MTC SOLUTIONS

Connectors Design Guide

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Disclaimer

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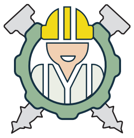
Mass Timber Hardware Specialist

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

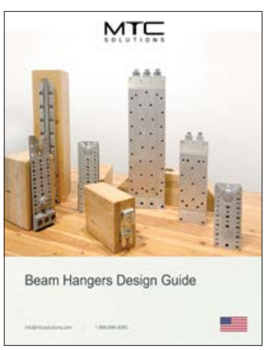
MTC Solutions provide the right tools to design code-compliant buildings, educating the mass timber industry on connection solutions.

Structural Screw Catalog

Structural Screw Connection Design Guide

Structural Fasteners

Accessories



Beam Hangers Design Guide

Beam Hangers

Connector Design Guide

Connectors

Rigging Design Guide

Rigging Devices

Fall Arrest Anchor Design Guide

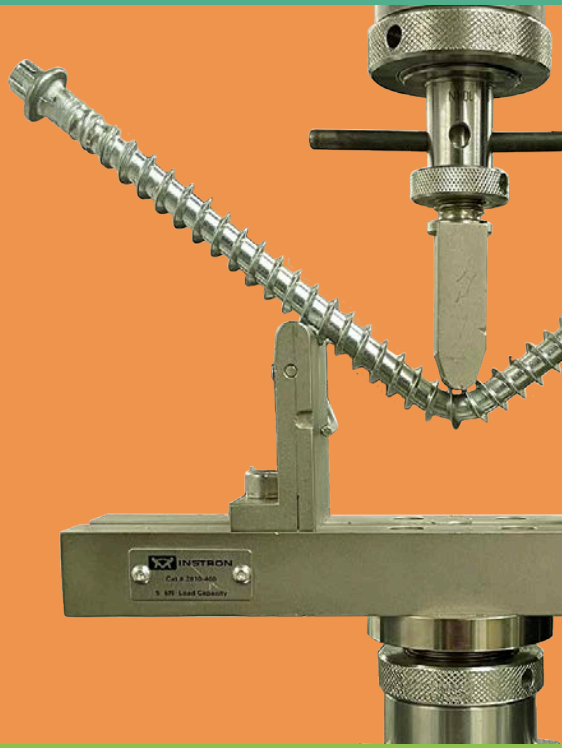
Fall Arrest

WHO ARE WE?

YOUR MASS TIMBER HARDWARE SUPPLIER

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

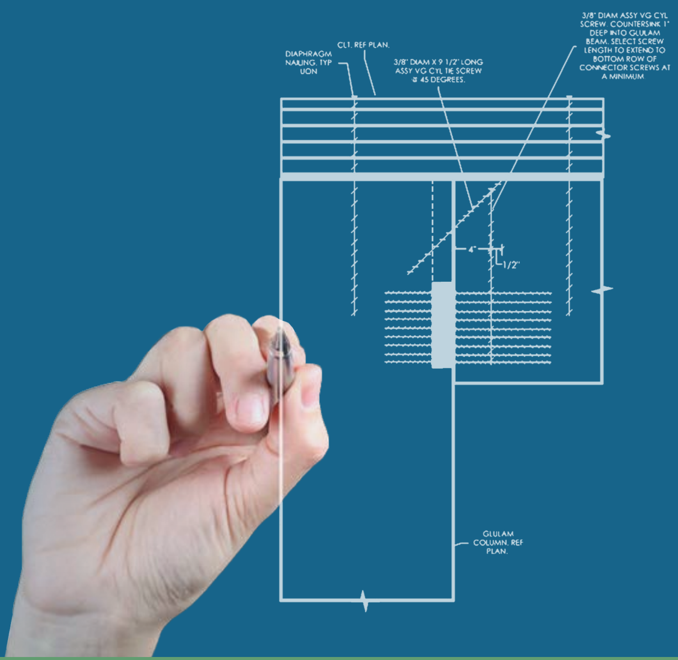
LEADING WITH INNOVATION & RESEARCH



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

WE MAKE YOU THE EXPERT

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



CONNECTIONS DESIGN SUPPORT

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

MANUFACTURERS' HELP DESK

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

TESTED & PROVEN SOLUTIONS

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

Clayton Community Center

Surrey, BC

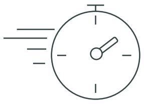
Courtesy of Western Archrib

General Notes To The Designer

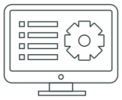
1. All suggestions and details shown are to be treated as general and cannot be assumed to be valid for all construction requirements and specific site conditions.
2. Listed factored resistances are obtained based on tested values and analyzed using CSA O86-19 and ASTM E2126 standards.
3. Listed factored resistance values are in the linear-elastic range of the connection.
4. Designers 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.
5. Listed factored resistance values presented must be adjusted in accordance with all applicable adjustment factors as detailed in the CSA O86-19, Clause 12, unless otherwise indicated.
6. Connectors in combination with carbon steel fasteners are to be used in dry service conditions and temperature below 50°C such that K_{SF}=1.0 and K_T=1.0.
7. For standard term loading, the load duration factor is K_D=1. For short-term loading, the load duration factor is K_D=1.15, per CSA O86-19 Clause 5.3.2.1.
8. Listed factored resistance values apply to different timber species according to their respective mean relative densities (G) as per CSA O86-19.
9. Cyclic test data have been analyzed using ASTM E2126 Equivalent Energy Elastic Plastic (EEEP) method and is used to report the ductility value for the connector. Based on North American standards, an energy dissipative connection must be moderately ductile, with ductility defined as the ratio of the ultimate displacement and the yield displacement during cyclic loading per ASTM E2126. These standards define moderately ductile connections as connections with a ductility ratio of 3.0 or higher. The ductility ratio for the tested connectors is listed in the appropriate tables.
10. Connections must respect the geometry requirements as specified in the connection Geometry Requirement sections of this guide.
11. Installation of the connector fasteners into voids, splits and gaps is to be avoided.
12. A design professional must be contacted immediately, and appropriate measures must be taken if splitting of the wood or wood-based material is observed during installation or prior to installation of the fasteners. A design professional must also be notified in instances of fastener damage or breakage.

MTBL - Mass Timber Bracket Light

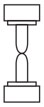
The Mass Timber Brackets Light are engineered from thin 1.5mm galvanized steel with a reinforced perimeter and are easily installed with ASSY self-tapping screws. The MTBLs can withstand loads similar to thicker 3mm steel brackets, providing a cost-effective solution.



