X-RAD

VIDEO SOFTWARE ETA 15/0632

X-RAD CONNECTION SYSTEM

REVOLUTIONARY
A radical innovation in timber constructions. It redefines the standard for shear, resistance, transportation the assembling and resistance of CLT panels. X-RAD offers excellent static and seismic performance.

PATENTED
Handling and assembly of ultra-rapid CLT walls and floors. Drastic reduction of assembly time, construction site errors and risk of injury.

STRUCTURAL SAFETY
Ideal connection system for seismic design with tested and certified ductility values (CE - ETA 15/0632).

CHARACTERISTICS

FOCUS	CLT buildings fastening
CLT WALLS	from 100 to 200 mm
STRENGTH	R_K up to 280 kN
FASTENERS	XVGS, XBOLT, MGS

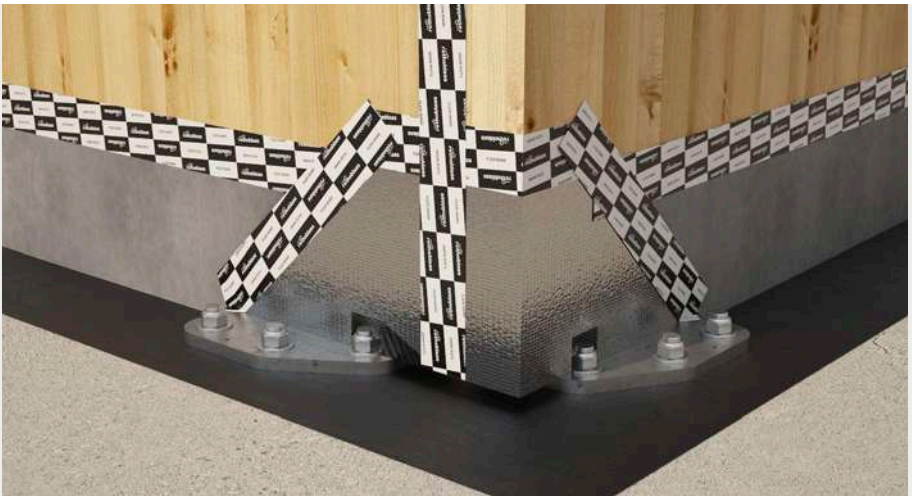
VIDEO
Scan the QR Code and watch the video on our YouTube channel

MATERIAL

Steel perforated plates and beechwood laminated veneered lumber.

FIELDS OF USE

Transportation, assembling and realization of timber buildings with CLT (Cross Laminated Timber) structure.



INNOVATION

The metal box element incorporates a multi-layer beechwood profile which is connected to the angles of the CLT walls with full thread screws.

PROTECTION

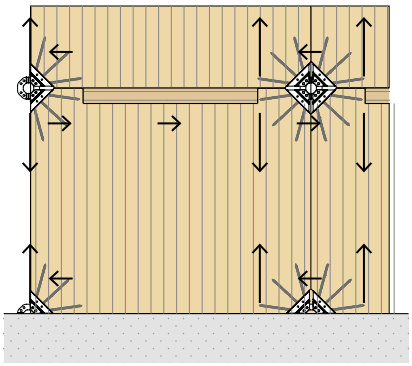
The use of X-SEAL and self-adhesive protection membranes for CLT walls at the ground connection ensures the structure durability.

CONSTRUCTION SITE SET UP TIMES

The standardisation and the reduction of the total number of joints make the X-RAD system successful when the construction site set up times are a determining factor for the construction of the work. These advantages were demonstrated during the construction of the first X-RAD system buildings, when comparing the X-RAD system and all the necessary operations to the traditional use of anchors it was much quicker.

COMPARISON OF FASTENING TIMES BETWEEN X-RAD SOLUTION AND TRADITIONAL ANGLE BRACKETS

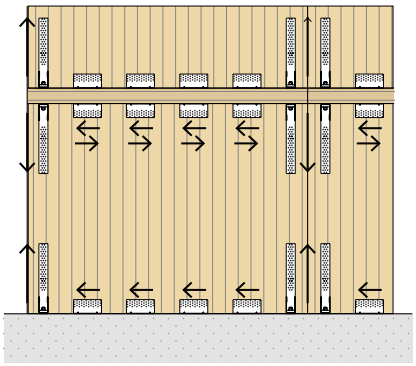
X-RAD SYSTEM



Average time needed to install 1 X-ONE: **about 5 minutes.**

Total time required for positioning and complete assembly of a wall (no. 4 X-ONE in the factory + n. 4 X-PLATE on site): **about 30 minutes.**

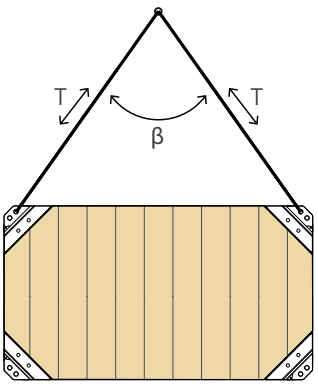
TRADITIONAL SYSTEM



Total time required for positioning and complete assembly of a wall on site (fastening of no. 4 WHT440 + no. 4 TCN240 + no. 4 TTN200): **about. 60 - 70 minutes.**

VERTICAL LIFTING

The CLT walls are assembled on site using bolted joints and specific plates, specially developed to allow any geometric configuration of the panels. The X-RAD system allows lifting, handling and assembling CLT panels directly from the transport vehicle to the structure under construction, avoiding warehousing and storage phases.
The X-RAD system is certified according to the Machinery Directive 2006/42/EC for additional use as a vertical lifting point for the transport of CLT panels.



