MTC SOLUTIONS

# Structural Screw Connection Design Guide

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## Disclaimer

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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

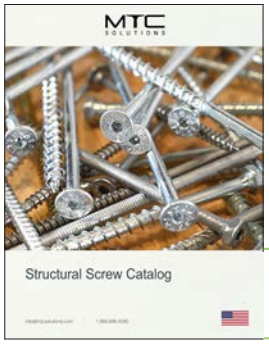
We are dedicated to making your project a success, from design and installation support to delivering high quality products with speed and accuracy.

### 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.




Structural Screw Catalog

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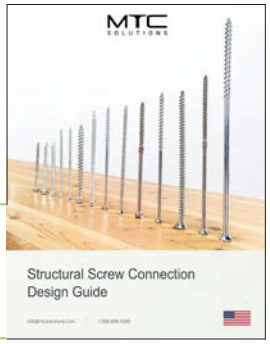


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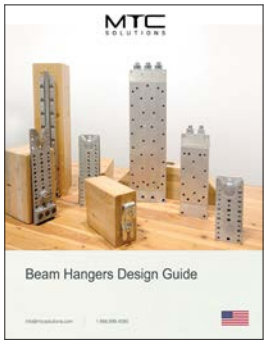


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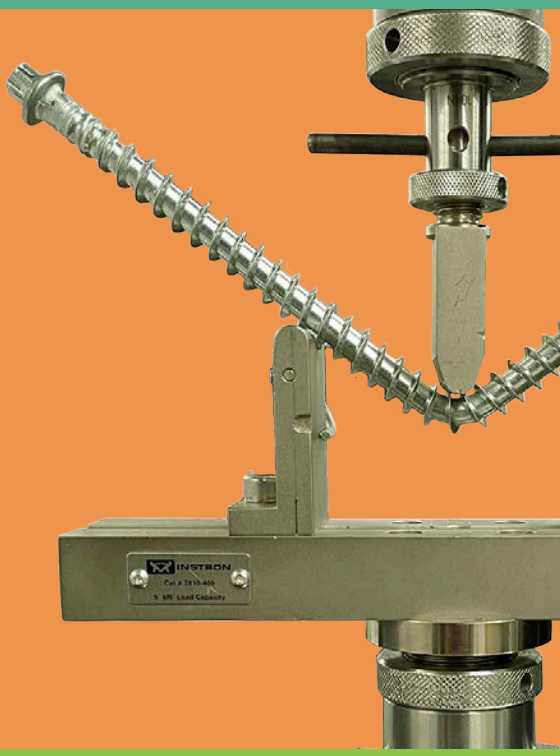
WHO ARE WE?

# YOUR MASS TIMBER HARDWARE SUPPLIER

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

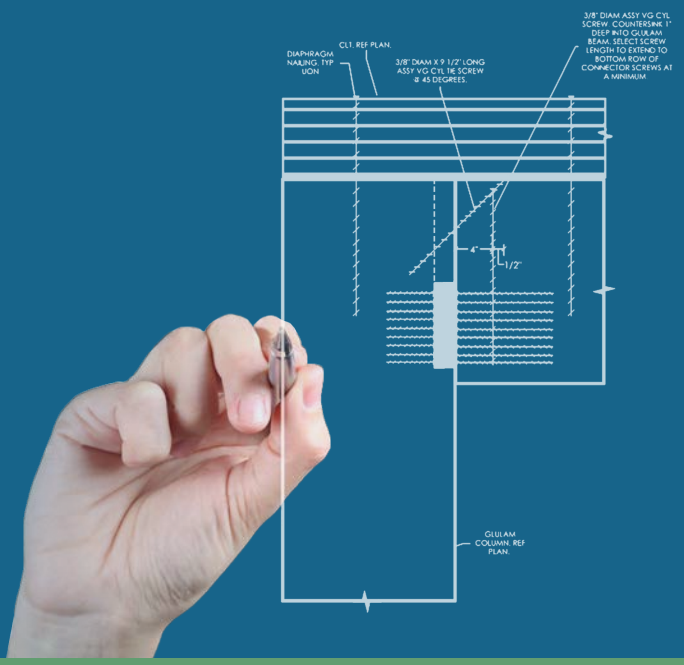
# LEADING WITH INNOVATION & RESEARCH

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

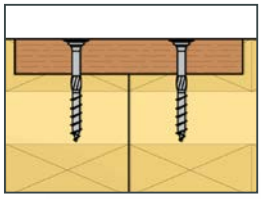
Use our comprehensive & practical resources to find the most cost-effective solutions for your structural elements.

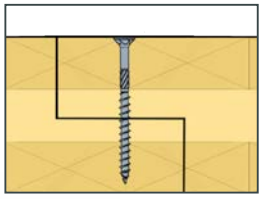
# TESTED & PROVEN SOLUTIONS

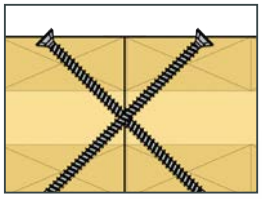
Count on MTC Solutions' 10+ years of expertise, providing tested & proven ICC approved solutions, support, and resources.

# General Information









Panel to Panel Connections

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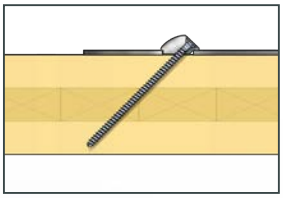

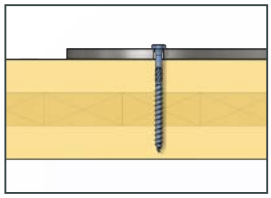

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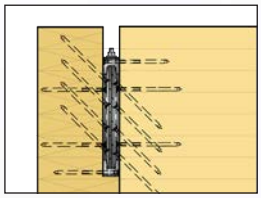

Post to Beam Connections

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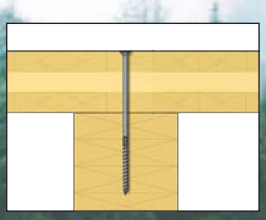

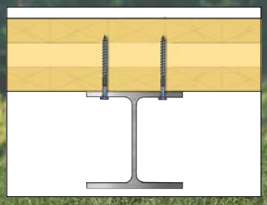

Panel to Beam Connections

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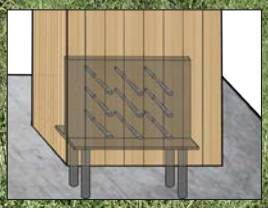

Self-Drilling Dowel Connections

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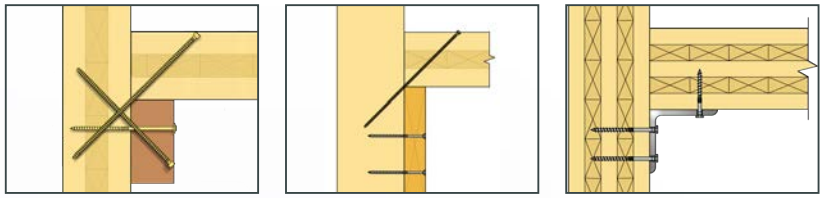

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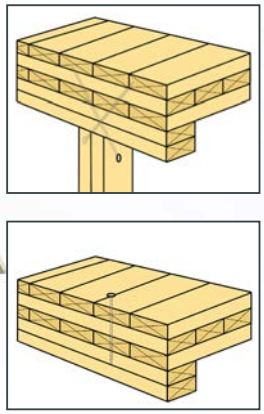

Floor to Wall Connections

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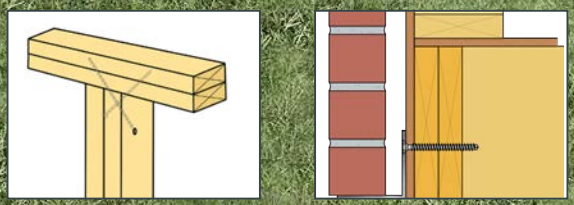

Wall Connections

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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

ES 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

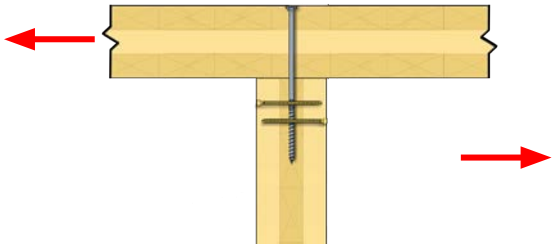
The high withdrawal resistance and tensile strength of fully threaded self-tapping screws can be used in many ways to compensate for low strength loading directions in timber or CLT. Some common failure modes and reinforcing solutions are explained below.

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.

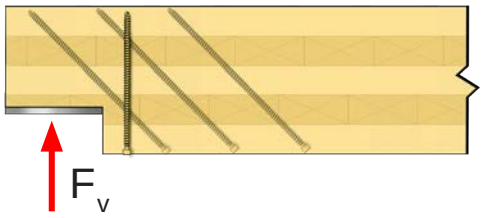
Notches at the tension face of bending members can also overstress the CLT members. In many cases, fully threaded fasteners can be designed to transfer the tensile load components, preventing accidental brittle failure modes.

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.

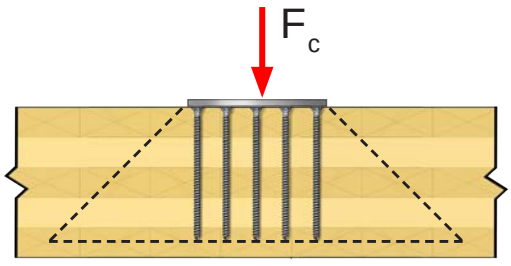
CLT can sometimes be limited by the relatively low rolling shear strength and stiffness of the crossing plies. Reducing the thickness of cross layers may mitigate this issues of low rolling shear strength and stiffness. Fully threaded screws can be used to reinforce the CLT against shear stresses activated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



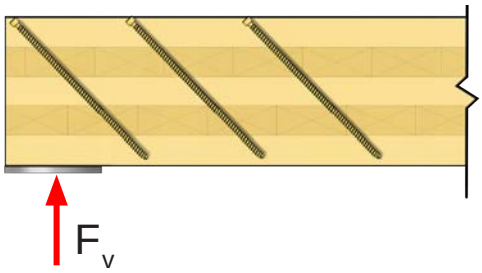
CLT floor to wall connection reinforcement to minimize risk of brittle failures




CLT notch reinforcement with a full thread screws




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



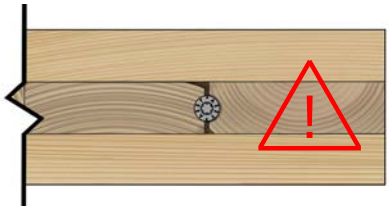

CLT rolling shear reinforcement using inclined full thread screws

## 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.



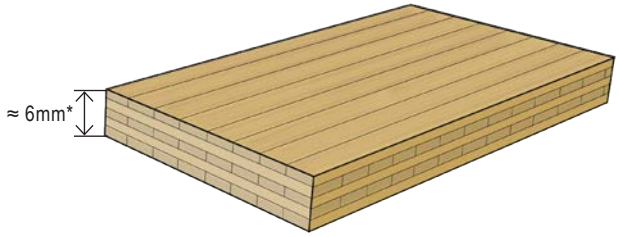
Screw Installed in a Gap in the Narrow Edge

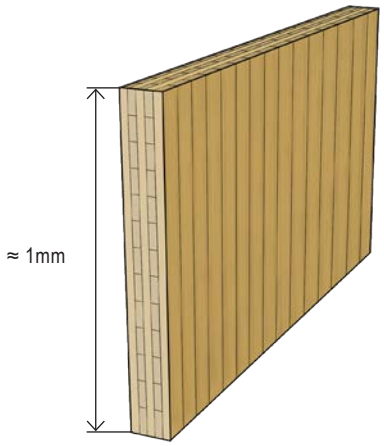
Screw Installed in the Narrow Edge

## 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.

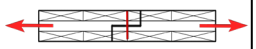
## Design Table Guidelines

**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

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

$N_r$ 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.

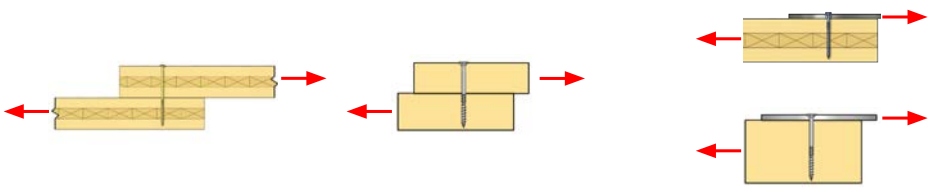
# Connection Design

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.

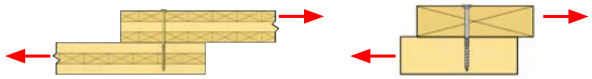


## $N'_{m,\perp}$ - Parallel to Grain Loading of Side Member

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

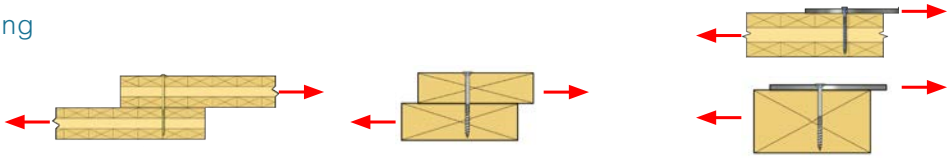
## $N'_{s,\perp}$ - Parallel to Grain Loading of Main Member

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.

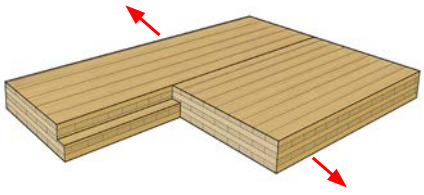


## P' - Withdrawal Loading

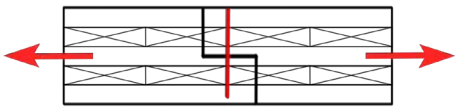
Connection with self-tapping screw loaded in withdrawal through one or two wood members. Factored withdrawal resistances in the provided tables is the minimum of the withdrawal, tensile and the head-pull through capacity of the fastener. Other failure modes remain responsibility of the qualified designer.

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

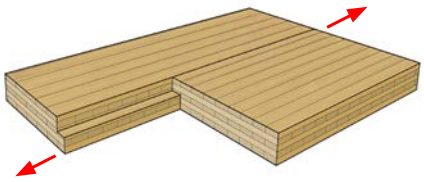
Loading perpendicular to the connection plane:



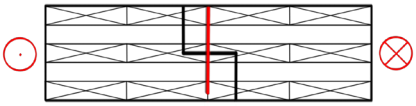
Icon:



Loading parallel to the connection plane:



Icon:



# 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

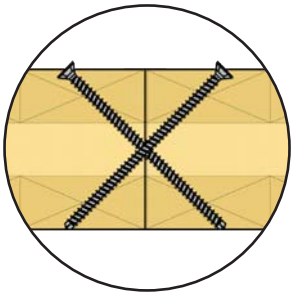
Courtesy of Alex Schreyer

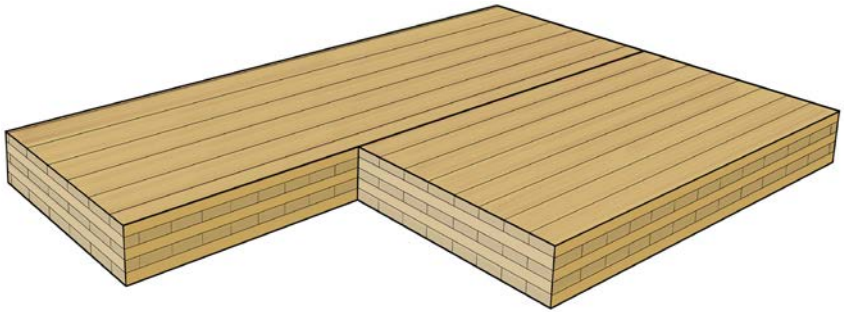
# Typical Panel to Panel Connections

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.

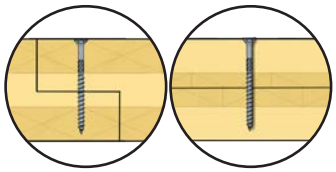
- **The Butt joint** is the simplest connection type from a fabrication point of view, as the panels are simply cut straight at the edges. It requires short machining time and less material is lost during production.
- **Lap joints** require more prefabrication than butt joints. For this, part of the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

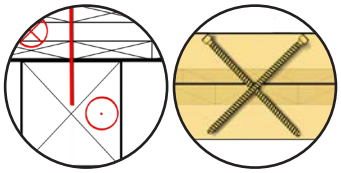




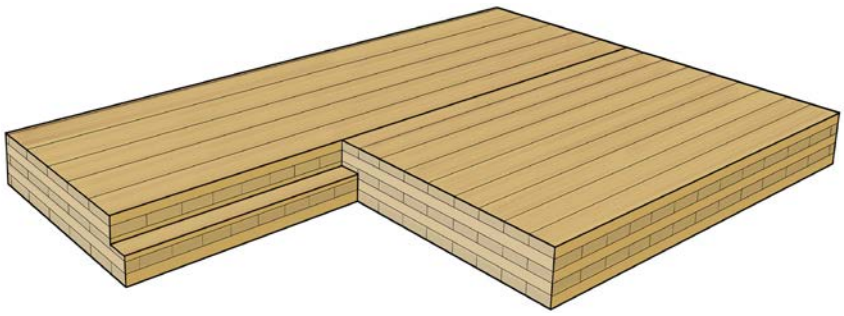
## Lap Joint Connection



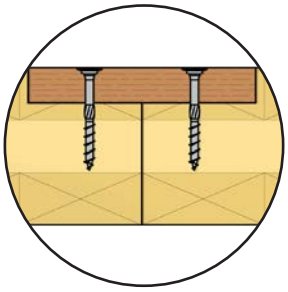
Lap Joint Connection in Shear

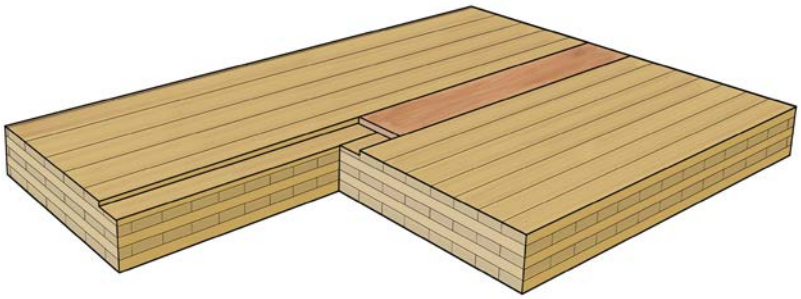


Lap Joint Connection with Inclined Screws



## Surface Spline Connection



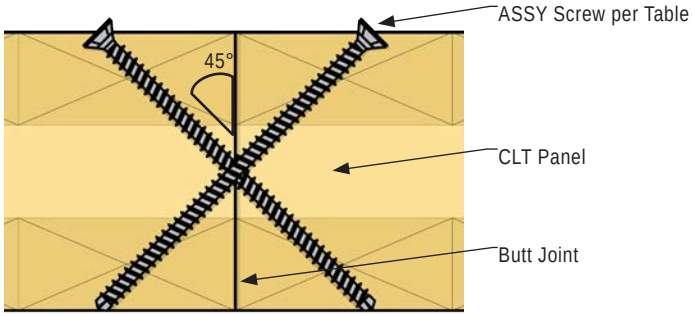


# CLT Butt Joint Connection in Shear

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.



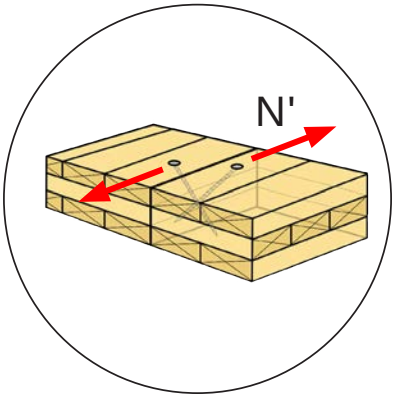



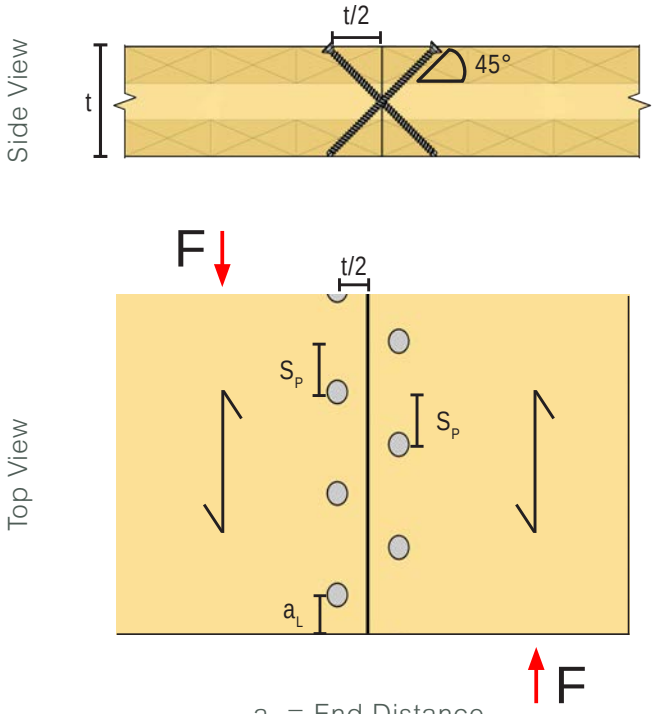

Table PP.1.1, Factored Resistances for CLT Butt Joints Loaded in Shear

| 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 | $N'_{\parallel}$ | | 105 | VG Cyl 6 x 140 | 664 | 764 | 24 |
| | $N'_{\perp}$ | | | | 464 | 534 | |
| 5 PLY | $N'_{\parallel}$ | | 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. $N'_{\parallel}$ 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°.