Fast Installation



Performance Based Design



Ductile Connection

MTBL 90

MTBL 105

Code Approval	TESTED IN NORTH AMERICA	ETA

Associated Hardware

Fasteners and Installation Tools

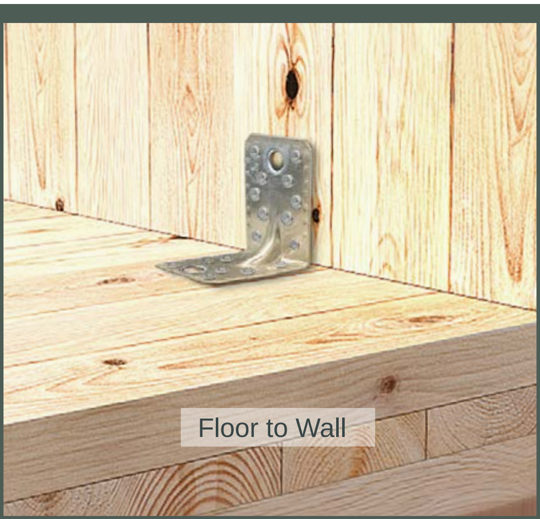
ASSY Ecofast 4.5 x 50 mm

Countersunk Head

AW 20 Bit

Applications

Wall to Ceiling



Floor to Wall

Wall to Wall

Factored Resistance Values in CLT

Table 1, F1 - Factored Lateral Resistance in CLT Using MTBL

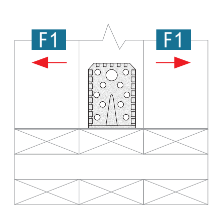
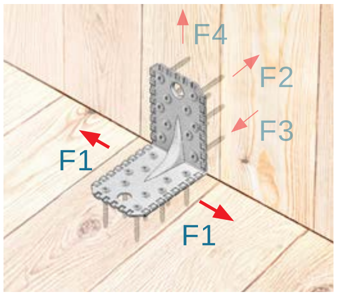
Configuration			Fasteners		Factored Resistance [kN]		Estimated Slip Modulus [kN / mm]	Ductility Ratio
					F1 - Lateral Resistance			
	Angle Bracket	Relative Density	Type	Quantity	Standard Loading KD = 1.0	Short Term Loading KD = 1.15		
	MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	6.7	7.7	2.1	7.5
	MTBL 105			26	6.8	7.9	3.1	10.0

Table 2, F1 - Estimated Ultimate Lateral Resistance in CLT Using MTBL

Configuration		Fasteners		Ultimate Resistance [kN]	
				F1 - Lateral Resistance	
Angle Bracket	Relative Density	Type	Quantity	Estimated 5th Percentile	Estimated 95th Percentile
MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	10.1	17.5
MTBL 105			26	10.4	16.2

Load Direction



Notes:
1. See detailed notes under table 4

Table 3, F4 - Factored Uplift Resistance in CLT Using MTBL

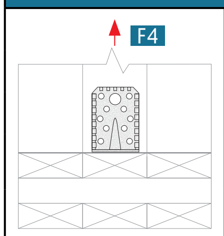
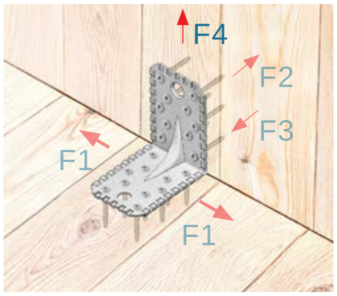
Configuration			Fasteners		Factored Resistance [kN]		Estimated Slip Modulus [kN / mm]	Ductility Ratio
					F4 - Uplift Resistance			
	Angle Bracket	Relative Density	Type	Quantity	Standard Loading KD = 1.0	Short Term Loading KD = 1.15		
	MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	6.3	7.2	5.4	15.8
	MTBL 105			26	6.0	6.9	4.3	14.6

Table 4, F4 - Estimated Ultimate Uplift Resistance in CLT Using MTBL

Configuration		Fasteners		Ultimate Resistance [kN]	
				F4 - Uplift Resistance	
Angle Bracket	Relative Density	Type	Quantity	Estimated 5th Percentile	Estimated 95th Percentile
MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	10.5	13.3
MTBL 105			26	10.2	12.8

Load Direction



Notes:
1. Listed factored resistance values are only valid for Limit State Design in Canada.
2. Listed factored resistance values are only valid for listed ASSY screws.
3. All connection design must meet all relevant requirements of General Notes to the Designer, page 7.
4. The MTBL were tested in monotonic and reverse cyclic loading configurations. Listed factored resistance values are calculated using test data and test-based calculation methods.
5. The estimated slip modulus was derived from cyclic loading, in accordance with the EEEP method as detailed in ASTM E2126.
6. The ultimate load values at 5th and 95th percentile was derived based on at least 12 brackets tested in each loading orientation, in accordance with the EN 14358 standard and CSA O86-19, Clause 11.
7. For the MTBL 105, the reference design values presented in this guide assume side B is always perpendicular to the load direction “F4” and parallel to the load directions “F2” and “F3”. The load direction “F1” is independent of install direction. See page 11.
8. Connector placement must respect the requirements presented in the MTBL Geometry Requirements Section, page 11.
9. The maximum installation torque for the 4.5mm diameter ASSY Ecofast screws is 3.4 N·m.

Table 5, F2 - Factored Withdrawal Resistance in CLT Using MTBL

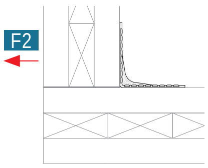
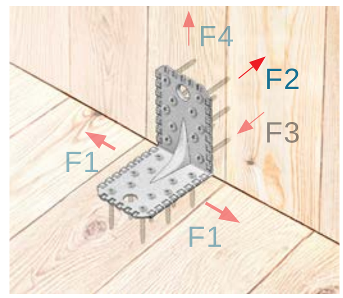
Configuration			Fasteners		Factored Resistance [kN]		Estimated Slip Modulus [kN / mm]
					F2 - Withdrawal Resistance		
	Angle Bracket	Relative Density	Type	Quantity	Standard Loading KD = 1.0	Short Term Loading KD = 1.15	
	MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	5.8	6.7	3.7
	MTBL 105			26	7.9	9.1	5.2

Table 6, F2 - Estimated Ultimate Withdrawal Resistance in CLT Using MTBL

Configuration		Fasteners		Ultimate Resistance [kN]	
				F2 - Withdrawal Resistance	
Angle Bracket	Relative Density	Type	Quantity	Estimated 5th Percentile	Estimated 95th Percentile
MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	10.0	12.4
MTBL 105			26	12.4	19.2

Load Direction



Notes:
1. See detailed notes under table 8.