FIRE BEHAVIOR

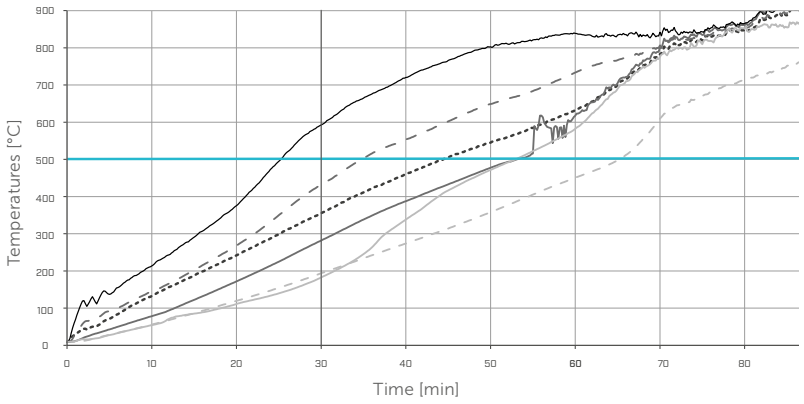
The X-RAD system provides for the positioning of the structural connection, consisting of X-ONE and X-PLATE, in axis to the wall. This allows the perfectly shaped components of the X-SEAL system to adhere to the metal components of the connection, guaranteeing airtightness and thermal-acoustic insulation. In order to understand the fire behaviour of this system, a research programme has been initiated at the Technical University of Munich (TUM). At this stage, an MI inter-storey node complete with X-ONE, X-PLATE and X-SEAL and their sealing with acrylic tape, assembled inside a CLT panel 100 mm thick, was studied. Two different types of specimens were tested:

- **(A)** structural wall with X-RAD system without any coating on fire side;
- **(B)** structural wall with X-RAD system covered with plasterboard sheets according to DIN EN520 assembled in adherence.

To monitor the temperature evolution during the test, thermocouples have been installed in 6 different positions inside the connection. As described in Eurocode EN 1993:1-2, steel components show a significant reduction in yield strength, modulus of elasticity and proportionality limit above 400°C. At 500°C, the yield strength has been reduced by 20% and the modulus of elasticity by 40%. The temperature of 500°C will be considered as a reference value during the test.

EVOLUTION OF AVERAGE TEMPERATURES REGISTERED

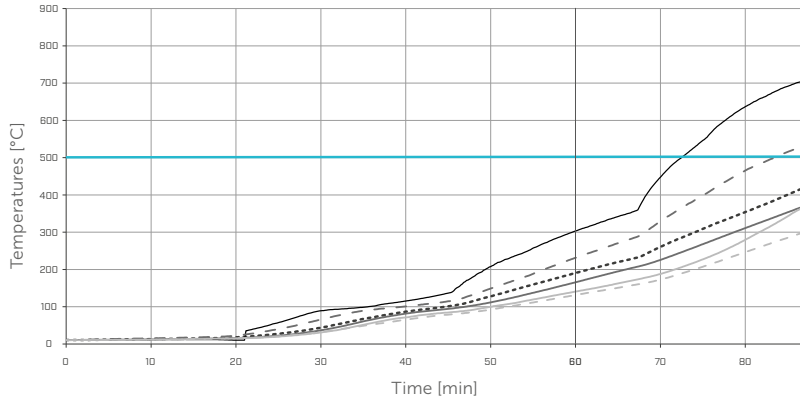
SPECIMEN (A)
UNCOATED (SIDE EXPOSED TO FIRE)



The analysis of the results shows that most of the components of the X-RAD system (except the most external parts of the X-ONE) maintain a temperature below 500°C for at least 30 minutes, while still showing good fire behaviour, thanks to the protection offered by the X-SEAL system.

- X-PLATE F (1/3/5)
- X-ONE BASESCREW FA (8/10)
- X-PLATE FA (2/4/6)
- X-ONE - X-PLATE (11/12/13/14)
- X-ONE BASESCREW F (7/9)
- X-ONE - CRACK (17/18)

SPECIMEN (B)
COATED (SIDE EXPOSED TO FIRE)



The analysis of the results shows that all the components of the X-RAD system maintain a temperature below 500°C for over 60 minutes, thus showing excellent fire behaviour, thanks to the protection offered by the X-SEAL system and the coated plasterboards.