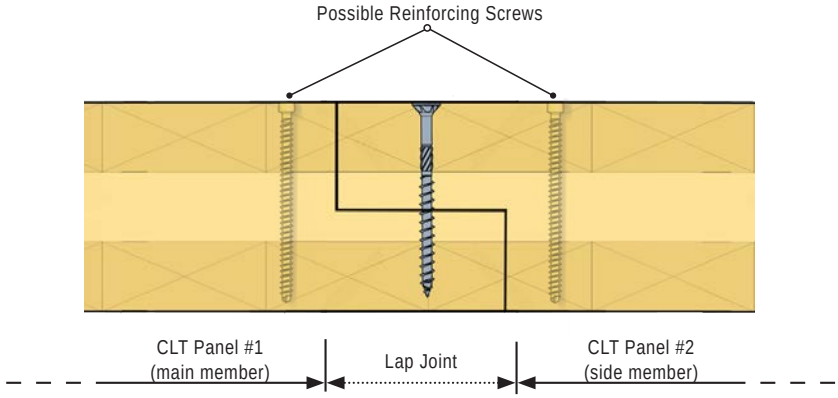
## Geometry Requirements

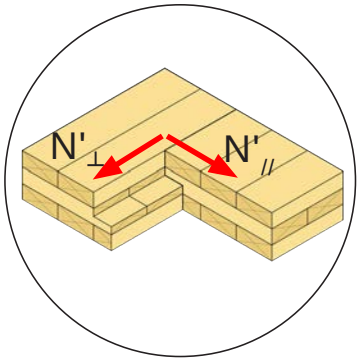



$a_L$ = End Distance

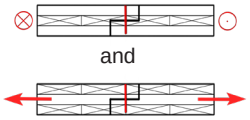
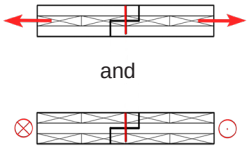
# CLT Lap Joint Connection in Shear

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.



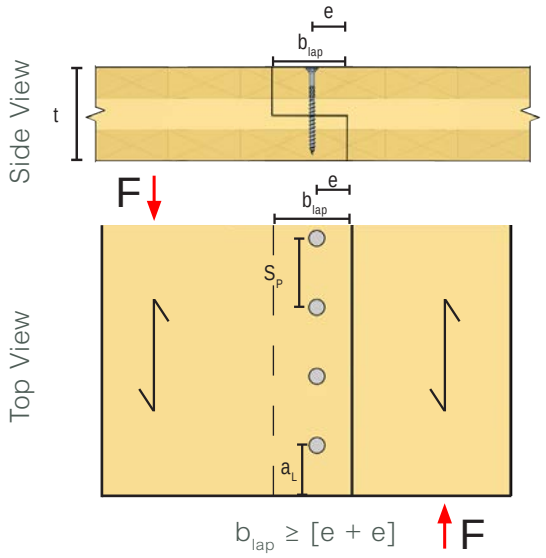

## Table PP.2.1, Factored Resistances for CLT Lap Joints Loaded in Shear

| 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 |

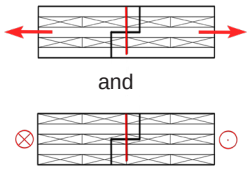
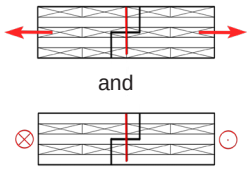
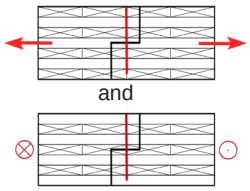
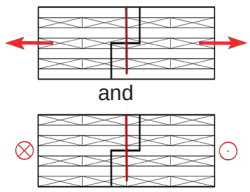
Notes:

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 | $N'_{II}$ |  | 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 | $N'_{II}$ |  | 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 |

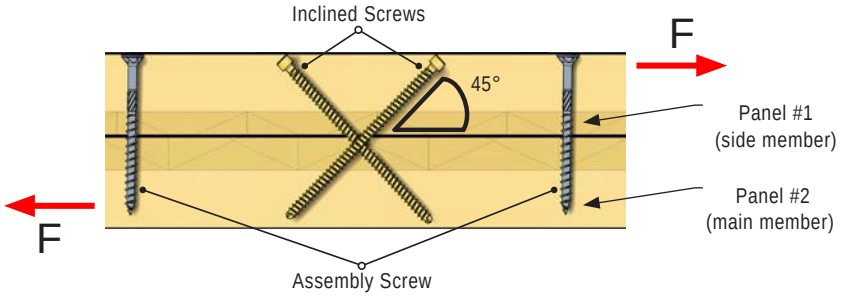
Notes:

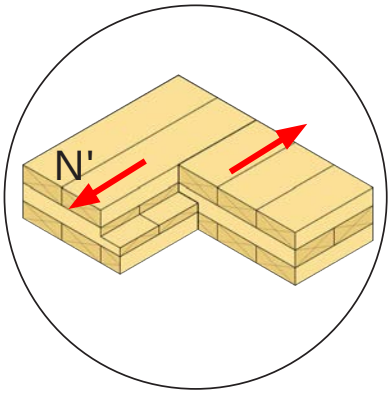
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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. $N'_{II}$ 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.



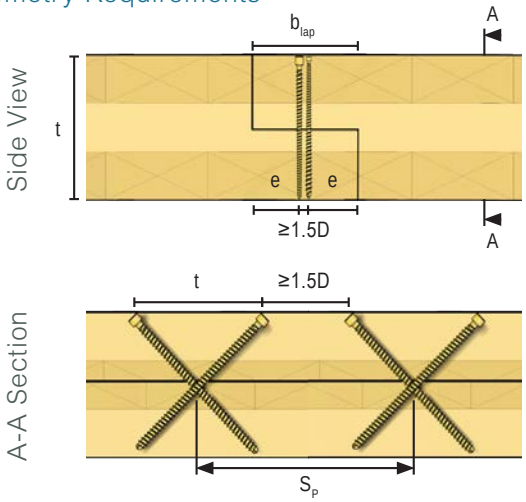

## Table PP.3.1, Factored Resistances for CLT Lap Joints with Inclined Screw Crosses

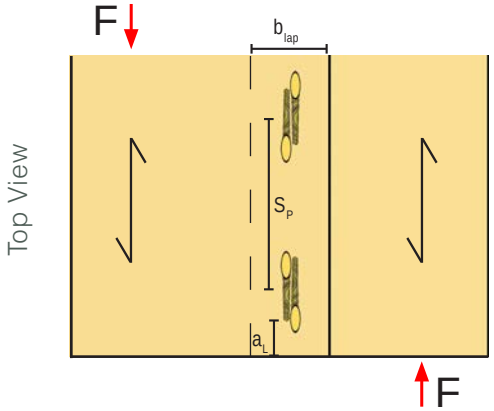
| Panel & Joint Configuration | | | | Fastener Options | Factored Resistance per Screw Cross [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|
| Loading | | | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 3 PLY | $N'_{//}$ | | 105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

Notes:

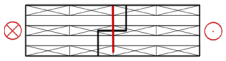
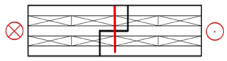
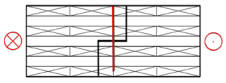
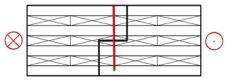
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
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 | | | Panel Thickness (t) | Fastener Options | Factored Resistance per Screw Cross [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|
| Loading | | | | | 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.

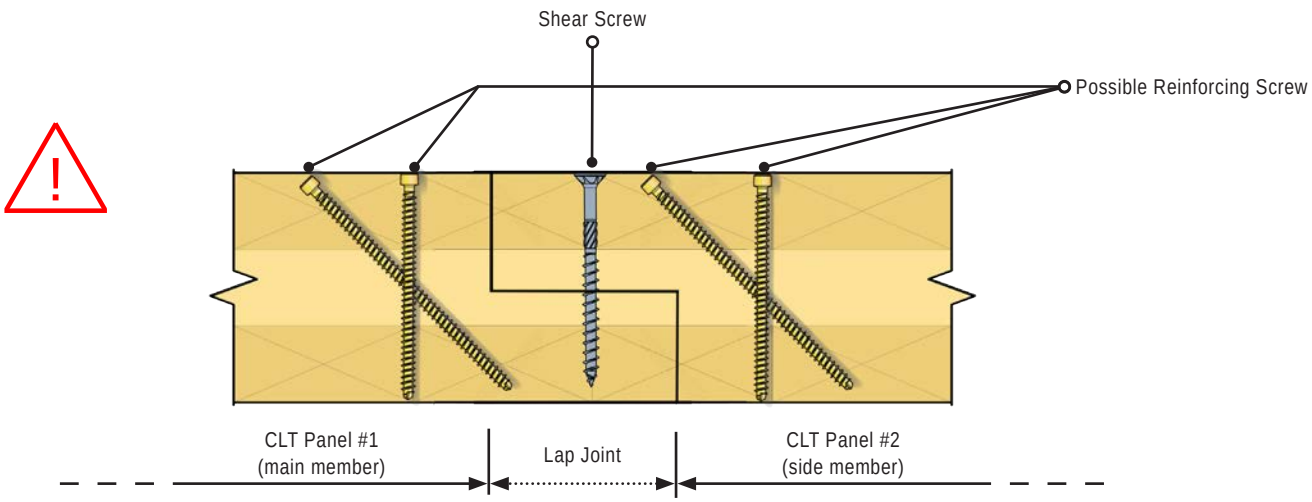
Coding standards, including the CSA O86, do not provide directives for notches on the tension side of CLT panels. Therefore, there are no fully developed procedures outlining the unique material characteristics, stress distribution patterns and crack propagation path along the unglued lamella edges within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

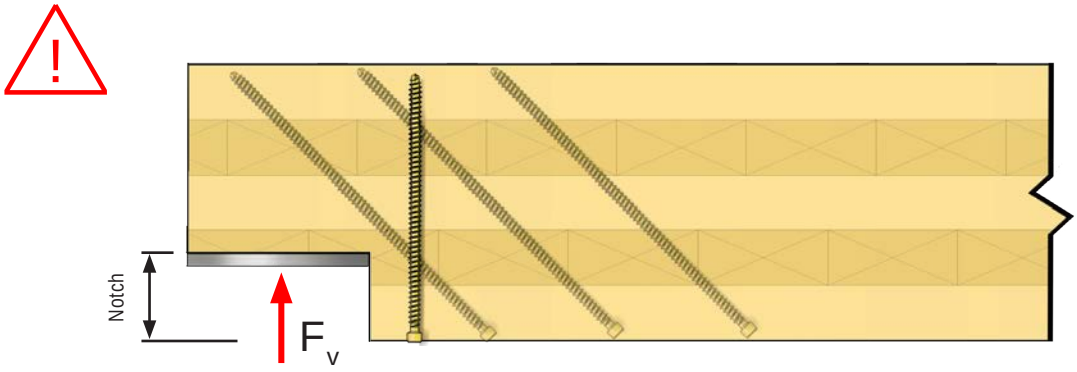
Designers are asked to be more conservative when designing notches with out of plane loading or to avoid them whenever possible.

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



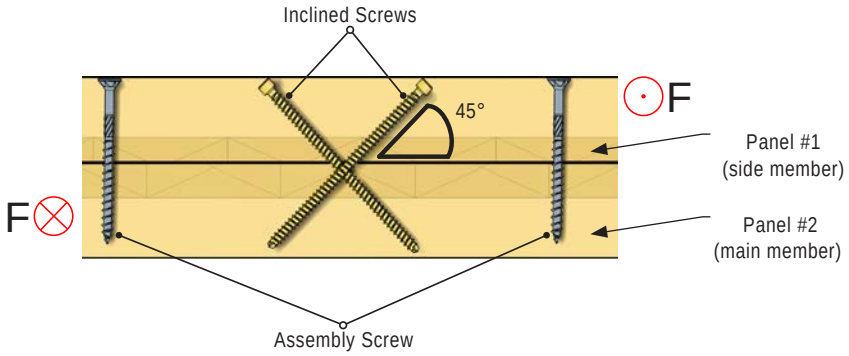



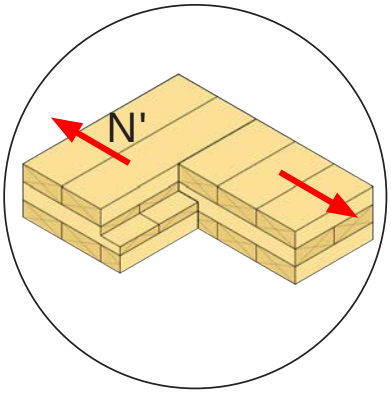
# Brock Commons

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.



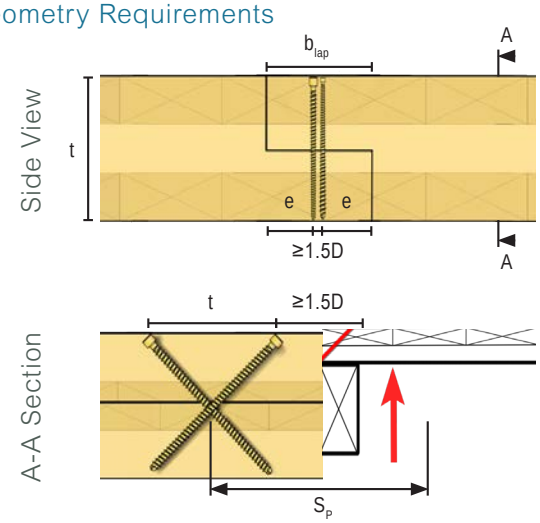

## Table PP.4.1, Factored Resistances for CLT Lap Joints with Inclined Screw Crosses

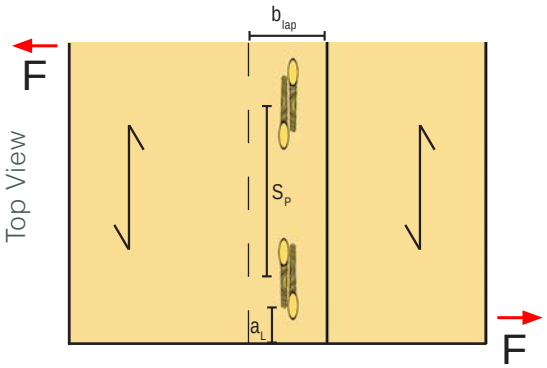
| Panel & Joint Configuration | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|
| Loading | | | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 3 PLY | $N'_{II}$ | | 105 | VG cyl 6 x 140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

Notes:

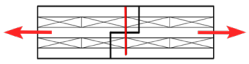
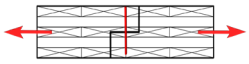
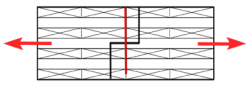
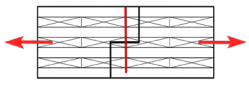
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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. $N'_{II}$ 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 | | | 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 | |
| 5 PLY | $N'_{\parallel}$ |  | 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 | $N'_{\parallel}$ |  | 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. $N'_{\parallel}$ 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.

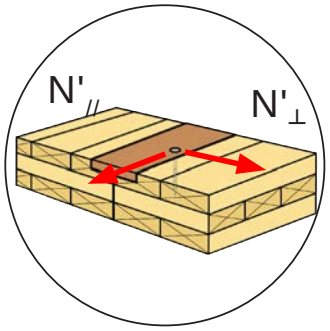
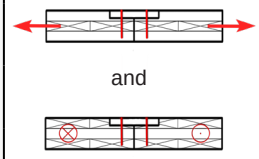
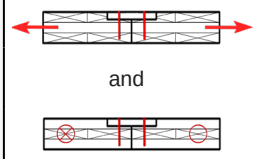
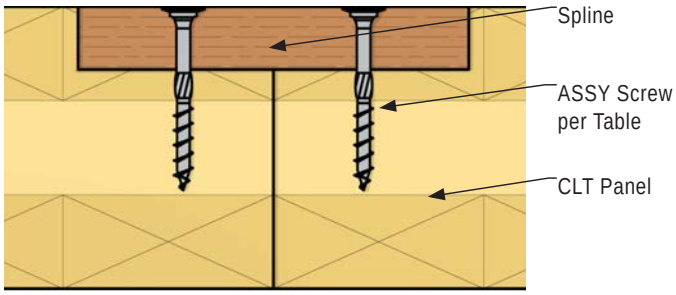



Table PP.5.1, Factored Resistances for CLT Surface Spline Joints Loaded in Shear

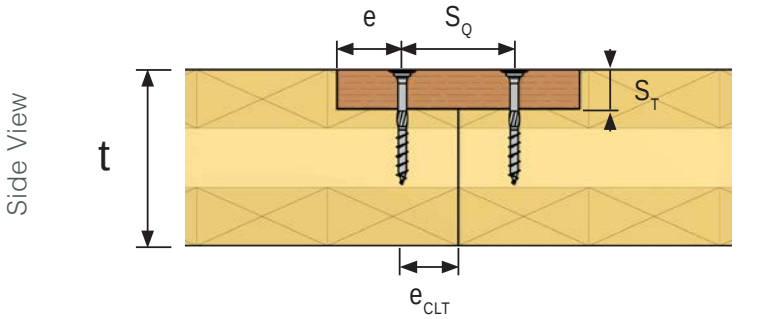
| Panel & Spline Configuration | | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|---|
| Loading | | | Spline Thickness | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 3 PLY | $N'_{//}$ |  | 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 |

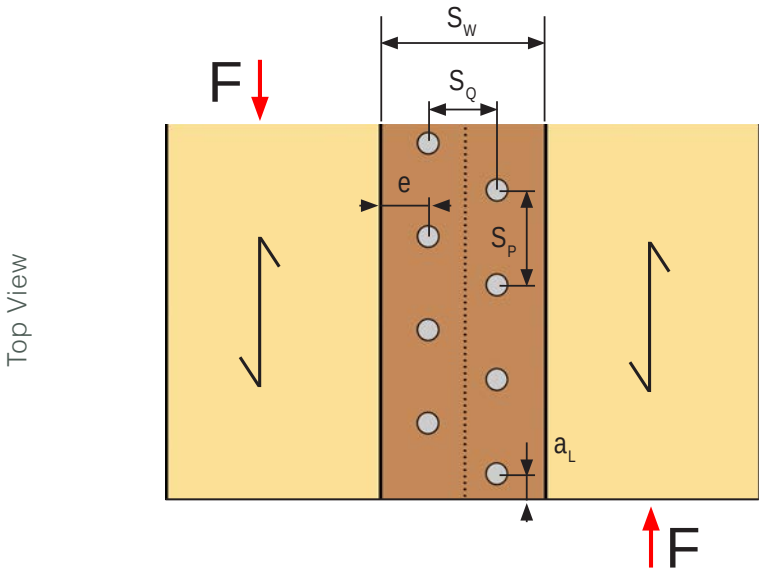
Notes:

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 $\Theta = 90°$.

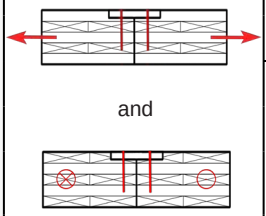
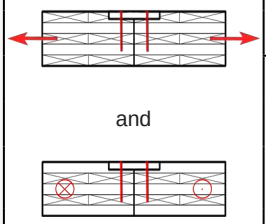



## Geometry Requirements



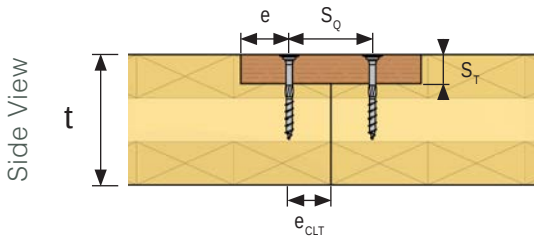

## Table PP.5.2, Factored Resistances for CLT Surface Spline Joints Loaded in Shear

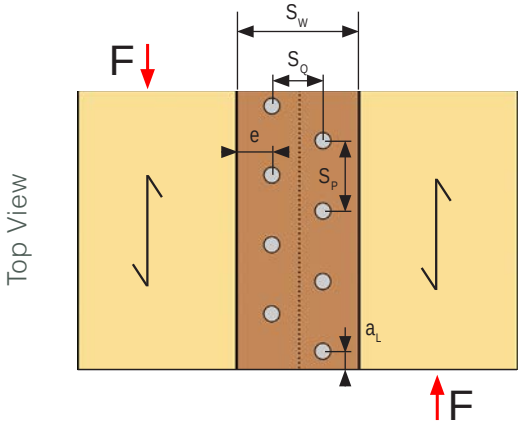
| Panel & Spline Configuration | | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|---|
| Loading | | | Spline Thickness | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 5 PLY | $N'_{II}$ |  | 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:

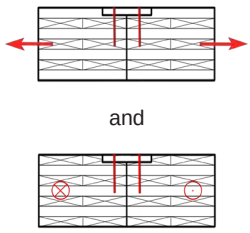
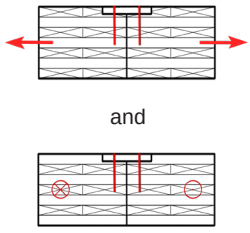
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. 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. $N'_{II}$ 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

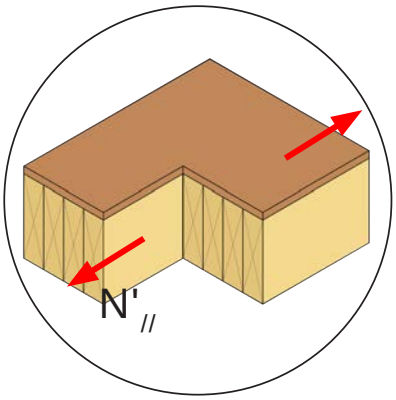
| Panel & Spline Configuration | | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|---|
| Loading | | | Spline Thickness | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 7 PLY | $N'_{//}$ |  | 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:

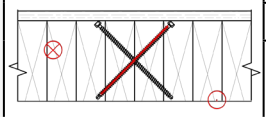
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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.