Table 7, F3 - Factored Compression Resistance in CLT Using MTBL

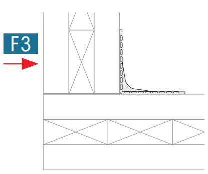
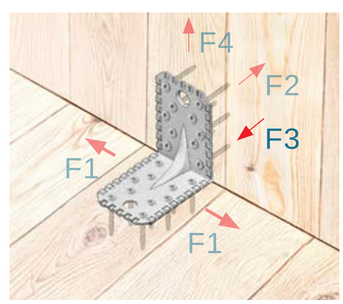
Configuration			Fasteners		Factored Resistance [kN]		Estimated Slip Modulus [kN / mm]
					F3 - Compression Resistance		
	Angle Bracket	Relative Density	Type	Quantity	Standard Loading KD = 1.0	Short Term Loading KD = 1.15	
	MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	7.9	9.1	1.8
	MTBL 105			26	8.2	9.4	3.2

Table 8, F3 - Estimated Ultimate Compression Resistance in CLT Using MTBL

Configuration		Fasteners		Ultimate Resistance [kN]	
				F3 - Compression Resistance	
Angle Bracket	Relative Density	Type	Quantity	Estimated 5th Percentile	Estimated 95th Percentile
MTBL 90	0.42 (SPF)	Ecofast 4.5 x 50	20	13.3	17.7
MTBL 105			26	14.5	16.1

Load Direction

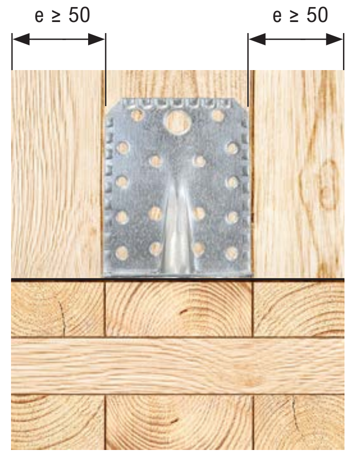


Notes:
1. Listed factored resistance values are only valid for Limit State Design in Canada.
2. Listed factored resistance values are only valid for listed ASSY screws.
3. All connection design must meet all relevant requirements of General Notes to the Designer, page 7.
4. The MTBL were tested in monotonic and reverse cyclic loading configurations. Listed factored resistance values are calculated using test data and test-based calculation methods.
5. The estimated slip modulus was derived from cyclic loading, in accordance with the EEEP method as detailed in ASTM E2126.
6. The ultimate load values at 5th and 95th percentile was derived based on at least 12 brackets tested in each loading orientation, in accordance with the EN 14358 standard and CSA O86-19, Clause 11.
7. For the MTBL 105, the reference design values presented in this guide assume side B is always perpendicular to the load direction "F4" and parallel to the load directions "F2" and "F3". The load direction "F1" is independent of install direction. See page 11.
8. Connector placement must respect the requirements presented in the MTBL Geometry Requirements Section, page 11.
9. The maximum installation torque for the 4.5mm diameter ASSY Ecofast screws is 3.4 N·m.

Geometry Requirements

MTBL 90

Front View



MTBL 105

Front View

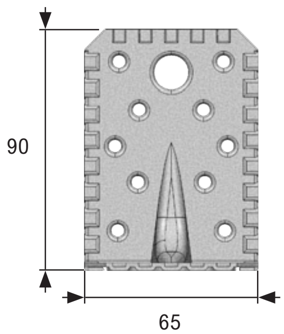
Notes:

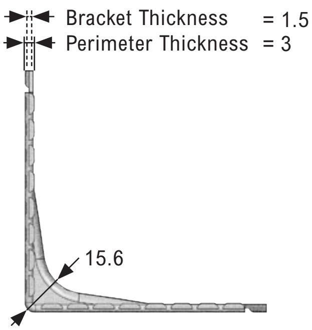
1. All dimensions are in mm.
2. Distances "e" are minimum edge distances.

Connector Detailing

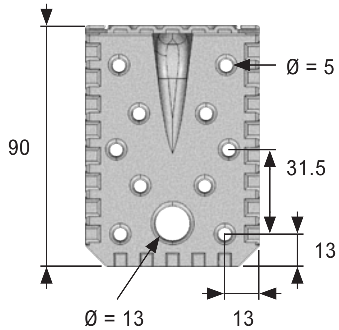
MTBL 90

Side A



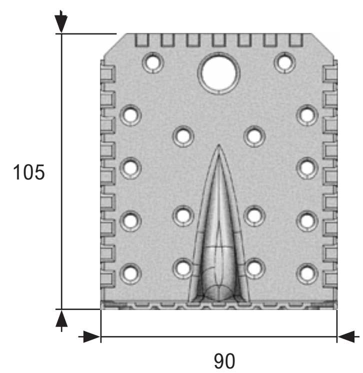


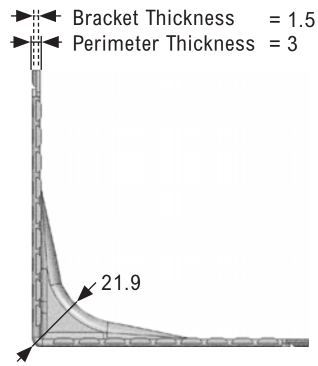
Side B



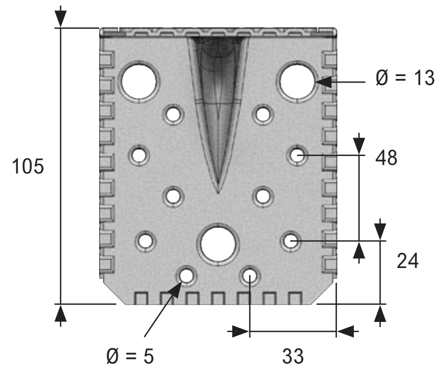
MTBL 105

Side A





Side B



Notes:

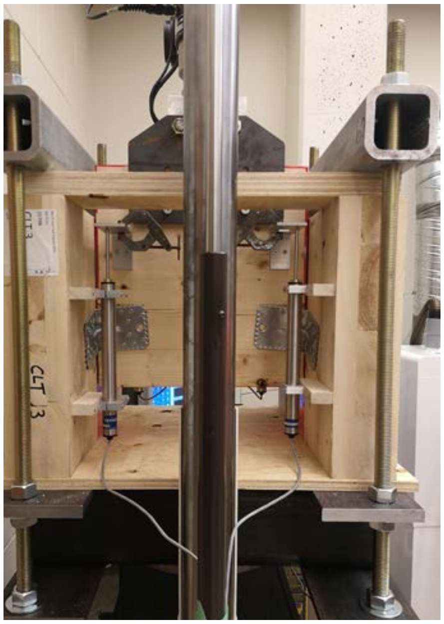
1. All dimensions are in mm.
2. All 5 mm holes are to be filled.
3. For the MTBL 105, the reference design values presented in this guide assume side B always perpendicular to the load direction "F4" and parallel to the load directions "F2" and "F3". The load direction "F1" is independent of install direction.