- X-PLATE F (3/5)
- X-ONE BASESCREW FA (8/10)
- X-PLATE FA (2/4/6)
- X-ONE - X-PLATE (11/12/13/14)
- X-ONE BASESCREW F (7/9)
- X-ONE - CRACK (17/18)

X-ONE

CODES AND DIMENSIONS

X-ONE

CODE	L [mm]	B [mm]	H [mm]	pcs
XONE	273	90	113	1

X-VGS SCREW

CODE	L [mm]	b [mm]	d_1 [mm]	TX	pcs
XVGS11350	350	340	11	TX50	25

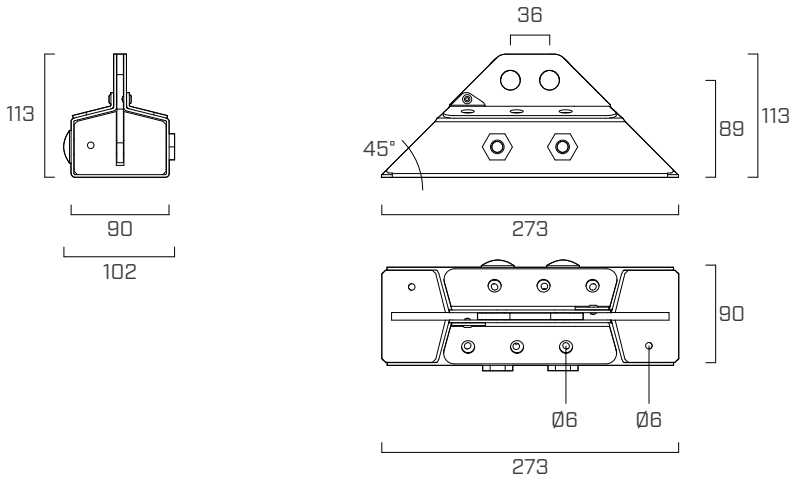
MANUAL TEMPLATE

CODE	description	pcs
ATXONE	manual template for X-ONE assembly	1

AUTOMATIC TEMPLATE

CODE	description	pcs
JIGONE	automatic template for X-ONE assembly	1

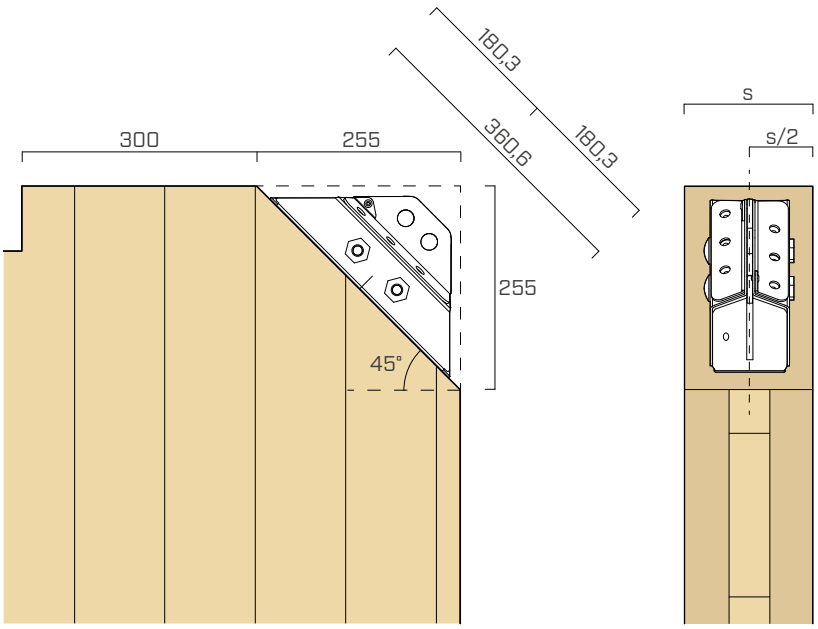
GEOMETRY



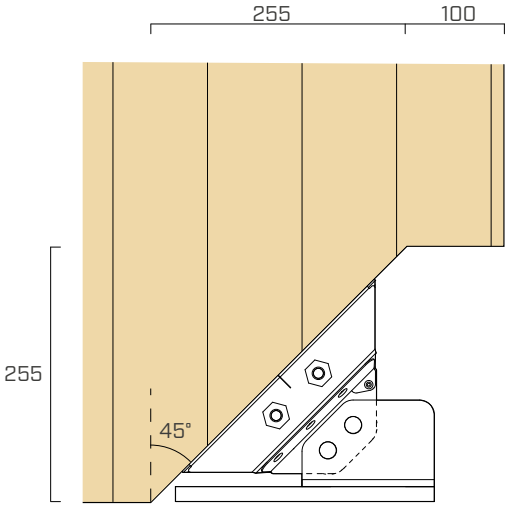
POSITIONING

Regardless of the panel thickness and its location on the construction site, the shear for fastening X-ONE is made at the top of the walls at 45°, and has a length of 360,6 mm.

