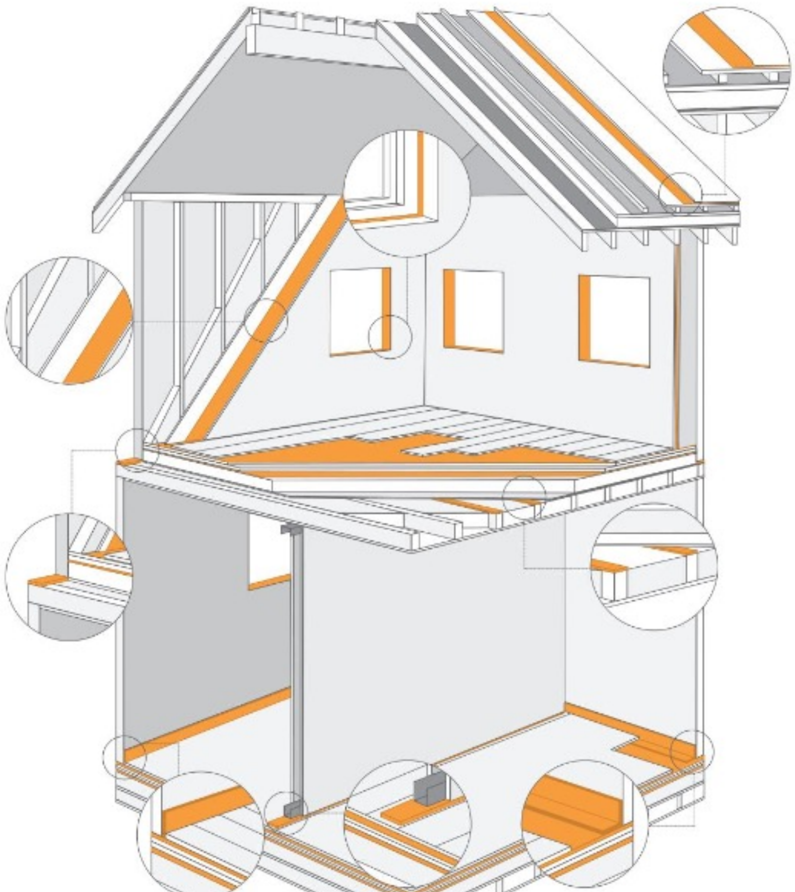


MASS TIMBER ACOUSTICS & APPLICATIONS

standards, connection details and implications on sound transmission & the flanksound project

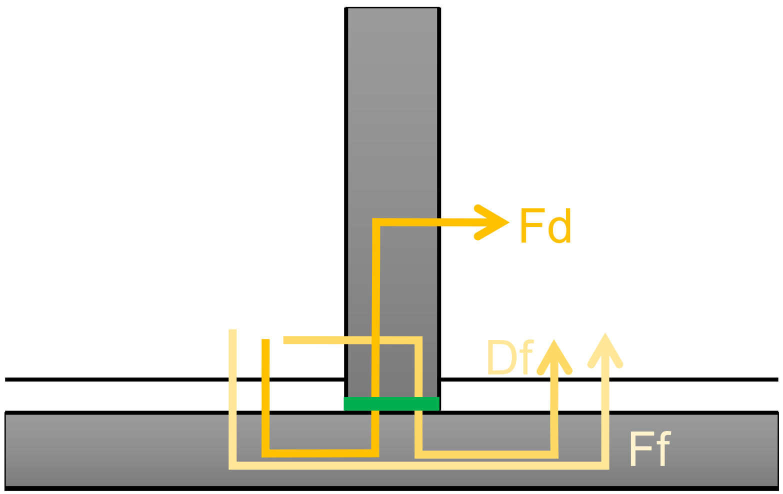
Eng. Paola Brugnara

Outline

- Laboratory testing
- On-site testing
- Flanksound project
- Characterization of resilient interlayers
- Friction
- Next steps and future developments

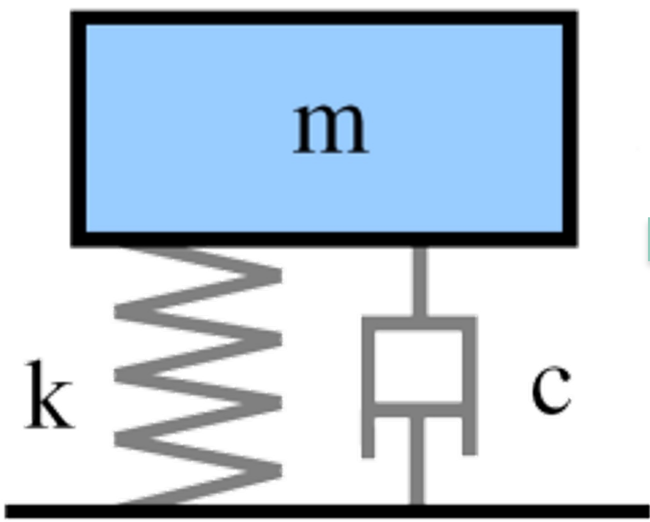
Wooden structures like all lightweight constructions, do not have a high acoustic performance at low frequincies.

Flanking transmission



The profile works like a **spring + damper** system.
The elastic component (spring) dissipates energy **"bouncing"** (obviously if the system is too loaded or too little, the spring does not activate), the damping component stops the spring from bouncing and **transforms the motion into viscous friction**. The lack of one of the two components would result in the lack of energy dissipation.

DESOLIDARISATION: construction technique or action which keeps elements isolated or separated when contact would allow the transmission of vibrations and, therefore, noise.



MASS

+

SPRING

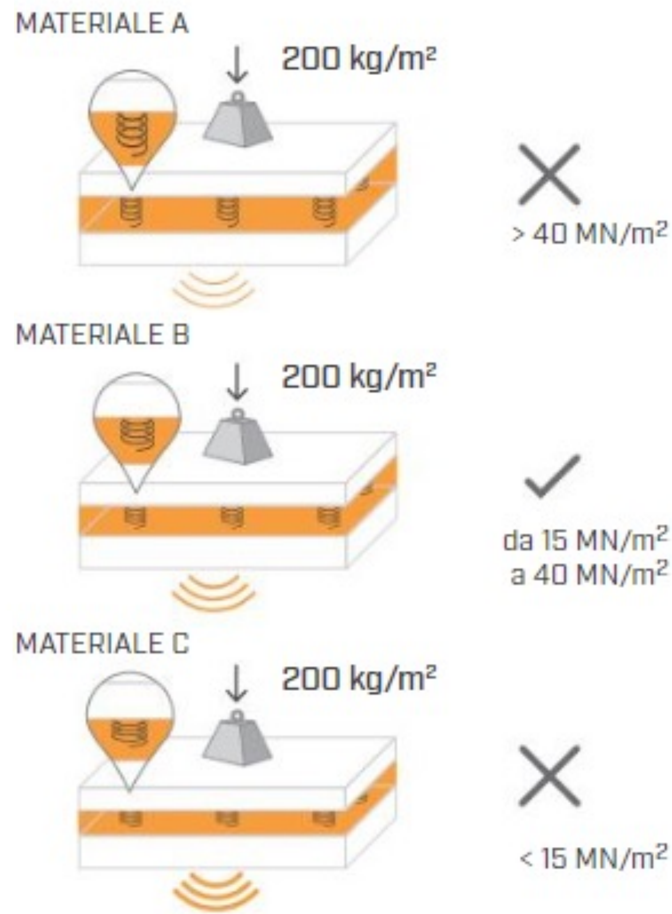
+

MASS

MASS SYSTEM - SPRING - MASS

Every material has a different dynamic stiffness value and can be outlined like a mass system - spring - mass.

