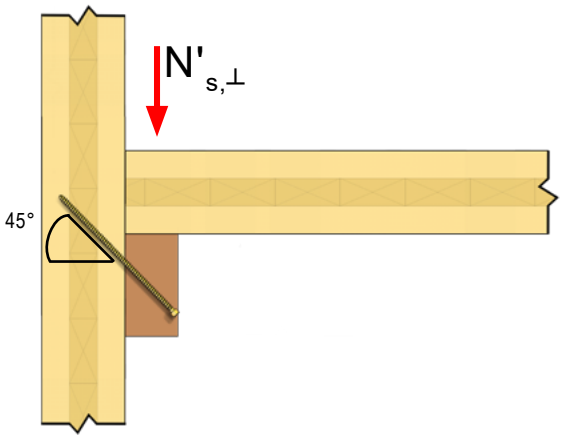
Shear screws installed at 90° angle are used during installation to ensure proper placement and tight connection between side and main member, and to provide ductility to this critical connection. The shear screws can also reduce the eccentricity created by the inclined screws.

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

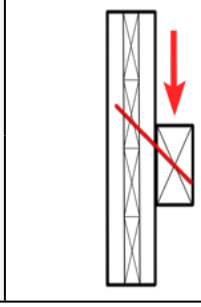


Complete Ledger Connection



45° Inclined Screws

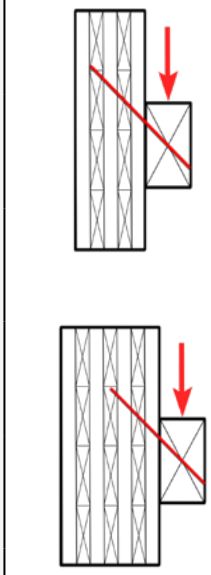
Table LG.2.1, Factored Resistances for CLT Wall to Ledger Connections; 45° Inclined Screws Only

CLT Panel & Ledger Configuration					Fastener Options	Factored Resistance [N]
Loading			Ledger Thickness	Panel Thickness (t)		
3 PLY	$N'_{s,\perp}$		44	≥ 79	VG CSK 8 x 160	2,089
			44	≥ 105	VG CSK 8 x 180	

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
7. The side member, assumed as Engineered Wood Products (EWP), must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition.
8. Factored Lateral Resistance only apply to parallel (gravity shear) loading.
9. Due to stiffness differences, shear screws may not be assumed to take any load. They are only there to facilitate installation and insure a tight fit panel joint.
10. $N'_{s,\perp}$ Main member loaded along the major CLT span direction; side member loaded perpendicular-to-grain.

Table LG.2.2, Factored Resistances for CLT Wall to Ledger Connections; 45° Inclined Screws Only

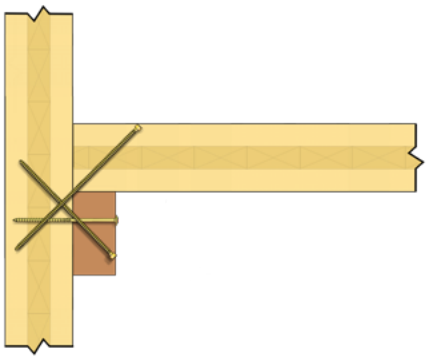
CLT Panel & Ledger Configuration						Fastener Options	Factored Resistance
Loading			Ledger Thickness	Panel Thickness (t)			
7 PLY & 5 PLY	$N'_{s,\perp}$		44	≥ 131		VG CSK 8 x 160	2,089
				≥ 175		VG CSK 8 x 180	
			89	≥ 131		VG CSK 8 x 280	4,178
			133	≥ 131		VG cyl 8 x 360	5,799
				≥ 175		VG cyl 8 x 360	5,825
				≥ 191		VG cyl 8 x 380	6,267

Notes:

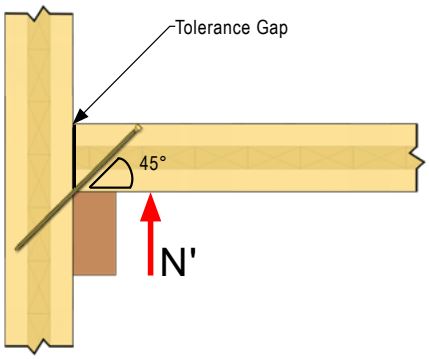
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Connector placement must respect the minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
7. The side member, assumed as Engineered Wood Products (EWP), must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition.
8. Factored Lateral Resistance only apply to parallel (gravity shear) loading.
9. Due to stiffness differences, shear screws may not be assumed to take any load. They are only there to facilitate installation and insure a tight fit panel joint.
10. $N'_{s,\perp}$ Main member loaded along the major CLT span direction; side member loaded perpendicular-to-grain.

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, factored resistances shall be reduced accordingly.

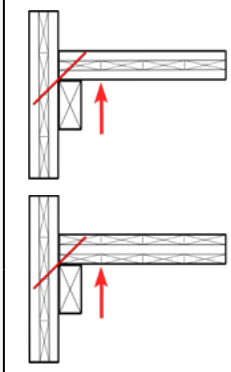


Example of Finished Install



45° Inclined Toe Screws

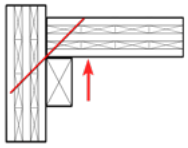
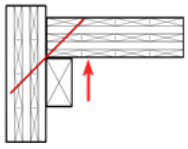
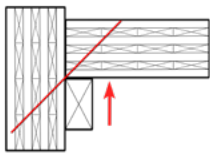
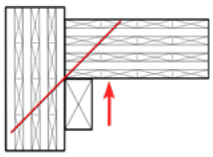
Table LG.3.1, Factored Resistances for CLT Wall to Ledger Connections; 45° Inclined Toe Screws

CLT Panel & Ledger Configuration			Fastener Options	Factored Resistance [N]	
Loading		Panel Thickness (t)		Standard Loading [K_D =1.0]	Short Term Loading [K_D =1.15]
3 PLY	$N'_{//}$  $N'_{\perp}$	79	VG CSK 8 x 200	2,910	3,350
		87	VG CSK 8 x 220	3,060	3,520
		105	VG CSK 8 x 280	4,340	4,990

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
7. Factored Lateral Resistance may be applied to uplift and horizontal tension loading towards the panel joint.
8. Adjustment for end grain factor (J_E=0.67) in CLT may be neglected as corresponding withdrawal resistances are already multiplied by the angle to grain reduction factor Rα. (Clause 12.6.6; CSA O86-2019)
9. The upper limit of the adjusted withdrawal resistance may be set by the allowable fastener tensile strength, no further increase allowed.
10. When tolerance gaps are present between the CLT wall and floor panel, the factored resistances shall be reduced accordingly.
11. $N'_{//}$ Main member loaded along the major CLT span direction; side member loaded along the major CLT span direction.
    $N'_{\perp}$ Main member loaded along the minor CLT span direction; side member loaded along the major CLT span direction.

Table LG.3.2, Factored Resistances for CLT Wall to Ledger Connections; Uplift 45° Inclined Screws Only

CLT Panel & Ledger Configuration			Panel Thickness (t)	Fastener Options	Factored Resistance [N]	
Loading					Standard Loading [K_D =1.0]	Short Term Loading [K_D =1.15]
5 PLY	$N'_{//}$		139	VG Cyl 8 x 360	5,380	6,190
	$N'_{\perp}$		175	VG CSK 10 x 430	7,630	8,770
7 PLY	$N'_{//}$		191	VG CSK 10 x 480	8,650	9,950
			220	VG CSK 10 x 580	11,440	13,160
	$N'_{\perp}$		245	VG CSK 10 x 650	13,040	15,000

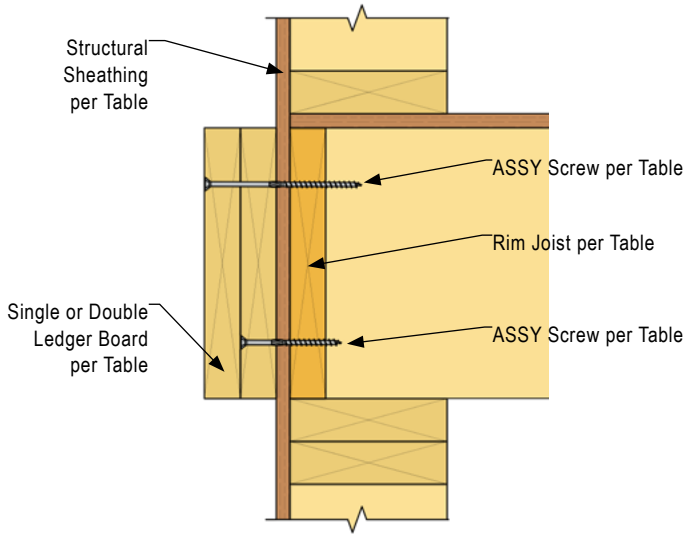
Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be 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°.
7. Factored Lateral Resistance may be applied to uplift and horizontal tension loading towards the panel joint.
8. Adjustment for end grain factor (J_E=0.67) in CLT may be neglected as corresponding withdrawal resistances are already multiplied by the angle to grain reduction factor Rα. (Clause 12.6.6; CSA O86-2019)
9. The upper limit of the adjusted withdrawal resistance may be set by the allowable fastener tensile strength, no further increase allowed.
10. When tolerance gaps are present between the CLT wall and floor panel, the factored resistances shall be reduced accordingly.
11. $N'_{//}$ Main member loaded along the major CLT span direction; side member loaded along the major CLT span direction.
    $N'_{\perp}$ Main member loaded along the minor CLT span direction; side member loaded along the major 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.



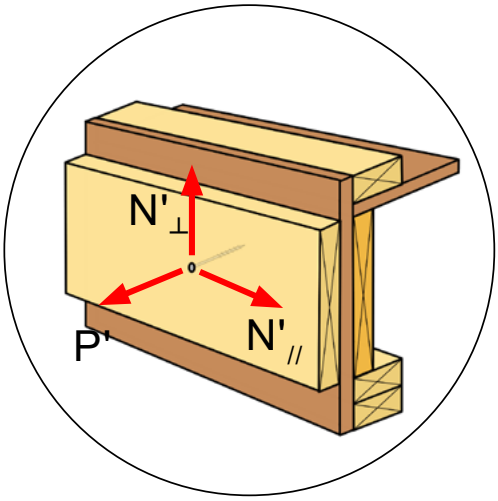


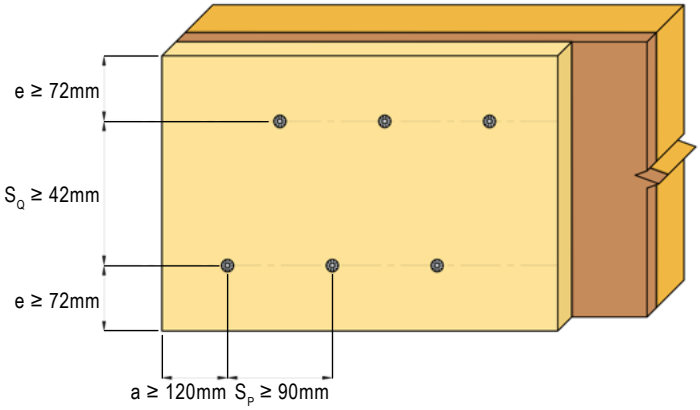
Table LG.6.1, Factored Resistances for Ledger Board to Rim Joist Connection