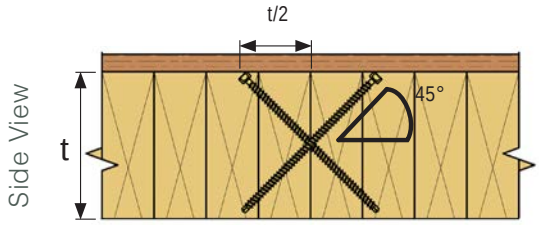

## Table PP.6.1, Factored Resistances for NLT Butt Joints Loaded in Shear

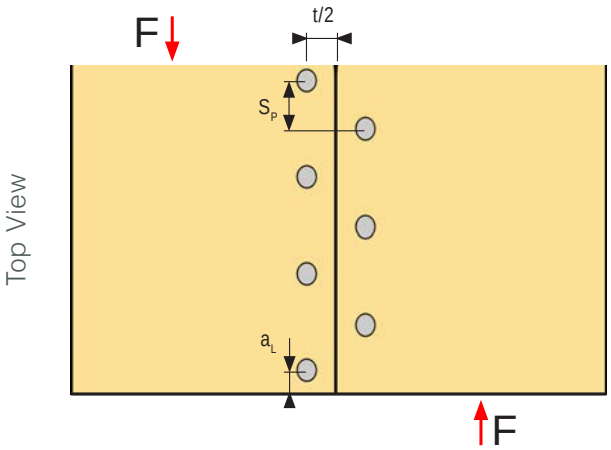
| NLT Panel & Joint Configuration | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|
| Loading | | | Panel Thickness (t) | | Standard Loading $C_D$ =1.0 | Short Term Loading $C_D$ =1.15 | |
| NLT | $N'_{//}$ |  | 89 | VG Cyl 6 x 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. $N'_{//}$ Angle between loading direction and wood grain in the shear plane Θ = 0°.

## Geometry Requirements




# Kiln

Portland, Oregon

# First Tech Credit Union

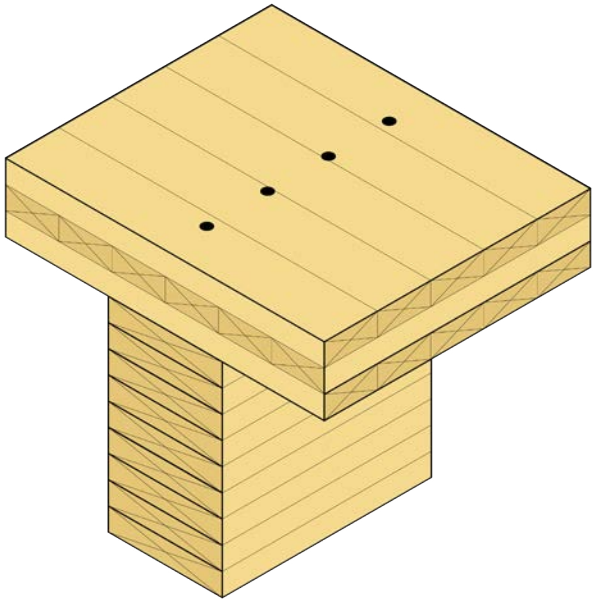
Hillsboro, Oregon

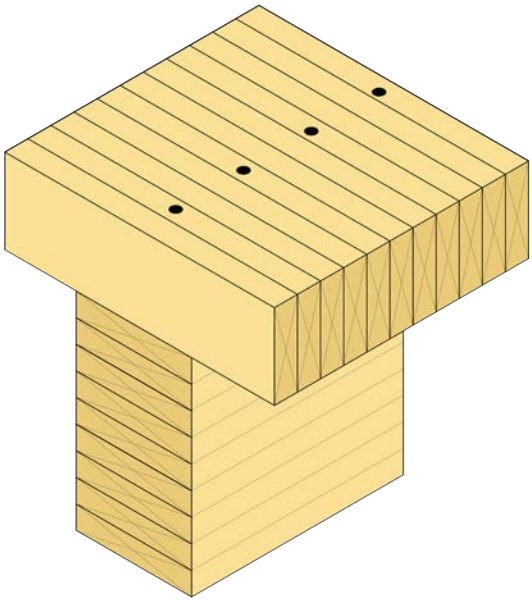
Courtesy of Oregon Forest Resources Institute

# Panel to Beam Connections

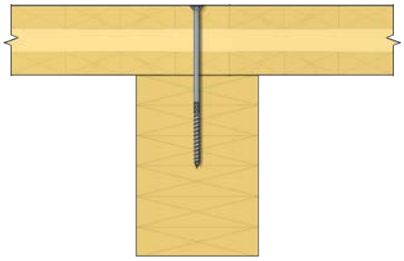
For post and beam structures, diaphragm forces are often transferred to collector elements such as beams, which then transfer the forces to the lateral load resisting system on the way down to the foundation. Floor to beam connections often benefit from the high strength and stiffness of fully threaded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

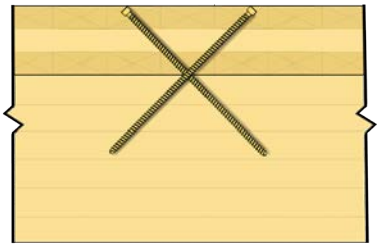




## Typical Panel to Glulam Beam Connections

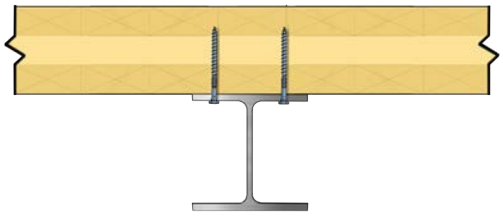


CLT panel to Glulam beam connection with a fastener in shear, see page 38 for details.

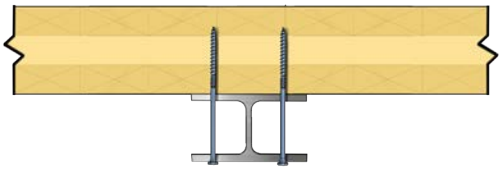


Connection with inclined fasteners arranged in a screw cross, see page 44 for details.

## Typical Panel to Steel Beam Connections



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



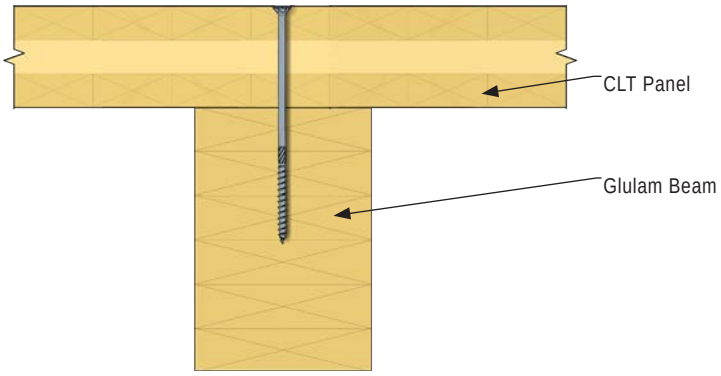
CLT shallow H-beam connection using shear screws, see Steel to Wood Connections Section.

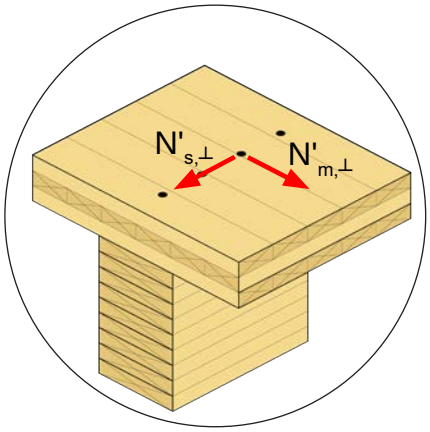
# CLT Panel to Beam Connection in Shear

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.

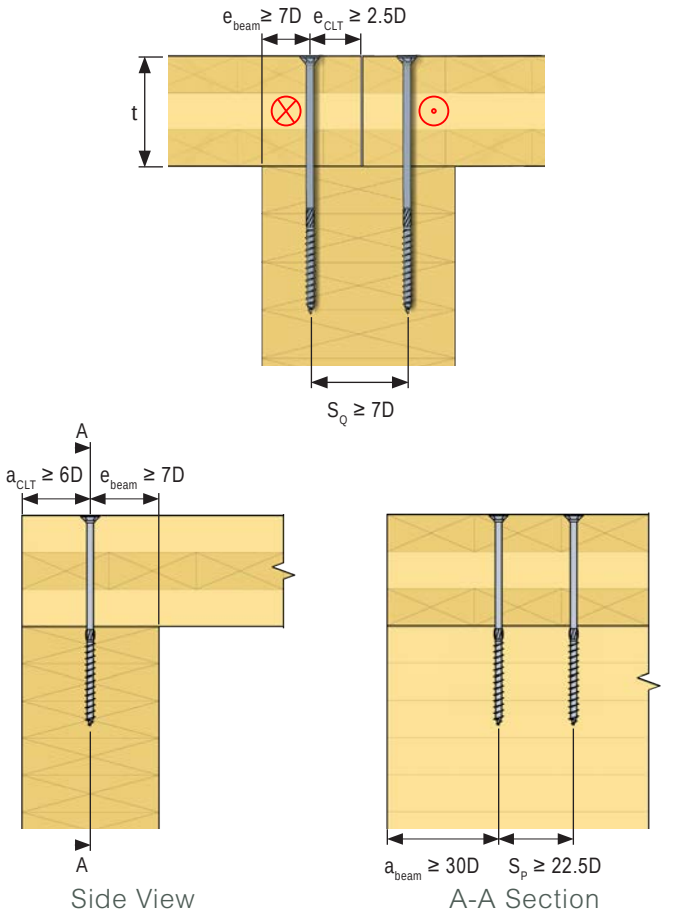
If the CLT panel or the beam is expected to shrink, screws should be countersunk enough so that they do not push into the concrete slap on top of the CLT panel.



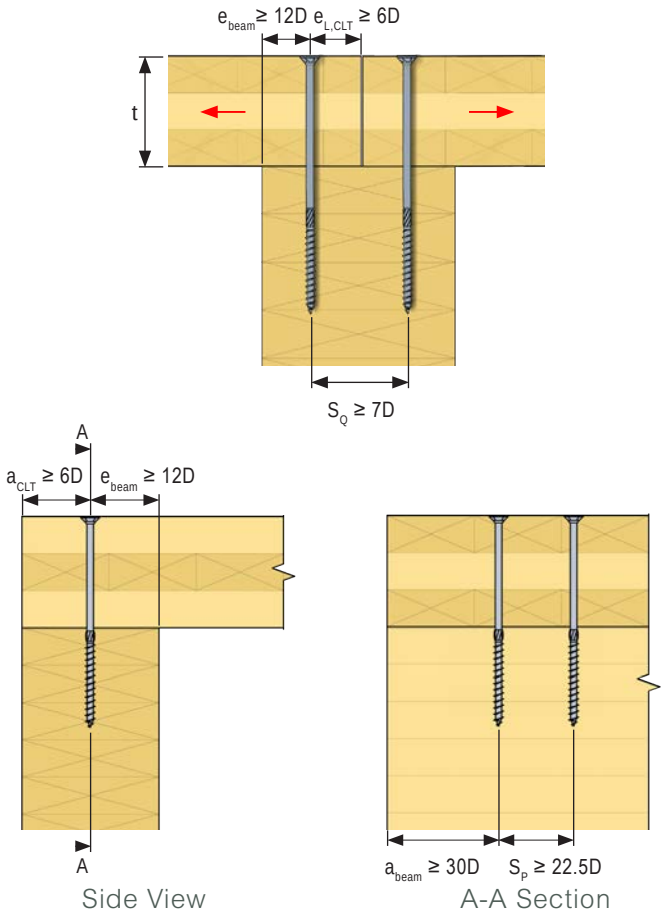




## Geometry Requirements

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

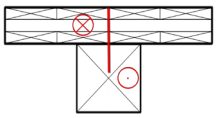
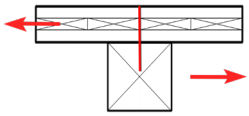
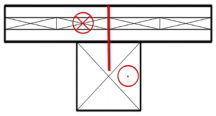
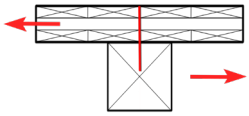



### $N'_{m,\perp}$ & $N'_{\perp}$




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

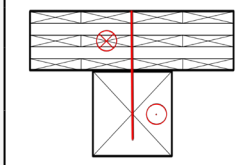
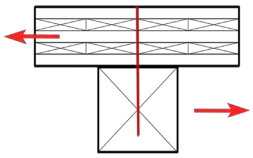
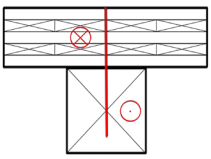
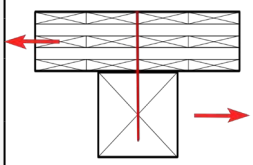
## Table PB.1.1, Factored Resistances for CLT Panel to Beam Connections in Shear

| 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 | $N'_{II}$ |  | 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. $N'_{II}$ 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°.

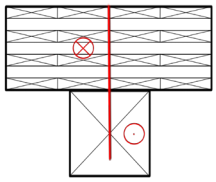
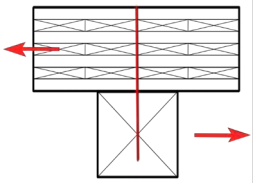
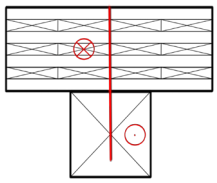
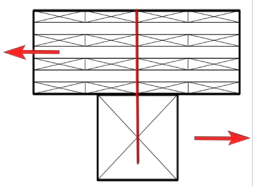
## Table PB.1.2, Factored Resistances for CLT Panel to Beam Connections in Shear

| 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°.

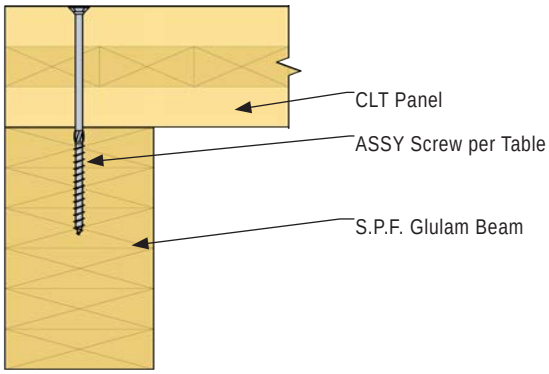
## Table PB.1.3, Factored Resistances for CLT Panel to Beam Connections in Shear

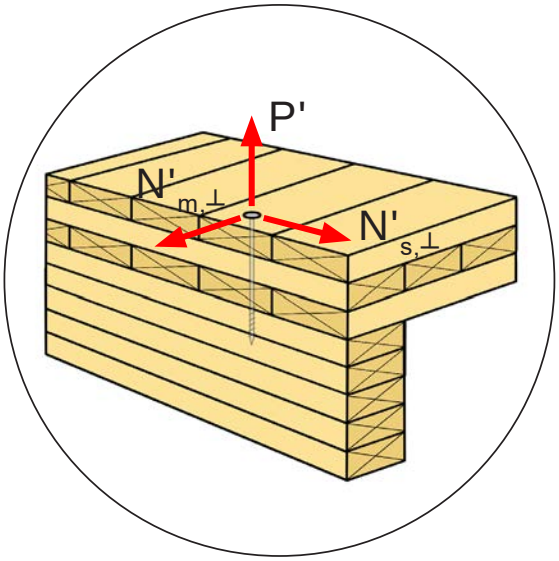
| CLT Panel & Beam Configuration | | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|---|
| | Loading | | Beam Type | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 7 PLY | $N'_{//}$ |  | 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:

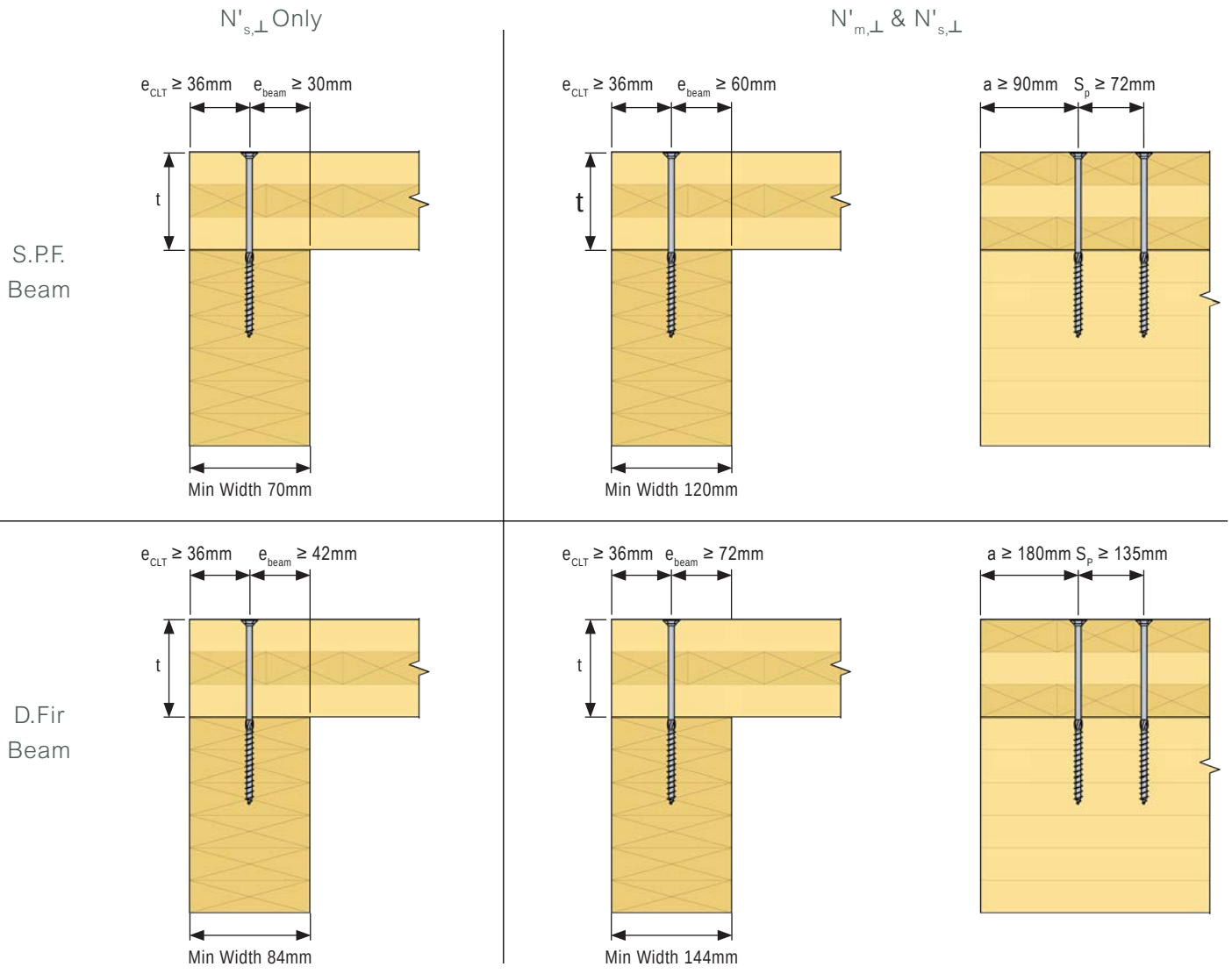
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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.