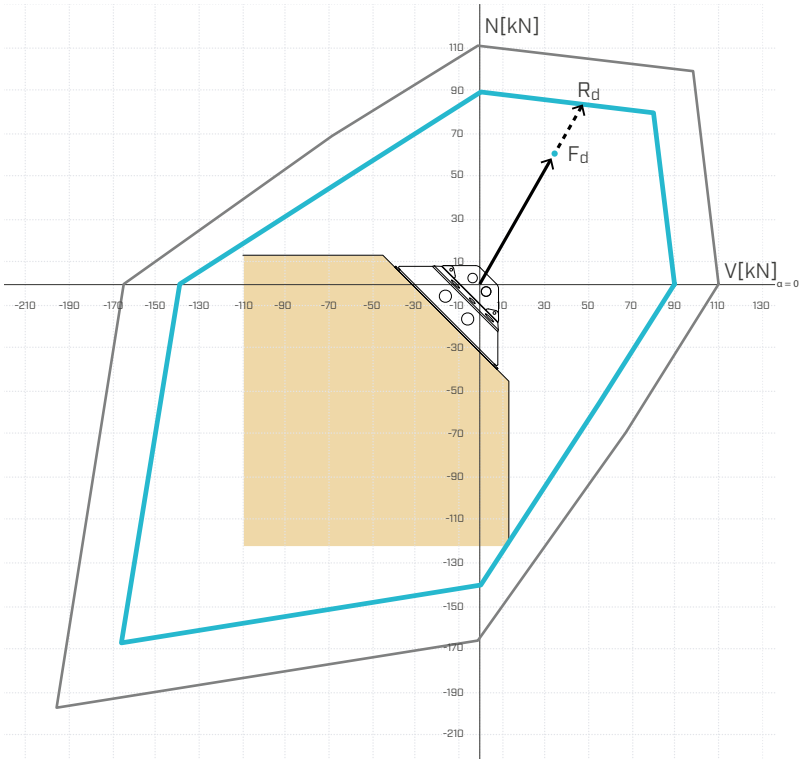
INTER-STOREY AND TOP NODES SPECIAL STANDARD SHEAR



BOTTOM NODES SPECIAL STANDARD SHEAR



DESIGN STRENGTHS



Design strength domain according to EN 1995-1-1 and EN 1993-1-8

The verification of the X-ONE connection is considered successful when the representative point of the F_d stress falls within the design strength domain:

$$F_d \leq R_d$$

The X-ONE design domain refers to the strength values and γ_M coefficients shown in the table and for loads with instantaneous life class (earthquake and wind).

LEGEND:

R_k

R_d EN 1995-1-1

A table summarizing the **characteristic strengths** in the various stress configurations and a reference to the relative safety coefficient according to the failure mode (steel or timber) is shown.

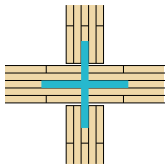
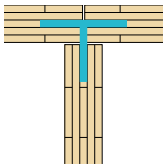
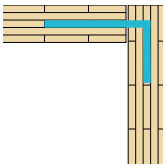
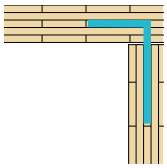
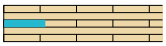
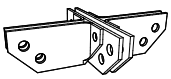
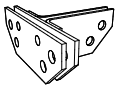
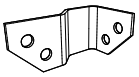
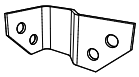
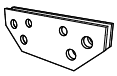
	GLOBAL STRENGTH	STRENGTH COMPONENTS		FAILURE MODES		PARTIAL SAFETY COEFFICIENTS (1)
α	R_k [kN]	V_k [kN]	N_k [kN]			γ_M
0°	**111,6**	111,6	111,6	VGS tension		γ_{M2} = 1,25
45°	**141,0**	99,7	99,7	block tearing on M16 holes		γ_{M2} = 1,25
90°	**111,6**	0,0	111,6	VGS tension		γ_{M2} = 1,25
135°	**97,0**	-68,6	68,6	VGS tension		γ_{M2} = 1,25
180°	**165,9**	-165,9	0,0	VGS thread extract		$\gamma_{M,timber}$ = 1,3
225°	**279,6**	-197,7	-197,7	timber compression		$\gamma_{M,timber}$ = 1,3
270°	**165,9**	0,0	-165,9	thread withdrawal VGS		$\gamma_{M,timber}$ = 1,3
315°	**97,0**	68,6	-68,6	VGS tension		γ_{M2} = 1,25
360°	**111,6**	111,6	0,0	VGS tension		γ_{M2} = 1,25

NOTES:

(1) The partial safety coefficients should be taken according to the current regulations used for the calculation. The table shows the values on steel side according to EN 1993-1-8 and on the timber side according to EN 1995-1-1.