Ledger Configuration						Factored resistance [N]			
Type		Thickness	Ledger Board	Rim Joist	Fastener Options	$N'_{//}$	$N'_{\perp}$	P'_{ECO}	P'_{SK}
SPF / OSB / Plywood	G = 0.42 or Structural 1, Marine Grade G = 0.50	12	32mm EWP	32mm EWP	Eco / SK 6 x 90	910	420	1,120	1,120
				38mm Lumber	Eco / SK 6 x 90	890	410	1,320	1,750
			38mm Lumber	32mm EWP	Eco / SK 6 x 90	890	420	1,120	1,120
				38mm Lumber	Eco / SK 6 x 90	870	390	1,320	1,750
			44mm EWP	32mm EWP	Eco / SK 6 x 120	1,020	490	1,120	1,120
				38mm Lumber	Eco / SK 6 x 120	980	480	1,320	1,750
			64mm EWP	32mm EWP	Eco / SK 6 x 140	1,020	580	1,120	1,120
				38mm Lumber	Eco / SK 6 x 140	980	590	1,320	1,750
			Double 38mm Lumber	32mm EWP	Eco / SK 6 x 140	950	530	1,120	1,120
				38mm Lumber	Eco / SK 6 x 140	940	540	1,320	1,750
			89mm EWP	32mm EWP	Eco / SK 6 x 160	1,020	580	1,120	1,120
				38mm Lumber	Eco / SK 6 x 160	980	600	1,320	1,750

Notes:

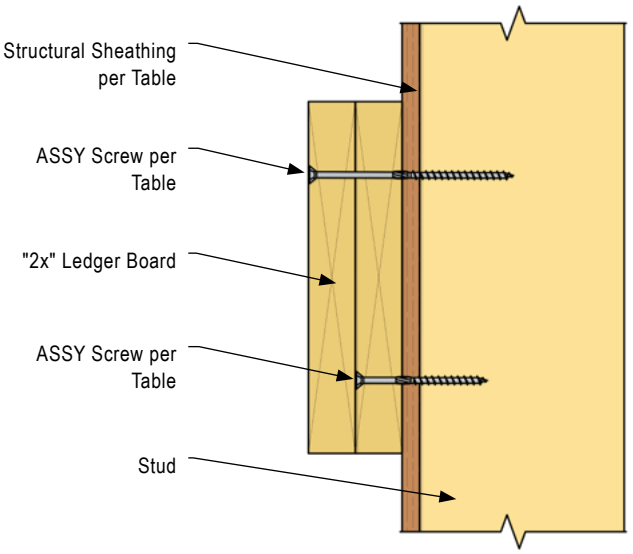
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fastener 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 90° angle intersecting the shear plane at the interface of members.
6. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC 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.
8. Double ledger boards must be independently fastened to each other as per the applicable design codes or standards.
9. It is recommended that additional backing be provided whenever the screw protrudes behind the rim joist.

Geometry Requirements



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.



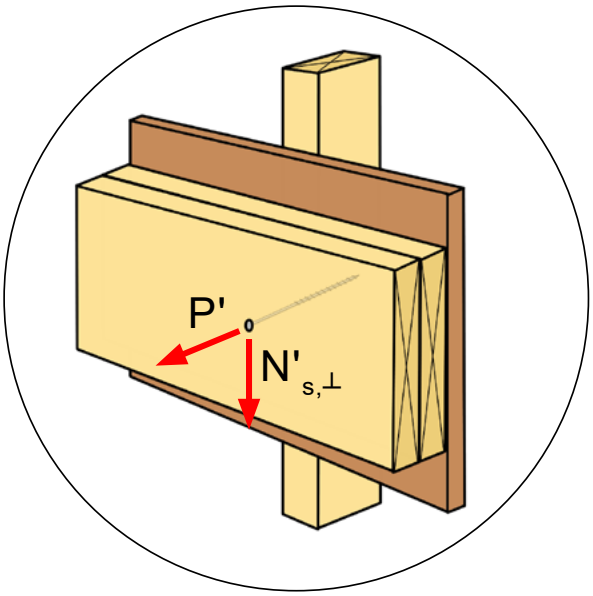


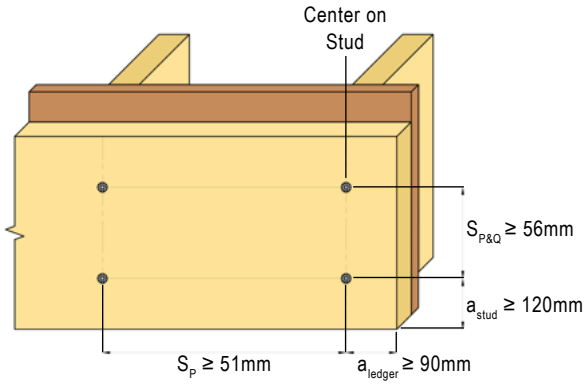
Table LG.7.1, Factored Resistances for Ledger Board to Stud Wall Connection

Ledger Configuration				Fastener Options	Factored Resistance [N]		
	Thickness	Stud Type	Ledger Board		$N'_{s,\perp}$	P'_{ECO}	P'_{SK}
OSB / Plywood	12	38 mm Stud	32 mm EWP	Eco / SK 6 x 90	570	1,470	1,470
			38 mm Lumber		540	1,320	
			44 mm EWP	Eco / SK 6 x 120	630	2,170	2,390
			64 mm EWP	Eco / SK 6 x 140	740	2,170	
			Double 38mm Lumber	Eco / SK 6 x 160	720	1,320	
			89 mm EWP	Eco / SK 6 x 160	750	2,170	

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fastener 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 90° angle intersecting the shear plane at the interface of members.
6. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC 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.
8. Double ledger boards must be independently fastened to each other as per the applicable design codes or standards.

Geometry Requirements



Specific Ledger to Stud Connection Design

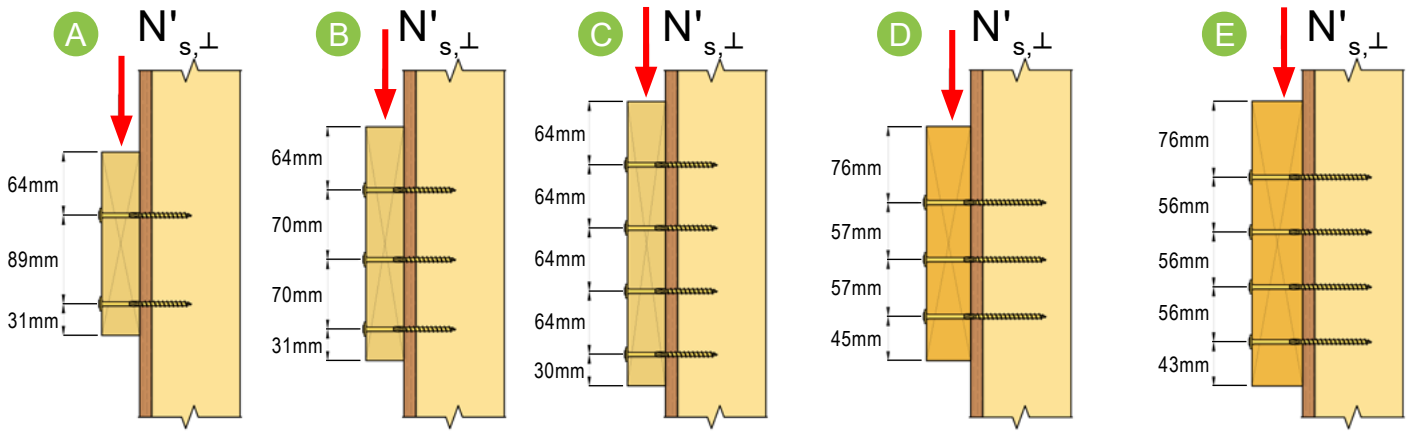
Table LG.7.2, Adjusted Resistance for Ledger Board to Stud Wall Connection

Ledger Configuration						Fastener Options	Number of Effective Fastener in a Row (n_F)	Adjusted Resistance [N]		
Thickness		Stud Type	Ledger Board	Assembly				$N'_{s,\perp}$	P'_{ECO}	P'_{SK}
OSB / Plywood	12.7 mm	38 mm Lumber	38 x 184 mm Lumber	A		Eco / SK 6 x 90	2	1,090	2,640	3,060
			38 x184 mm Double Lumber			Eco / SK 6 x 160	2	1,440	2,640	5,280
			38 x 235 mm Lumber	B		Eco / SK 6 x 90	3	1,630	3,960	4,600
			38 x 235 mm Double Lumber			Eco / SK 6 x 160	3	2,160	3,960	7,920
			38 x 286 mm Lumber	C		Eco / SK 6 x 90	4	2,170	5,280	6,130
			38 x 286 mm Double Lumber			Eco / SK 6 x 160	4	2,880	5,280	10,560
			44 x 235 EWP	D		Eco / SK 6 x 120	3	1,900	6,510	7,910
			89 x 235 EWP			Eco / SK 6 x 160	3	2,250	6,510	7,220
			44 x 287 EWP	E		Eco / SK 6 x 120	4	2,530	8,680	10,540
			89 x 287 EWP			Eco / SK 6 x 160	4	2,990	8,680	9,620

Notes:

1. Adjusted resistances apply to effective number fastener in a row (n_F), conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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 90° angle intersecting the shear plane at the interface of members.
6. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC 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.
8. Double ledger boards must be independently fastened to each other as per the applicable design codes or standards.
9. Adjusted resistances calculations include the factored resistance (N' or P') and effective number fastener in a row (n_F).

Geometry Requirements



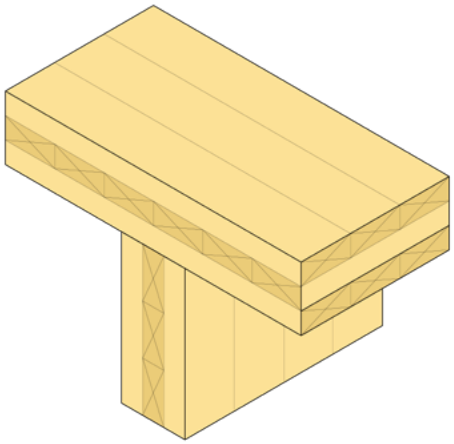
Note:

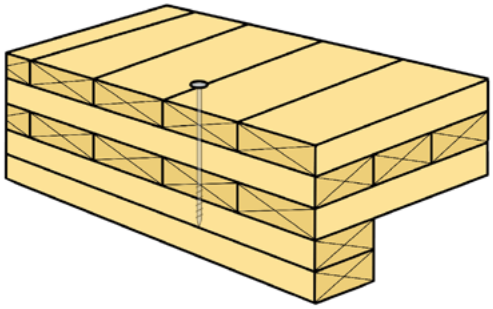
1. Minimum spacing requirements

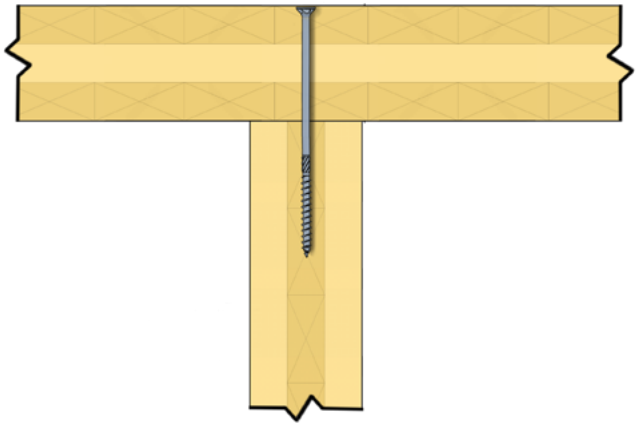
Floor to Wall Connections

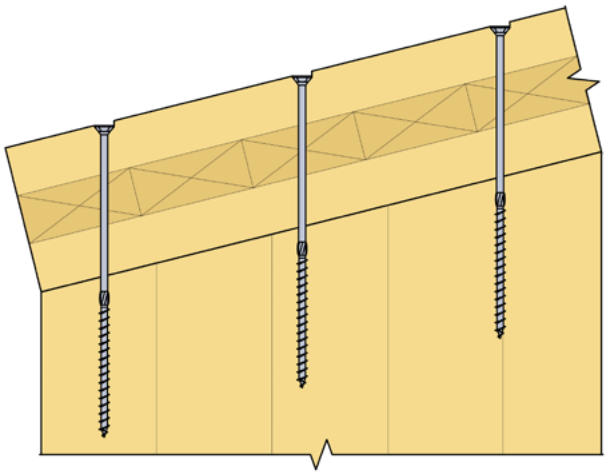
For CLT floor to wall connections, the designer should allocate special attention to ensure that minimum end and edge distance requirements for the narrow edge of CLT are satisfied.