Testing

Data Analysis

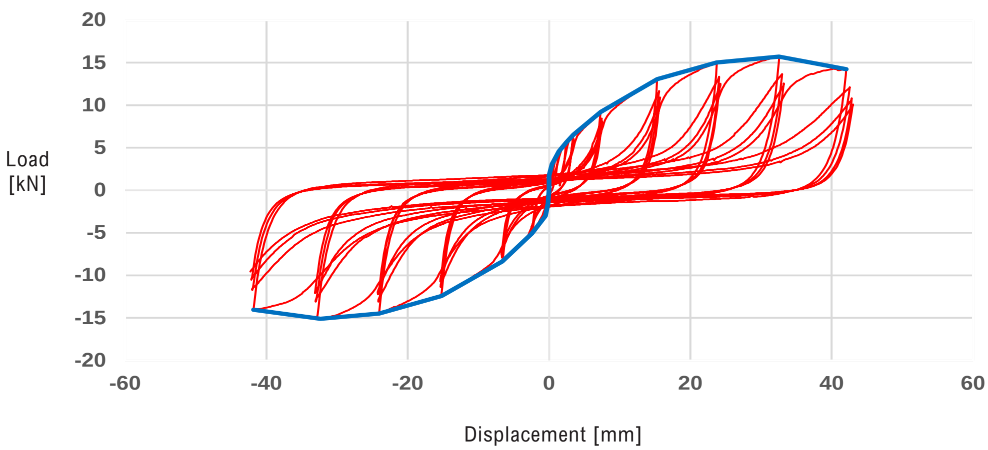
The load-displacement graphs presented in this section show hysteresis loops and envelope curves and have been selected to show an average result from a set of tests. The envelope curves were obtained from the hysteresis loop created by the reverse cyclic tests.

For the reverse cyclic test, ASTM E2126 was followed to analyze the results. Analysis has shown that the MTBL angle brackets have an average ductility ratio of 3 or more in all loading directions following the Equivalent Energy Elastic-Plastic (EEEP) method in both monotonic and cyclic loading conditions.

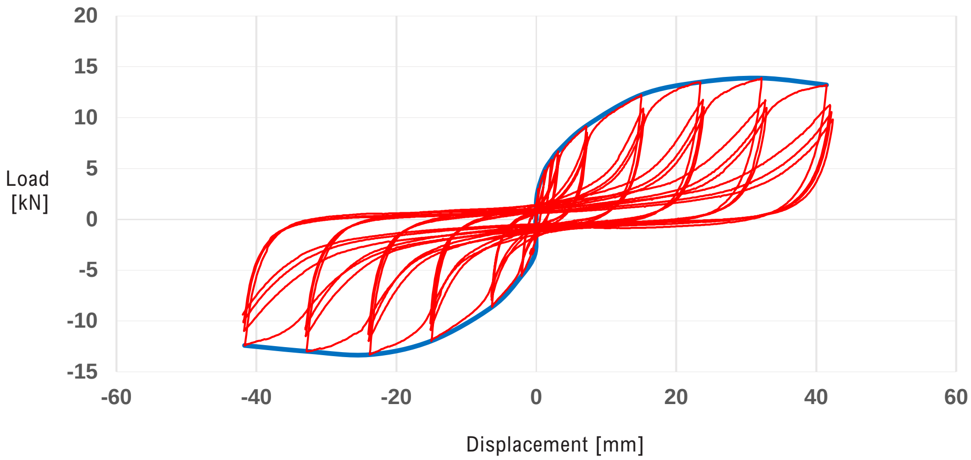


F1 - Lateral Load / Displacement Curves in CLT

MTBL 90



MTBL 105

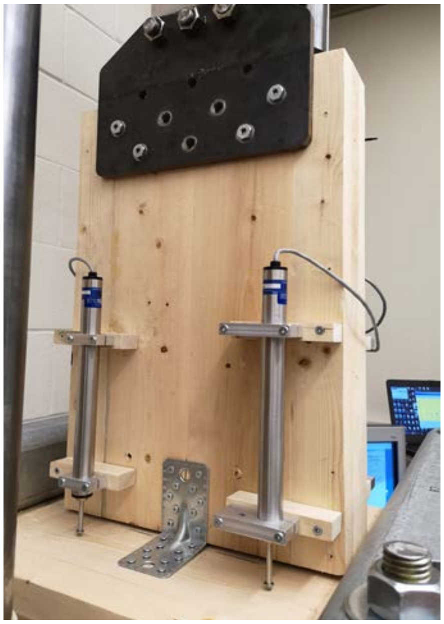


Notes:
1. The MTBLs were tested in monotonic and reverse cyclic loading configurations.
2. Graphs shown represent an average result recorded in the tests.

Data Analysis

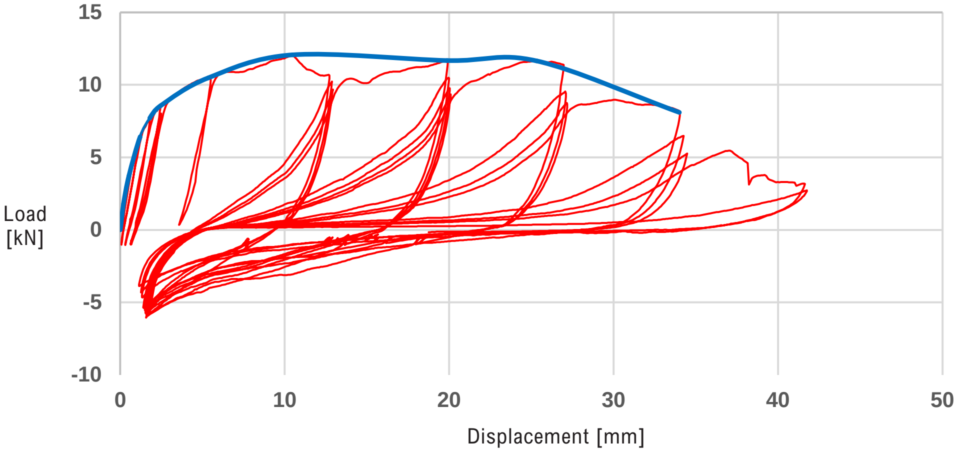
The witnessed failure modes varied depending on loading direction, however, ductile steel failure and ductile screw yielding were the prevalent failure modes observed. In load directions F1 Lateral and F3 Compression, steel yielding was recorded. In load directions F2 Withdrawal and F4 Uplift, both screw withdrawal and steel yielding was observed.

Throughout the testing, it was observed that the MTBL 90 and the MTBL 105 performed similarly in a variety of selected test setups. This result is due to similarities in the design of each MTBL with respect to hole patterns and the amount and location of fasteners on each leg.