A floating mass system can be associated with this type of system, in which the structural floor or system sub-floor represents the base mass, the impact sound insulation product is the spring and the supporting mass and flooring constitute the upper mass. In this context, the element that serves as the spring is defined as the "resilient layer" and is attributed the "dynamic stiffness s' [MN/m^3]".



The dynamic stiffness s' [MN/m^3] expresses the elastic deformation capacity of a impact sound insulation product subject to dynamic stress and is measured in the lab based on EN ISO 29052-1. This parameter includes the elastic and damping characteristics of the material, including those of the air enclosed within it.

DYNAMIC STIFFNESS AND AIR INSIDE THE MATERIALS

One element that can influence this behaviour is the air contained inside the materials. In fact, dynamic stiffness is the sum of two factors:

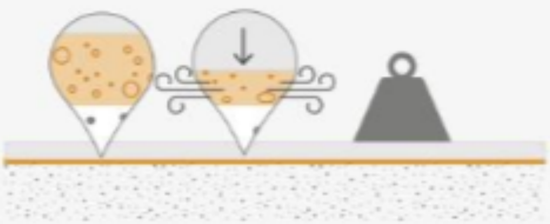
$$s' = s't + s'a$$

where:

s'	real dynamic stiffness
s't	apparent dynamic stiffness
s'a	dynamic stiffness for surface unit of the gas contained inside the material

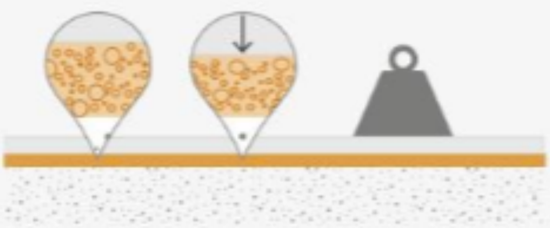
OPEN CELL MATERIALS

Fibrous and open cell materials allow for air to pass within them. In general, for these it is necessary to always consider the real dynamic stiffness value, which includes the contribution of the air.

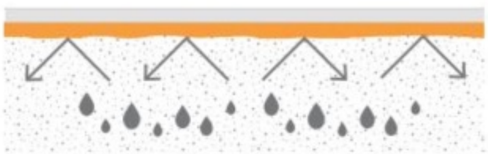


CLOSED CELL MATERIALS

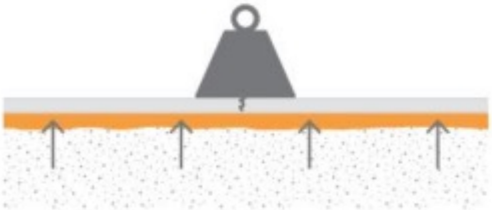
Closed cell materials or homogeneous and isotropic materials are considered impermeable to air, and therefore airflow can be ignored, obtaining s' = s't [MN/m^3].



IMPACT SOUND NOISE INSULATION



CONSTRUCTION REQUIREMENTS



USE REQUIREMENTS

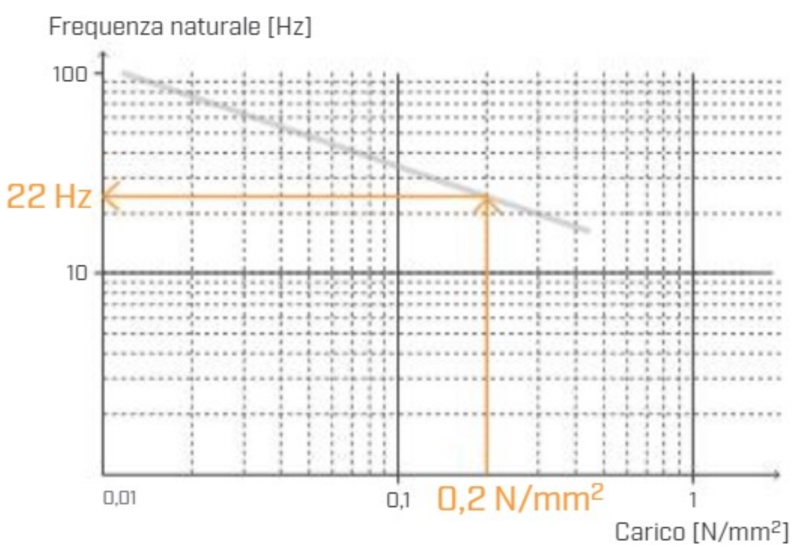
From a theoretical point of view, these types of product aim to **create a decoupled system** and reduce the amount of energy (vibrations) that is transferred from the system. **The system is decoupled if the resonant frequency is exceeded.** The resonant frequency depends on how the material is loaded. In the formula below, it is noted that the load (m ') is a necessary parameter for the calculation of the resonance frequency.

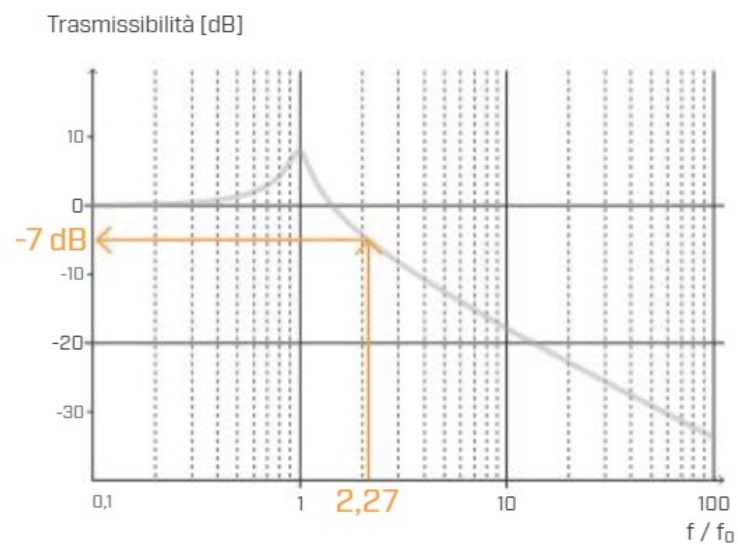
$$f_r = \frac{1}{2\pi}\sqrt{\frac{s'_t}{m'_t}}$$

If we don't impose a load range, we cannot know the resonance frequency and it is impossible to guarantee that the system is decoupled and consequently a negative transmissibility value.