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.



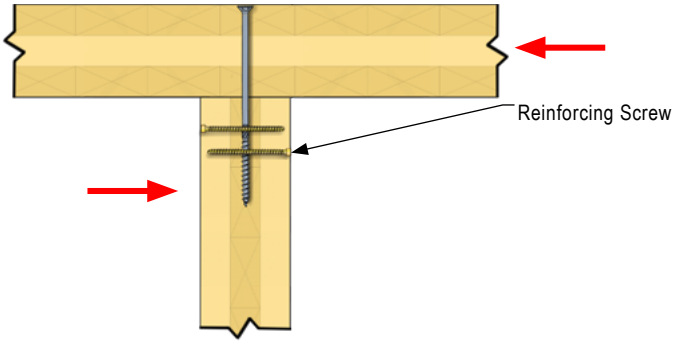






Reinforcement Possibilities

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

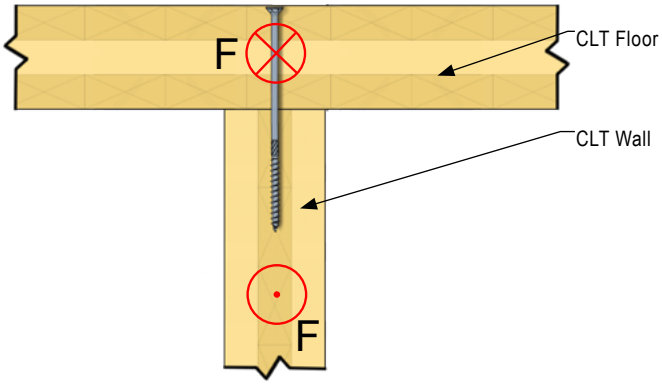
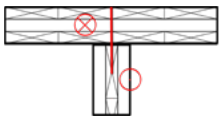
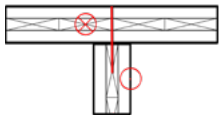
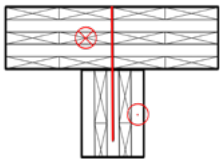
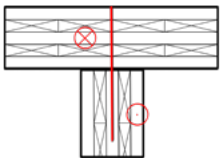


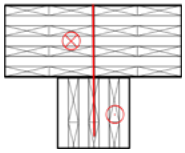
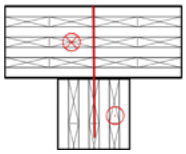
Table FW.1.1, Factored Resistances for CLT Floor to Wall Panel Connections Loaded in Shear

Panel Configuration				Fastener Options	Factored Resistance [N]		Minimum Spacing in a Row (S_P)
	Loading		Panel Thickness (t)		Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
3 PLY	$N'_{//}$		79	Eco 6 x 160	480	550	60
			87				
			105	Eco 6 x 200			
				Eco 8 x 200	850	980	80
	$N'_{\perp}$		79	Eco 6 x 160	420	480	60
			87				
			105	Eco 6 x 200			
				Eco 8 x 200	720	830	80
5 PLY	$N'_{//}$		130	Eco 8 x 240	1050	1210	80
			140				
			175	Eco 8 x 300			
				Eco 10 x 300	1550	1780	100
	$N'_{\perp}$		130	Eco 8 x 240	750	860	80
			140		770	890	
			175	Eco 8 x 300	850	980	
				Eco 10 x 300	1150	1320	100

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of both CLT members.
6. Adjustment for end grain factor (J_E=0.67) in CLT shall be applied.
7. For loading perpendicular to the wall surface, effects of splitting shall be considered.
8. $N'_{//}$ Main member loaded perpendicular to grain (ϴ = 90°; narrow edge); side member loaded parallel to grain (ϴ = 0°).
   $N'_{\perp}$ Main member loaded perpendicular to grain (ϴ = 90°; narrow edge); side member loaded perpendicular to grain (ϴ = 90°).

Table FW.1.2, Factored Resistances for CLT Panel to Wall Connections Loaded in Shear

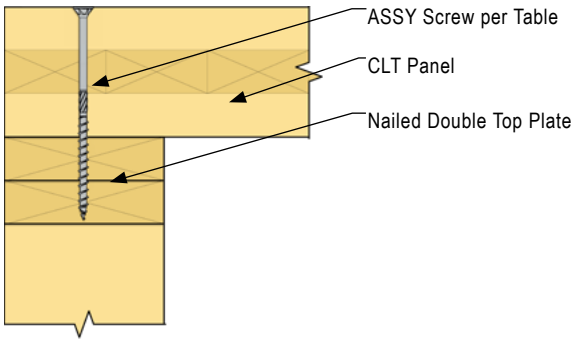
Panel Configuration			Panel Thickness (t)	Fastener Options		Factored Resistance [N]		Minimum Spacing in a Row (S_P)
Loading						Standard Loading K_D =1.0	Short Term Loading K_D =1.15	
7 PLY	$N'_{//}$		191		Eco 8 x 300	850	980	80
					Eco 10 x 300	1250	1440	100
			219		Eco 8 x 340	850	980	80
					Eco 10 x 360	1250	1440	100
			245		Eco 10 x 380	850	980	
					SK 12 x 400	1780	2050	120
	$N'_{\perp}$		191		Eco 8 x 300	730	840	80
					Eco 10 x 300	1030	1180	100
			219		Eco 8 x 340	730	840	80
					Eco 10 x 360	1080	1240	100
			245		Eco 10 x 380	730	840	
					SK 12 x 400	1540	1770	120

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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 minimum spacing, edge, & end distance requirements for ASSY screws, as specified in the Detailing Section of this guide, pages 92 to 104.
5. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of both CLT members.
6. Adjustment for end grain factor (J_E=0.67) in CLT shall be applied.
7. For loading perpendicular to the wall surface, effects of splitting shall be considered.
8. $N'_{//}$ Main member loaded perpendicular to grain (ϴ = 90°; narrow edge); side member loaded parallel to grain (ϴ = 0°).
   $N'_{\perp}$ Main member loaded perpendicular to grain (ϴ = 90°; narrow edge); side member loaded perpendicular to grain (ϴ = 90°).

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.



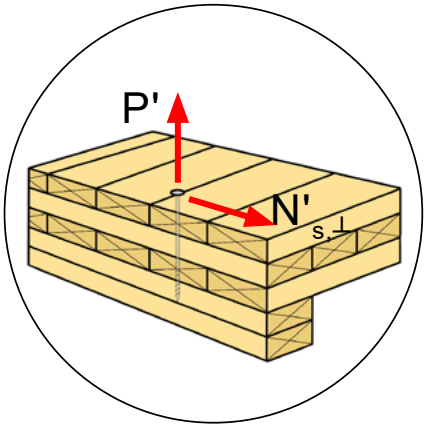


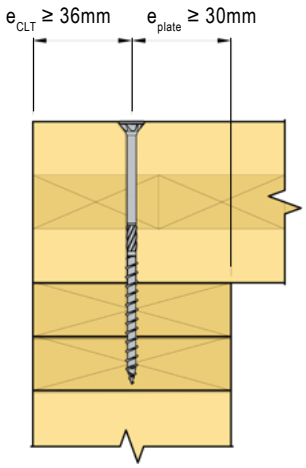
Table FW.2, Factored Resistances for CLT Floor to Top Plate Connection (Top)

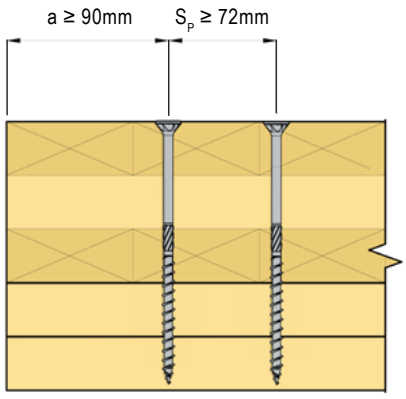
Panel & Top Wall Configuration			Fastener Options	Factored Resistance [N]		
Wall Top Plate		Panel Thickness (t)		$N'_{s,\perp}$	P'_{ECO}	P'_{SK}
3 PLY	Double 38 mm Lumber	79	Eco / SK 6 x 160	720	1320	2170
		87	Eco / SK 6 x 160	680		
		105	Eco / SK 6 x 180	690		
5 PLY	Double 38 mm Lumber	130	Eco / SK 6 x 200	660	1320	2170
		140	Eco / SK 6 x 220	710		
		175	Eco / SK 6 x 260	720		

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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 90° angle intersecting the shear plane at the interface of the wall and floor members.
6. Double top plates and built-up studs must be independently fastened to each other as per the applicable design codes or standards.

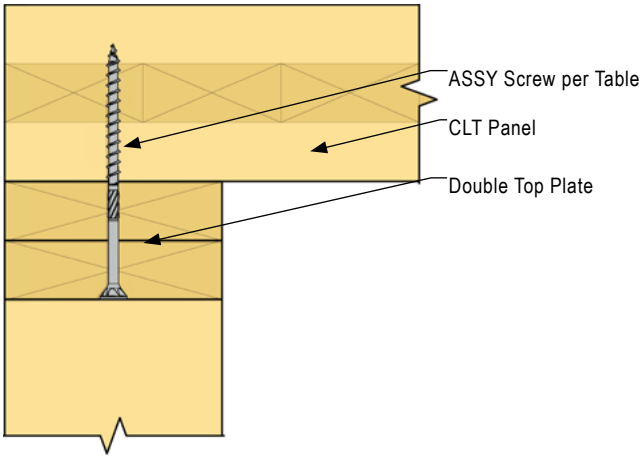
Geometry Requirements





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.



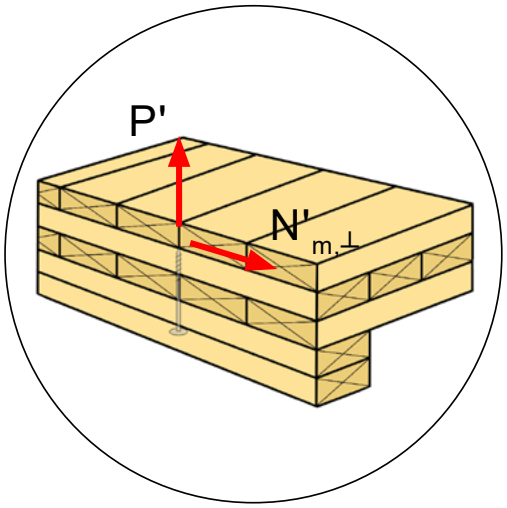


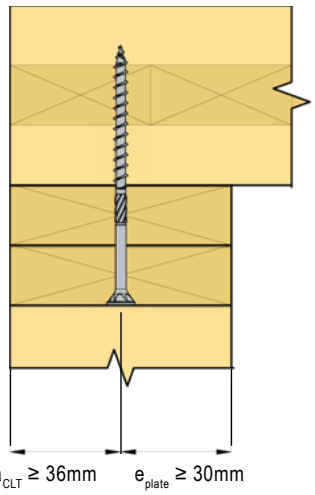
Table FW 3. Factored Resistances for CLT Floor to Top Plate Connection (Bottom)

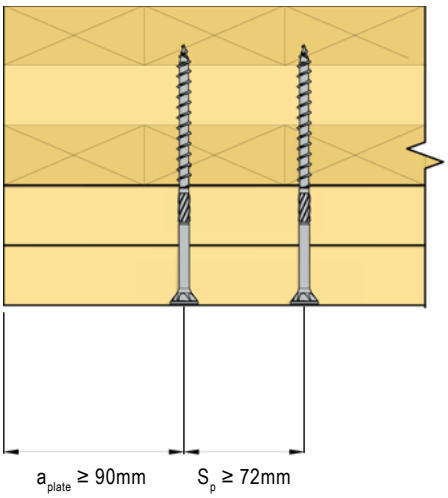
Panel & Top Wall Configuration			Fastener Options	Factored Resistance [N]		
Wall Top Plate		Panel Thickness (t)		$N'_{m,\perp}$	P'_{ECO}	P'_{SK}
3 PLY	Double 2" Lumber	79	Eco / SK 6 x 140	730	1320	2610
		87				
		105				

Notes:

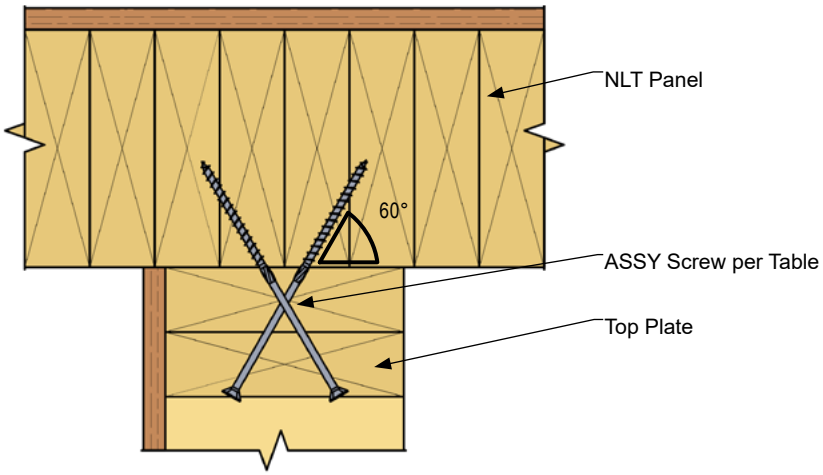
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fasterner 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 90° angle intersecting the shear plane at the interface of the wall and floor members.
6. Double top plates and built-up studs must be independently fastened to each other as per the applicable design codes or standards.