X-PLATE

CODES AND DIMENSIONS

X-SHAPE	T-SHAPE	G-SHAPE	J-SHAPE	I-SHAPE	O-SHAPE
					
X-PLATE TOP					
					
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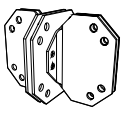	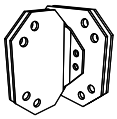	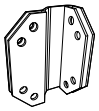	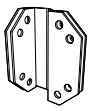	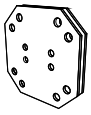	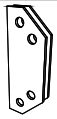
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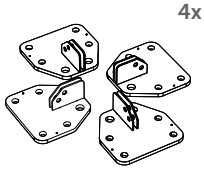
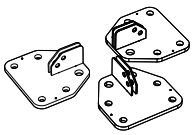
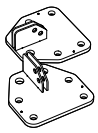
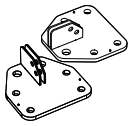
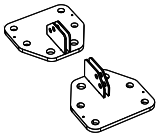
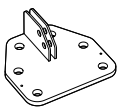
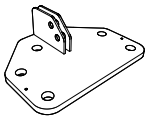
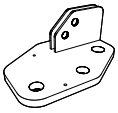
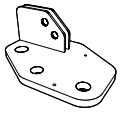
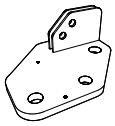
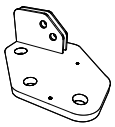
X-PLATE BASE					
4x 	3x 	2x 	2x 	2x 	1x 
					
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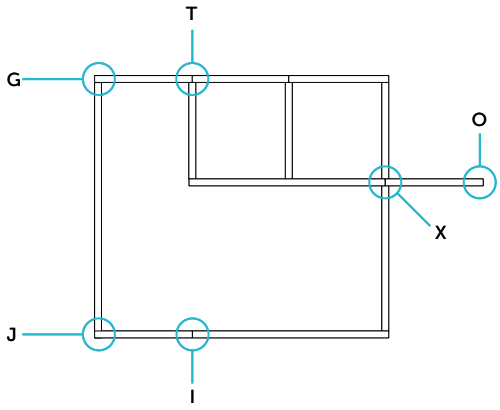
X-PLATE SYSTEM

X-ONE makes the CLT panel a module with specific connections for fastening. X-PLATE allows modules to become buildings. Panels with thickness between 100 and 200 mm can be connected.
X-PLATE plates are the ideal solution for every construction site situation, developed for all geometric configurations. The X-PLATE plates are identified according to their positioning on the building level (X-BASE, X-MID, X-TOP) and according to the geometric configuration of the node and the thickness of the connected panels.

X-PLATE MID-TOP CODE COMPOSITION

LEVEL + NODE + THICKNESS

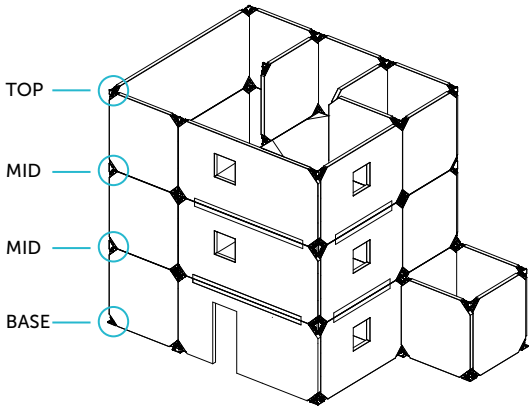
- LEVEL: indicates that they are MID (M) and TOP (T) inter-storey plates
- NODE: indicates the type of node (X, T, G, J, I, O)
- THICKNESS: indicates the thickness of the panel that can be used with that plate. There are three families of standard thickness values, 100 mm - 120 mm - 140 mm. All panel thickness values between 100 and 200 mm can be used, using universal plates for G, J, T and X nodes, in combination with specially developed SPACER shimming plates. The universal plates are available in the MID-S and TOP-S versions for panels with thickness between 100 and 140 mm and in the MID-SS and TOP-SS versions for panels with thickness between 140 and 200 mm.



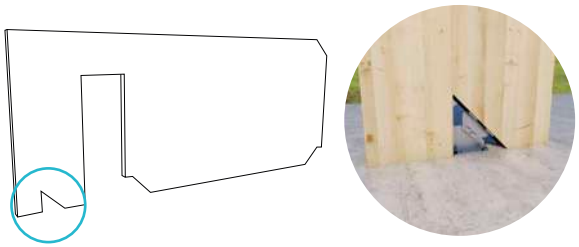
BASE X-PLATE CODE COMPOSITION

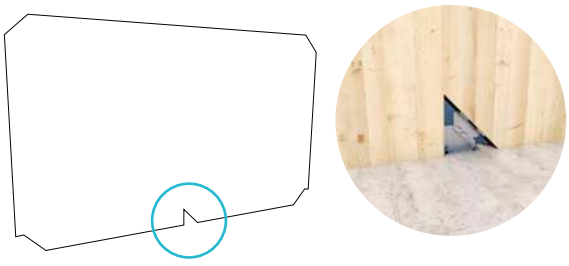
LEVEL + THICKNESS + ORIENTATION

- LEVEL: B indicates that they are base plates.
- THICKNESS: indicates the thickness interval of the panel that can be used with that plate. There are two families of plates, the first designed for thickness values from 100 to 130 mm (BMINI code), the second for thickness values from 130 to 200 mm (BMAXI code).
- ORIENTATION: indicates the orientation of the plate with respect to the wall, right/left (R/L), indication present only for asymmetrical plates.