XYLOFON 35 SHORE TABLE OF USE [1]

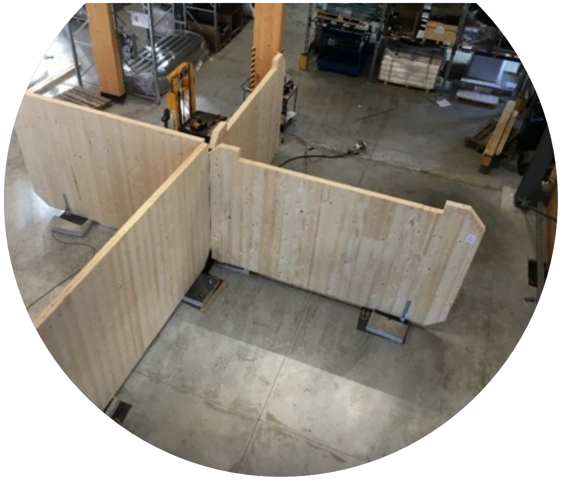
Code	APPLICABLE COMPRESSION [N/mm²]		DEFORMATION [mm]		APPLICABLE LINEAR LOAD [kN/m]	
	from	to	min	max	from	to
XYL35080	0,027	0,275	0,06	0,60	2,16	22,00
XYL35100					2,70	27,50
XYL35120					3,24	33,00
XYL35140					3,78	38,50

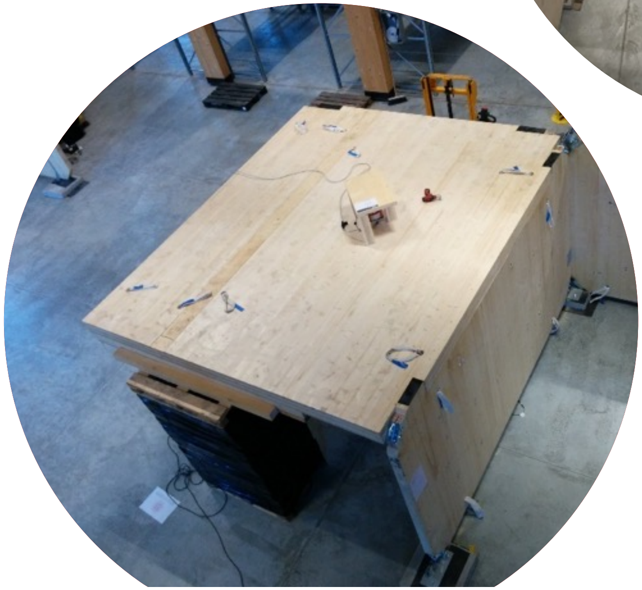




- **Compressive modulus in static conditions** and not the dynamic elastic modulus (which is generally used for dynamic loads like in bridges or under service equipment).
- According to ISO 12354, measurements and **calculating models are not reliable at low frequencies** due to the hypothesis of homogeneous sound field distribution, which is not verified at low frequencies.
- The thicker is the acoustic profile, the higher is the deformation and the less is the **stiffness of the building**. As consequence it is needed multiplying the number of brackets and connectors to compensate the stiffness/resistance loss.
- Laboratory measurements of the **vibration reduction index Kij** in accordance with the EN ISO 10848 and experimental data suitable for the acoustic design.

Flanksound Project

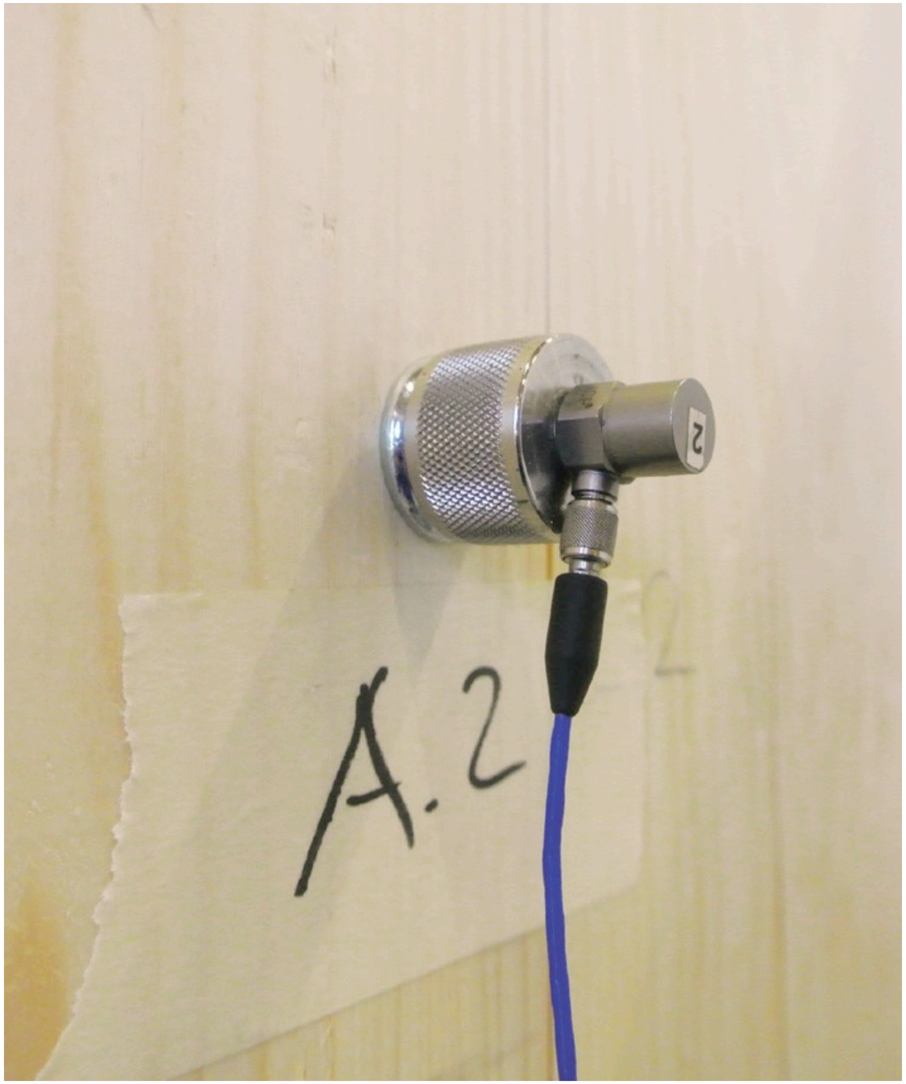




AIM
Creation of a dataset of K_{ij} for CLT junctions

MEASUREMENT CAMPAIGN

- ✓ Seven CLT manufacturers
- ✓ L, T, X vertical and horizontal junctions
- ✓ Influence of kind and number of screws, hold-down, angle brackets
- ✓ Resilient interlayer at the wall-floor junction



FLANKSOUND PROJECT

THE FLANKSOUND PROJECT

EXPERIMENTAL MEASUREMENTS OF K_{ij} FOR CLT JUNCTIONS

Rothoblaas has funded a research aimed at measuring the vibration reduction index K_{ij} for a variety of junctions between CLT panels, with the twofold aim of providing specific experimental data suitable for the acoustic design of CLT buildings and of contributing to development of the calculation methods.

EN ISO 10848

The vibration reduction index measurements were carried out in compliance with EN ISO 10848.

Test setup

CLT panels were provided by seven different manufacturers and therefore underwent different production processes, showing different characteristics such as the number and thickness of the planks, the side gluing of the layers, and whether there are anti-shrinkage cuts in the core. Different kinds of screws and connectors were tested, as well as different resilient layers at the wall-floor junction.