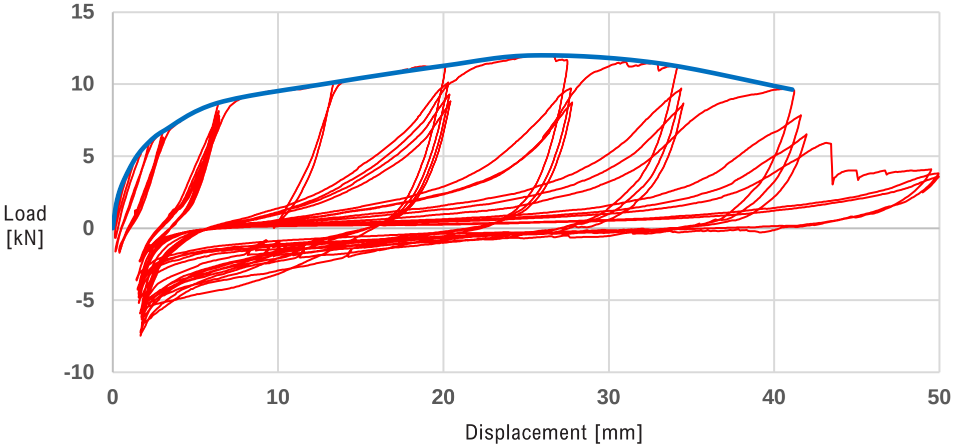


F4 - Uplift Load / Displacement Curves in CLT

MTBL 90



MTBL 105



Notes:

1. The MTBLs were tested in monotonic and reverse cyclic loading configurations.
2. Graphs shown represent an average result recorded in the tests.

First Tech Federal Credit Union

Hillsboro, Oregon

BSP-S - Solid Base Shear Plate

The BSP-S Solid Base Shear Plate connector is designed for high strength shear connections in seismic applications. The BSP-S is easily installed on CLT shear walls using high-capacity code approved ASSY self-tapping screws. The failure mechanism of the BSP-S connector is designed to be the screw yielding in failure mode (f).

BSP-S

High Capacity Connector

Seismic Applications

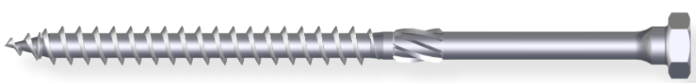
Fast Installation

Code Approval

TESTED IN NORTH AMERICA

Associated Hardware

Fasteners and Installation Tools



ASSY Kombi 12 x 140 mm

Hexegonal Head

17 mm Magnetic Socket

Specified Magnetic Socket Bit for Installation

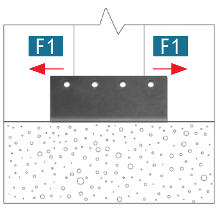
**Hardware package does not include the concrete anchors

Applications

CLT Shear Wall to Concrete Foundation

Factored Resistance Values in CLT Shear Wall

Table 9, F1 - Factored Lateral Resistance in CLT Using BSP-S

Configuration		Fasteners		Factored Resistance [kN]	
	Relative Density	Type	Quantity	F1 - Lateral Resistance	
				Standard Loading [K_D = 1.0]	Short Term Loading [K_D = 1.15]
	0.42 (SPF)	Kombi 12 x 140	4	37.22	42.80

Notes:

1. Listed factored resistance values are only valid for Limit State Design in Canada.
2. Listed factored resistance values are only valid for listed ASSY screws.
3. All connection design must meet all relevant requirements of General Notes to the Designer, page 7.
4. Listed factored resistance values are calculated using test data and test-based calculation methods.
5. Connector placement must respect the requirements presented in the BSP-S Geometry Requirements Section.
6. The maximum installation torque for the 12mm diameter ASSY Kombi screw is 47.3 N·m.
7. The failure mode observed for the steel to wood portion of the BSP-S, is yielding of the self-tapping screws in mode (f).
8. No uplift forces shall be assigned to the base shear connections.
9. The BSP-S system must be fastened using anchor rods that are designed to transfer the full factored resistance values or more as shown in Table 9.

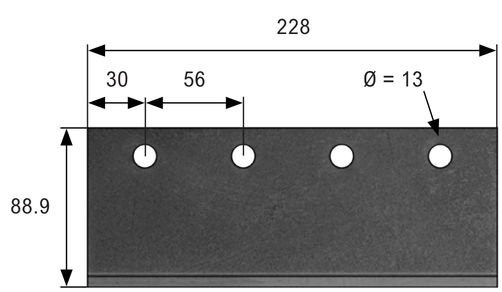
Geometry Requirements

Front View

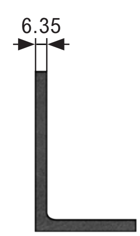
Notes:

1. Distances "e" are minimum end distances.

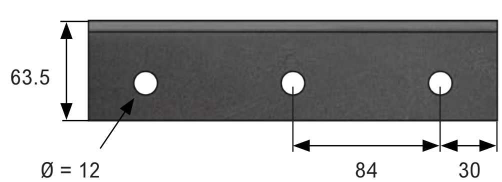
Connector Detailing



Front View



Side View



Top View

Notes:

1. All dimensions shown in this page are in mm.
2. All 13 mm holes are to be filled with ASSY Kombi 12 x 140.
3. All 12 mm holes are to be filled with anchor rods (refer to note 9 under Table 9).

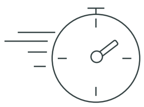
Ritchie Market

Edmonton, Alberta

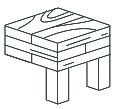
Courtesy of Western Archrib

MTS15 - Mass Timber Strap

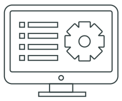
The Mass Timber Strap 15 is a tested high-capacity connector designed for use in various mass timber elements. The MTS15 is an ideal solution for tension applications using strong code approved ASSY self-tapping screws for a fast and easy installation.