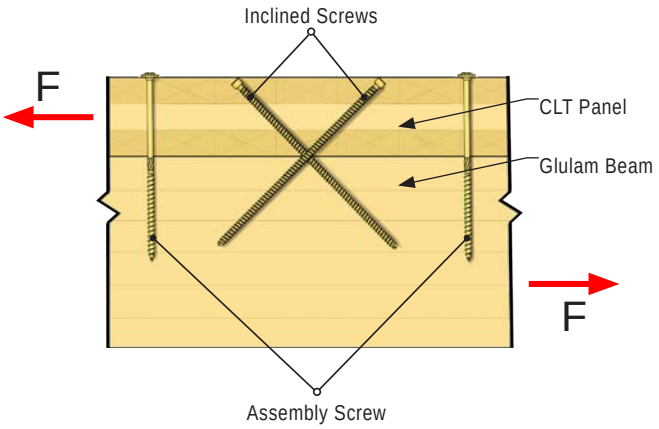
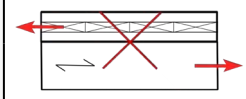
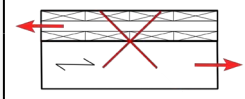


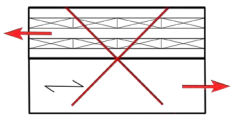
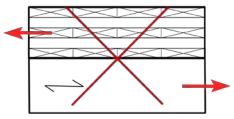
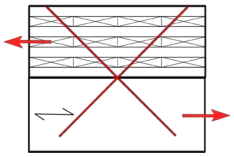
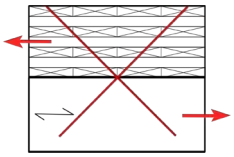

Table PB.2.1, Factored Resistances for CLT Panel to Beam Connection Inclined Screws Crosses

| 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

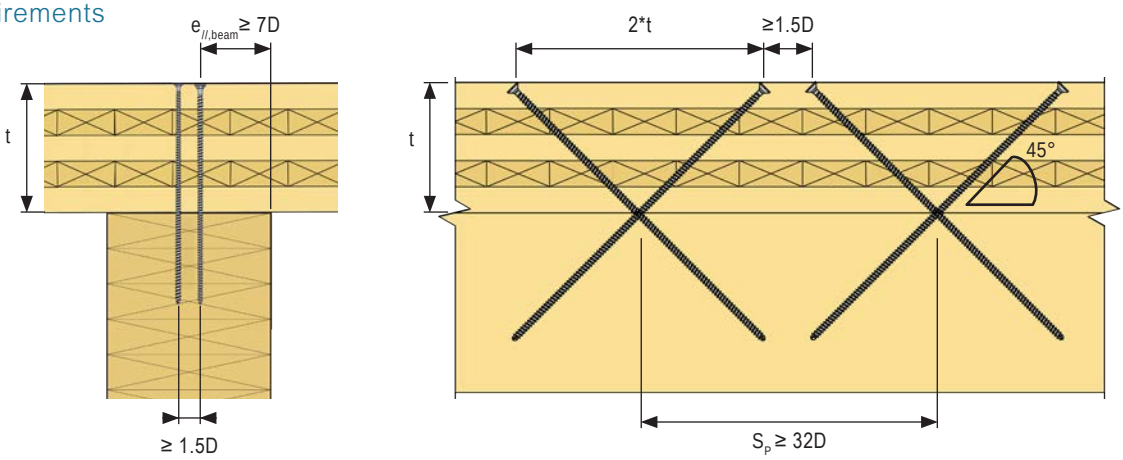
| CLT Panel & Joint Configuration | | | | | Fastener Options | Factored Resistance per Screw Cross [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|---|
| Loading | | | Beam Type | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 5 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

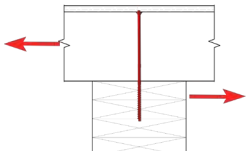
CLT - SPF

Beam - D.Fir



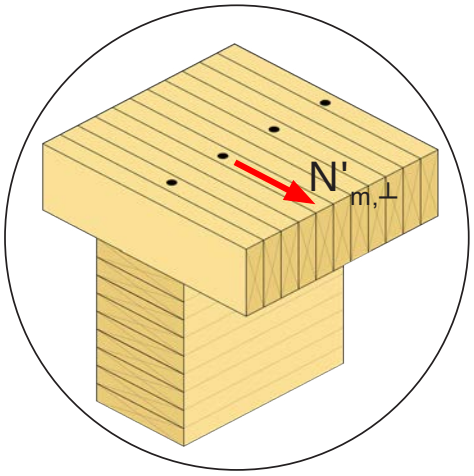
# NLT Panel to Beam Connection in Shear

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

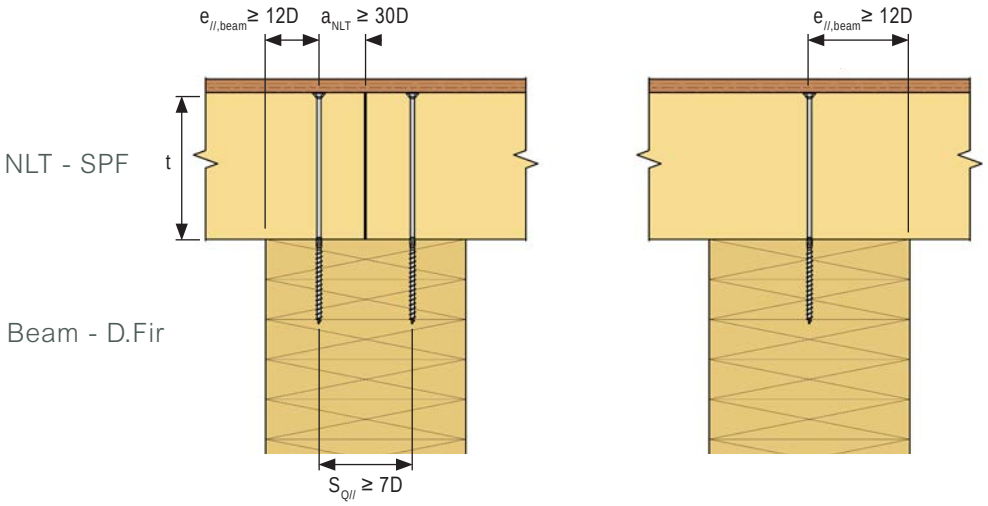
| NLT Panel & Beam Configuration | | | | | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|---|
| Loading | | | Beam Type | Panel Thickness (t) | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| NLT | $N'_{m,\perp}$ |  | 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°).

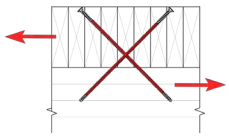



## Geometry Requirements



# 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 | |

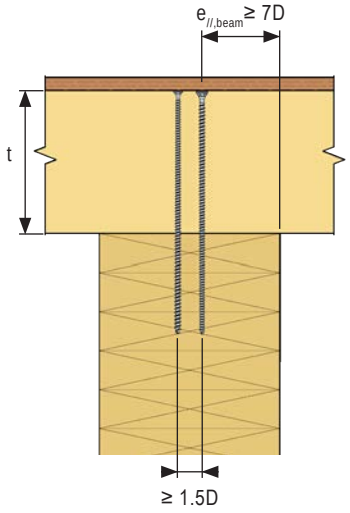
Notes:

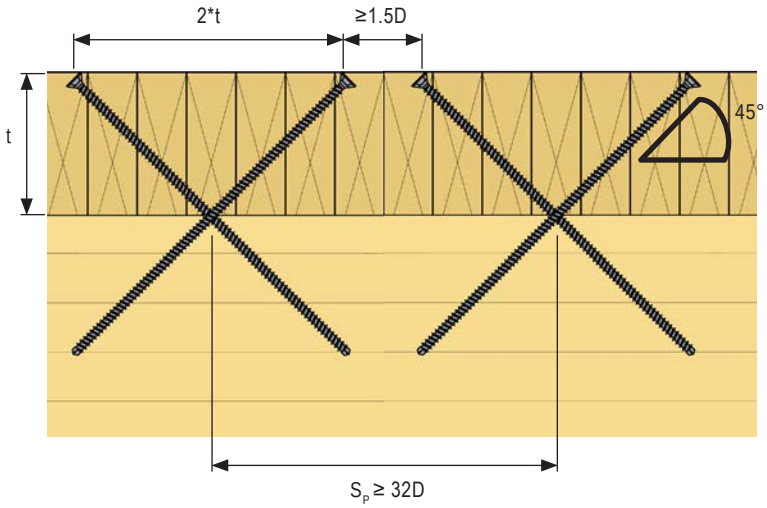
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
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

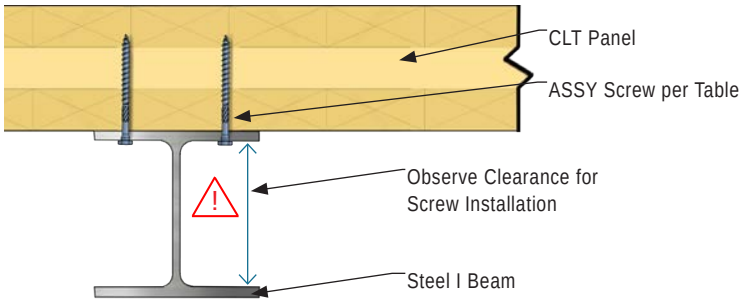
NLT - SPF

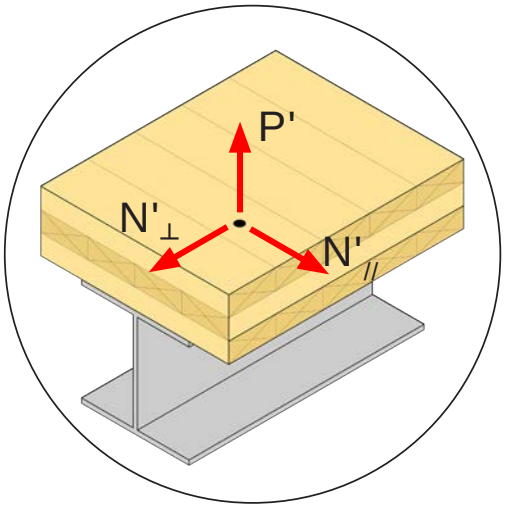
Beam - D.Fir



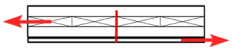
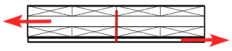



# CLT Panel to Steel Beam Connection




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

| CLT Panel & Steel Beam Configuration | | | | | | Factored Resistance [N] | |
|---|---|---|---|---|---|---|---|
| Loading | | | Panel Thickness (t) | Steel Thickness | Fastener Options | 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 | | | |

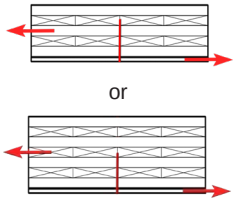
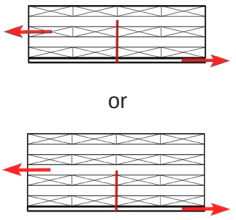
Notes:

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

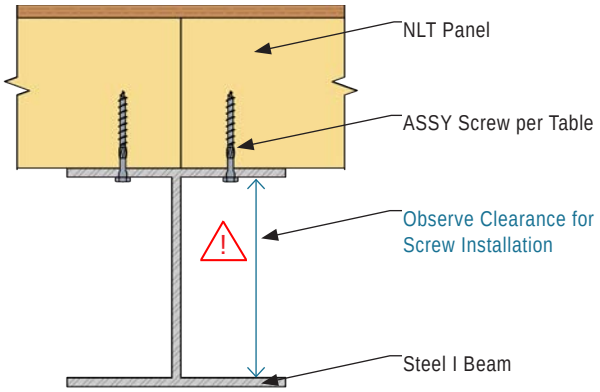
| Screw Nominal Diameter | Steel Plate Hole Diameter |
|---|---|
| in. [mm] | in. [mm] |
| 1/4" [6] | **9/32" [7]** |
| 5/16" [8] | **3/8" [9]** |
| 3/8" [10] | **7/16" [11]** |
| 1/2" [12] | **17/32" [13]** |

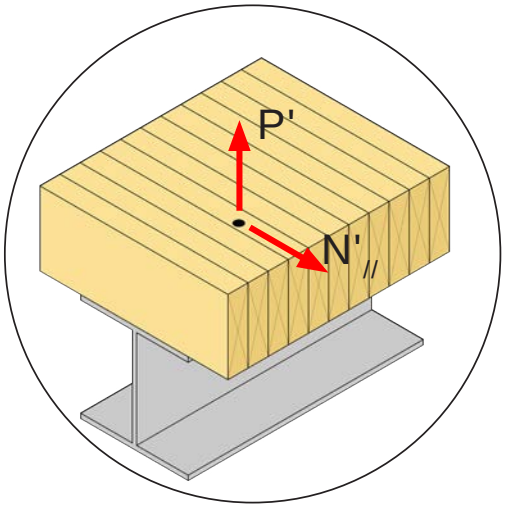
## Table PB.6.2, Factored Resistances for CLT Steel Side Plate Connections

| 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

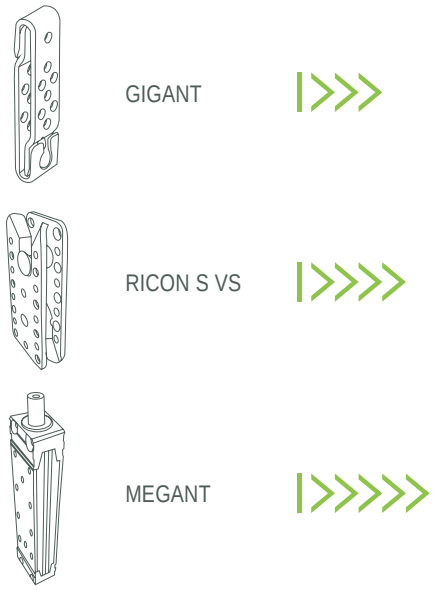
ETA

## 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.




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

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

## Easy to Install

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

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

## High Architectural Value

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

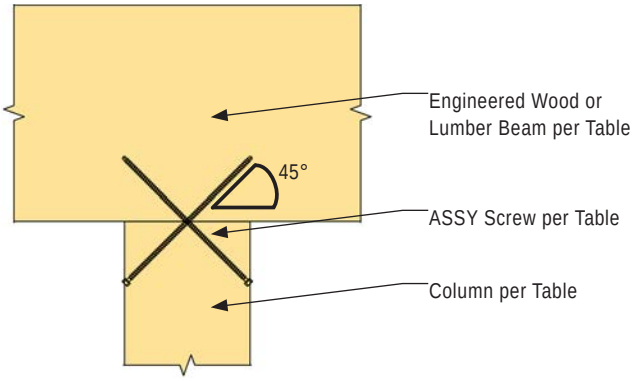
# Carbon 12

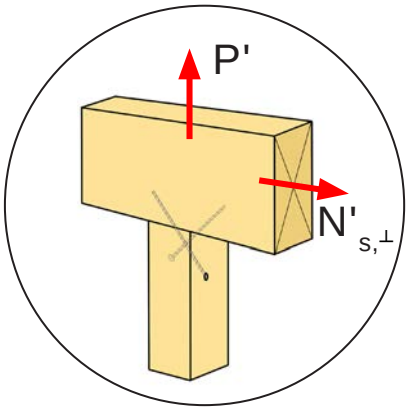
Portland, Oregon

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.



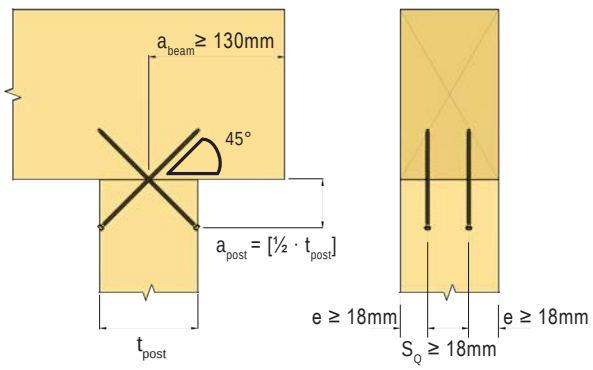

## Table PT.1, Factored Resistances for Beam to Post Connection (Bearing)

| 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:

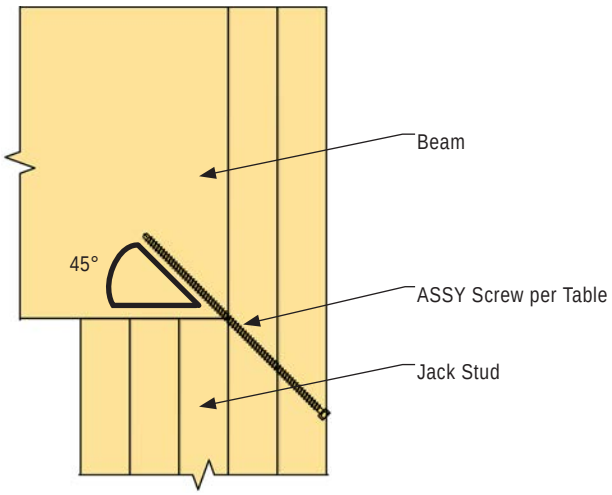
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.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



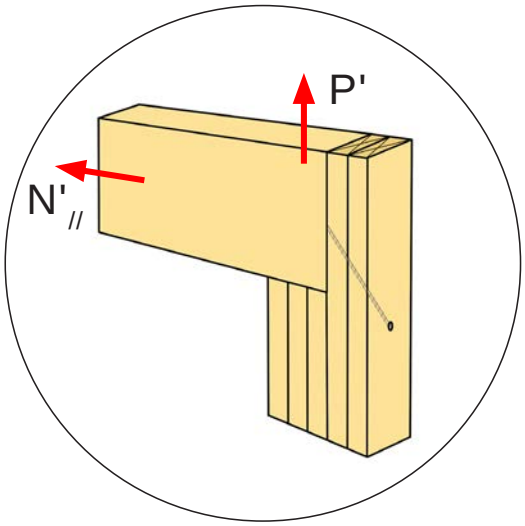



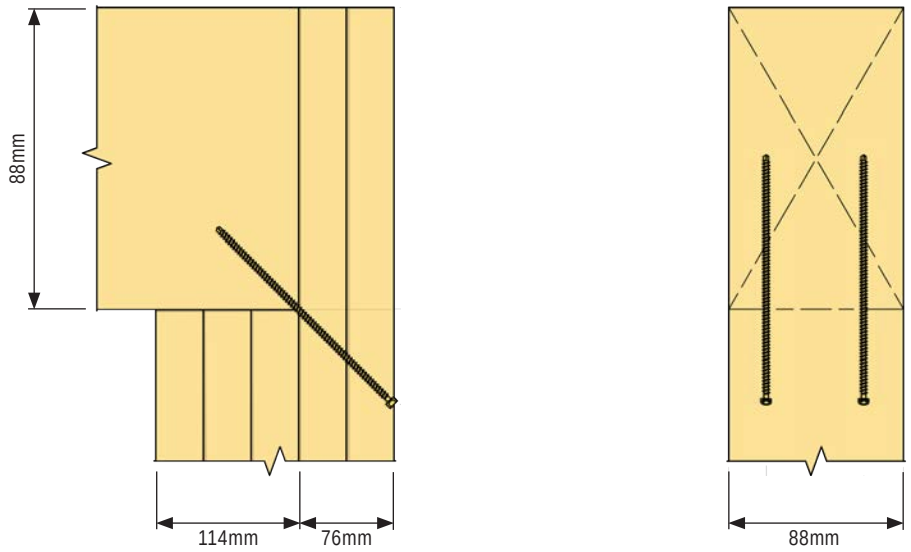

Table PT.2, Factored Resistances for Beam to Jack Stud Connection

| 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 |

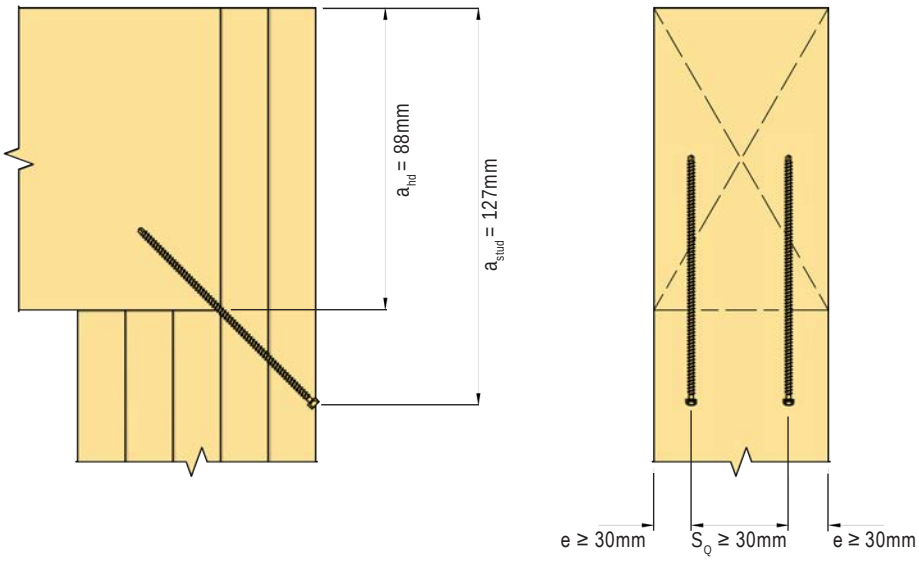
Notes:

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.

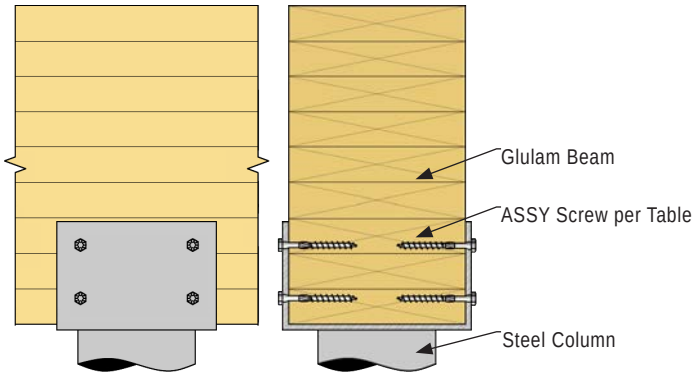
## Minimum Timber Requirements

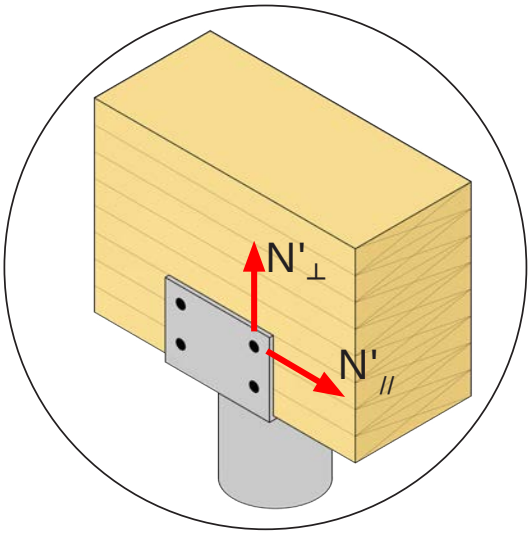



## Geometry Requirements



# Wood Beam to Steel Column - Shear Screws



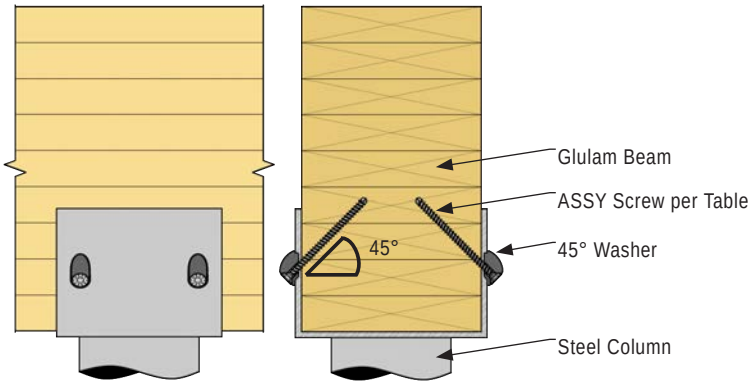

## Table PT.3, Factored Resistances for Steel Column

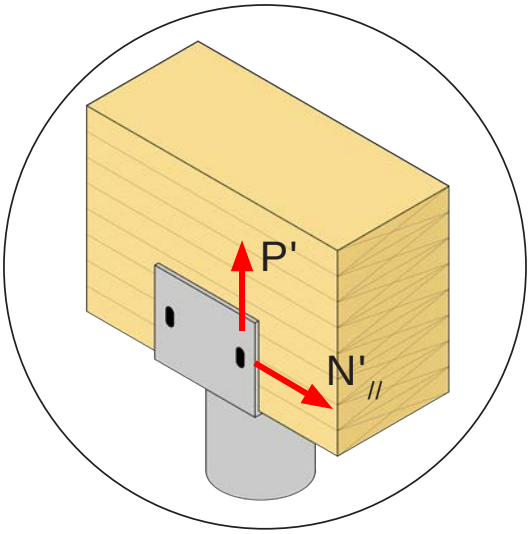
| Wood & Steel Beam Configuration | | Fastener Options | | Factored Resistance [N] | |
|---|---|---|---|---|---|
| Beam Type | Steel Thickness [mm] | | | $N'_{//}$ | $N'_{\perp}$ |
| SPF (0.42) | 6.35 | | Kombi 8 x 60 | 2320 | 1390 |
| | | | Kombi 8 x 80 | | 1540 |
| | | | Kombi 8 x 100 | | |
| | 12.7 | | 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