ACCESSORIES: X-PLATE BASE EASY PLATES FOR NON-STRUCTURAL FASTENINGS





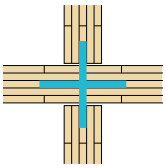
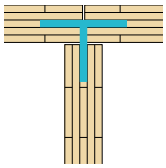
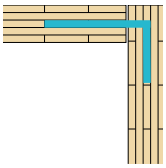
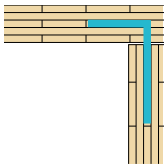
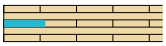
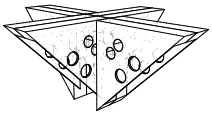
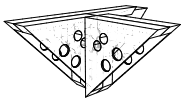
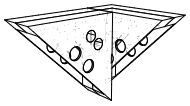
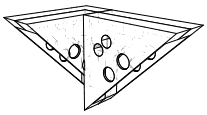
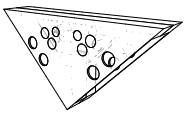
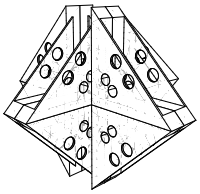
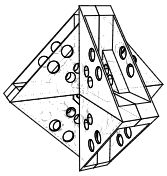
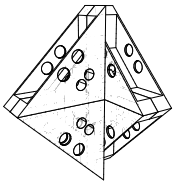
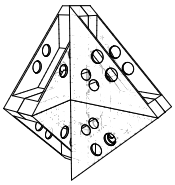
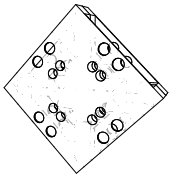
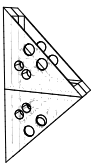
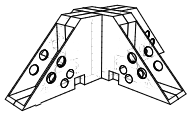
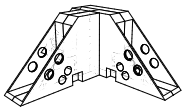
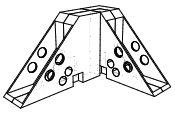
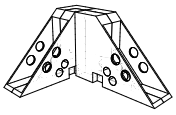
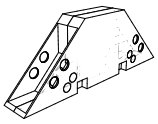
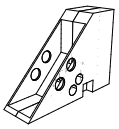
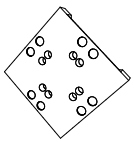
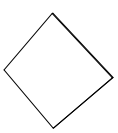
Where a foundation fastening is required for non-structural walls or temporary fastening for correct wall alignment (e.g. walls with very long length), it is possible to install the BEASYT plate (as an alternative to the X-ONE plate) on the bottom corner of the CLT panel (with simplified 45° shear without horizontal sawing) and the BEASYC plate (as an alternative to X-PLATE BASE plates) on the foundation slab.

CODES AND DIMENSIONS

CODE	s [mm]	$Ø_{SUP}$ [mm]	n. $Ø_{SUP}$	$Ø_{INT}$ [mm]	n. $Ø_{INT}$	pcs
BEASYT	5	9	3	17	2	1
BEASYC	5	17	2	13	2	1

X-SEAL

CODES AND DIMENSIONS

X-SHAPE	T-SHAPE	G-SHAPE	J-SHAPE	I-SHAPE	O-SHAPE
					
X-SEAL TOP					
					
XSEALTX100 **XSEALTX120** **XSEALTX140** 8 COMPONENTS	**XSEALTT100** **XSEALTT120** **XSEALTT140** 5 COMPONENTS	**XSEALTG100** **XSEALTG120** **XSEALTG140** 4 COMPONENTS	**XSEALTJ100** **XSEALTJ120** **XSEALTX140** 4 COMPONENTS	**XSEALTI100** **XSEALTI120** **XSEALTI140** 2 COMPONENTS	
X-SEAL MID					
					
XSEALMX100 **XSEALMX120** **XSEALMX140** 16 COMPONENTS	**XSEALMT100** **XSEALMT120** **XSEALMT140** 9 COMPONENTS	**XSEALMG100** **XSEALMG120** **XSEALMG140** 6 COMPONENTS	**XSEALMJ100** **XSEALMJ120** **XSEALMJ140** 6 COMPONENTS	**XSEALMI100** **XSEALMI120** **XSEALMI140** 3 COMPONENTS	**XSEALMO100** **XSEALMO120** **XSEALMO140** 3 COMPONENTS
X-SEAL BASE					
					