HIGHLIGHTS

- 7 different CLT manufacturers
- L, T, X vertical and horizontal junctions
- influence of type and number of screws
- influence of type and number of angle brackets
- influence of type and number of hold-downs
- use of resilient layers

Test setup

Test setup

Test setup

Measurement equipment

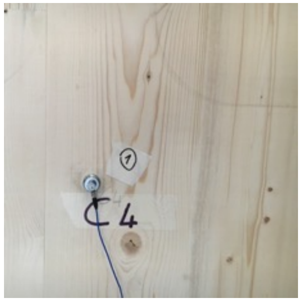
ISO 10848

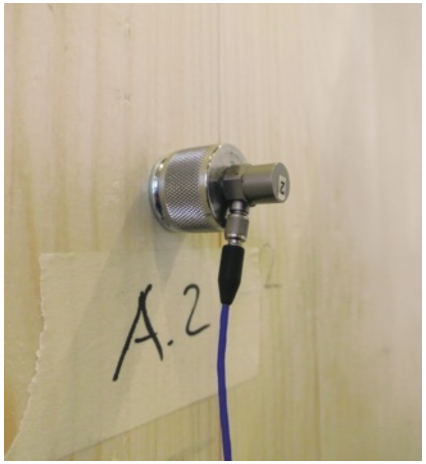
- **Vibration velocity level**
  shaker, pink noise filtered at 30 Hz
- **Structural reverberation time**
  Impulse Response

Screws

Magnets

Accelerometers



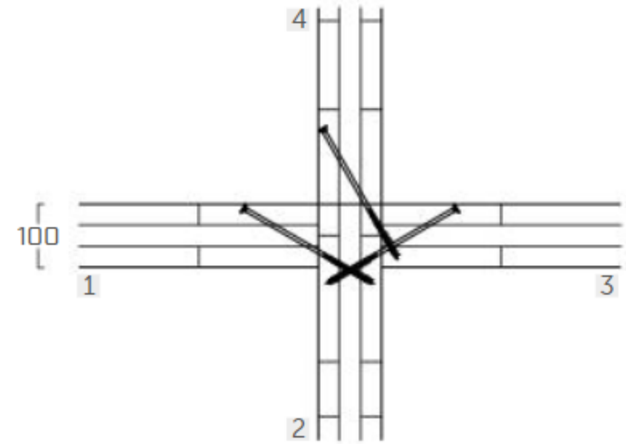


Resilient interlayers

WALL-WALL JUNCTION

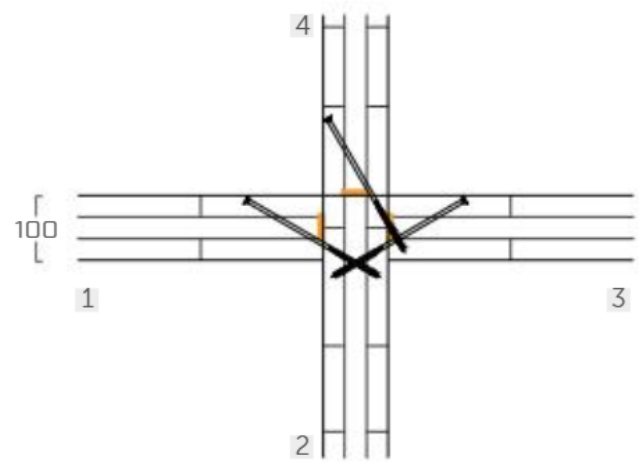
Product: Compressible EPDM sealing gasket for regular junctions

FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 400 mm



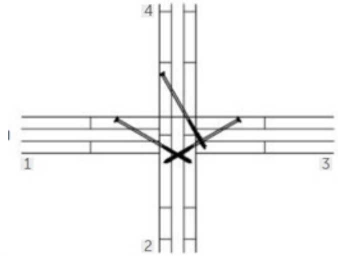
RESILIENT PROFILE
NO

FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 400 mm



RESILIENT PROFILE
CONSTRUCTION SEALING

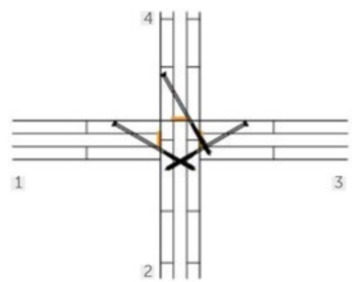
FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 400 mm



RESILIENT PROFILE
NO

f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{14} (dB)	13,1	12,4	13,7	10,8	13,2	12,2	12,8	14,4	15,9	17,0	19,7	21,2	25,0	27,9	29,7	32,6	15,2
K_{12} (dB)	9,9	10,4	8,7	8,0	9,8	7,7	8,4	9,4	11,2	10,1	11,5	12,3	15,0	16,8	18,0	21,2	9,8
K_{13} (dB)	12,5	12,1	12,7	12,3	14,6	13,3	11,9	14,0	16,8	16,8	20,5	21,7	23,9	27,5	28,3	31,6	15,8
K_{42} (dB)	12,9	11,2	11,6	9,8	12,7	12,5	11,6	11,9	13,8	12,6	13,4	13,9	16,8	18,6	20,7	22,9	12,5

FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 400 mm



RESILIENT PROFILE
CONSTRUCTION SEALING

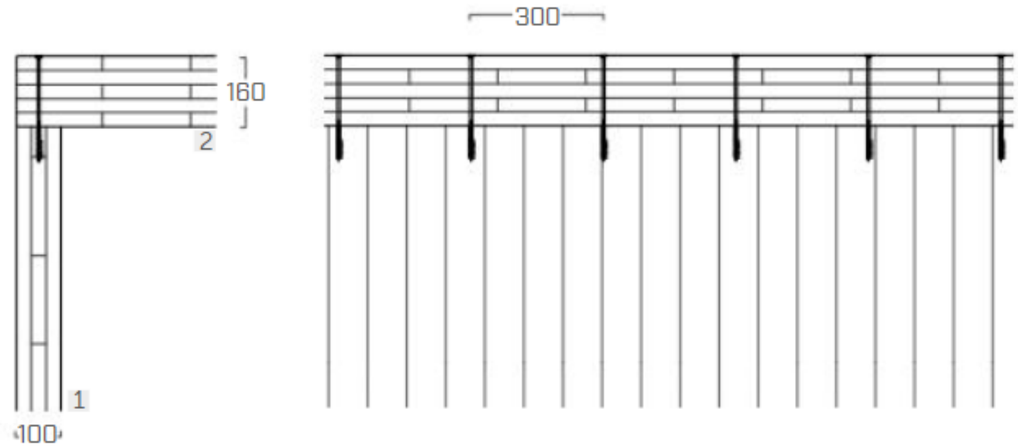
f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{14} (dB)	11,4	8,5	6,9	10,1	14,1	10,9	14,6	17,1	16,9	20,9	22,0	22,8	28,7	33,4	37,2	39,3	16,6
K_{12} (dB)	5,9	6,3	7,3	6,3	8,4	6,1	8,5	11,6	12,2	13,6	12,8	16,5	17,6	19,6	23,6	25,1	10,7
K_{13} (dB)	13,4	12,3	11,0	12,9	15,5	14,6	17,0	17,5	19,7	26,4	25,1	28,1	27,4	35,4	39,9	39,6	19,6
K_{42} (dB)	9,5	8,1	9,0	8,2	12,7	11,5	14,3	13,3	17,1	18,5	17,3	20,5	23,9	24,4	29,2	32,8	14,8

Resilient interlayers

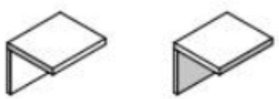
WALL-FLOOR JUNCTION

Product: Resilient soundproofing profile in monolithic polyurethane mixture

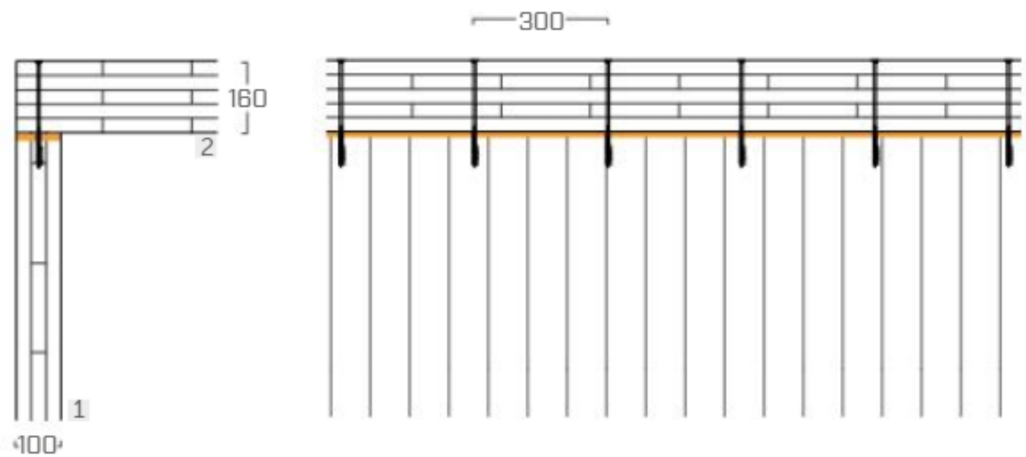
FASTENING SYSTEM
Screws **HBS Ø8 X 240** mm **(HBS8240)**
step 300 mm