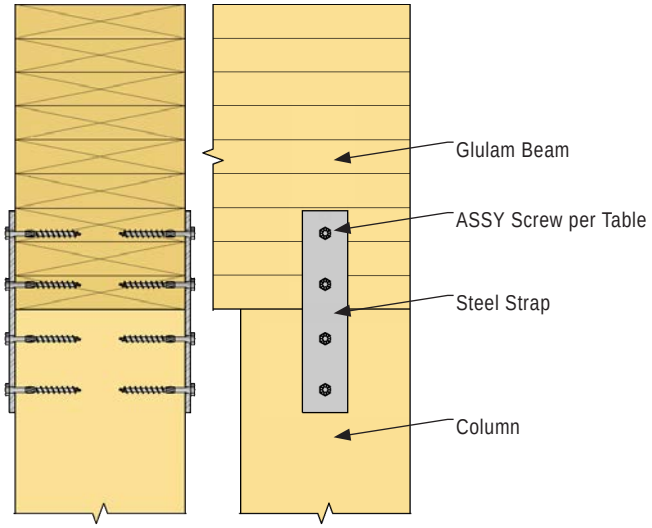

## Table PT.4.1, Factored Resistances for Steel Column with Inclined Screws

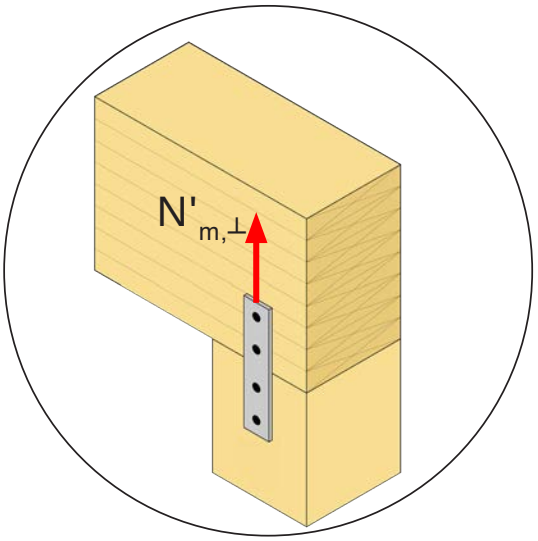
| Wood & Steel Beam Configuration | | Fastener Options | | Factored Resistance [N] | |
|---|---|---|---|---|---|
| Beam Type | Steel Thickness [mm] | | | P' | $N'_{//}$ |
| SPF (0.42) | 6.35 | | VG CSK 8 x 120 | 3920 | 1730 |
| | | | VG CSK 8 x 140 | 4780 | |
| | | | VG CSK 8 x 160 | 5640 | |
| | 9.5 | | 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



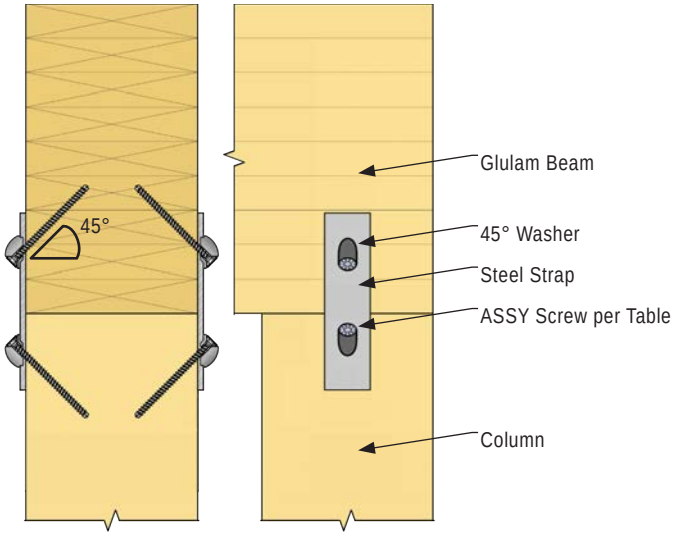

## Table PT.5, Factored Resistances for Beam Bearing Straps

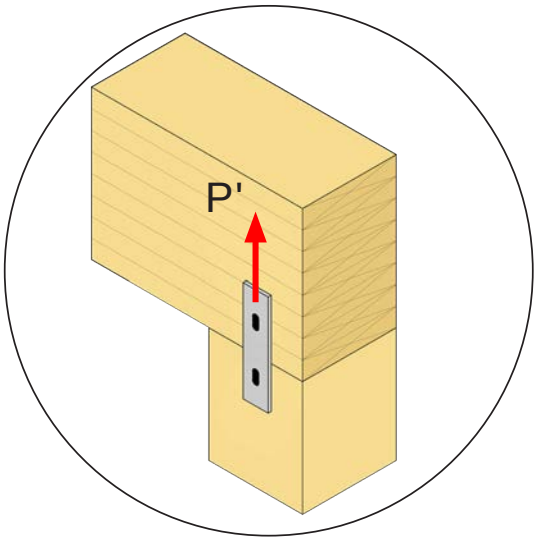
| Wood & Steel Beam Configuration | | Fastener Options | Factored Resistance [N] |
|---|---|---|---|
| Beam Type | Steel Thickness [mm] | | $N'_{m,\perp}$ |
| SPF (0.42) | 6.35 | Kombi 8 x 60 | 1390 |
| | | Kombi 8 x 80 | 1540 |
| | | Kombi 8 x 100 | |
| | 12.7 | Kombi 8 x 60 | 1190 |
| | | Kombi 8 x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



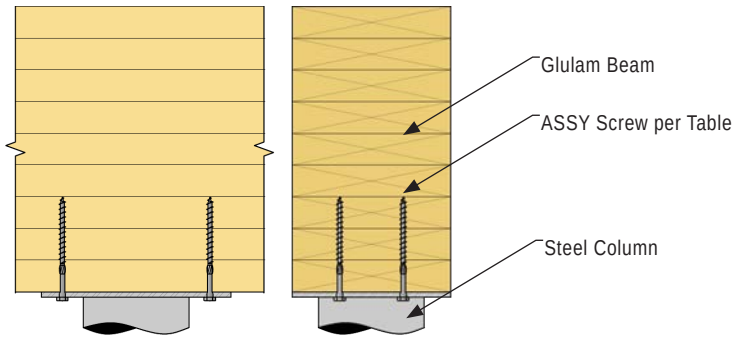

## Table PT.6.1, Factored Resistances for Beam Bearing Straps with Inclined Screws

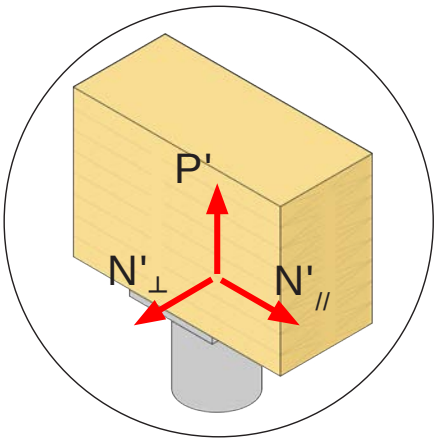
| Wood & Steel Beam Configuration | | Fastener Options with 45° Washers | | Factored Resistance [N] |
|---|---|---|---|---|
| Beam Type | Steel Thickness [mm] | | | P' |
| SPF (0.42) | 6.35 | | VG CSK 8 x 120 | 3920 |
| | | | VG CSK 8 x 140 | 4780 |
| | | | VG CSK 8 x 160 | 5640 |
| | 9.5 | | VG CSK 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



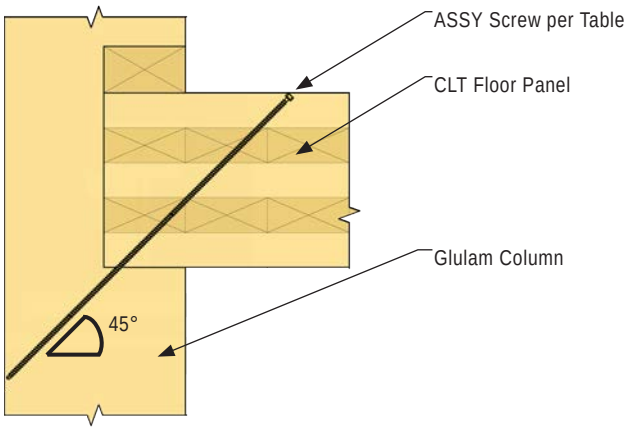

## Table PT.7, Factored Resistances for Steel Column - Bottom Plate

| 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



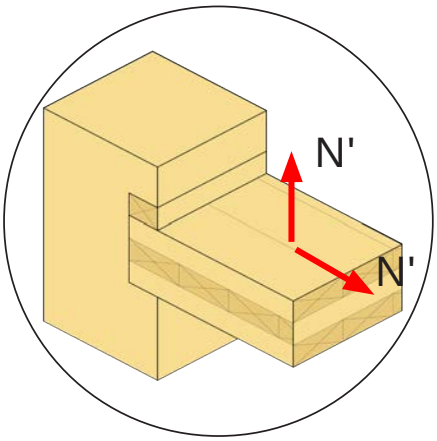




Table PT.8, Factored Resistances for Housed CLT Floor Uplift Connections; 45° Inclined Screws

| 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 | $N'_{II}$ | 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 | $N'_{II}$ | 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 | $N'_{II}$ | 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:

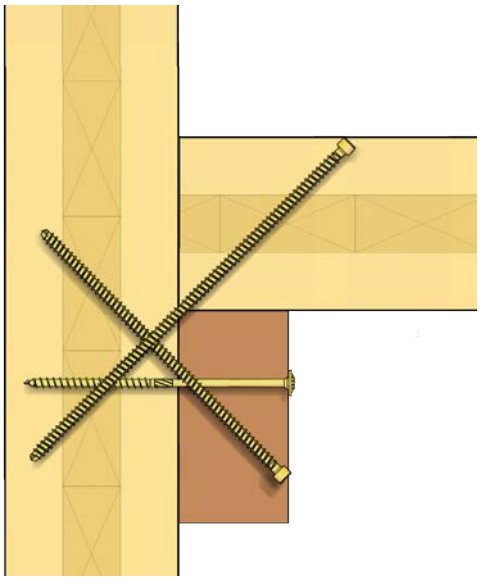
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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. $N'_{II}$ 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.

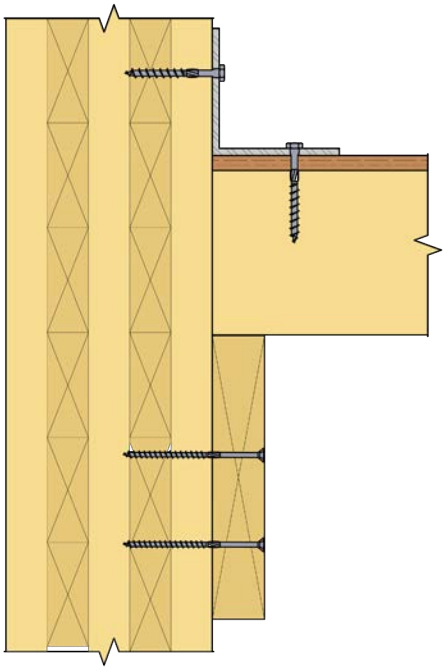
# Ledger Connections

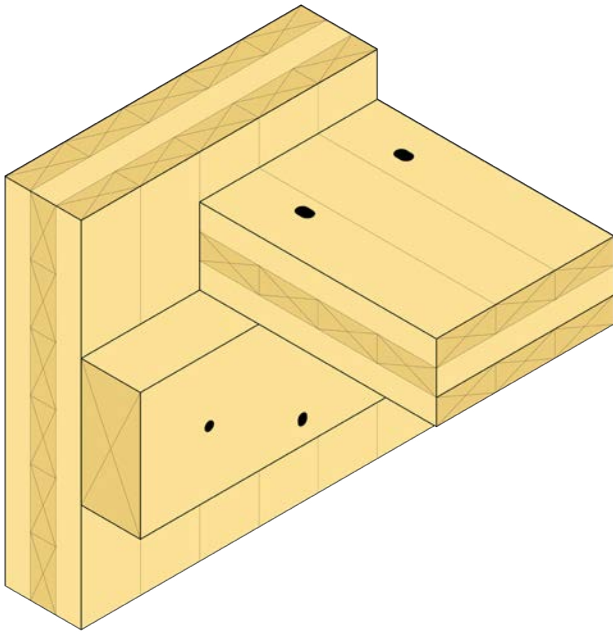


A typical detail used for balloon framing is the structural ledger. Most ledgers for construction with CLT are made from engineered wood products such as LVL, PSL, OSL and LSL. Steel ledgers are also an option. For most applications, connections will exhibit perpendicular-to-grain loading in the side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

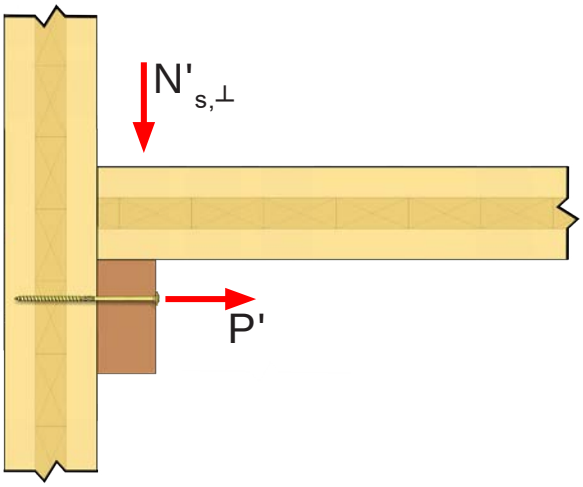
For steel angle connections, see the Steel to Wood Connections Section.





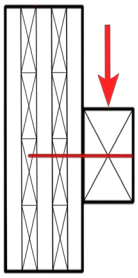


# CLT Ledger Connection - 90° Shear Screws Only




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 ($\Theta = 0°$); side member loaded perpendicular to grain ($\Theta = 90°$).

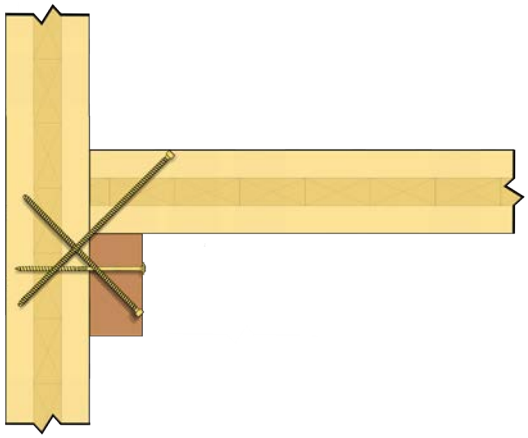
# Complete CLT Ledger Connection

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.

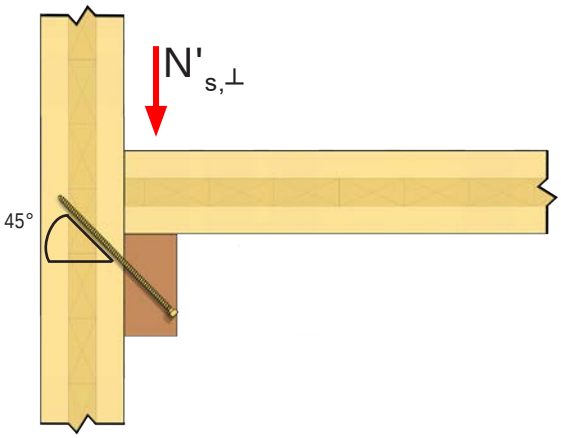
Shear screws installed at 90° angle are used during installation to ensure proper placement and tight connection between side and main member, and to provide ductility to this critical connection. The shear screws can also reduce the eccentricity created by the inclined screws.

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

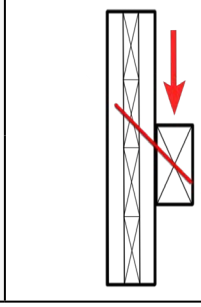


Complete Ledger Connection




45° Inclined Screws

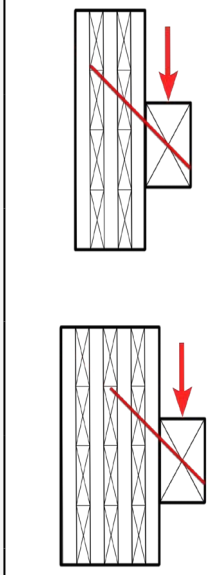
Table LG.2.1, Factored Resistances for CLT Wall to Ledger Connections; 45° Inclined Screws Only

| 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

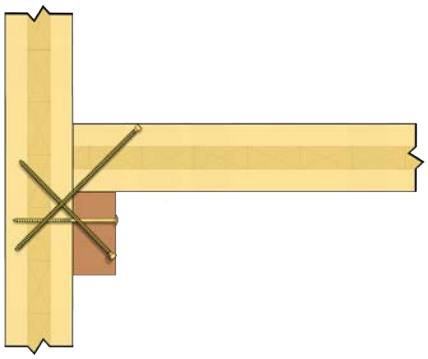
| CLT Panel & Ledger Configuration | | | | | Fastener Options | Factored Resistance |
|---|---|---|---|---|---|---|
| Loading | | | Ledger Thickness | Panel Thickness (t) | | |
| 7 PLY & 5 PLY | $N'_{s,\perp}$ |  | 44 | ≥ 131 | VG CSK 8 x 160 | 2,089 |
| | | | | ≥ 175 | VG CSK 8 x 180 | |
| | | | 89 | ≥ 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:

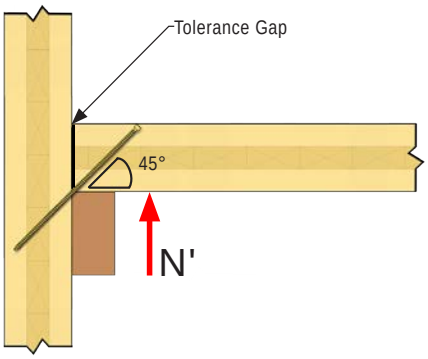
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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

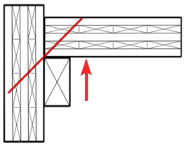
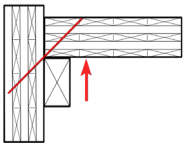
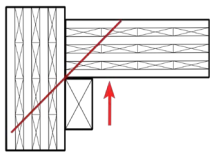
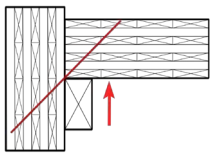
Table LG.3.1, Factored Resistances for CLT Wall to Ledger Connections; 45° Inclined Toe Screws

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

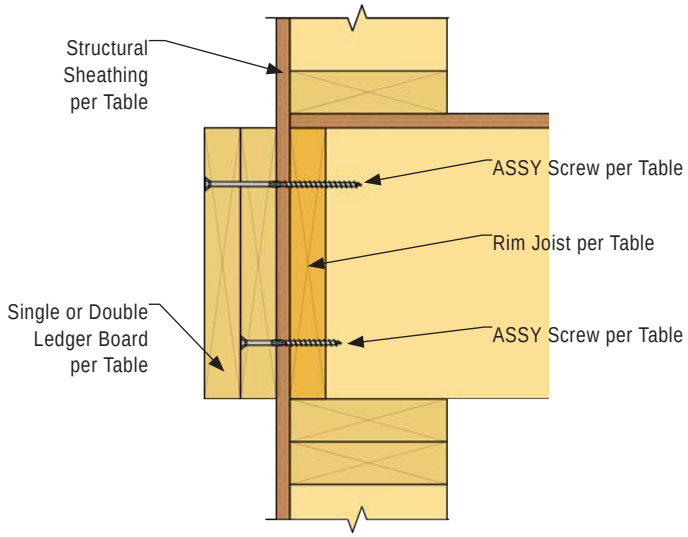
Notes:

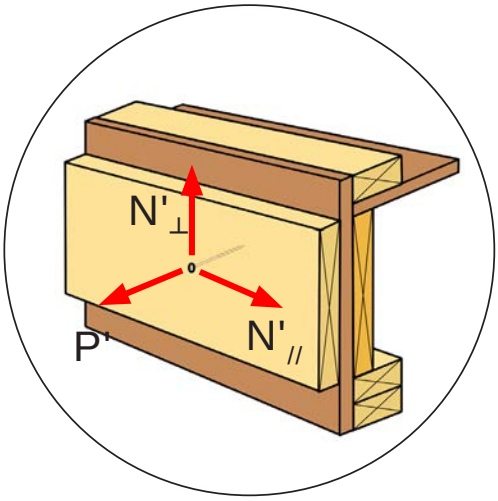
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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.