Geometry Requirements





NLT Floor to Top Plate Connection - Inclined Screws



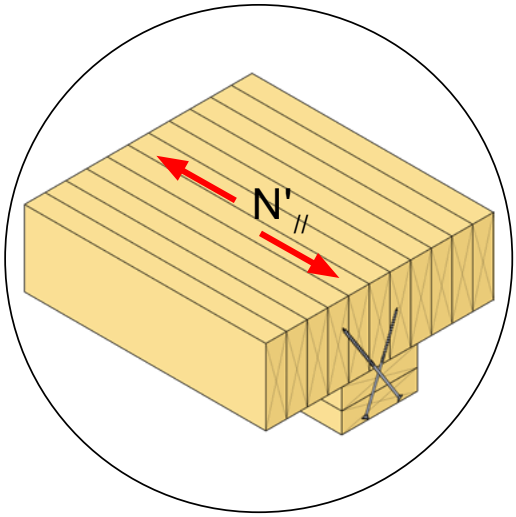


Table FW.9, Factored Resistances for Built-Up Stud to Top Plate Connections

Panel & Top Wall Configuration			Fastener Options		Factored Resistance per Screw Cross [N]
Wall Top Plate	Loading	Buil-Up Top Plate			
Double 2" Lumber	$N'_{//}$	Double 38 mm Lumber		Eco 6 x 120	1490
				Eco 6 x 140	1870
				Eco 6 x 160	
		Triple 38 mm Lumber		Eco 6 x 180	1830
				Eco 6 x200	1870
				Eco 6 x 220	

Notes:

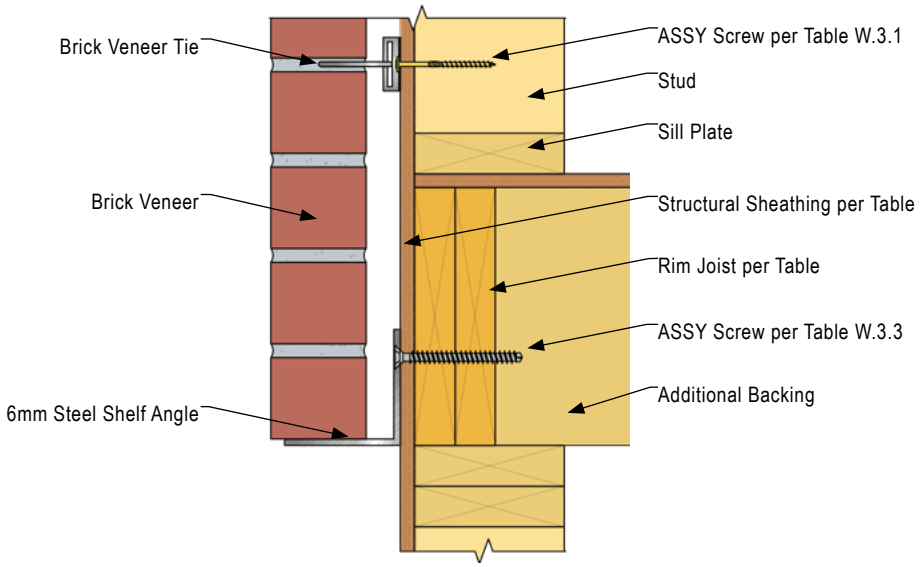
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. Fastener 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 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 fastened 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.



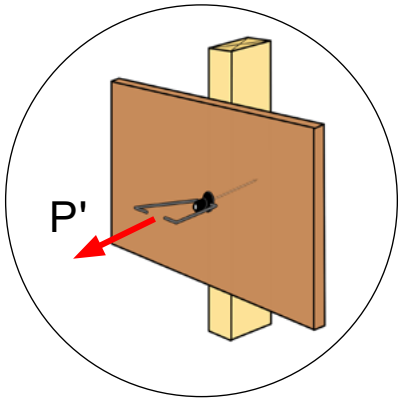


Table W.3.1, Factored Resistances for Brick Veneer Tie Connection

Sheating Configuration		Stud Backing	Tie Plate Thickness	Fastener Options	Factored Resistance [N]
Type	Thickness				P'
Plywood (G = 0.42)	12 - 25	38mm Lumber	16 ga	Eco 6 x 60	1430
				Eco 6 x 70	1660

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fastener 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. The factored withdrawal design value shall not exceed the Factored tensile strength of the screw.
6. Refer to the brick veneer tie manufacturer for specific installation and design requirements.
7. Wall sheathing must be independently fastened to the stud wall backing as per the applicable design codes or standards.
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.

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

Screw Nominal Diameter	Steel Plate Hole Diameter
in. [mm]	in. [mm]
1/4" [6]	**9/32" [7]**
5/16" [8]	**3/8" [9]**
3/8" [10]	**7/16" [11]**
1/2" [12]	**17/32" [13]**

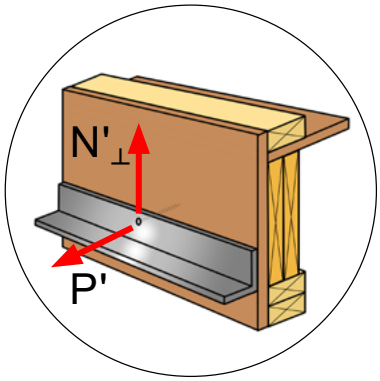


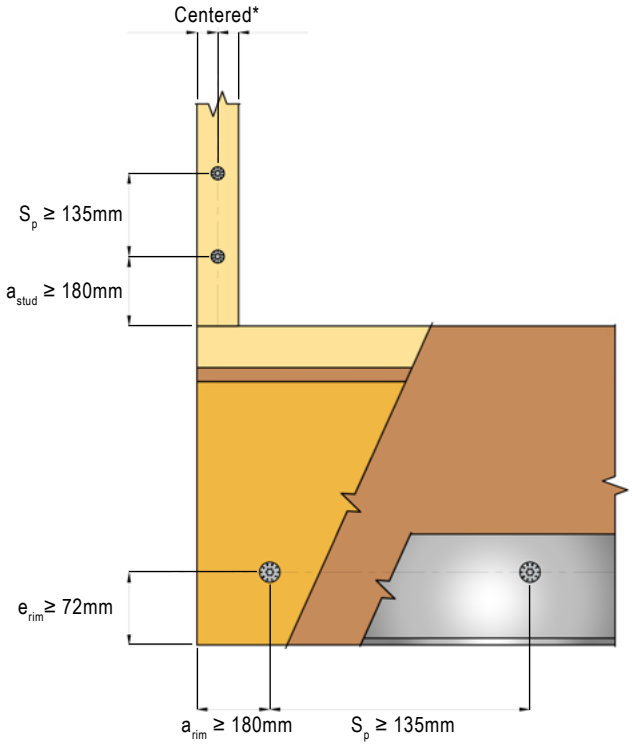
Table W.3.3, Refence Design Values for Brick Veneer Shelf Angle Connection

Sheating Configuration			Steel Thickness	Rim Joist	Additional Backing	Fastener Options		Factored Resistance [N]	
Type		Thickness						$N'_{\perp}$	P'
Plywood	G = (0.49)	12	6	32mm EWP	32mm EWP		VG CSK 10 x 100	1850	4480
							VG CSK 12 x 120	2670	5320
					45mm EWP		VG CSK 10 x 100	1850	5250
							VG CSK 12 x 120	2670	6230
				38 mm Lumber	38 mm Lumber		VG CSK 10 x 100	1700	6760
							VG CSK 12 x 120	2440	8100

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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 90° angle intersecting the shear plane at the interface of the wall and the steel angle.
6. Factored resistances apply to screws installed perpendicular to the grain of the main wood member.
7. The factored withdrawal design value shall not exceed the Factored tensile strength of the screw.
8. Shelf angle steel must conform to ASTM A36/A36M-14: Standard Specification for Carbon Structural Steel (or better).
9. 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. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition shown above.
11. Wall sheathing must be independently fastened to the rim joist as per the applicable design codes or standards.
12. Rim joist backing must be independently fastened to the rim joist as per the applicable design codes or standards.
13. It is recommended that additional backing be provided whenever the screw protrudes behind the rim joist.

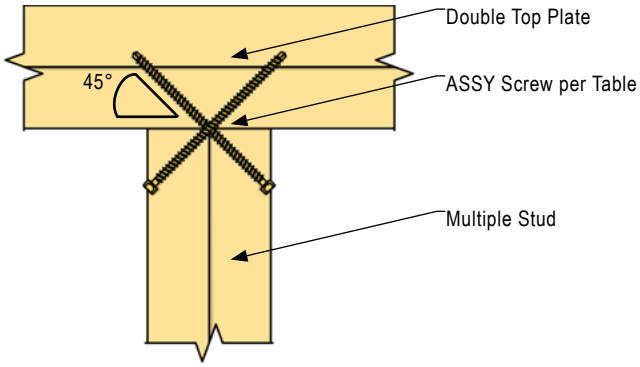
Geometry Requirements



Notes:
* 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.