XSEALBX100 **XSEALBX120** **XSEALBX140** 8 COMPONENTS	**XSEALBT100** **XSEALBT120** **XSEALBT140** 5 COMPONENTS	**XSEALBG100** **XSEALBG120** **XSEALBG140** 4 COMPONENTS	**XSEALBJ100** **XSEALBJ120** **XSEALBJ140** 4 COMPONENTS	**XSEALBI100** **XSEALBI120** **XSEALBI140** 2 COMPONENTS	**XSEALBO100** **XSEALBO120** **XSEALBO140** 2 COMPONENTS
X-SEAL BASE			**X-SEAL SPACER**		
					
XSEALSPARE50 **XSEALSPARE60** **XSEALSPARE70**			**XSEALSPACER5** **XSEALSPACER10**		

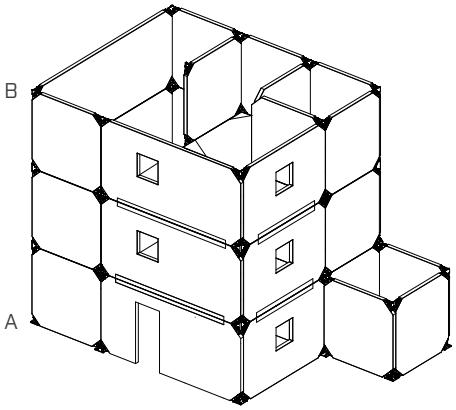
The X-SEAL system uses the same logic as the X-PLATE plates. Each configuration is characterized and described by:

- **LEVEL**: indicates whether it is base B (BASE), inter-storey M (MID) or T coverage (TOP) level.
- **NODE**: indicates the type of node (X, T, G, J, I, O).
- **THICKNESS**: indicates the thickness of the panel that can be used. There are three families of standard thickness values: 100 mm - 120 mm - 140 mm. All panel thickness values between 100 mm and 200 mm can be used, combining the basic components for standard thickness values with SPACER elements having thickness values of 5 and 10 mm.

THERMO-HYGROMETRIC BEHAVIOUR

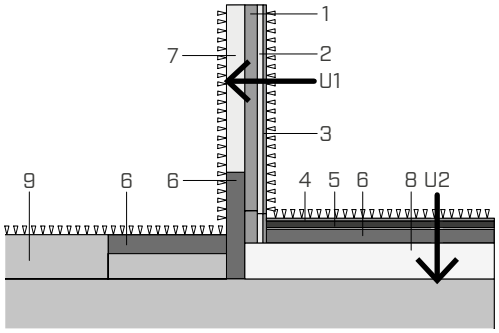
The X-RAD system thermal analysis is carried out in order to quantify and verify the point-to-point thermal bridge.
The most unfavourable conditions in which to concentrate the study and verification are the ground connection of the BASE G element and the node of the wall and floor connection of the roof, TOP G.
The study is performed using a FEM - 3D model. The reference stratigraphy considered represents a possible standard situation in current building practice. The image shows the construction panels and the materials considered. The choice of specific materials allows to contextualize the verifications and does not exclude the use of different products.

An overview of the study with some of the results obtained is given below. To obtain the full study report or for more information contact the Rothoblaas technical office.



NODE A | Ground connection

coefficient	description	value
X Chi (16 cm)	heat flow	- 0,330 W/node
fRsi (Te = - 5 °C)	temperature factor	0,801



1. CLT 10 cm
2. Timber fibre insulation 5 cm
3. Plasterboard
4. Timber floor
5. Concrete screed
6. Extruded polystyrene XPS 12 cm
7. Timber fibre insulation 12 cm
8. Concrete
9. Ground

NODE A | Thermal flow (Chi)

insulation	wall transmittance	value
12 + 5 cm	0,190 W/m^{2}K	- 0,380 W/node
16 + 5 cm	0,160 W/m^{2}K	- 0,330 W/node
24 + 5 cm	0,121 W/m^{2}K	- 0,260 W/node

NODE A | Danger of mould (Tsi)

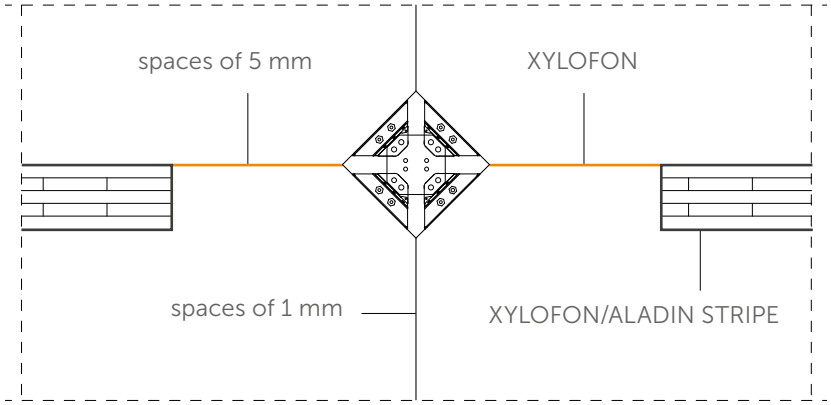
temperature (te)	Tsi insulation 12 cm	Tsi insulation 16 cm	Tsi insulation 24 cm
fRsi-average	*0,801*	*0,811*	*0,824*
- 5,0 °C	15,2 °C	15,5 °C	15,8 °C
0,0 °C	16,0 °C	16,2 °C	16,5 °C
5,0 °C	16,8 °C	16,9 °C	17,1 °C