Fast Installation

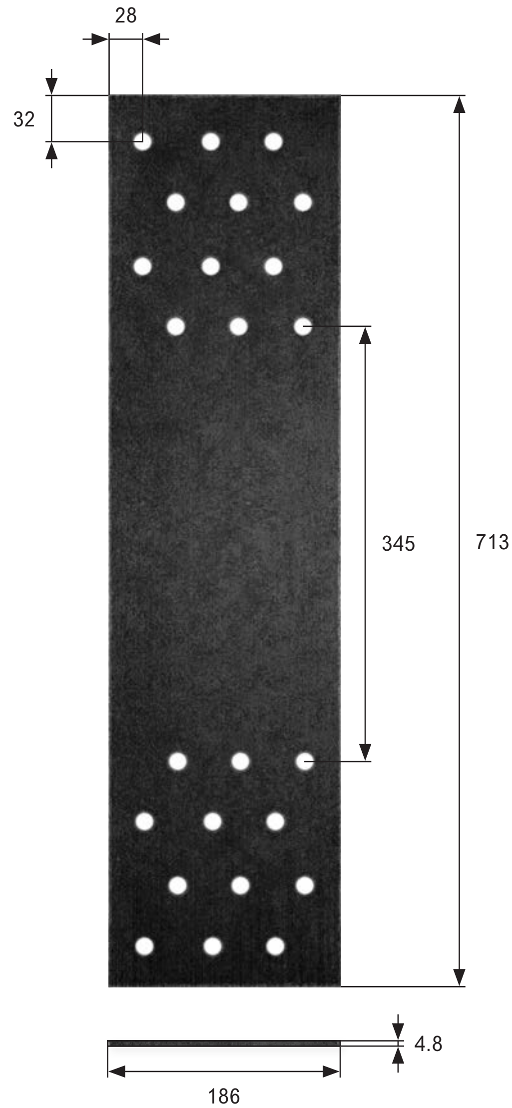


Mass Timber Panels



Performance Based Design

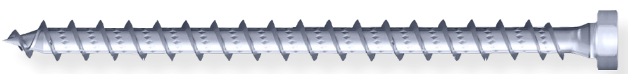
Code Approval



**All dimensions are in mm.

Associated Hardware

Fasteners and Installation Tools



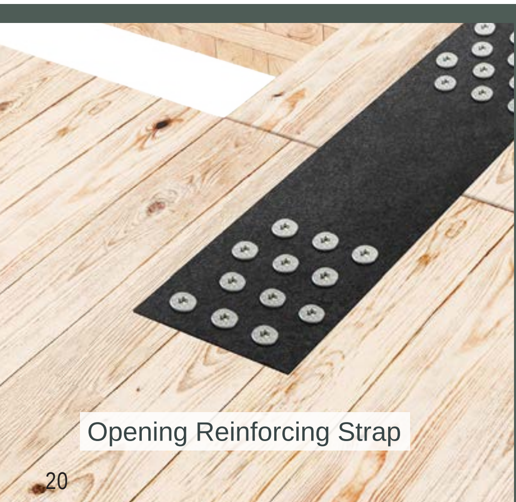
ASSY Kombi LT 12 x 160 mm

Hexagonal Head

17 mm Magnetic Socket

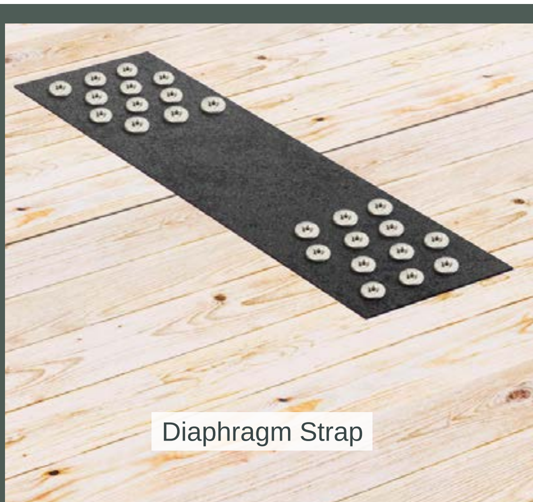
Specified Magnetic Socket Bit for Installation

Applications



Opening Reinforcing Strap

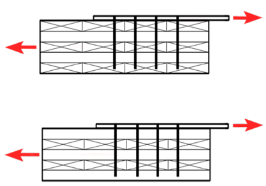
Wall Strap



Diaphragm Strap

Factored Resistance Values in CLT

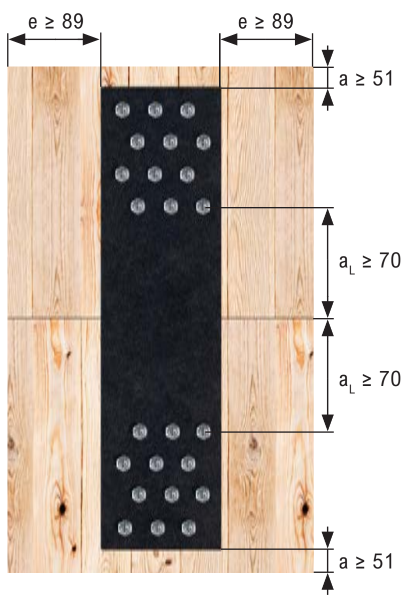
Table 10, Tested Factored Lateral Resistance in CLT Using MTS15

CLT Panel & Plate Configuration					Fasteners		Factored Resistance [kN]		Estimated Slip Modulus [kN/ mm]
			Relative Density	Panel Thickness [mm]	Type	Quantity	Standard Loading K_D = 1.0	Short Term Loading K_D = 1.15	
5 PLY +	N_r		SPF (0.42)	≥ 175	Kombi LT 12 x 160	24	100	115	25.8

Notes:

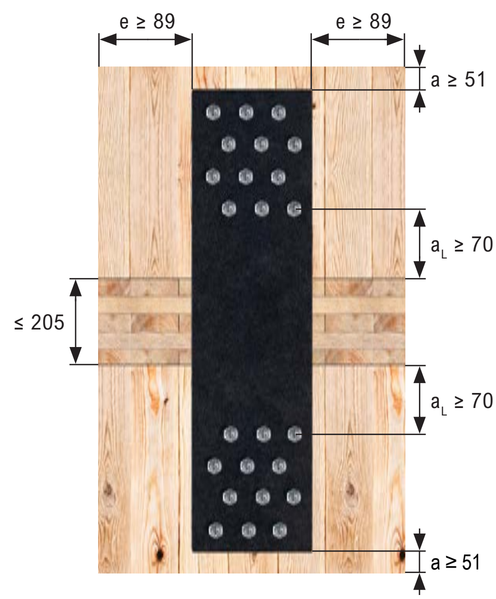
1. Listed factored resistance values are only valid for Limit State Design in the Canada.
2. Listed factored resistance values are only valid for listed ASSY screws.
3. All connection design must meet all relevant requirements of General Notes to the Designer, page 7.
4. Listed factored resistance values are calculated using test data and test-based calculation methods.
5. Connector placement must respect the requirements presented in the MTS 15 - Geometry Requirements section.
6. Shall pre-drilling be required, a 1/4" diameter drill bit may be used for pre-drilling.
7. The maximum installation torque for the 12mm diameter ASSY Kombi screws is 47.3 N·m.

Geometry Requirements



Diaphragm Strap Installation

Top View



Wall Strap Installation

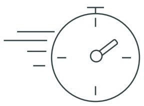
Front View

Notes:

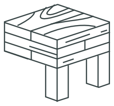
1. All dimensions shown in this page are in mm.
2. All geometry requirements are in accordance with the testing performed.
3. Distances "a" are minimum end distances.
4. Distances "a_L" are minimum loaded end distances.
5. Distances "e" are minimum edge distances.

MTS-i - Mass Timber Straps Incline

The MTS-i Mass Timber Strap series offers two solutions: the MTS-i 30 and the MTS-i 40 series. The MTS-i 30 and MTS-i 40 are designed to be a capacity protected connection in mass timber structures and are easy to install with code approved ASSY self-tapping screws and 45-degree washers. By using high strength inclined screws, the MTS-i offers higher stiffness and capacity for various tension applications, making it a one-of-a-kind off the shelf connecting solution.