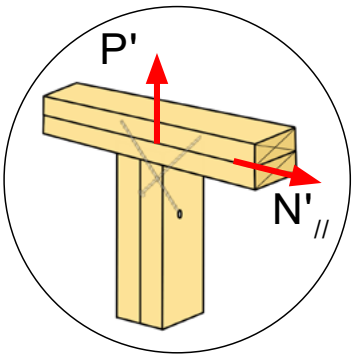


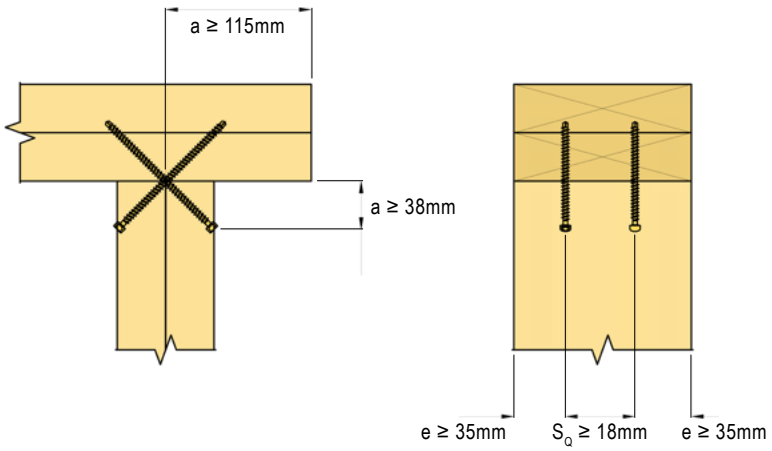
Table W.4, Factored Resistances for Built-Up Stud to Top Plate Connections

Top Plate & Stud Configuration			Fastener Options		Factored Resistance per Screw Cross [N]
Top Plate	Loading	Buil-Up Stud			
Double 38 mm Lumber	N'// or P'	Dbl. 38 mm Lumber		VG Cyl 6 x 120	3000
				VG Cyl 6 x 140	
				VG Cyl 6 x 160	
		Trip. 38 mm Lumber		VG Cyl 6 x 140	2980
				VG Cyl 6 x 160	4090
				VG Cyl 6 x 180	4490

Notes:

1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fastener 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 studs and the top plate.
6. The angle between force and fastener axis is 45°.
7. 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



Kwantlen Polytechnic University

Richmond, British Columbia

UMass Design Building

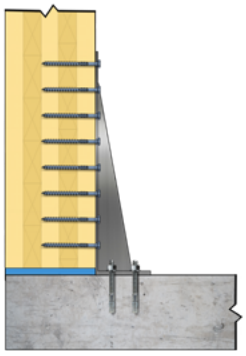
Amherst, Massachusetts

Courtesy of Alex Schreyer/Mass U Mass

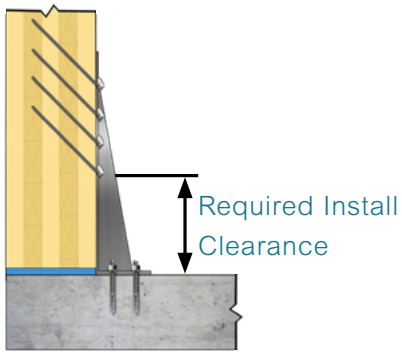
Steel to Wood Connections

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.

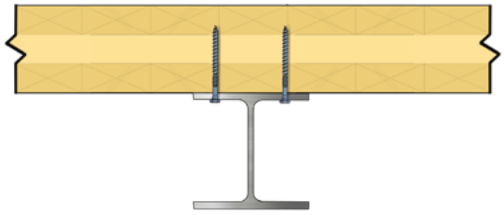
The possibility of using inclined screws, either with angled washers or reamed housing to accept the screw head offers high capacity options. The high connection strength of inclined screws thereby opens new doors toward innovative and economical design in modern mass timber structures. Due to the high 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.



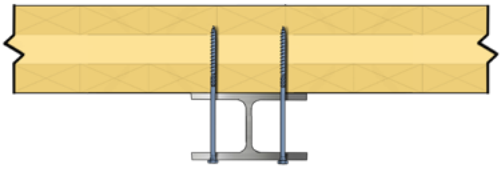
CLT wall hold down connection using shear screws, see page 86 for details.



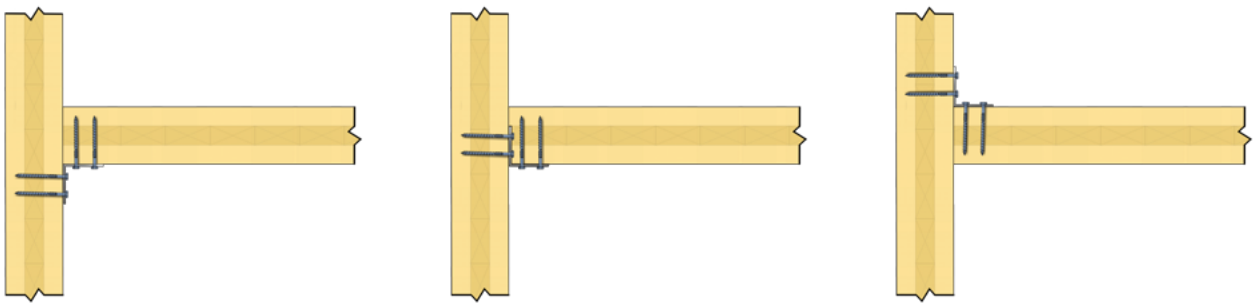
CLT wall hold down connection using inclined screws, see page 88 for details.



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.

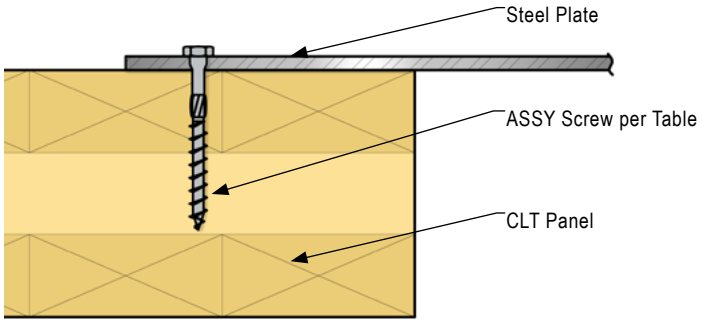


CLT floor to wall connections using angle brackets in different configurations, see page 86 for details on steel to wood connection.

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.

The tapered shoulder of the Kombi head reduces slip and also provides a suitable bearing surface for the steel side plate.



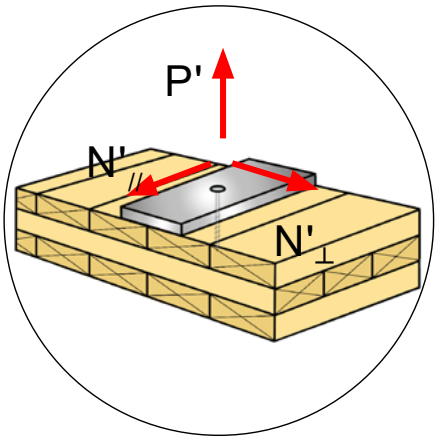
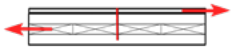
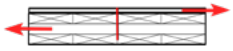


Table SC.1.1, Factored Resistances for CLT Steel Side Plate Connections

CLT Panel & Steel Plate Configuration						Fastener Options	Factored Resistance [N]	
Loading				Panel Thickness [t]	Steel Plate Thickness		N'	P'
3 PLY	$N'_{//}$			79 to 105	4.76	Kombi 8 x 80	2203	2350
					6.35	Kombi 8 x 80		
					12.7	Kombi 8 x 80		
	$N'_{\perp}$			79 to 105	4.76	Kombi 8 x 80	1545	
					6.35	Kombi 8 x 80		
					12.7	Kombi 8 x 80		

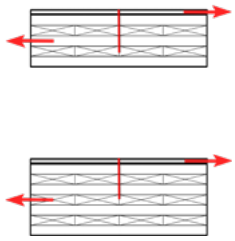
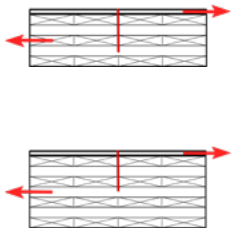
Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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. Factored resistances require the fasteners to be installed at a 90° angle intersecting the shear plane at the interface of steel side member and CLT.
6. The angle between force and fastener axis is 90°.
7. The side member must be ASTM A36 grade steel or higher. In accordance with CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
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. $N'_{//}$ Main member loaded parallel to grain (ϴ = 0°).
   $N'_{\perp}$ Main member loaded perpendicular to grain (ϴ = 90°).
   P' Steel plate loaded in withdrawal.

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

Screw Nominal Diameter	Steel Plate Hole Diameter
in. [mm]	in. [mm]
1/4" [6]	**9/32" [7]**
5/16" [8]	**3/8" [9]**
3/8" [10]	**7/16" [11]**
1/2" [12]	**17/32" [13]**

Table SC.1.2, Factored Resistances for CLT Steel Side Plate Connections

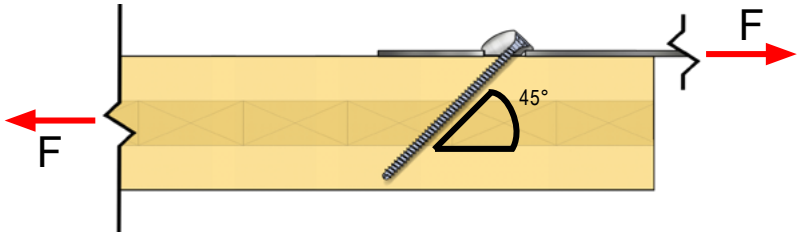
CLT Panel & Steel Plate Configuration					Fastener Options	Factored Resistance [N]	
	Loading		Panel Thickness [t]	Steel Plate Thickness		N'	P'
5 PLY & 7 PLY	$N'_{//}$		139 to 245	4.76	Kombi 8 x 80	2200	2350
					Kombi 10 x 120	3250	4780
					Kombi 12 x 120	4620	5460
					Kombi 12 x 140		
				6.35	Kombi 8 x 80	2200	2350
					Kombi 10 x 120	3250	4780
					Kombi 12 x 120	4620	5460
					Kombi 12 x 140		
				12.7	Kombi 10 x 120	3250	4780
					Kombi 12 x 120	4620	5460
					Kombi 12 x 140		
	$N'_{\perp}$		139 to 245	4.76	Kombi 8 x 80	1540	2350
					Kombi 10 x 120	2280	4780
					Kombi 12 x 120	3240	5460
					Kombi 12 x 140		
				6.35	Kombi 8 x 80	1540	2350
					Kombi 10 x 120	2280	4780
					Kombi 12 x 120	3240	5460
					Kombi 12 x 140		
				12.7	Kombi 10 x 120	2280	4780
					Kombi 12 x 120	3240	5460
					Kombi 12 x 140		

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.



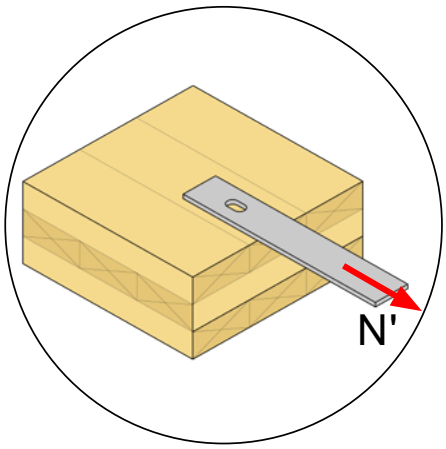
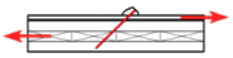
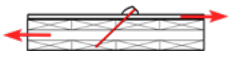


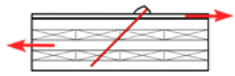
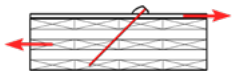
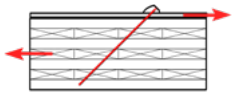
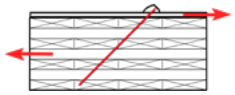
Table SC.2.1, Factored Resistances for CLT Steel Side Plate Connections

CLT Panel & Steel Plate Configuration					Fastener Options	Factored Resistance [N]
Loading			Steel Plate Thickness	Panel Thickness (t)		
3 PLY	$N'_{//}$		4 - 12.7	≥ 87	VG CSK 8 x 140	3920
				≥ 105	VG CSK 8 x 160	4710
			6.4 - 19.1	≥ 105	VG CSK 10 x 160	5380
	$N'_{\perp}$		4 - 12.7	≥ 87	VG CSK 8 x 140	4220
				≥ 105	VG CSK 8 x 160	4960
			6.4 - 19.1	≥ 105	VG CSK 10 x 160	5670

Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fastener 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 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.
8. The side member must be ASTM A36 grade steel or higher. In accordance with CSA O86 2019, Clause 12.6.5 is used to find the embedment strength with steel side plate.
9. 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.
11. $N'_{//}$ Factored resistance per screw in tension with loading direction along major span direction of CLT panel.
    $N'_{\perp}$ Factored resistance per screw in tension with loading direction along minor span direction of CLT panel.