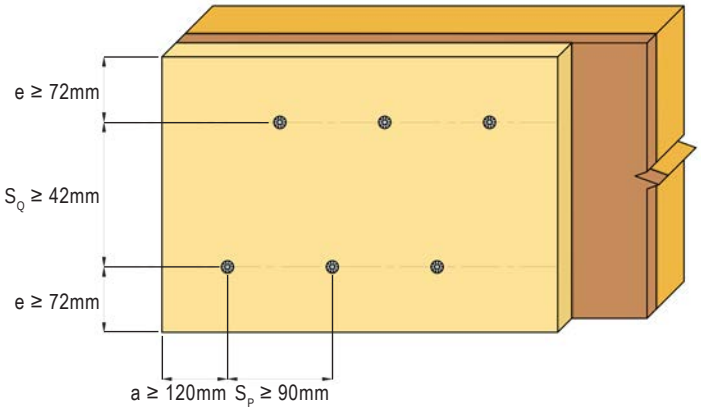

## Table LG.6.1, Factored Resistances for Ledger Board to Rim Joist Connection

| Ledger Configuration | | | | | Fastener Options | Factored resistance [N] | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | | Thickness | Ledger Board | Rim Joist | | $N'_{//}$ | $N'_{\perp}$ | $P'_{ECO}$ | $P'_{SK}$ |
| 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:

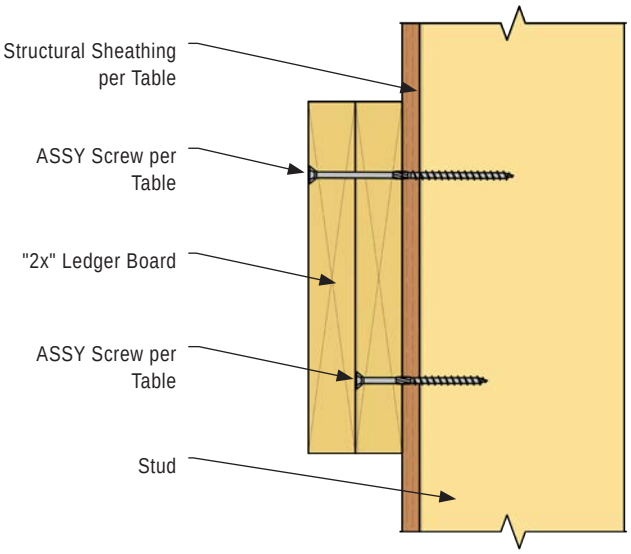
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
4. 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. It is recommended that additional backing be provided whenever the screw protrudes behind the rim joist.

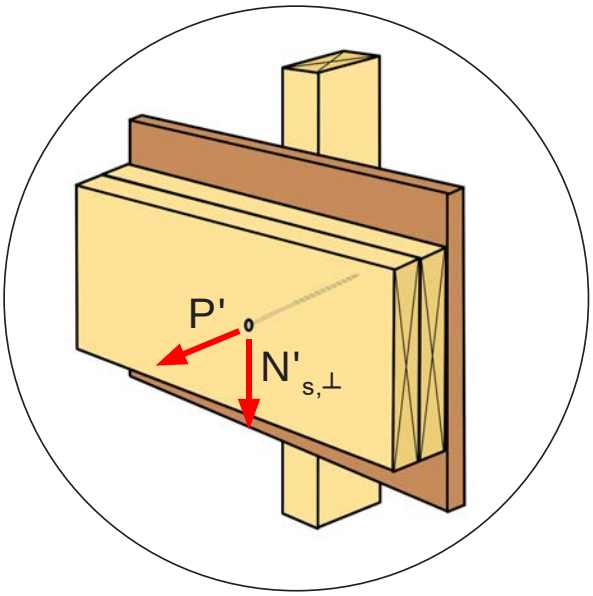
## Geometry Requirements



# 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.



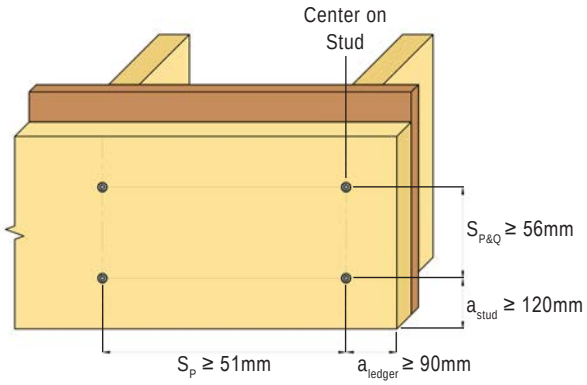

## Table LG.7.1, Factored Resistances for Ledger Board to Stud Wall Connection

| 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. 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.

### Geometry Requirements



# Specific Ledger to Stud Connection Design

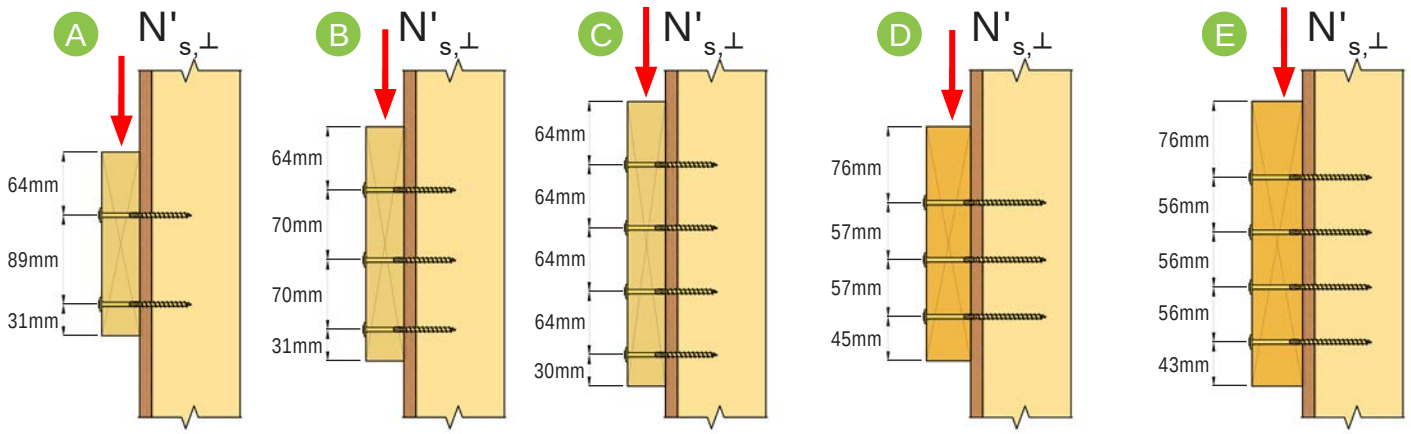
## Table LG.7.2, Adjusted Resistance for Ledger Board to Stud Wall Connection

| 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



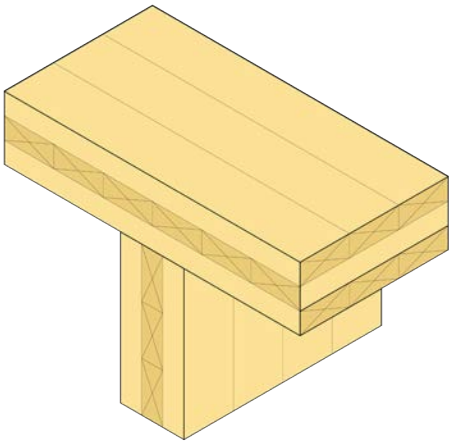

Note:

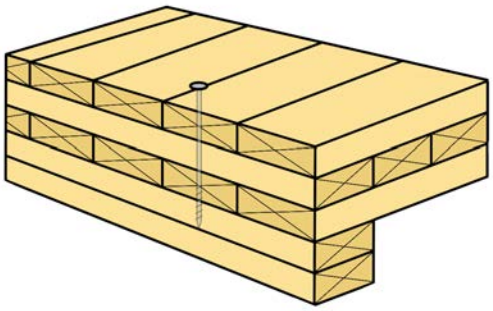
1. Minimum spacing requirements

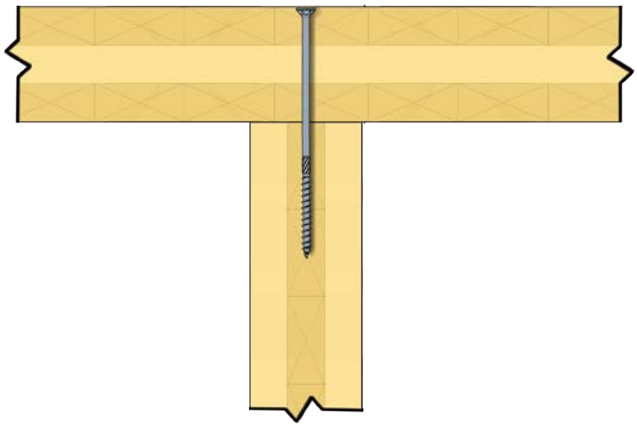
# Floor to Wall Connections

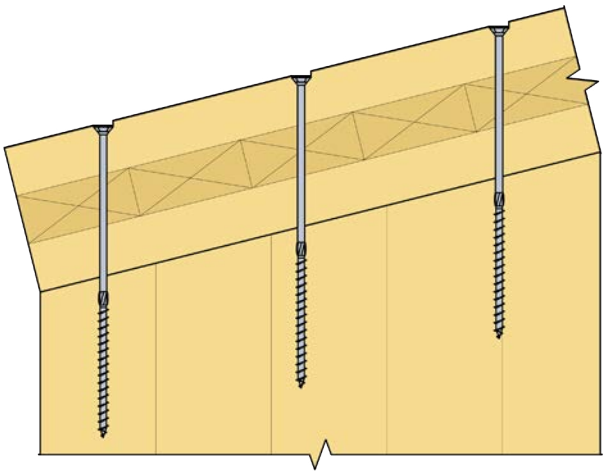
For CLT floor to wall connections, the designer should allocate special attention to ensure that minimum end and edge distance requirements for the narrow edge of CLT are satisfied.

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.



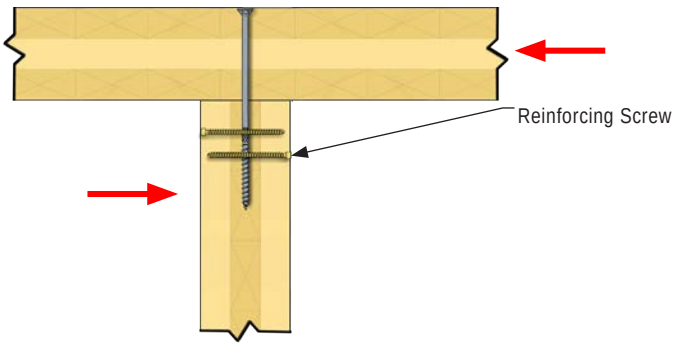






## Reinforcement Possibilities

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

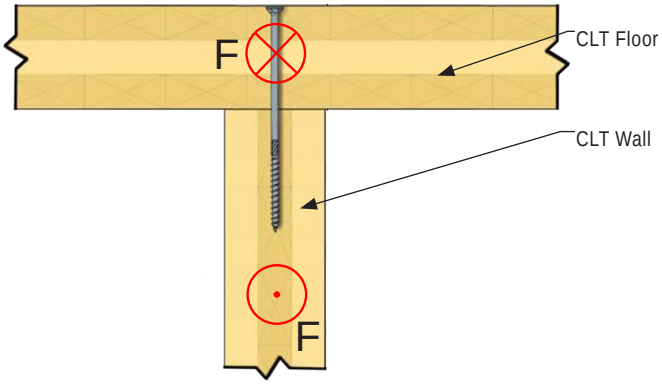
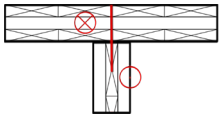
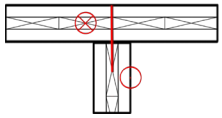
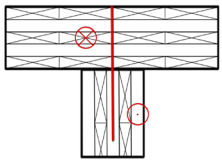
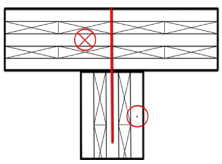


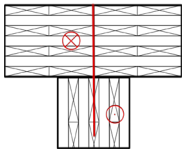
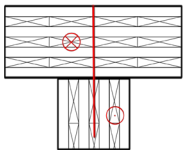

Table FW.1.1, Factored Resistances for CLT Floor to Wall Panel Connections Loaded in Shear

| 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 | $N'_{II}$ |  | 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 | $N'_{II}$ |  | 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. $N'_{II}$ 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

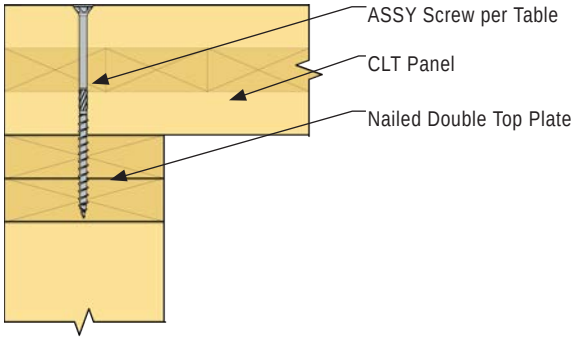
| Panel Configuration | | | Panel Thickness (t) | Fastener Options | Factored Resistance [N] | | Minimum Spacing in a Row ($S_P$) |
|---|---|---|---|---|---|---|---|
| Loading | | | | | Standard Loading $K_D$ =1.0 | Short Term Loading $K_D$ =1.15 | |
| 7 PLY | $N'_{\parallel}$ |  | 191 | Eco 8 x 300 | 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 |

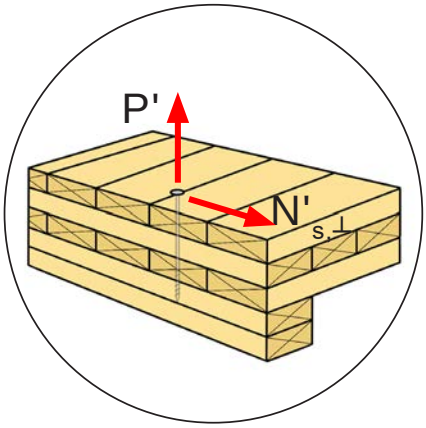
Notes:

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. $N'_{\parallel}$ Main member loaded perpendicular to grain ($\Theta$ = 90°; narrow edge); side member loaded parallel to grain ($\Theta$ = 0°).
   $N'_{\perp}$ Main member loaded perpendicular to grain ($\Theta$ = 90°; narrow edge); side member loaded perpendicular to grain ($\Theta$ = 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.



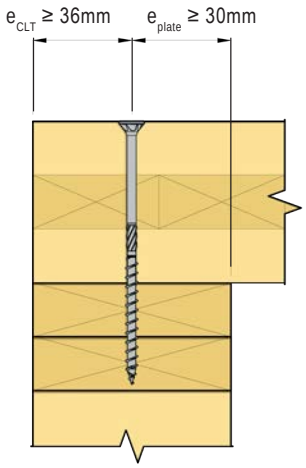

## Table FW.2, Factored Resistances for CLT Floor to Top Plate Connection (Top)

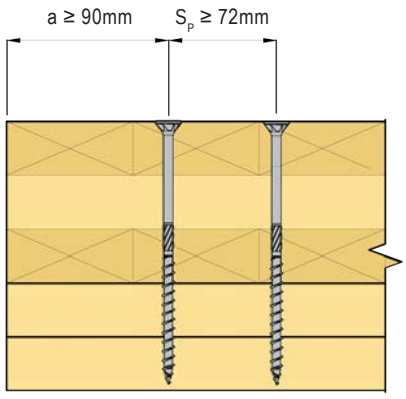
| Panel & Top Wall Configuration | | | Fastener Options | Factored Resistance [N] | | |
|---|---|---|---|---|---|---|
| Wall Top Plate | | Panel Thickness (t) | | $N'_{s,\perp}$ | $P'_{ECO}$ | $P'_{SK}$ |
| 3 PLY | Double 38 mm Lumber | 79 | Eco / SK 6 x 160 | 720 | 1320 | 2170 |
| | | 87 | Eco / SK 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.

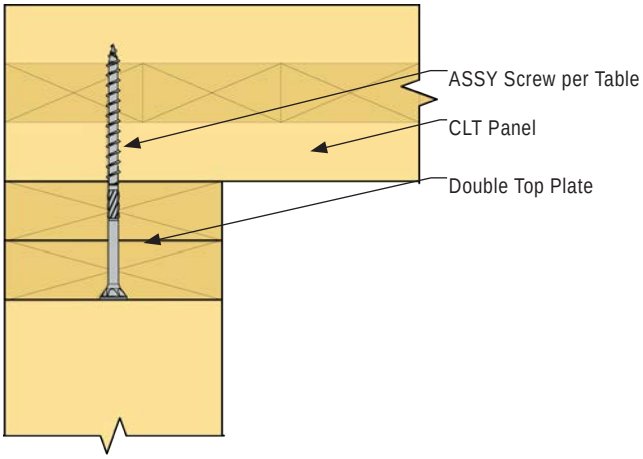
## Geometry Requirements

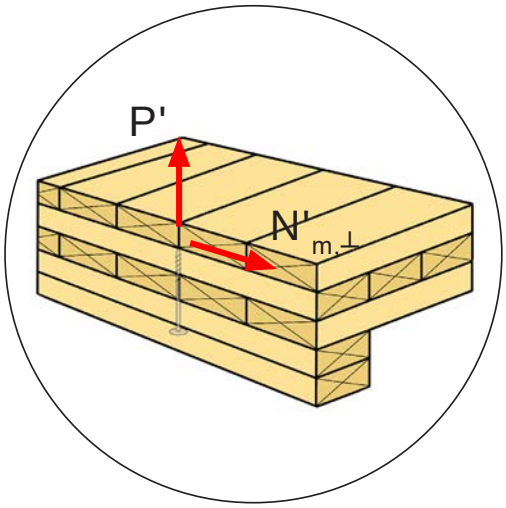


# CLT Floor to Top Plate Connection - Bottom Screwed

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.



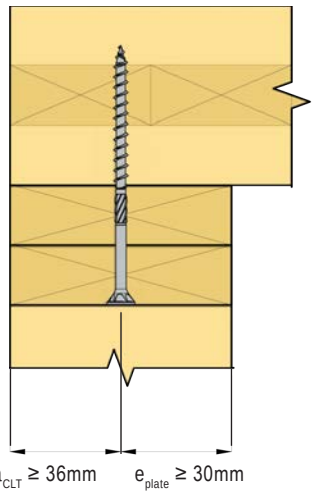

## Table FW 3. Factored Resistances for CLT Floor to Top Plate Connection (Bottom)

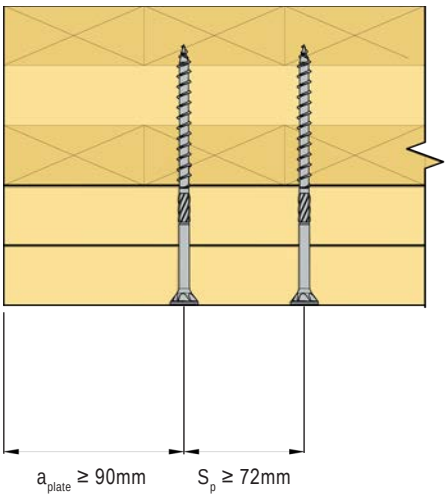
| Panel & Top Wall Configuration | | | Fastener Options | Factored Resistance [N] | | |
|---|---|---|---|---|---|---|
| Wall Top Plate | | Panel Thickness (t) | | $N'_{m,\perp}$ | $P'_{ECO}$ | $P'_{SK}$ |
| 3 PLY | Double 2" Lumber | 79 | Eco / SK 6 x 140 | 730 | 1320 | 2610 |
| | | 87 | | | | |
| |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

Notes:

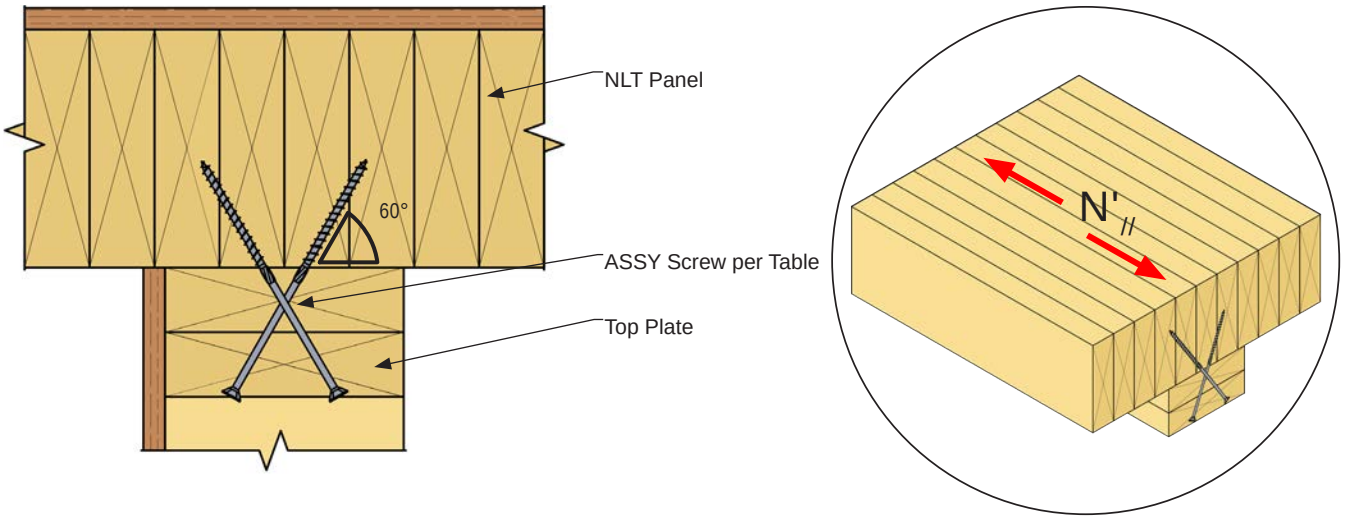
1. Factored resistances apply to a single fastener, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.
3. All connection design must meet all relevant 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:

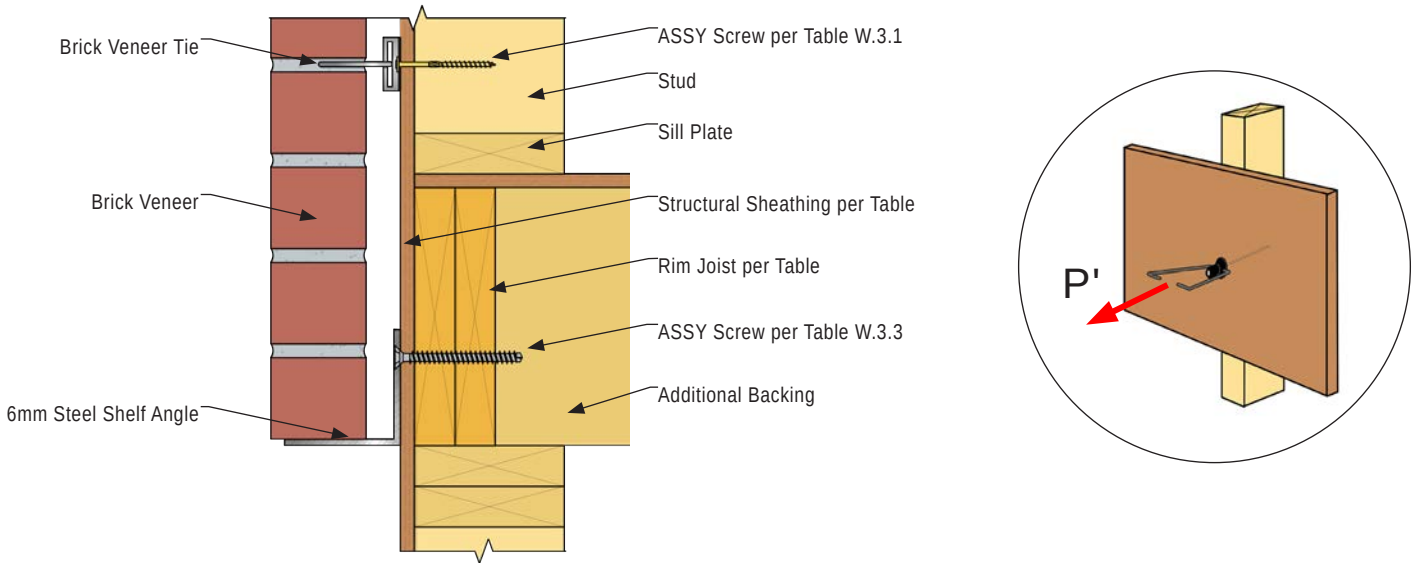
1. Factored resistances listed apply to two fasteners installed in a screw cross configuration, conforming to the connection geometry and the loading configuration described for that design value.
2. Factored resistance listed are only valid for Limit State Design in Canada and for listed ASSY screws.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

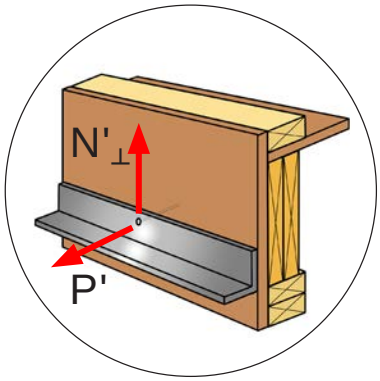
| Sheating Configuration | | Stud Backing | Tie Plate Thickness | Fastener Options | Factored Resistance [N] |
|---|---|---|---|---|---|
| Type | Thickness | | | | P' |
| Plywood (G = 0.42) | 12 - 25 | 38mm Lumber | 16 ga | Eco 6 x 60 | 1430 |
| | | | | Eco 6 x 70 | 1660 |

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. 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. 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]** |



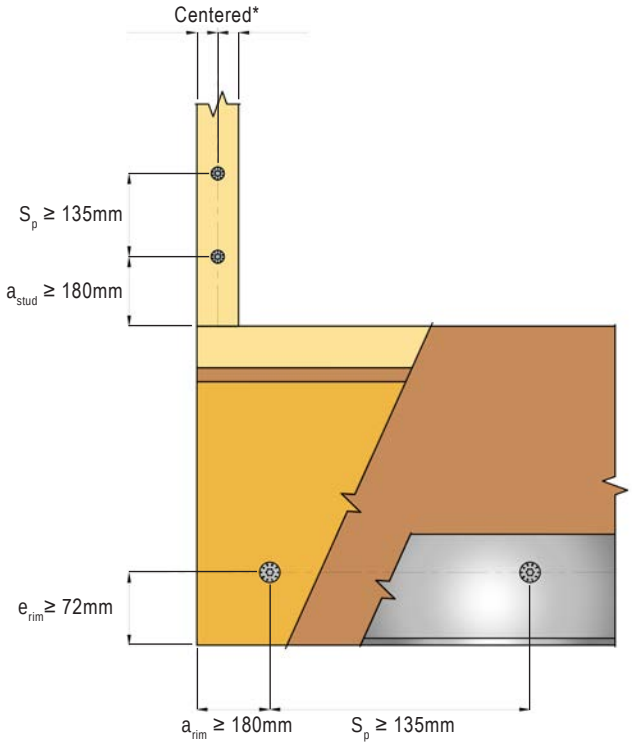

## Table W.3.3, Refence Design Values for Brick Veneer Shelf Angle Connection

| 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.

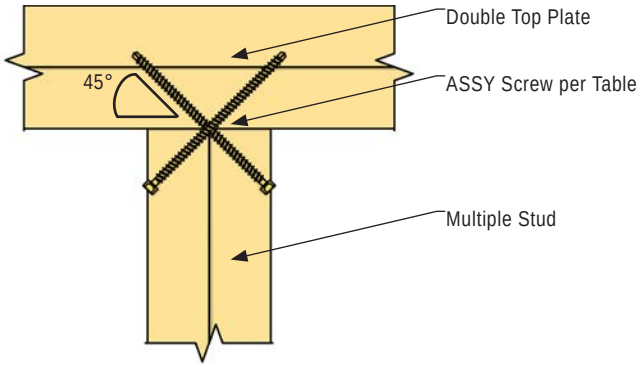
## Geometry Requirements

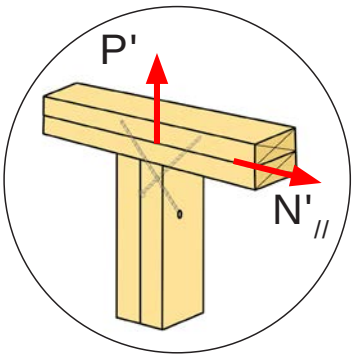



Notes:
* Fastener shall be installed centered on stud.

# 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.



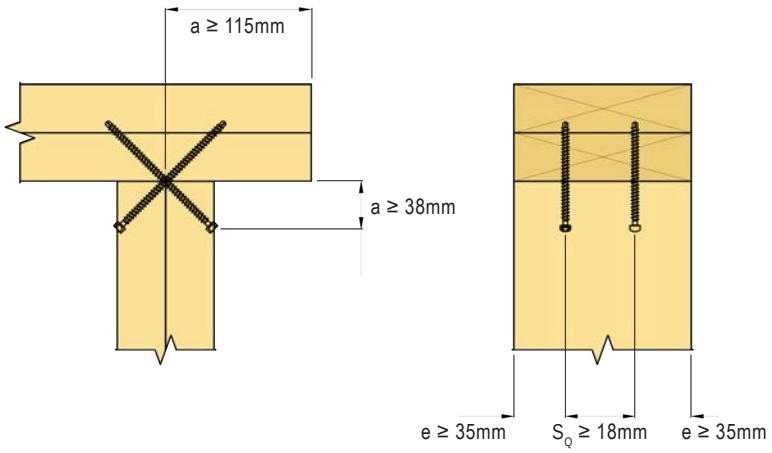

## Table W.4, Factored Resistances for Built-Up Stud to Top Plate Connections

| 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. 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 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

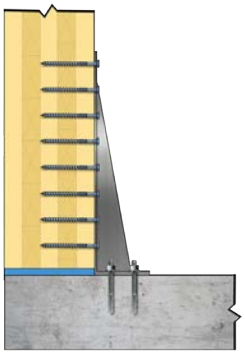
Amherst, Massachusetts

Courtesy of Alex Schreyer/Mass U Mass

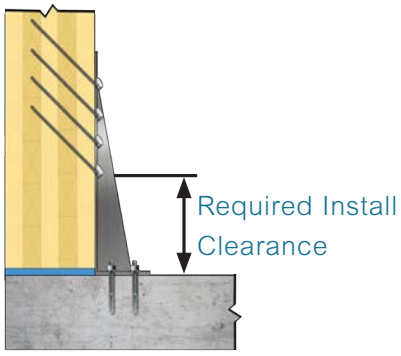
# Steel to Wood Connections

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.

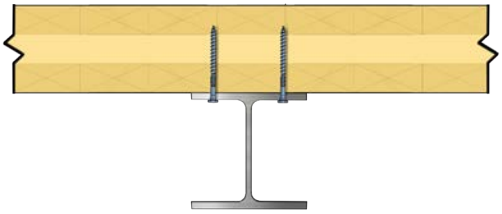
The possibility of using inclined screws, either with angled washers or reamed housing to accept the screw head offers high capacity options. The high connection strength of inclined screws thereby opens new doors toward innovative and economical design in modern mass timber structures. Due to the high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



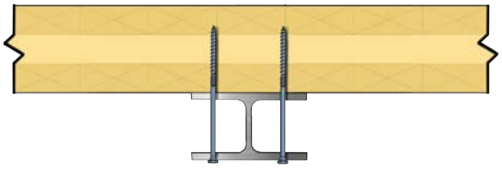
CLT wall hold down connection using shear screws, see page 86 for details.



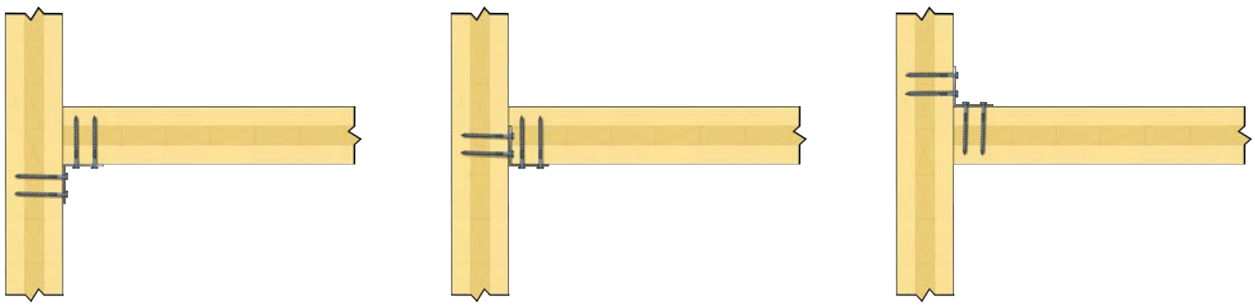

CLT wall hold down connection using inclined screws, see page 88 for details.



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.

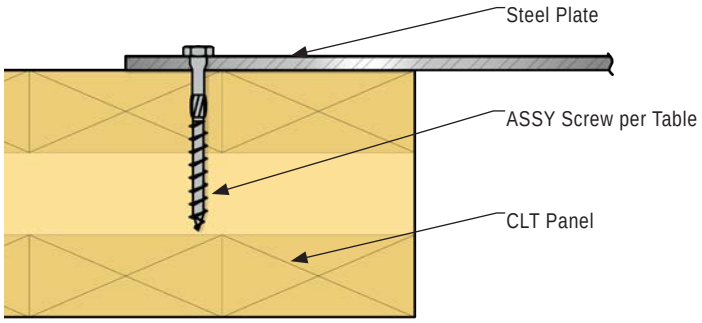


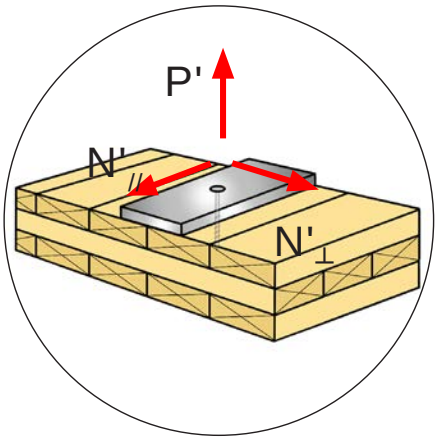
CLT floor to wall connections using angle brackets in different configurations, see page 86 for details on steel to wood connection.

# CLT Panel with Steel Side Plate in Shear

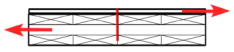
The ASSY Kombi screw is engineered for steel to wood connections where the screw is loaded perpendicular to the screw axis.

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 | | |

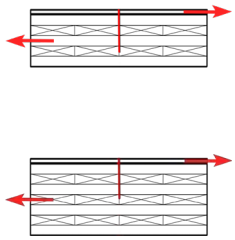
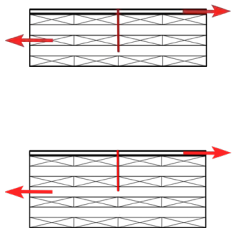
Notes:

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

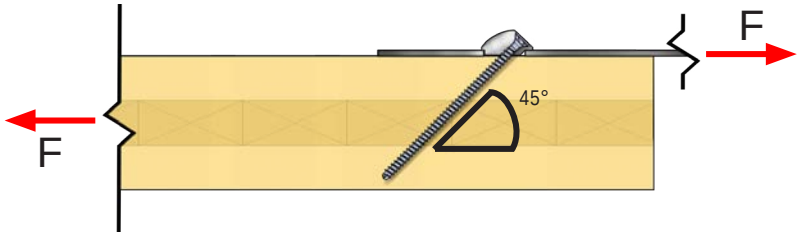
| CLT Panel & Steel Plate Configuration | | | | | Fastener Options | Factored Resistance [N] | |
|---|---|---|---|---|---|---|---|
| Loading | | | Panel Thickness [t] | Steel Plate Thickness | | N' | P' |
| 5 PLY & 7 PLY | $N'_{//}$ |  | 139 to 245 | 4.76 | Kombi 8 x 80 | 2200 | 2350 |
| | | | | | Kombi 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.



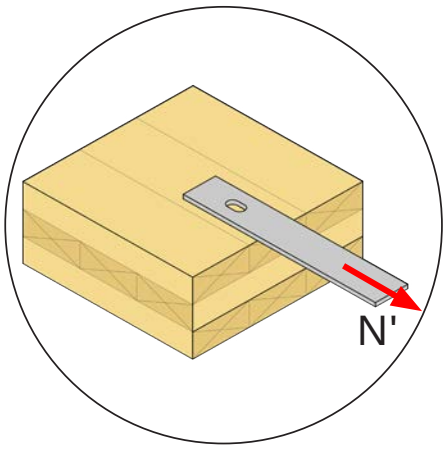
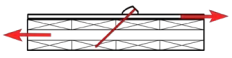



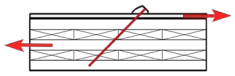
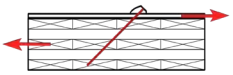
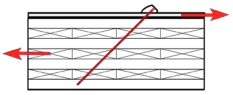
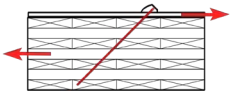

Table SC.2.1, Factored Resistances for CLT Steel Side Plate Connections

| CLT Panel & Steel Plate Configuration | | | | | Fastener Options | Factored Resistance [N] |
|---|---|---|---|---|---|---|
| | Loading | | Steel Plate Thickness | Panel Thickness (t) | | |
| 3 PLY | $N'_{\parallel}$ |  | 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. 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 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. $N'_{\parallel}$ 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

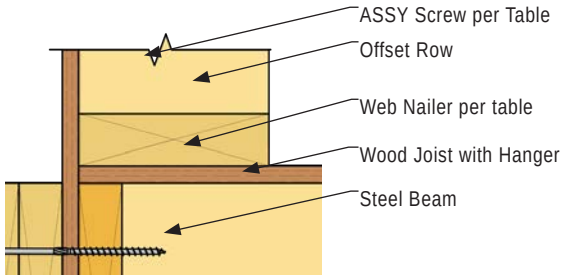
| CLT Panel & Steel Plate Configuration | | | | | Fastener Options | Factored Resistance [N] |
|---|---|---|---|---|---|---|
| Loading | | | Steel Plate Thickness | Panel Thickness (t) | | |
| 5 PLY | $N'_{//}$ |  | 4 - 12.7 | ≥ 131 | VG CSK 8 x 180 | 5520 |
| | | | | ≥ 139 | VG CSK 8 x 200 | 6030 |
| | | | | ≥ 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 |

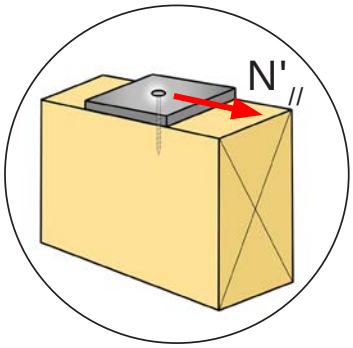
See notes under Table Table SC.2.1, page 88.

# Steel Beam to Wood Connection

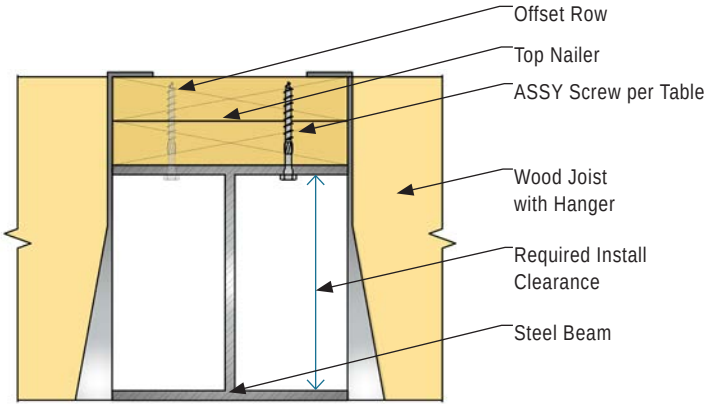
Timber joist members can be connected to structural steel I-beams by providing either web or top flange nailers that the joists can be attached to. Self-tapping screws can be installed to structurally connect nailers to the steel beam and be able to transfer in-plane lateral diaphragm forces.

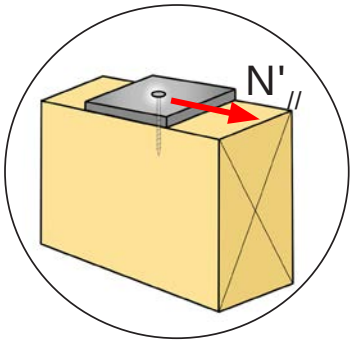
## Steel Beam to Web Nailer Connection




## Steel Beam to Top Nailer Connection



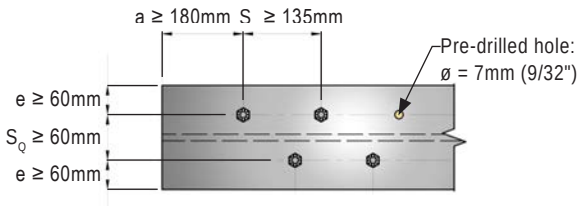
## Table SC.3.1, Factored Resistances for Steel Beam to Web Nailer Connection

| 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 | |

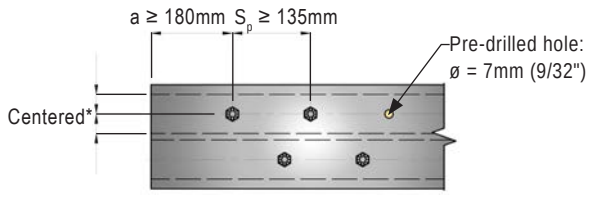
Notes:

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.

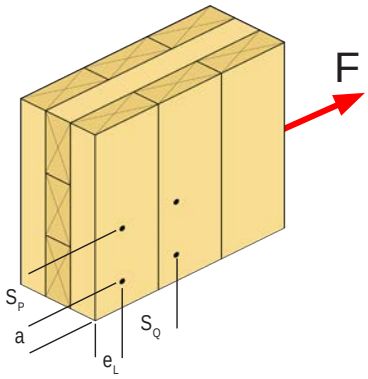
## Geometry Requirements

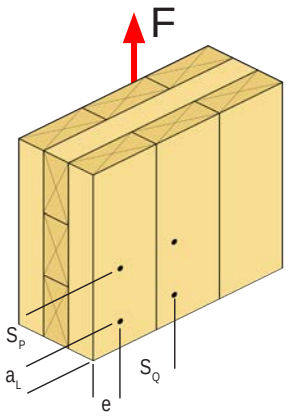
### Spacing and Edge Distance Requirements

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.

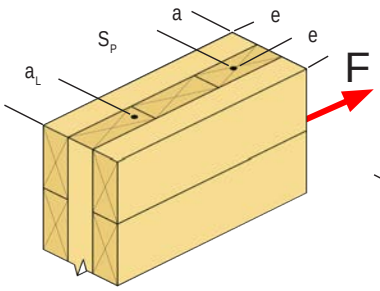
The spacing and edge distance requirements for self-tapping screws, vary when compared to other fasteners. If pre-drilling is implemented, the spacing and edge distance requirements as per CSA O86-19 Clause 12.6.2 may apply.