Fast Installation



Mass Timber Panels

High Capacity Connector

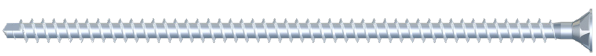
MTS-i 30

MTS-i 40

Associated Hardware

Fasteners and Installation Tools

ICC ES LISTED



ASSY VG CSK 8 x 220 mm

Countersunk Head

45° Washer

Applications

Opening Reinforcing Strap

Wall Strap

Diaphragm Strap

Spline Connection Reinforcement

Factored Resistance Values in CLT

Table 11, Factored Lateral Resistance in CLT Using MTS-i 30

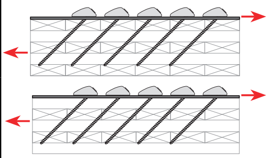
CLT Panel & Plate Configuration					Fasteners		Factored Resistance [kN]	
			Panel Thickness [mm]	Relative Density	Type	Quantity	Standard Loading $K_D = 1.0$	Short Term Loading $K_D = 1.15$
5 PLY +	**Nr**		≥ 140	SPF (0.42)	VG CSK 8 x 220	30	121	139
				D.Fir (0.49)			129	148

Table 12, Estimated Ultimate Lateral Resistance in CLT Using MTS-i 30

Configuration		Fasteners		Ultimate Resistance [kN]	
				F1 - Lateral Resistance	
Tension Strap	Relative Density	Type	Quantity	Estimated 5th Percentile	Estimated 95th Percentile
MTS-i 30	SPF (0.42)	VG CSK 8 x 220	30	184	251
	D.Fir (0.49)			215	286

Notes:
1. See detailed notes under Table 14.

Table 13, Factored Lateral Resistance in CLT Using MTS-i 40

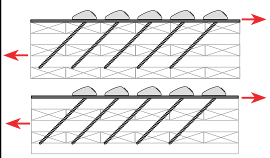
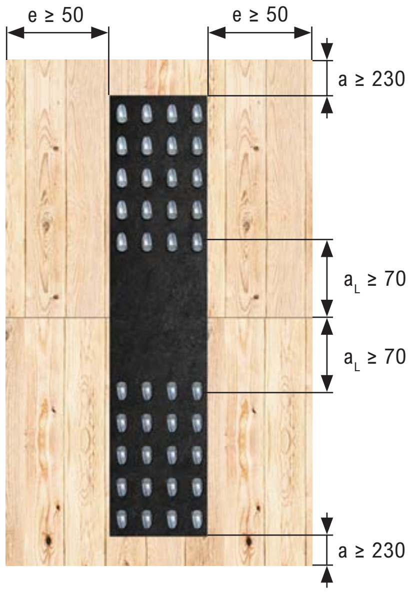
CLT Panel & Plate Configuration					Fasteners		Factored Resistance [kN]	
			Panel Thickness [mm]	Relative Density	Type	Quantity	Standard Loading $K_D = 1.0$	Short Term Loading $K_D = 1.15$
5 PLY +	**Nr**		≥ 140	SPF (0.42)	VG CSK 8 x 220	40	161	185
				D.Fir (0.49)			171	197

Table 14, Estimated Ultimate Lateral Resistance in CLT Using MTS-i 40

Configuration		Fasteners		Ultimate Resistance [kN]	
				F1 - Lateral Resistance	
Tension Strap	Relative Density	Type	Quantity	Estimated 5th Percentile	Estimated 95th Percentile
MTS-i 30	SPF (0.42)	VG CSK 8 x 220	30	245	335
	D.Fir (0.49)			258	345

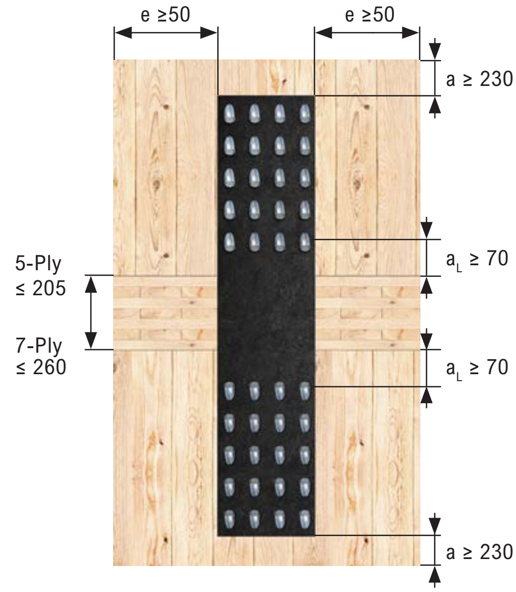
Notes:
1. Listed factored resistance values are only valid for Limit State Design in the Canada.
2. Listed factored resistance values are only valid for listed ASSY screws.
3. All connection design must meet all relevant requirements of General Notes to the Designer, page 7.
4. Fasteners and 45-degree washers must be placed according to the Installation Considerations section "B" on page 21.
5. Screw installation shall start with the inner most screw of the tension strap as shown in Installation Consideration section "C" on page 21.
6. Connector placement must respect the requirements presented in the MTS-i Geometry Requirements section on page 20.
7. Shall pre-drilling be required, a 3/16" diameter drill bit may be used for pre-drilling.
8. The maximum installation torque for the 8mm diameter VG CSK screws is 16.7 N·m.