Table SC.2.2, Factored Resistances for CLT Steel Side Plate Connections

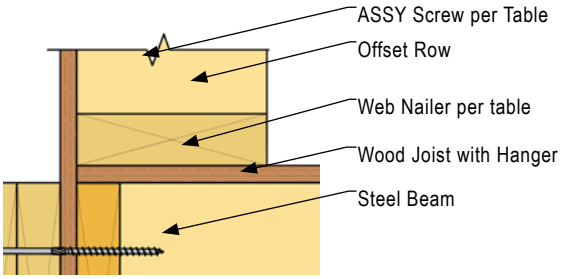
CLT Panel & Steel Plate Configuration					Fastener Options	Factored Resistance [N]
Loading			Steel Plate Thickness	Panel Thickness (t)		
5 PLY	$N'_{//}$		4 - 12.7	≥ 131	VG CSK 8 x 180	5520
				≥ 139	VG CSK 8 x 200	6030
				≥ 175	VG CSK 8 x 240	7600
			6.4 - 19.1	≥ 131	VG CSK 10 x 180	6380
				≥ 139	VG CSK 10 x 200	7030
				≥ 175	VG CSK 10 x 240	8980
	$N'_{\perp}$		4 - 12.7	≥ 131	VG CSK 8 x 180	5670
				≥ 139	VG CSK 8 x 200	6520
				≥ 175	VG CSK 8 x 240	7830
			6.4 - 19.1	≥ 131	VG CSK 10 x 180	6560
				≥ 139	VG CSK 10 x 200	7610
				≥ 175	VG CSK 10 x 240	9260
7 PLY	$N'_{//}$		6.4 - 19.1	≥ 191	VG CSK 10x 260	9660
				≥ 220	VG CSK 10 x 320	12510
				≥ 245	VG CSK 10 x 340	13460
			6.4 - 25.4	≥ 191	VG CSK 12 x 280	12030
				≥ 220	VG CSK 12 x 300	13340
	$N'_{\perp}$		6.4 - 19.1	≥ 191	VG CSK 10x 260	10380
				≥ 220	VG CSK 10 x 320	13030
				≥ 245	VG CSK 10 x 340	13580
			6.4 - 25.4	≥ 191	VG CSK 12 x 280	12930
				≥ 220	VG CSK 12 x 300	13900

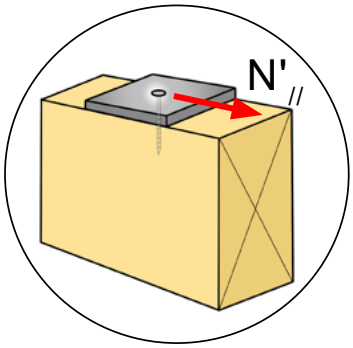
See notes under Table Table SC.2.1, page 88.

Steel Beam to Wood Connection

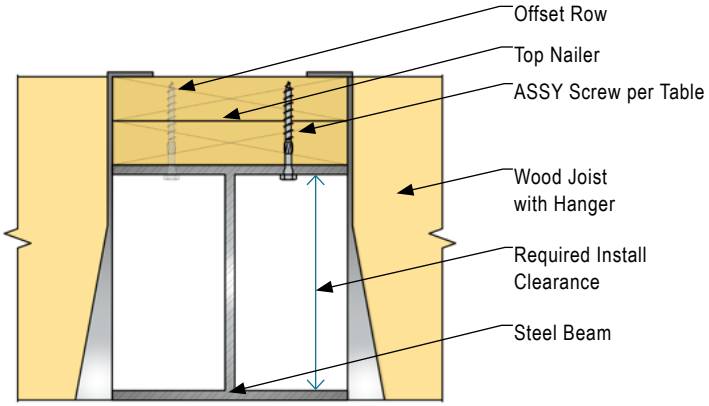
Timber joist members can be connected to structural steel I-beams by providing either web or top flange nailers that the joists can be attached to. Self-tapping screws can be installed to structurally connect nailers to the steel beam and be able to transfer in-plane lateral diaphragm forces.

Steel Beam to Web Nailer Connection





Steel Beam to Top Nailer Connection



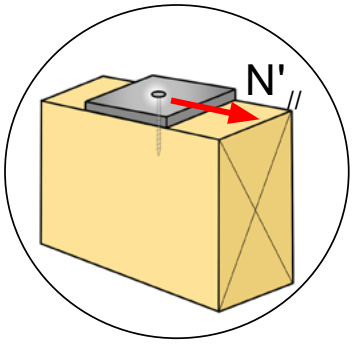


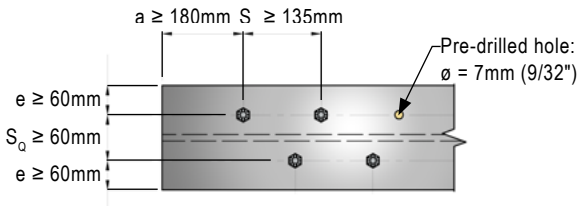
Table SC.3.1, Factored Resistances for Steel Beam to Web Nailer Connection

Steel Beam & Wood Configuration				Fastener Options		Factored Resistance [N]
Loading	Nailer Relative Density	Nailer Thickness	Flange Thickness			
$N'_{//}$	(G = 0.42)	38	2.5		Kombi 8 x 60	2270
			5		Kombi 8 x 60	
			7		Kombi 8 x 60	
			10		Kombi 8 x 60	
			12.5		Kombi 8 x 60	
	(G = 0.50)	44	2.5		Kombi 8 x 60	2470
			5		Kombi 8 x 60	
			7		Kombi 8 x 60	
			10		Kombi 8 x 60	
			12.5		Kombi 8 x 60	

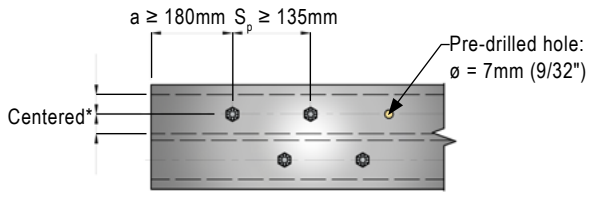
Notes:

1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada 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. Fasterner 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 90° angle intersecting the shear plane at the interface of the steel and wood members.
6. Factored resistances 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.
8. Steel beams must conform to ASTM A36/A36M-14: Standard Specification for Carbon Structural Steel (or better).
9. Engineered Wood Products (EWP) must have a relative density equivalent to 0.50 as per their respective CCMC Evaluation Report for the loading condition shown above.

Geometry Requirements



Top Connection



Web Connection

Notes:
* Fastener shall be installed centered on nailer.

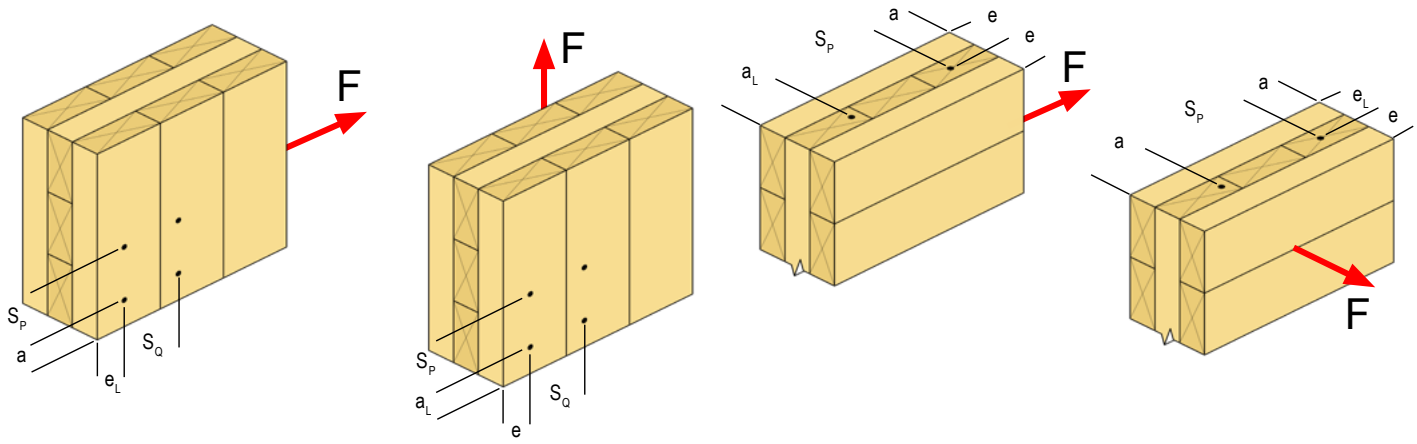
Geometry Requirements

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 CSA O86-19 Clause 12.6.2 may apply.

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



Fasteners in Plane Surface

Fasteners in Narrow Edge

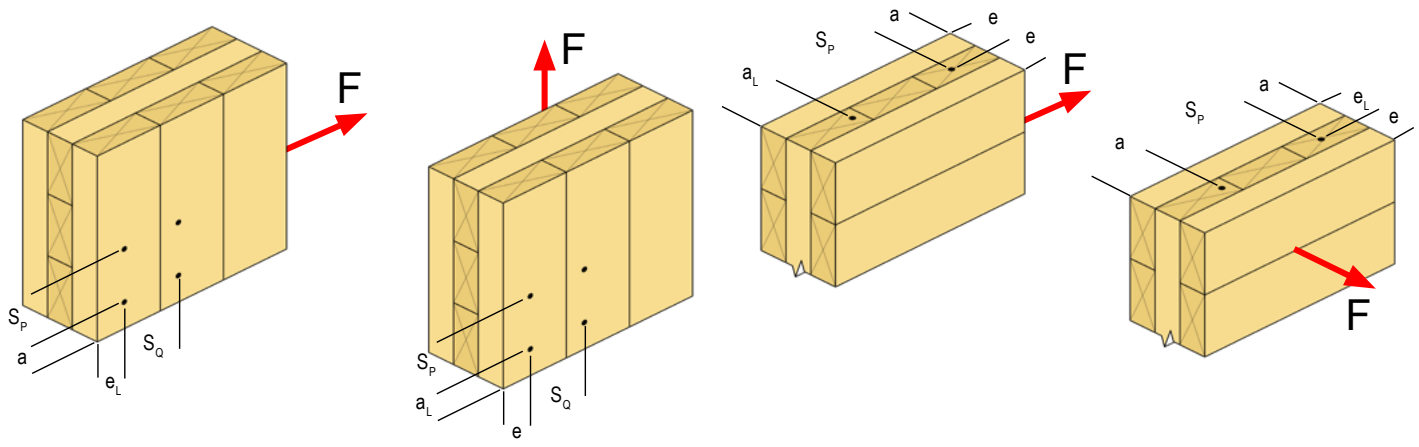
Table S.1.1, CLT Connection Geometry Requirements without Pre-drilling

CLT Plane	End Distance		Edge Distance		Spacing Between Fasteners in a Row	Spacing Between Rows
	a_L	a	e_L	e	S_P	S_Q
Fastener In Plane Surface	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

Notes:

1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
2. 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 verified in testing.
4. The listed values are applicable when the CLT panel thickness is at least 10·D.
5. 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 Distance		Edge Distance		Spacing Between Fasteners in a Row	Spacing Between Rows
	a_L	a	e_L	e	S_P	S_Q
Fastener In Plane Surface	50mm	50mm	4 D	3 D	3 D	3 D
Fastener in Narrow Edge	50mm	50mm	5 D	3 D	4 D	3 D

Notes:

1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
2. Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
3. Geometry requirements in CLT for ASSY scews with pre-drilled holes are taken from CSA O86 2019, clause 12.6.
4. Full penetration length must be pre-drilled with a hole diameter according to the pre-drilling recommendations, presented in Table S.5.