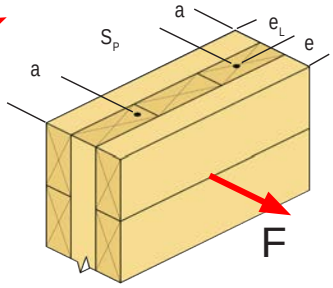
### Geometry Requirements in CLT for ASSY Screws Without Pre-Drilled Holes




Fasteners in Plane Surface




Fasteners in Narrow Edge

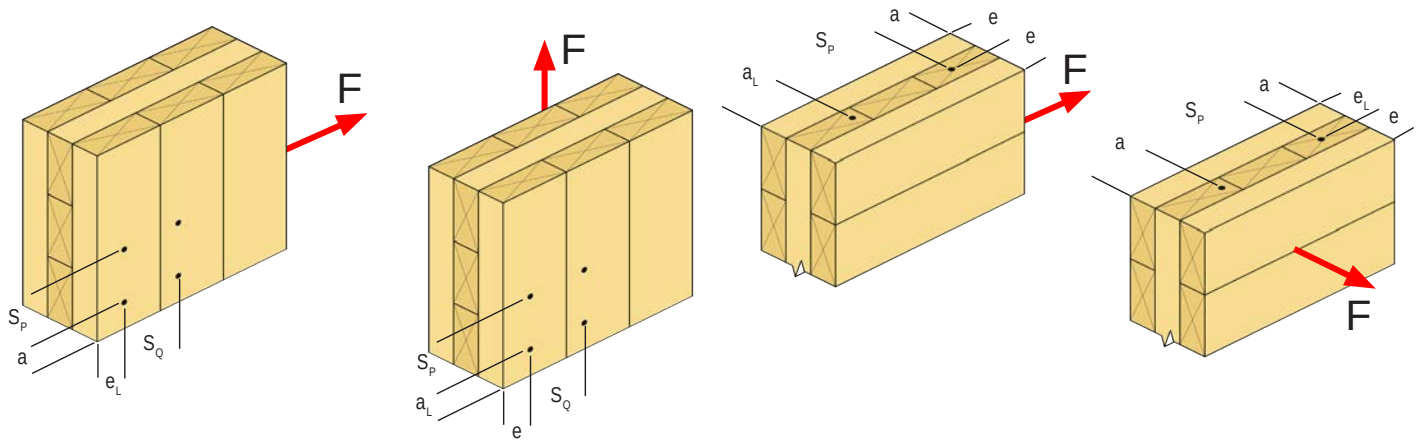
Table S.1.1, CLT Connection Geometry Requirements without Pre-drilling

| 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, $C_\Delta$=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.

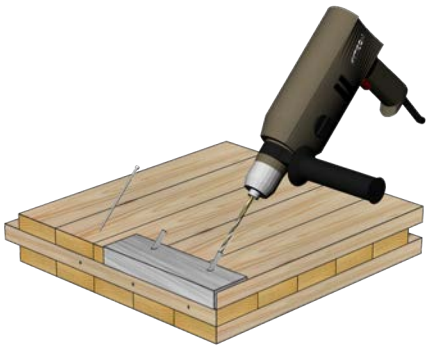
# Pre-Drilling Recommendations

## Table S.5, Pre-drilling hole diameter

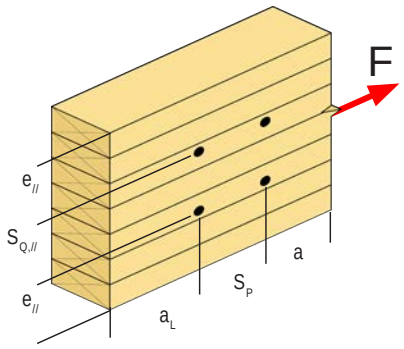
| Major Diameter | Softwood | Hardwood | Steel Plate |
|---|---|---|---|
| *[ D ]* | *in. [ mm ]* | *in. [ mm ]* | *in. [ mm ]* |
| 1 / 4” [6] | 5 / 32” [4] | 5 / 32” [4] | 9 / 32” [7] |
| 5 / 16” [8] | 3 / 16” [5] | 15 / 64” [6] | 23 / 64” [9] |
| 3 / 8” [10] | 15 / 64” [6] | 17 / 64” [7] | 7 / 16”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

Notes:

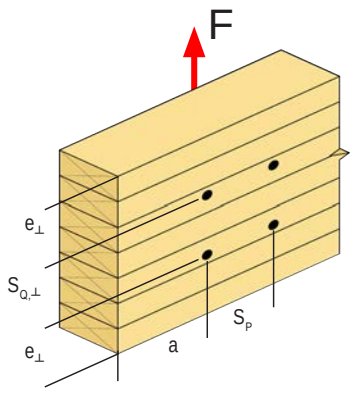
1. All connection design must meet all relevant requirements of the General Notes to the Designer section, page 16.
2. Consult a qualified design professional before pre-drilling.
3. Pre-drilled holes that exceed the diameters listed above may reduce the capacity of the screws.
4. Recommendations only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



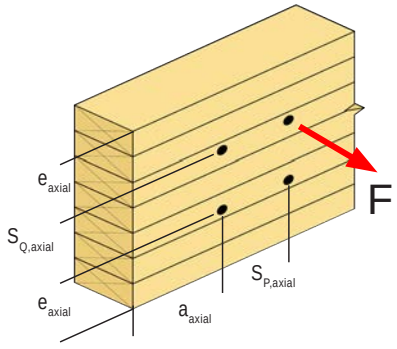
# Geometry Requirements for ASSY Screws




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, $C_{\Delta}$=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

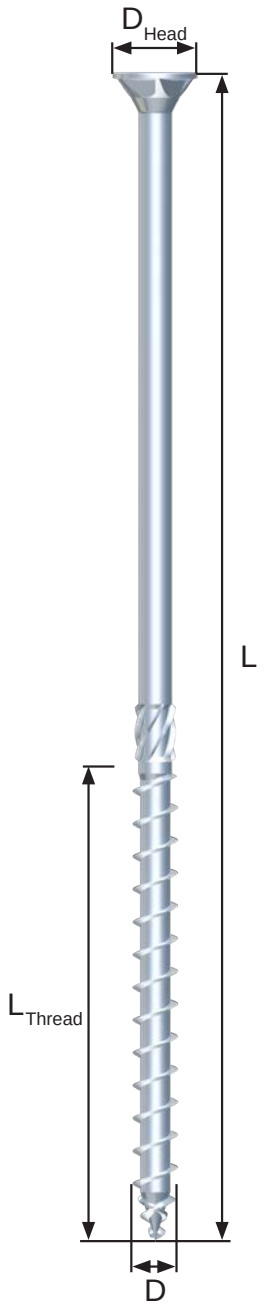
| Fastener Type | Factored Torsional Strength *[ N.m ]* | | | |
|---|---|---|---|---|
| | *[ D ]* | | | |
| | 6 | 8 | 10 | 12 |
| ASSY Eco / Kombi / SK | 7.27 | 16.73 | 32.73 | 47.27 |
| ASSY VG CSK / VG CYL | 7.27 | 16.73 | 32.73 | 54.55 |

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

# Hardware

## ASSY Ecofast

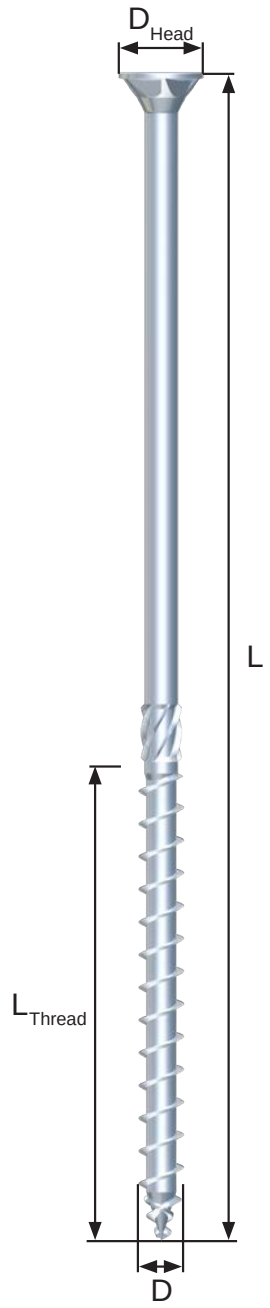
| Item# | Box size | D | L | | $L_{Thread}$ | | $D_{Head}$ | Bit |
|---|---|---|---|---|---|---|---|---|
| # | pieces | in. [mm] | in. | [mm] | in. | [mm] | in. [mm] | |
| 110060060000100 | 200 | 1/4 [ 6 ] | 2-1/8 | [60] | 1-1/2 | [37] | 0.472 [ 12 ] | AW 30 |
| 110060070000100 | 200 | | 2-3/4 | [70] | 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] | | | |

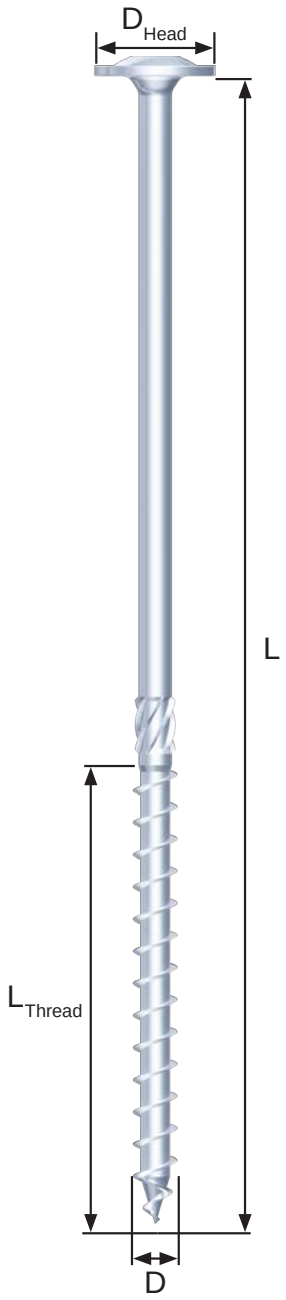
Notes:
1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.



# ASSY SK

| Item# | Box size | D | | L | | $L_{Thread}$ | | $D_{Head}$ | Bit |
|---|---|---|---|---|---|---|---|---|---|
| # | pieces | in. | | in. | [mm] | in. | [mm] | in. | |
| | | [mm] | | | | | | [mm] | |
| 120060060000303 | 100 | | | **2-1/8** | [60] | **1-1/2** | [37] | | |
| 120060070000303 | 100 | | | **2-3/4** | [70] | **1-5/8** | [42] | | |
| 120060080000303 | 100 | | | **3-1/8** | [80] | **2** | [50] | | |
| 120060090000303 | 100 | | | **3-1/2** | [90] | **2** | [50] | | |
| 120060100000300 | 100 | | | **4** | [100] | **2 3/8** | [60] | | |
| 120060120000300 | 100 | | | **4-3/4** | [120] | **2-3/4** | [70] | | |
| 120060140000303 | 100 | **1/4** | | **5-1/2** | [140] | **2-3/4** | [70] | **0.551** | |
| 120060160000303 | 100 | [ 6 ] | | **6-1/4** | [160] | **2-3/4** | [70] | [14] | **AW 30** |
| 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] | | |

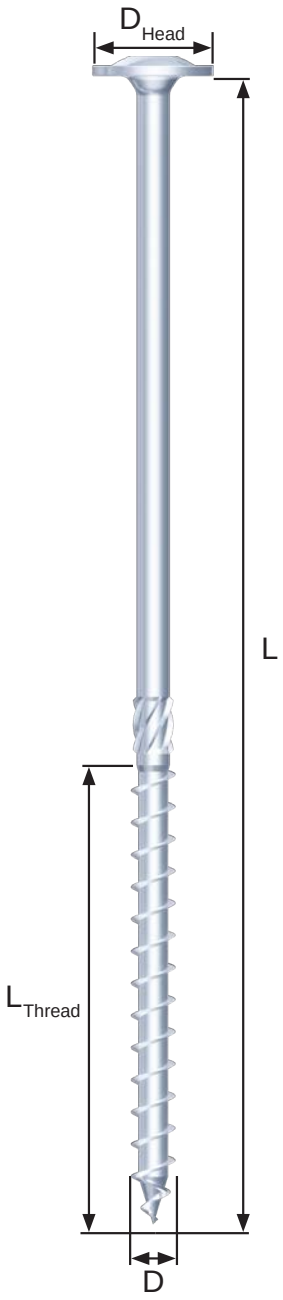
| Item# | Box size | D | | L | | $L_{Thread}$ | | $D_{Head}$ | Bit |
|---|---|---|---|---|---|---|---|---|---|
| # | pieces | in. | | in. | [mm] | in. | [mm] | in. | |
| | | [mm] | | | | | | [mm] | |
| 120080080000303 | 50 | | | **3 1/8** | [80] | **2** | [50] | | |
| 120080100000303 | 50 | | | **4** | [100] | **2 3/8** | [60] | | |
| 120080120000300 | 50 | | | **4 3/4** | [120] | **3 1/8** | [80] | | |
| 120080140000303 | 50 | | | **5 1/2** | [140] | **3 1/8** | [80] | | |
| 120080160000303 | 50 | | | **6 1/4** | [160] | **3 1/8** | [80] | | |
| 120080180000303 | 50 | | | **7 1/8** | [180] | **3 1/8** | [80] | | |
| 120080200000303 | 50 | | | **7 7/8** | [200] | **3 1/8** | [80] | | |
| 120080220000303 | 50 | | | **8 5/8** | [220] | **4** | [100] | | |
| 120080240000303 | 50 | **5/16** | | **9 1/2** | [240] | **4** | [100] | **0.870** | |
| 120080260000303 | 50 | [ 8 ] | | **10 1/4** | [260] | **4** | [100] | [22.1] | **AW 40** |
| 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** [ 10 ] | | **8 5/8** | [220] | **4** | [100] | **0.992** [25.2] | **AW 50** |
| 120100260000303 | 50 | | | **10 1/4** | [260] | **4** | [100] | | |
| 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** [ 12 ] | | **15 3/4** | [400] | **5 3/4** | [145] | **1.157** [29.4] | **AW 50** |
| 120120048000300 | 25 | | | **19** | [480] | **5 3/4** | [145] | | |
| 120120052000300 | 25 | | | **20 1/2** | [520] | **5 3/4** | [145] | | |

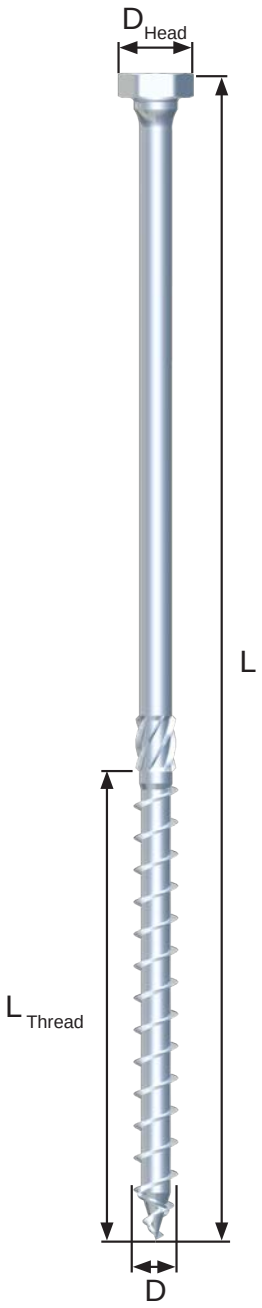



Notes:
1. For more ASSY fastener options, visit the MTC Solutions Website at mtcsolutions.com.

# ASSY Kombi

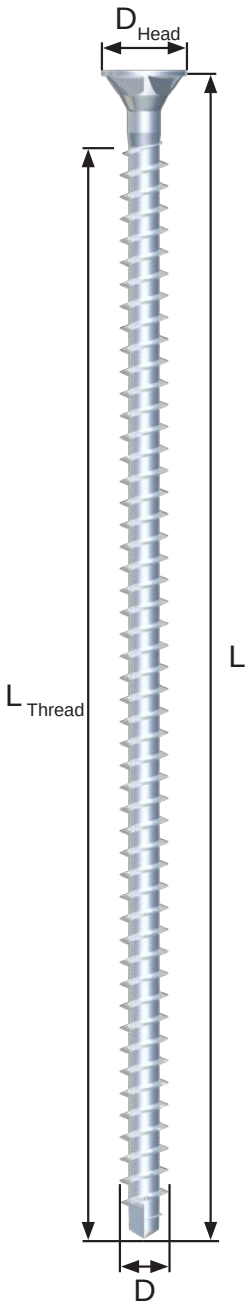
| Item# | Box size | D | | L | | $L_{Thread}$ | | $D_{Head}$ | Bit |
|---|---|---|---|---|---|---|---|---|---|
| # | pieces | in. [mm] | | in. | [mm] | in. | [mm] | in. [mm] | |
| 130080060000103 | 75 | 5/16 [ 8 ] | | 2 3/8 | [60] | 1 1/2 | [40] | 0.472 [12] | AW 40 or 1/2 socket |
| 130080080000103 | 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

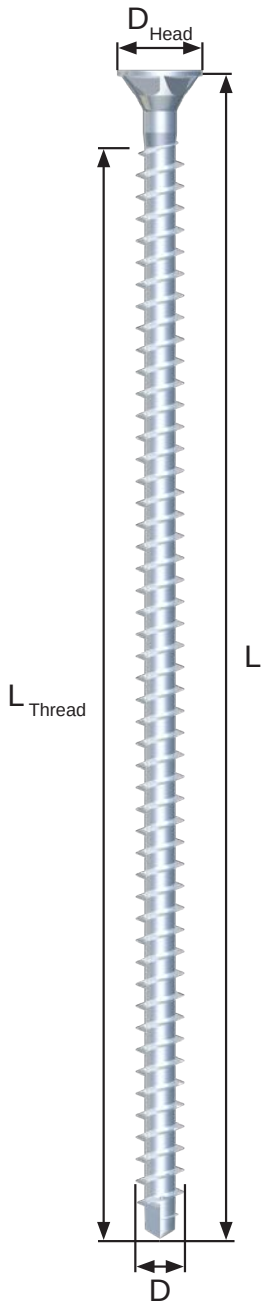
| Item# | Box size | D | | L | | $L_{Thread}$ | | $D_{Head}$ | Bit | |
|---|---|---|---|---|---|---|---|---|---|---|
| # | pieces | in. | | in. | [mm] | in. | [mm] | in. | | |
| | | [mm] | | | | | | [mm] | | |
| 140080080000102 | 75 | | 5/16 [ 8 ] | 3-1/8 | [80] | 2-1/2 | [61] | 0.591 [15] | | AW 40 |
| 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 | | | 7-7/8 | [200] | 7-1/4 | [183] | | | |
| 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 | | 3/8 [ 10 ] | 4 | [100] | 3 | [77] | 0.728 [18.5] | | AW 50 |
| 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 | | | 13 3/8 | [340] | 12 3/4 | [325] | | | |
| 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.

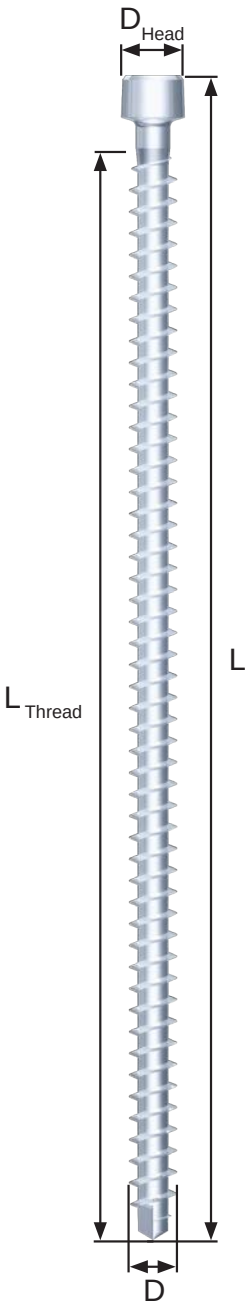
| Item# | Box size | D | | L | | $L_{Thread}$ | | $D_{Head}$ | Bit | |
|---|---|---|---|---|---|---|---|---|---|---|
| # | pieces | in. [mm] | | in. | [mm] | in. | [mm] | in. [mm] | | |
| 140120120000102 | 50 | | | **4 3/4** | [120] | **4 1/8** | [105] | | | |
| 140120140000100 | 50 | | | **5 1/2** | [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 | | | 3 1/8 | [80] | 2 7/8 | [73] | | | |
| 150060100000302 | 100 | | | 4 | [100] | 3 5/8 | [93] | | | |
| 150060120000302 | 100 | | | 4 3/4 | [120] | 4 1/2 | [113] | | | |
| 150060140000302 | 100 | | 1/4 [ 6 ] | 5 1/2 | [140] | 5 1/4 | [133] | 0.323 [8.2] | | AW 30 |
| 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 | | | 6 1/4 | [160] | 5 5/8 | [144] | | | |
| 150080180000302 | 50 | | | 7 1/8 | [180] | 6 1/2 | [164] | | | |
| 150080200000302 | 75 | | | 7 7/8 | [200] | 7 1/4 | [184] | | | |
| 150080220000302 | 75 | | | 8 5/8 | [220] | 8 | [204] | | | |
| 150080240000302 | 75 | | | 9 1/2 | [240] | 8 7/8 | [224] | | | |
| 150080260000302 | 75 | | | 10 1/4 | [260] | 9 5/8 | [244] | | | |
| 150080280000302 | 75 | | | 11 | [280] | 10 3/8 | [264] | | | |
| 150080300000302 | 75 | | 5/16 [ 8 ] | 11 7/8 | [300] | 11 1/8 | [284] | 0.394 [10] | | AW 40 |
| 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 | | | 7 1/8 | [180] | 6 1/2 | [165] | | | |
| 150100220000302 | 50 | | | 8 5/8 | [220] | 8 1/8 | [205] | | | |
| 150100260000302 | 50 | | | 10 1/4 | [260] | 9 5/8 | [245] | | | |
| 150100300000302 | 50 | | | 11 7/8 | [300] | 11 1/4 | [280] | | | |
| 150100340000302 | 50 | | | 13 3/8 | [340] | 12 3/4 | [325] | | | |
| 150100360000302 | 50 | | | 14 1/4 | [360] | 13 5/8 | [345] | | | |
| 150100400000302 | 50 | | | 15 3/4 | [400] | 15 | [380] | | | |
| 150100430000302 | 25 | | 3/8 [ 10 ] | 17 | [430] | 16 3/8 | [415] | 0.528 [13.4] | | AW 50 |
| 150100480000302 | 25 | | | 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

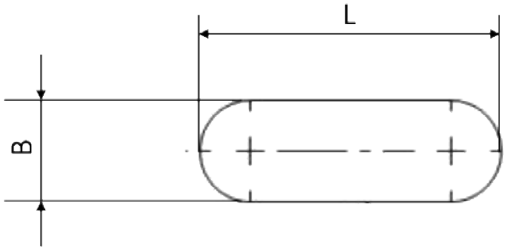

AW 50

# 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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