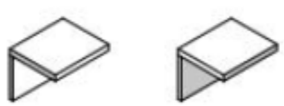
RESILIENT PROFILE
NO



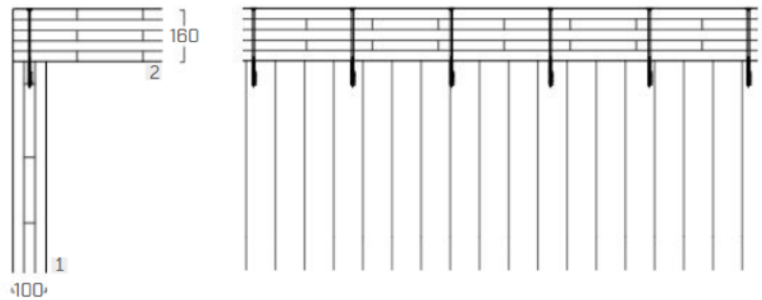
FASTENING SYSTEM
Screws **HBS Ø8 X 240** mm **(HBS8240)**
step 300 mm



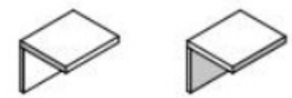
RESILIENT PROFILE
XYLOFON



FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 300 mm

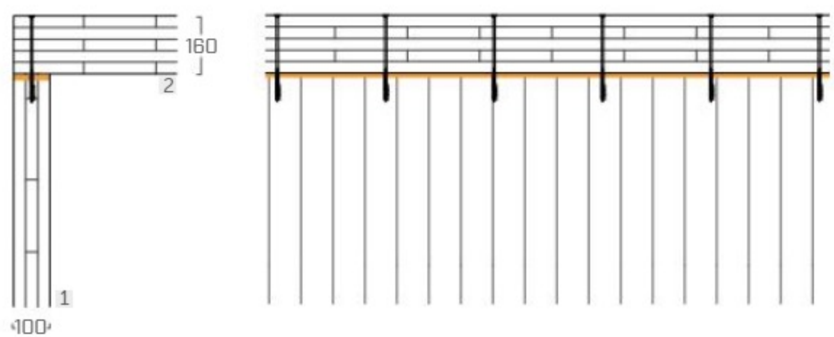


RESILIENT PROFILE
NO

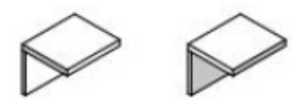


f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{12} (dB)	11,7	15,6	12,1	9,4	11,9	10,1	9,5	11,0	7,0	10,1	9,9	12,8	14,8	15,4	17,3	18,6	10,2

FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 300 mm



RESILIENT PROFILE
XYLOFON



f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{12} (dB)	12,6	10,8	13,6	11,1	9,2	13,3	11,3	16,5	10,2	14,6	14,9	17,4	19,6	25,0	28,5	25,1	13,2

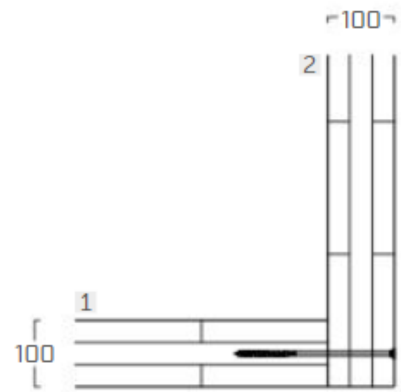
Number and type od screws

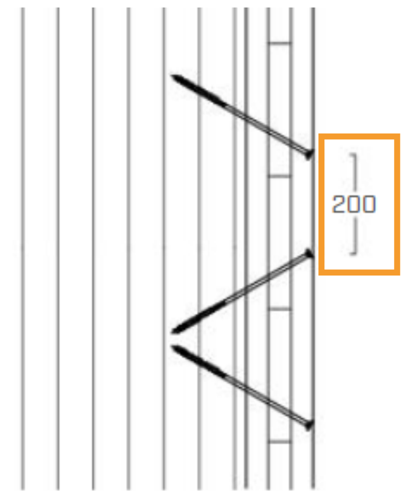
WALL-WALL JUNCTION

Product: HBS (partial threated screw) vs VGZ (full threaded screw)

FASTENING SYSTEM
Screws **HBS Ø8 X 240 mm (HBS8240)**
step 200 mm

RESILIENT PROFILE
NO

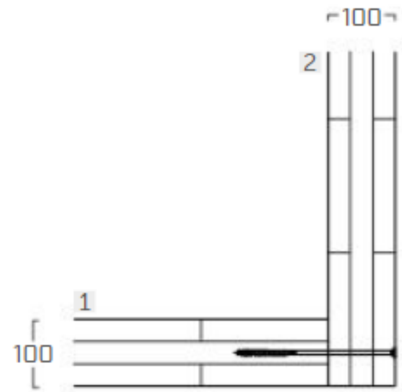


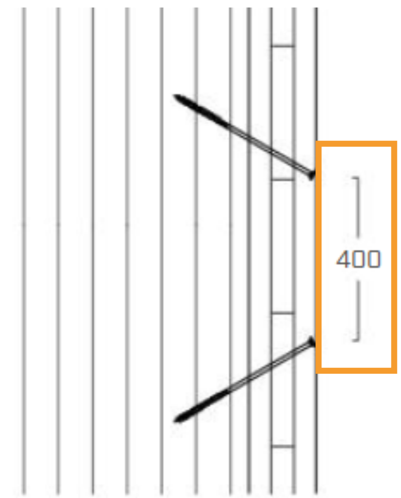


f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{12} (dB)	12,8	9,4	3,9	2,3	2,3	0,2	3,7	4,6	6,6	8,1	9,6	11,7	15,0	15,4	15,9	16,8	5,5

FASTENING SYSTEM
Screws **HBS Ø8 X 240** mm **(HBS8240)**
step 400 mm

RESILIENT PROFILE
NO

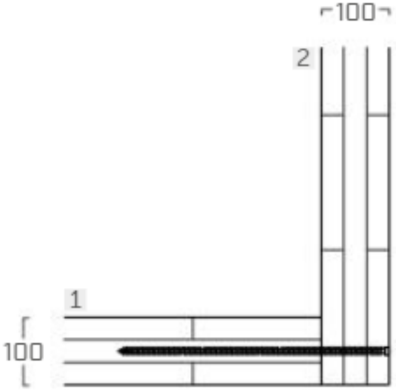


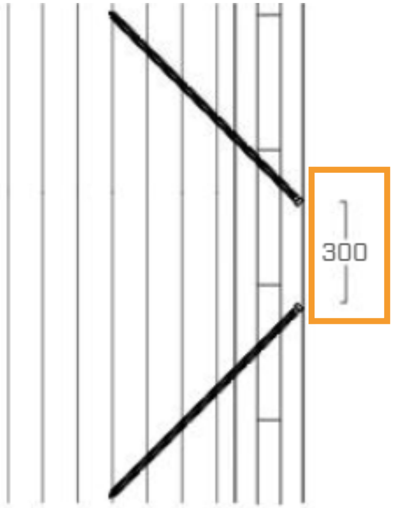


f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{12} (dB)	11,4	9,8	2,9	2,1	2,7	1,8	6,3	8,3	10,1	12,6	12,9	16,1	18,3	16,9	19,6	22,2	8,1