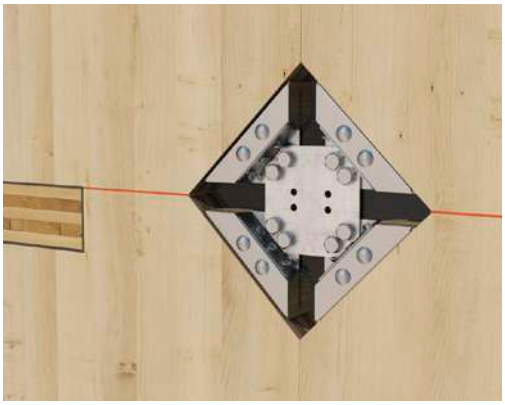
ACOUSTIC BEHAVIOUR

With X-RAD, structural nodes are concentrated in individual and distinct points. With regard to acoustics, a study was carried out within the Flanksound Project in order to achieve the acoustic characterization of structural nodes made with X-RAD.
Rothoblaas has therefore promoted research aimed at measuring the K_{ij} vibration reduction index for a variety of CLT panel joints, with the dual objective of providing specific experimental data for the acoustic design of CLT buildings and contributing to the development of calculation methods.
For further information and details on the project and measurement methods, refer to the SOUNDPROOFING SOLUTIONS catalogue.

ATTENTION TO DETAILS

Thanks to the point-to-point positioning of the structural nodes at the top of the CLT walls, X-RAD allows the non-interposition of floors between the walls. This brings important benefits from an acoustic point of view, which increase with the use of special profiles, providing the spaces indicated in the figure.





SPECIAL APPLICATIONS

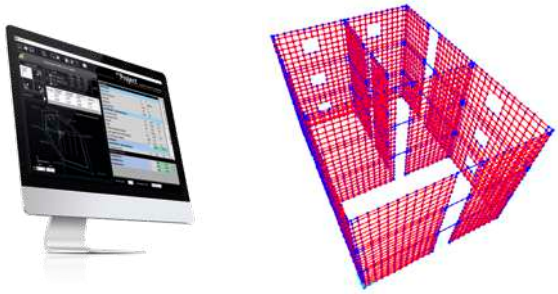
The X-RAD system opens new frontiers in the CLT structures connections field.
The high strength and extreme stiffness allow to increase the CLT panels exploitation level, optimizing the performance of timber and connections.
Innovative solutions can be created such as hybrid structures (timber-to-concrete, timber-to-steel), stiffening core structures and modular structures.

WANT TO KNOW MORE?

X-RAD is a complete construction system in every detail. A brief overview of the system is presented in this catalogue. For further information and details on the construction system, see the technical data sheet on the website www.rothoblaas.com, which contains, among other information, sections dedicated to the following topics.

MY PROJECT: X-ONE MODULE

Calculation of the X-ONE connector through the MyProject software.

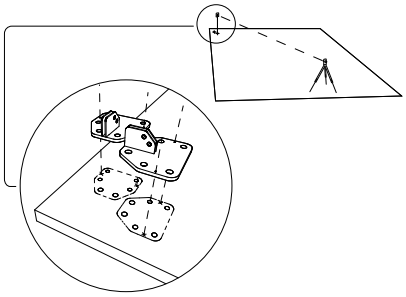


X-RAD SYSTEM MODELLING GUIDELINES

Proposal for a FEM modelling method for buildings made with X-RAD.

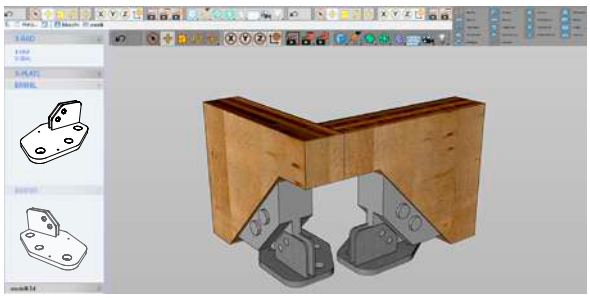
INSTALLATION

Details on manual and automated connector installation.



FROM MODELLING TO CONSTRUCTION SITE

Procedure for optimized design and execution.



CAD/CAM CONSTRUCTION DESIGN

Details of the nodes and geometries to be drawn in the CAD/CAM model.

POSSIBILITY OF ADVANCED PREFABRICATION

Possibility of advanced prefabrication of buildings made with X-RAD.