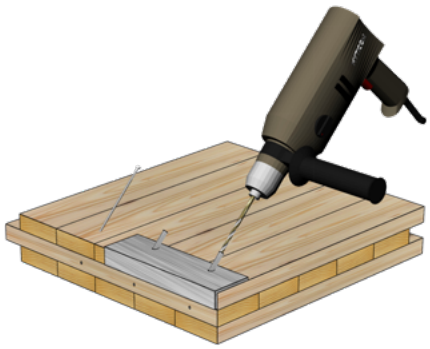
Pre-Drilling Recommendations

Table S.5, Pre-drilling hole diameter

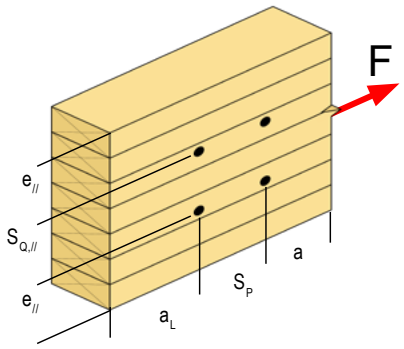
Major Diameter	Softwood	Hardwood	Steel Plate
[D]	*in. [mm]*	*in. [mm]*	*in. [mm]*
1 / 4” [6]	5 / 32” [4]	5 / 32” [4]	9 / 32” [7]
5 / 16” [8]	3 / 16” [5]	15 / 64” [6]	23 / 64” [9]
3 / 8” [10]	15 / 64” [6]	17 / 64” [7]	7 / 16” [11]
1 / 2” [12]	17 / 64” [7]	5 / 16” [8]	33 / 64” [13]

Notes:

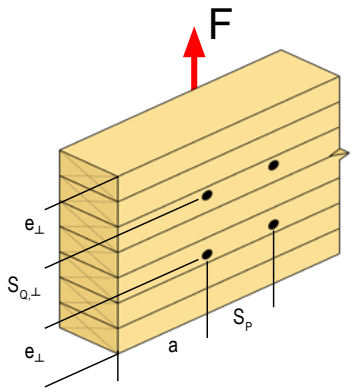
1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
2. Consult a qualified design professional before pre-drilling.
3. Pre-drilled holes that exceed the diameters listed above may reduce the capacity of the screws.
4. Recommendations only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



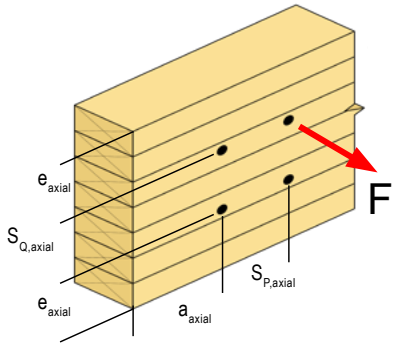
Geometry Requirements for ASSY Screws



Lateral loading parallel to grain



Lateral loading perpendicular to grain



Axial loading

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

Fastener Thread Type	Specific Gravity	End Distance			Edge Distance			Spacing Between Fasteners in a Row		Spacing Between Rows	
		a_L	a	a_{axial}	$e_{//}$	$e_{\perp}$	e_{axial}	S_p	$S_{p,axial}$	S_Q	$S_{Q,axial}$
Partial Thread	G ≤ 0.42	15 D	10 D	10 D	5 D	10 D	5 D	12 D	12 D	5 D	5 D
	0.42 < G ≤ 0.55	20 D	15 D	15 D	7 D	12 D	7 D	15 D	15 D	7 D	7 D
	D. Fir, G = 0.49	30 D	22.5 D	22.5 D	7 D	12 D	7 D	22.5 D	22.5 D	7 D	7 D
Full Thread	G ≤ 0.42	12 D	7 D	5 D	3 D	7 D	3 D	5 D	5 D	3 D	2.5 D
	0.42 < G ≤ 0.55	12 D	7 D	5 D	3 D	7 D	3 D	5 D	5 D	3 D	2.5 D
	D. Fir, G = 0.49	18 D	10.5 D	7.5 D	3 D	7 D	3 D	7.5 D	7.5 D	3 D	2.5 D

Notes:
1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
2. Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
3. According to CCMC 13677-R 2020.
4. Tabulated values listed above must prevent splitting in wood. Shall splitting be observed a design professional must be consulted immediately.
5. 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, C_{Δ}=1.0

End Distance			Edge Distance			Spacing Between Fasteners in a Row		Spacing Between Rows	
a	a_L	a_{axial}	$e_{//}$	$e_{\perp}$	e_{axial}	S_p	$S_{p,axial}$	S_Q	$S_{Q,axial}$
max(7 D;50mm)	50mm	50mm	4 D	3 D	3 D	4 D	4 D	3 D	3 D

Notes:
1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
2. Spacing, end and edge distance requirements are calculated with the nominal diameter of the fastener D.
3. Full penetration length must be pre-drilled with a hole diameter according to the pre-drilling recommvendations, presented in Table S.5.
4. According to CSA O86 2019, clause 12.6
5. Minimum fastener penetration 6·D.
6. * for softwood only

ASSY Allowable Fastener Tensile Strength

Table S.3, ASSY Allowable Tensile Strength

Major Diameter	ASSY Eco / Kombi / SK	ASSY VG CSK / VG CYL
[D]	*[kN]*	*[kN]*
6	9	9
8	15.12	15.12
10	19.20	19.20
12	24	24

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

ASSY Adjusted Fastener Torsional Strength

Table S.4, ASSY Adjusted Torsional Strength

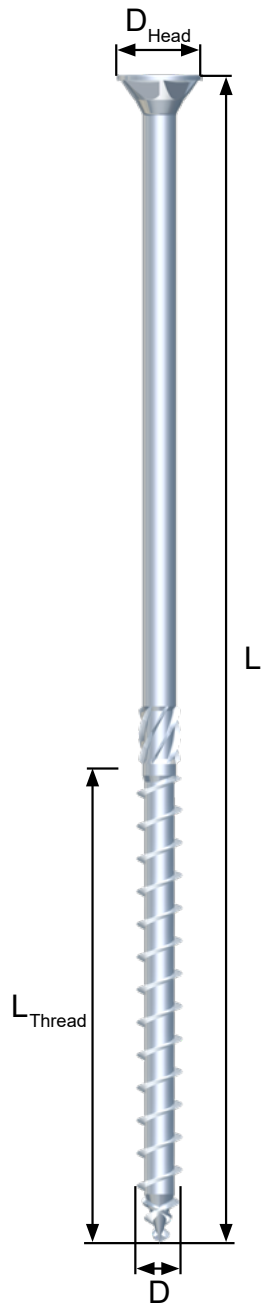
Fastener Type	Factored Torsional Strength *[N.m]*			
	[D]			
	6	8	10	12
ASSY Eco / Kombi / SK	7.27	16.73	32.73	47.27
ASSY VG CSK / VG CYL	7.27	16.73	32.73	54.55

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

Hardware

ASSY Ecofast

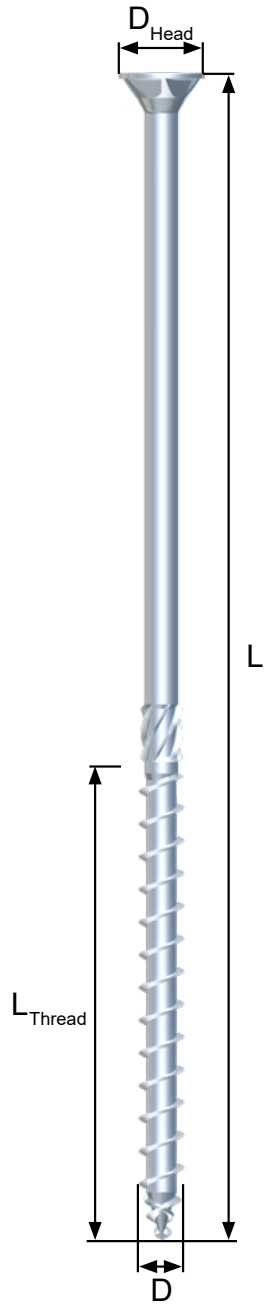
Item#	Box size	D		L		L_{Thread}		D_{Head}	Bit
#	pieces	in. [mm]		in.	[mm]	in.	[mm]	in. [mm]	
110060060000100	200	1/4 [6]		2-1/8	[60]	1-1/2	[37]	0.472 [12]	AW 30
110060070000100	200			2-3/4	[70]	1-5/8	[42]		
110060080000100	100			3-1/8	[80]	2	[50]		
110060090000100	100			3-1/2	[90]	2	[50]		
110060100000100	100			4	[100]	2 3/8	[60]		
110060120000100	100			4-3/4	[120]	2-3/4	[70]		
110060140000100	100			5-1/2	[140]	2-3/4	[70]		
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	5/16 [8]		3 1/8	[80]	2	[50]	0.591 [15]	AW 40
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			7 7/8	[200]	3 1/8	[80]		
110080220000300	75			8 5/8	[220]	4	[100]		
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:
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. [mm]		in.	[mm]	in.	[mm]	in. [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]			
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]			
110100380000300	50			**15**	[380]	**4 3/4**	[120]			
110100400000300	50			**15 3/4**	[400]	**4 3/4**	[120]			

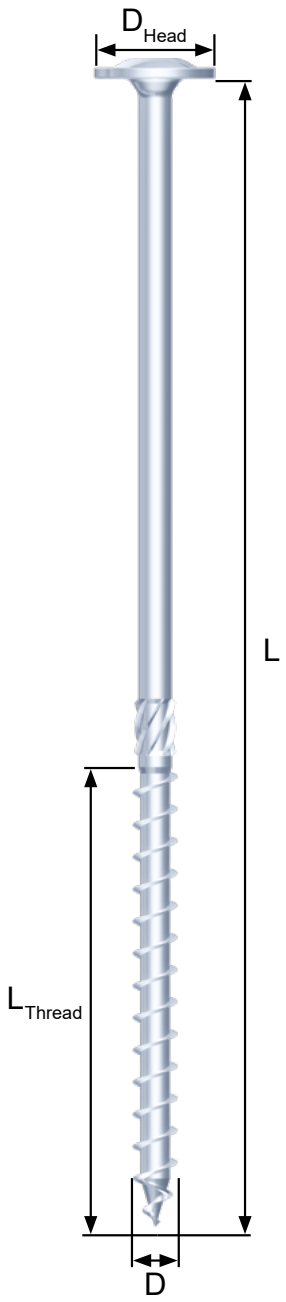
Notes:
1. For more ASSY fastener options, visit the **MTC Solutions Website** at mtcsolutions.com.



ASSY SK

Item#	Box size	D	L		L_{Thread}		D_{Head}	Bit
#	pieces	in. [mm]	in.	[mm]	in.	[mm]	in. [mm]	
120060060000303	100	1/4 [6]	2-1/8	[60]	1-1/2	[37]	0.551 [14]	AW 30
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		4-3/4	[120]	2-3/4	[70]		
120060140000303	100		5-1/2	[140]	2-3/4	[70]		
120060160000303	100		6-1/4	[160]	2-3/4	[70]		
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]		