FASTENING SYSTEM
Screws **VGZ Ø9 X 400** mm **(VGZ9400)**
step 300 mm

RESILIENT PROFILE
NO

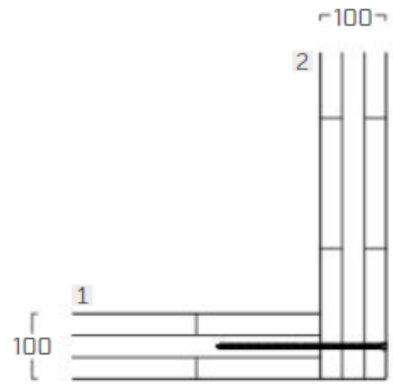


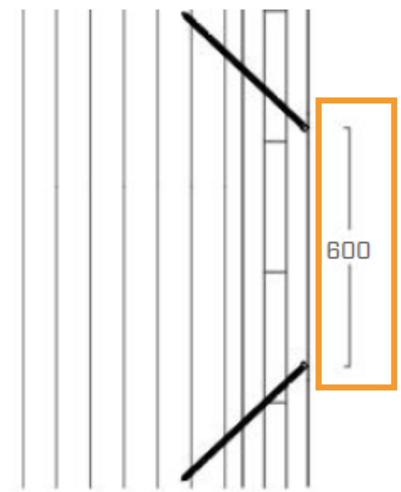


f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{12} (dB)	19,0	16,7	9,6	14,5	12,0	10,8	8,7	11,2	10,2	13,9	14,3	16,1	17,9	17,7	18,5	19,9	12,4

FASTENING SYSTEM
Screws **VGZ Ø7 X 260** mm **(VGZ7260)**
step 600 mm

RESILIENT PROFILE
NO



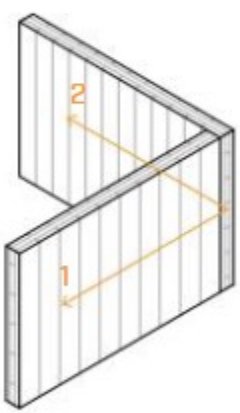


f (Hz)	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	AVG 200-1250
K_{12} (dB)	16,5	15,1	6,4	11,5	11,3	9,8	11,7	12,8	15,0	15,5	16,0	19,7	18,8	19,8	22,5	23,0	13,7

THE FLANKSOUND PROJECT

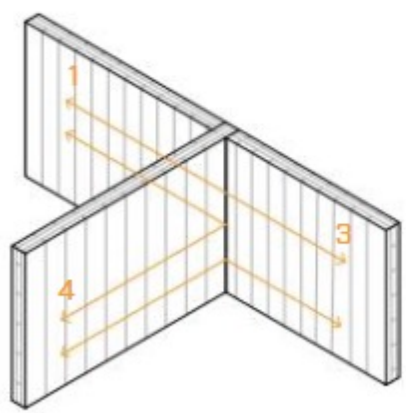
[Rothoblaas youtube channel -> (https://www.youtube.com/watch?v=5RM-2Vgs65Y](https://www.youtube.com/watch?v=5RM-2Vgs65Y)

L JUNCTIONS



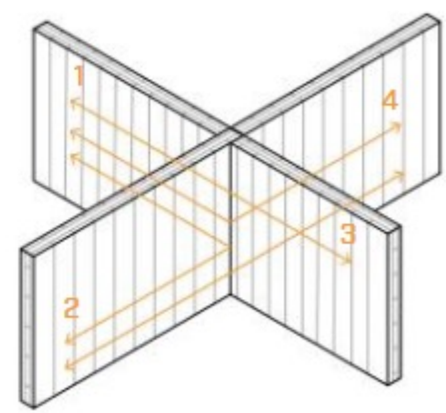
$K_{12} = K_{21}$

T JUNCTIONS



$K_{14} = K_{41}$ $K_{43} = K_{34}$
$K_{13} = K_{31}$

X JUNCTIONS



$K_{14} = K_{41}$ $K_{13} = K_{31}$
$K_{12} = K_{21}$ $K_{42} = K_{24}$

PUBLICATIONS

A. Speranza, L. Barbaresi, F. Morandi, **" *Experimental analysis of flanking transmission of different connection systems for CLT panels* "** in Proceedings of the World Conference on Timber Engineering 2016, Vienna, August 2016.

L. Barbaresi, F. Morandi, M. Garai, A. Speranza, **" *Experimental measurements of flanking transmission in CLT structures* "**
in Proceedings of the International Congress on Acoustics 2016, Buenos Aires, September 2016.

L. Barbaresi, F. Morandi, M. Garai, A. Speranza, **"*Experimental analysis of flankng transmission in CLT structures*"** of Meetings on Acoustics (POMA), a serial publication of the Acoustical Society of America - POMA-D-17-00015

L. Barbaresi, F. Morandi, J. Belcari, A. Zucchelli, Alice Speranza, **"*Optimising the mechanical characterisation of a resilient interlayer for the use in timber construction*"** in Proceedings of the International congress on sound and vibration 2017, London, July 2017

PUBLICATIONS

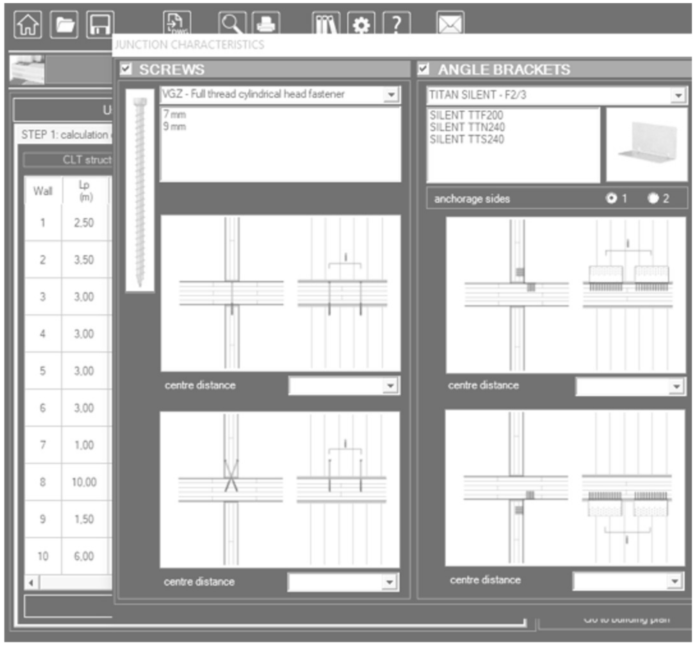
Alice Speranza, Francesca Di Nocco, Federica Morandi, Luca Barbaresi, Niko Kumer, ***"Sound insulation and flanking transmission in CLT buildings: a comparison between experimental measurements and predictions"*** EURONOISE 2018, Creta, May 2018