Geometry Requirements



Diaphragm Strap Installation

Top View



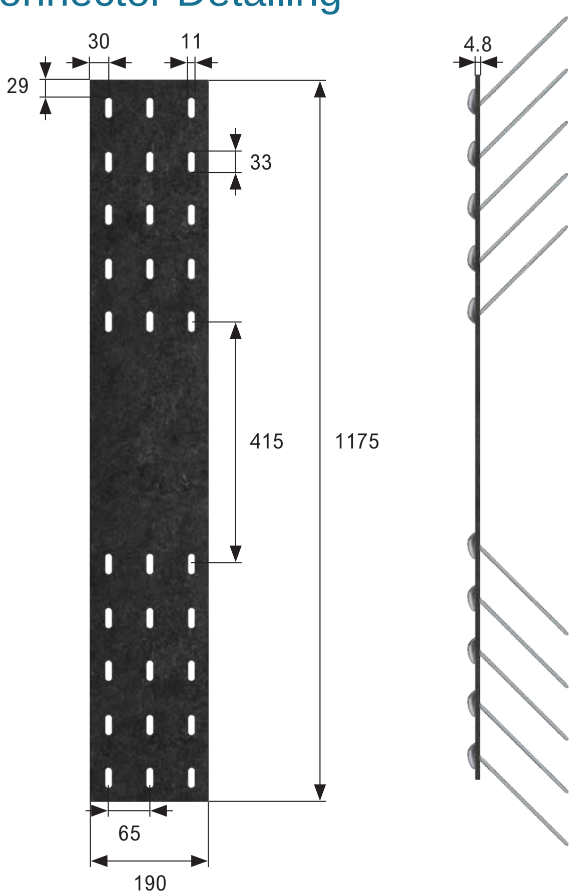
Wall Strap Installation

Front View

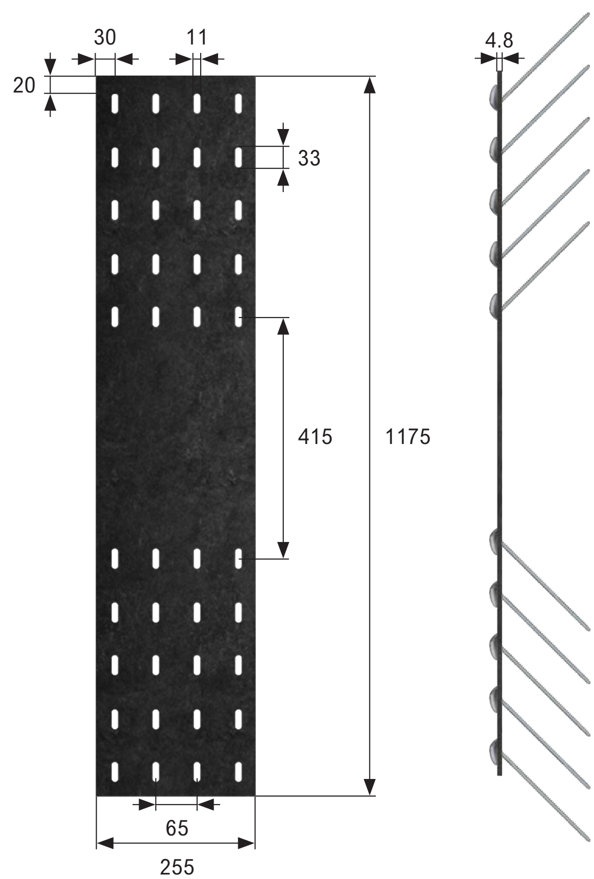
Notes:

1. All dimensions shown in this page are in mm.
2. Listed geometry requirements are valid for both MTS-i 30 and MTS-i 40
3. Distances “a” are minimum end distances.
4. Distances “a_L” are minimum loaded end distances.
5. Distances “e” are minimum edge distances.
6. Dimensions not to scale.

Connector Detailing



MTS-i 30

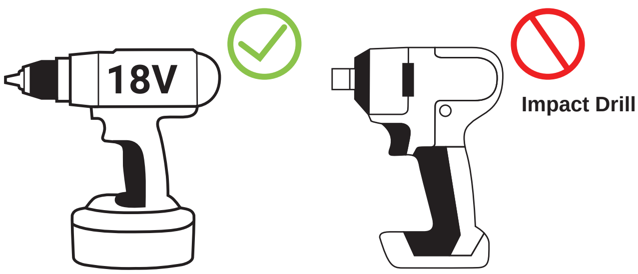


MTS-i 40

Installation Consideration

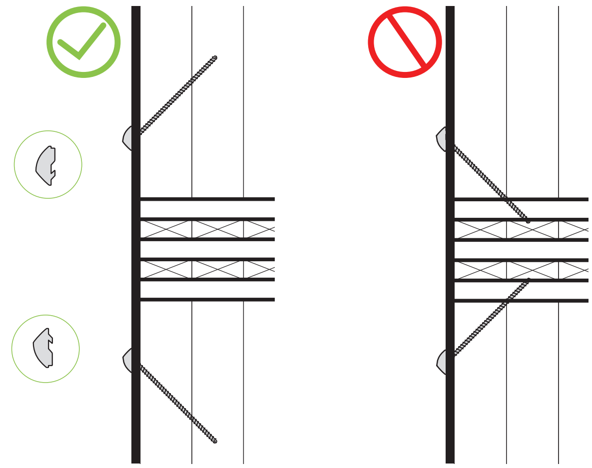
A Correct Drill for Installation

A cordless or corded drill with at least 18V must be used for the screw installation. The use of impact drills is prohibited. The maximum torque for 8 mm diameter screw is 16.7 N•m.



B Washer Orientation

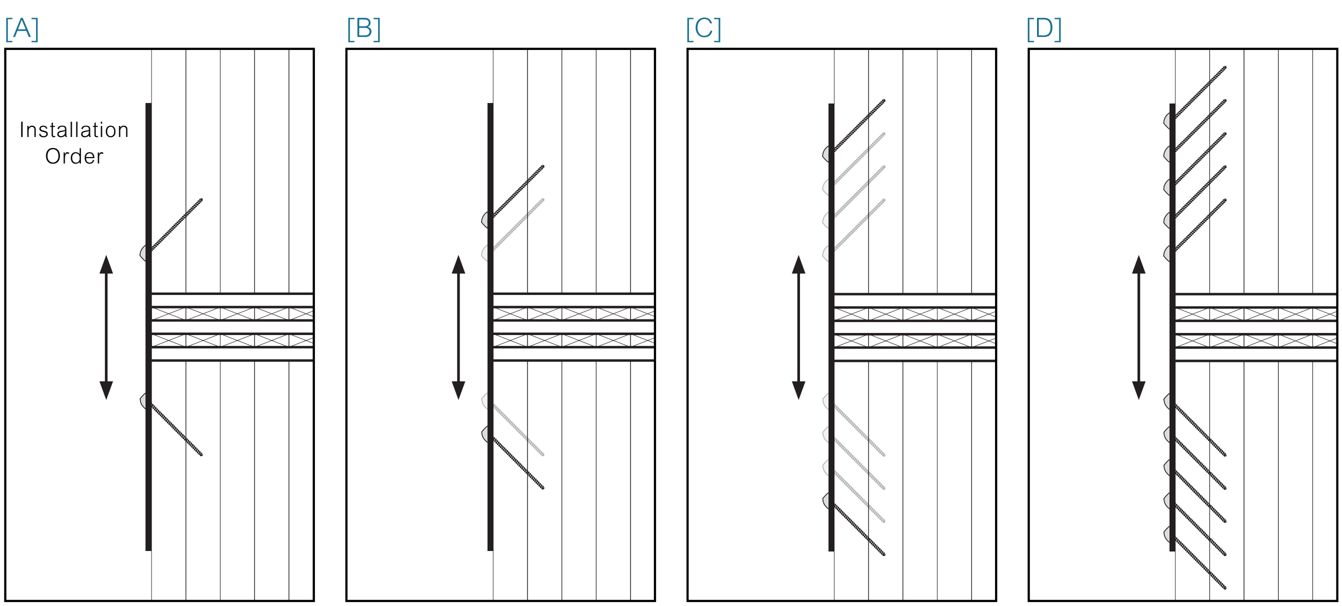
Washers must be installed so that the screw tip is pointing to the outside of the tension strap, not the middle.



C Order of Screw Installation

To ensure the tension screws are properly engaged and loads are transferred through the tension strap, the screws must be installed starting from the inner most screw row [A] to the outermost screws [D]. See the order of installation shown below.

Failure to install the tension strap with the correct screw order may result in the tension screws engaging and pushing the connector out of place.



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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