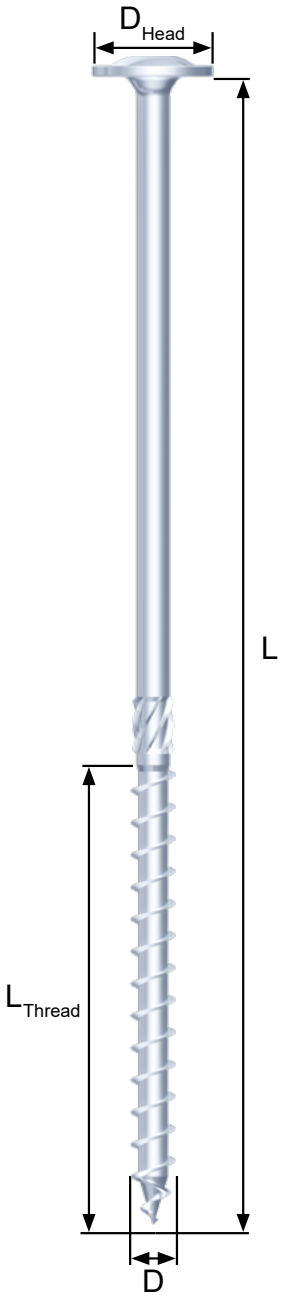
Item#	Box size	D	L		L_{Thread}		D_{Head}	Bit
#	pieces	in. [mm]	in.	[mm]	in.	[mm]	in. [mm]	
120080080000303	50	5/16 [8]	3 1/8	[80]	2	[50]	0.870 [22.1]	AW 40
120080100000303	50		4	[100]	2 3/8	[60]		
120080120000300	50		4 3/4	[120]	3 1/8	[80]		
120080140000303	50		5 1/2	[140]	3 1/8	[80]		
120080160000303	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		9 1/2	[240]	4	[100]		
120080260000303	50		10 1/4	[260]	4	[100]		
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. [mm]		in.	[mm]	in.	[mm]	in. [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**		**8 5/8**	[220]	**4**	[100]	**0.992**	
120100260000303	50	[10]		**10 1/4**	[260]	**4**	[100]	[25.2]	**AW 50**
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 Thread		D Head	Bit
#	pieces	in. [mm]		in.	[mm]	in.	[mm]	in. [mm]	
120120020000300	25			**7 7/8**	[200]	**4**	[100]		
120120026000300	25			**10 1/4**	[260]	**4 3/4**	[120]		
120120040000300	25	**1/2**		**15 3/4**	[400]	**5 3/4**	[145]	**1.157**	
120120048000300	25	[12]		**19**	[480]	**5 3/4**	[145]	[29.4]	**AW 50**
120120052000300	25			**20 1/2**	[520]	**5 3/4**	[145]		

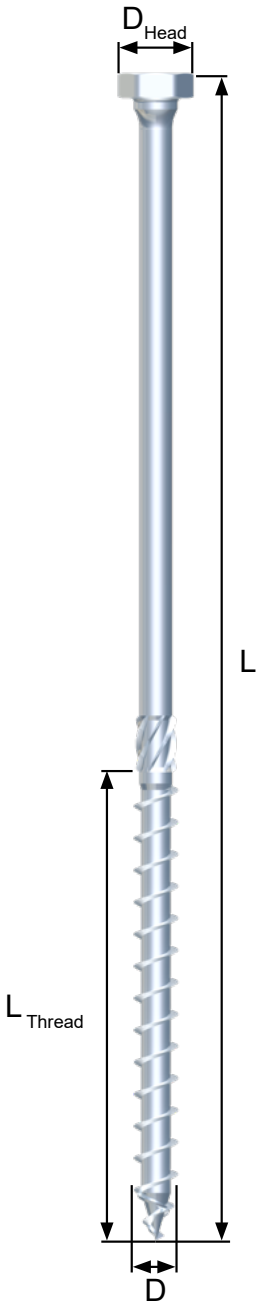


Notes:
1. For more ASSY fastener options, visit the **MTC Solutions Website** at mtcsolutions.com.

ASSY Kombi

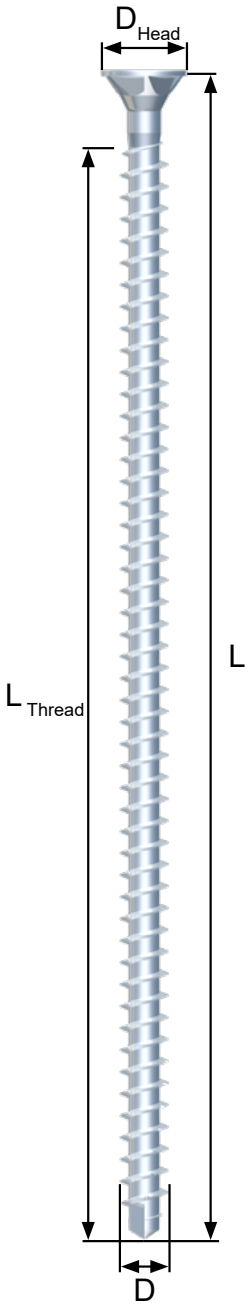
Item#	Box size	D		L		L_{Thread}		D_{Head}	Bit
#	pieces	in. [mm]		in.	[mm]	in.	[mm]	in. [mm]	
130080060000103	75		**5/16 [8]**	**2 3/8**	[60]	**1 1/2**	[40]	**0.472** [12]	**AW 40 or 1/2 socket**
130080080000103	75			**3 1/8**	[80]	**2**	[50]		
130080100000103	75			**4**	[100]	**2 3/8**	[60]		
130080120000103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

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



ASSY VG CSK

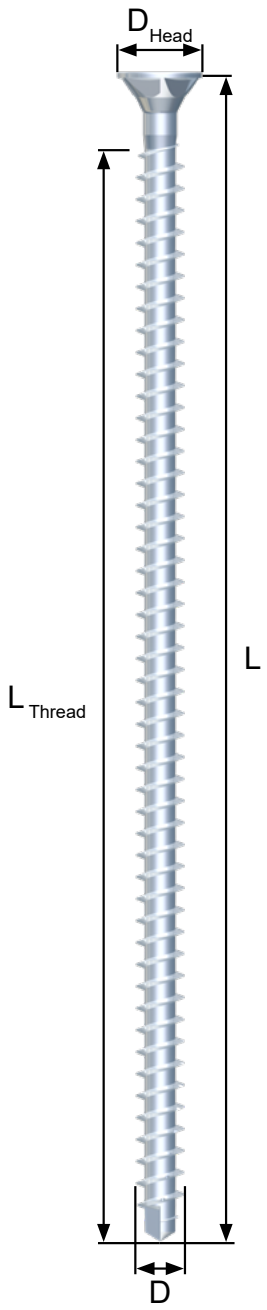
Item#	Box size	D		L		L Thread		D Head	Bit	
#	pieces	in. [mm]		in.	[mm]	in.	[mm]	in. [mm]		
140080080000102	75			**3-1/8**	[80]	**2-1/2**	[61]			
140080120000102	75			**4-3/4**	[120]	**4**	[103]			
140080140000100	75			**5-1/2**	[140]	**4-7/8**	[123]			
140080160000102	75			**6-1/4**	[160]	**5-5/8**	[143]			
140080180000102	75			**7-1/8**	[180]	**6-3/8**	[163]			
140080200000102	75		**5/16** [8]	**7-7/8**	[200]	**7-1/4**	[183]	**0.591** [15]		**AW 40**
140080220000102	75			**8-5/8**	[220]	**8**	[203]			
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			**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			**14 1/4**	[360]	**13 5/8**	[345]			
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.

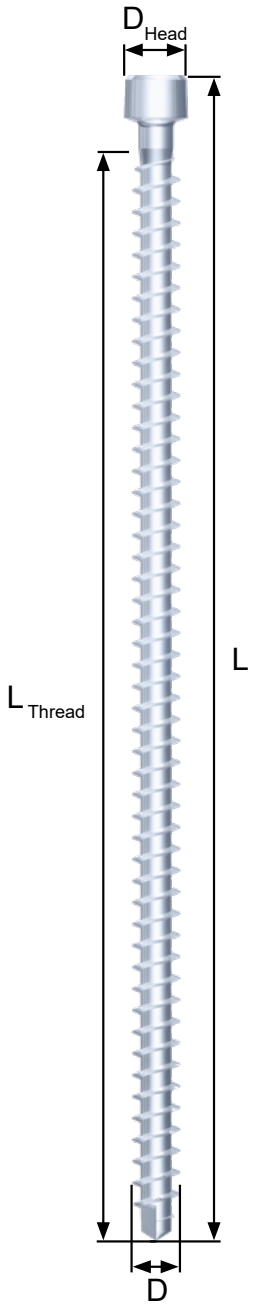
Item#	Box size	D		L		L_{Thread}		D_{Head}	Bit	
#	pieces	in. [mm]		in.	[mm]	in.	[mm]	in. [mm]		
140120120000102	50			**4 3/4**	[120]	**4 1/8**	[105]			
140120140000100	50			**5 1/2**	[140]	**4 7/8**	[125]			
140120160000102	50			**6 1/4**	[160]	**5 3/4**	[145]			
140120200000102	50			**7 7/8**	[200]	**7 1/4**	[185]			
140120260000102	50		**1/2 [12]**	**10 1/4**	[260]	**9 5/8**	[245]	**0.885** [22.5]		**AW 50**
140120280000102	50			**11**	[280]	**10 4/9**	[265]			
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 mtcsolutions.com.



ASSY VG Cyl

Item#	Box size	D		L		L_{Thread}		D_{Head}	Bit	
#	pieces	in.	[mm]	in.	[mm]	in.	[mm]	in. [mm]		
150060080000302	100	1/4 [6]		3 1/8	[80]	2 7/8	[73]	0.323 [8.2]		AW 30
150060100000302	100			4	[100]	3 5/8	[93]			
150060120000302	100			4 3/4	[120]	4 1/2	[113]			
150060140000302	100			5 1/2	[140]	5 1/4	[133]			
150060160000302	100			6 1/4	[160]	6	[153]			
150060180000302	100			7 1/8	[180]	6 3/4	[173]			
150060200000302	100			7 7/8	[200]	7 5/8	[193]			
150080160000302	50	5/16 [8]		6 1/4	[160]	5 5/8	[144]	0.394 [10]		AW 40
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			11 7/8	[300]	11 1/8	[284]			
150080330000302	50			13	[330]	12 3/8	[314]			
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	3/8 [10]		7 1/8	[180]	6 1/2	[165]	0.528 [13.4]		AW 50
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			17	[430]	16 3/8	[415]			
150100480000302	25			19	[480]	18	[456]			
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]			



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

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.


AW 30


AW 40

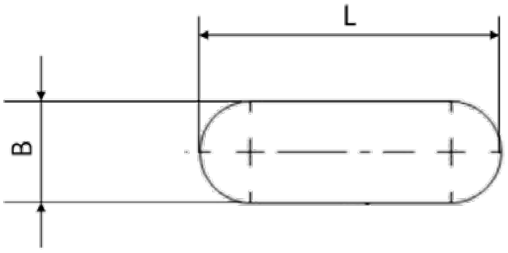

AW 50

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	B		L		Steel Plate Thickness	
	min	max	min	max	min	max
	in. *[mm]*					
5 / 16” *[8]*	**0.394** *[10]*	**0.433** *[11]*	**1.26** *[32]*	**1.299** *[33]*	**0.157** *[4]*	**0.591** *[15]*
3 / 8” *[10]*	**0.433** *[11]*	**0.472** *[12]*	**1.732** *[44]*	**1.772** *[45]*	**0.197** *[5]*	**0.787** *[20]*
1 / 2” *[12]*	**0.512** *[13]*	**0.551** *[14]*	**1.969** *[50]*	**2.008** *[51]*	**0.236** *[6]*	**0.934** *[25]*



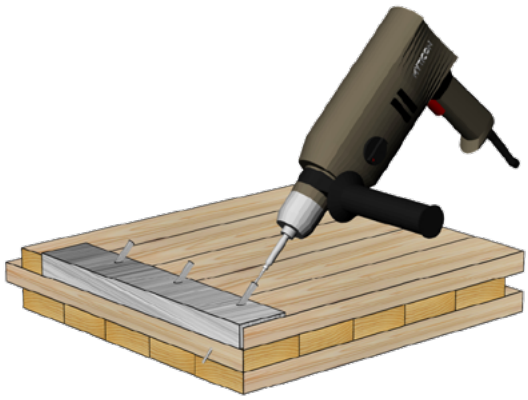
Notes:
1. For coated steel plates the hole size needs to be oversized taking the thickness of the coating into account. Test fitting of wedge washers into steel plate holes is required to assure required tolerances are in place.

Drill recommendation

Use low rpm drill with high torque:

- ½ drill for 1/4" [6mm] and 5/16" [8mm] screws
- ¾ drill for 3/8" [10mm] and 1/2" [12mm] 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.

Brock Commons

Vancouver, British Columbia

MTC Solutions provides sustainable, high quality mass timber connection solutions to a rapidly evolving and thriving industry. We drive innovation through certified research and development and contribute our part to the education of young talent and experienced professionals in the technology used in sustainable design.

Credit Stephane Groleau

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SOLUTIONS

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mtcsolutions.com