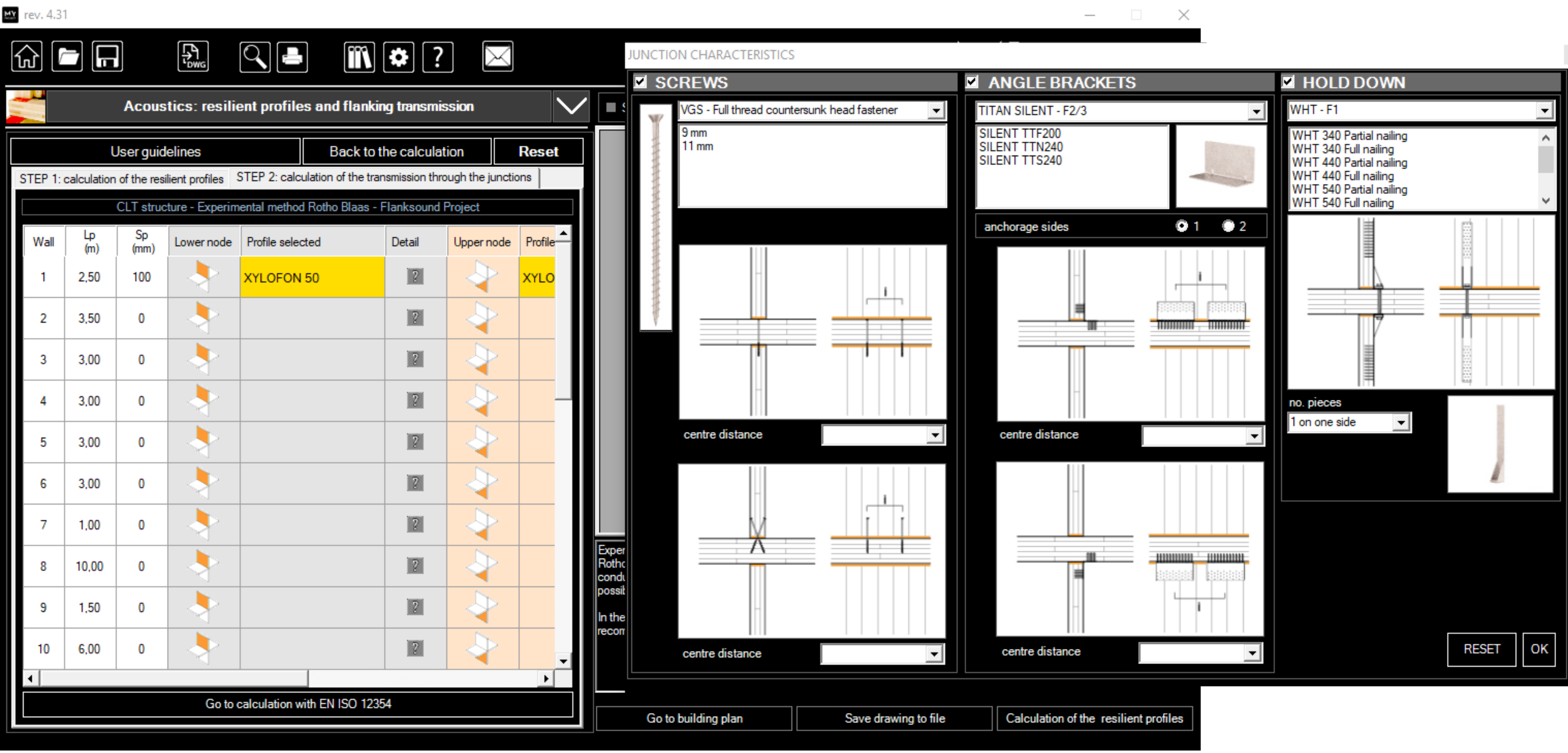
Antonino Di Bella, Nicola Granzotto, Gianfranco Quartaruolo, Alice Speranza, Federica Morandi, ***"Analysis of airborne sound reduction index of bare clt walls"*** World Conference on Timber Engineering 2018, Seoul, August 2018

Alice Speranza, Francesca Di Nocco, Federica Morandi, Luca Barbaresi, Niko Kumer, ***"Direct and flanking transmission in clt buildings: on site measurements, laboratory measurements and standards"*** World Conference on Timber Engineering 2018, Seoul, August 2018

Federica Morandi, Alice Speranza, Manuela Chiodega, Luca Barbaresi, Andrea Gasparella, ***"Interacción acústica/estructura en los edificios de madera acoustic/structure interaction in timber buildings"*** Congreso Latinoamericano de Estructuras de Madera, Motevideo, Novermber 2019

Software implementation



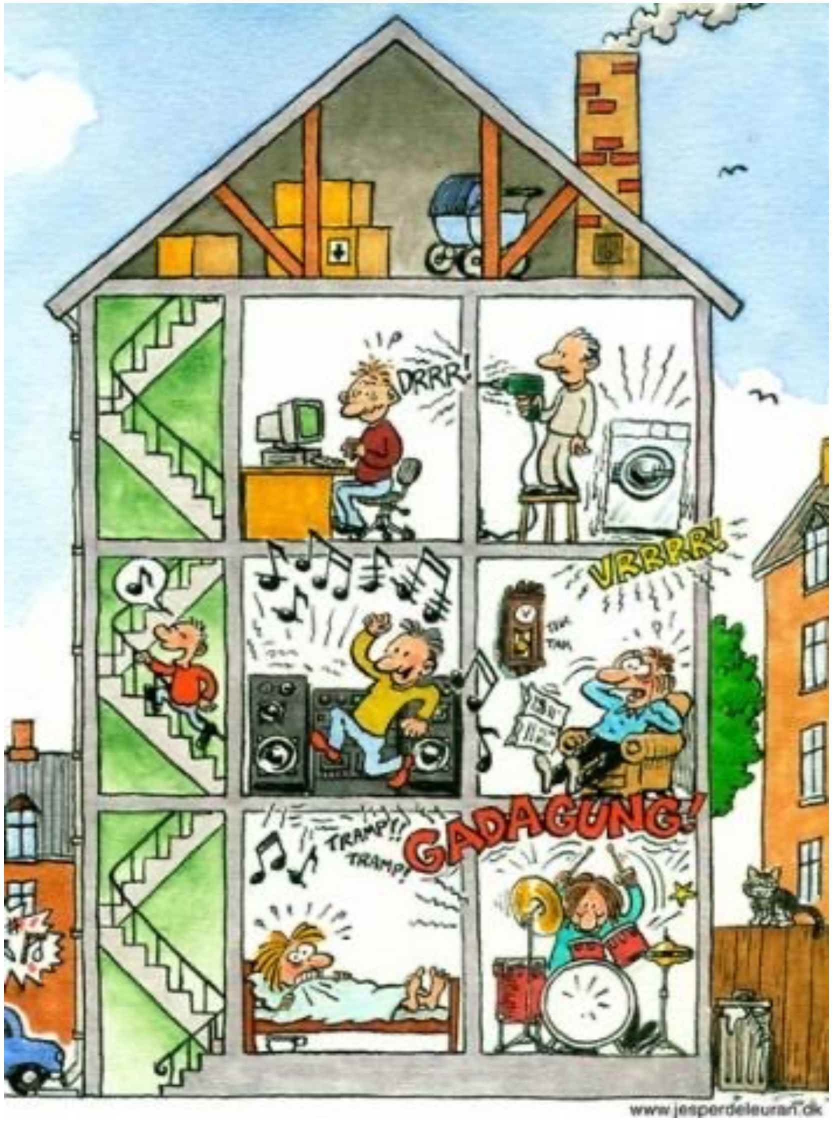

rev. 4.31
Acoustics: resilient profiles and flanking transmission
User guidelines
Back to the calculation
Reset
STEP 1: calculation of the resilient profiles
STEP 2: calculation of the transmission through the junctions
CLT structure - Experimental method Rotho Blaas - Flanksound Project
Wall
Lp (m)
Sp (mm)
Lower node
Profile selected
Detail
Upper node
Profile
1 2,50 100 XYLOFON 50 XYLO
2 3,50 0
3 3,00 0
4 3,00 0
5 3,00 0
6 3,00 0
7 1,00 0
8 10,00 0
9 1,50 0
10 6,00 0
Go to calculation with EN ISO 12354
JUNCTION CHARACTERISTICS
SCREWS
VGS - Full thread countersunk head fastener
9 mm
11 mm
centre distance
centre distance
ANGLE BRACKETS
TITAN SILENT - F2/3
SILENT TTF200
SILENT TTN240
SILENT TTS240
anchorage sides
1
2
centre distance
centre distance
HOLD DOWN
WHT - F1
WHT 340 Partial nailing
WHT 340 Full nailing
WHT 440 Partial nailing
WHT 440 Full nailing
WHT 540 Partial nailing
WHT 540 Full nailing
no. pieces
1 on one side
RESET
OK
Go to building plan
Save drawing to file
Calculation of the resilient profiles

AIRBORNE SOUND

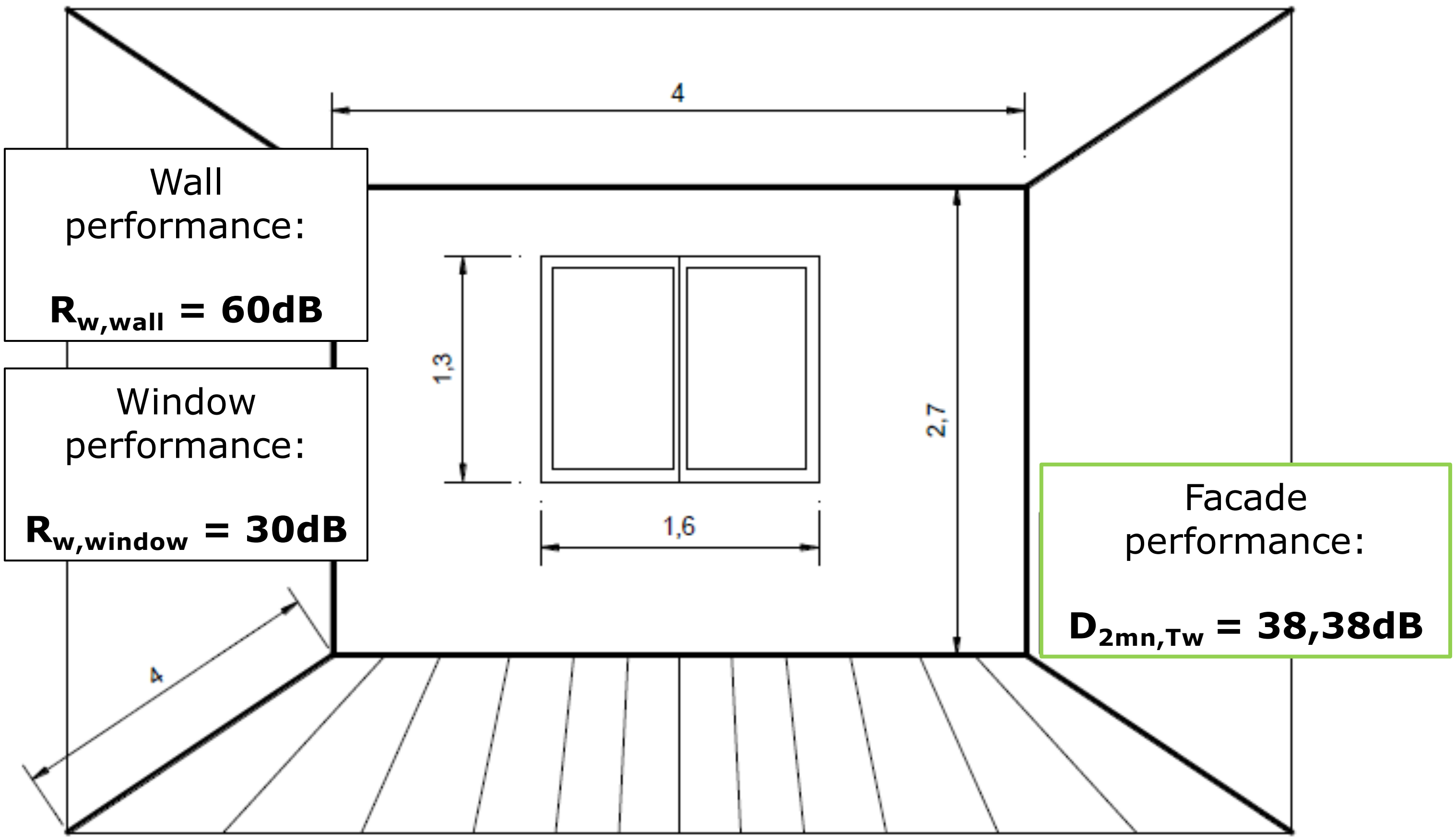
AIRBORNE NOISE: the medium carrying the sound energy is air.

IMPACT SOUND

STRUCTURAL NOISE: the sound crosses the structure carrying the vibrations from room to room, even when not contiguous.

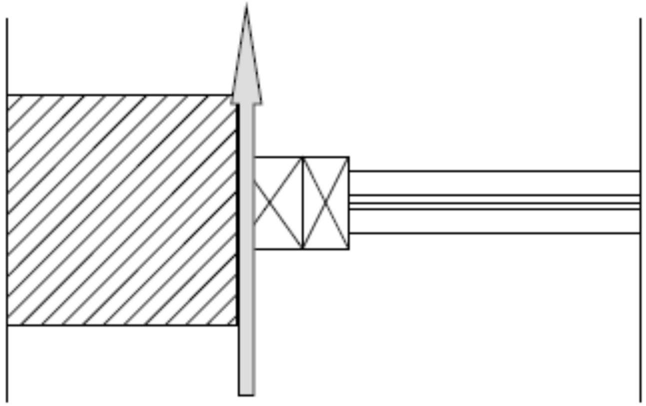

DRRR!
VRRRR!
TRAMP!!
TRAMP!
GADAGUNG!
www.jesperdeleuran.dk

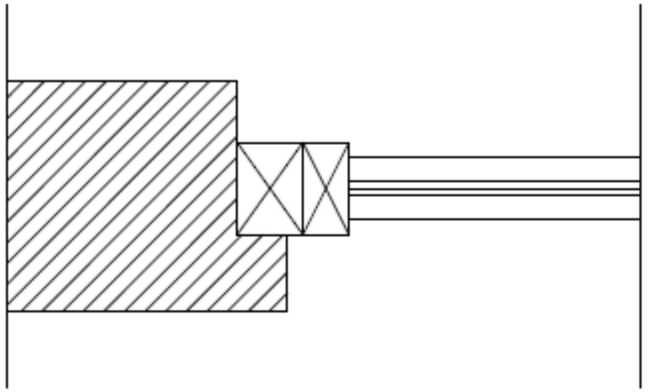
Wall + Window


4
Wall
performance:
$R_{w,wall}$ = 60dB
Window
performance:
$R_{w,window}$ = 30dB
1,3
2,7
1,6
4
Facade
performance:
$D_{2mn,Tw}$ = 38,38dB

Proper installation of windows

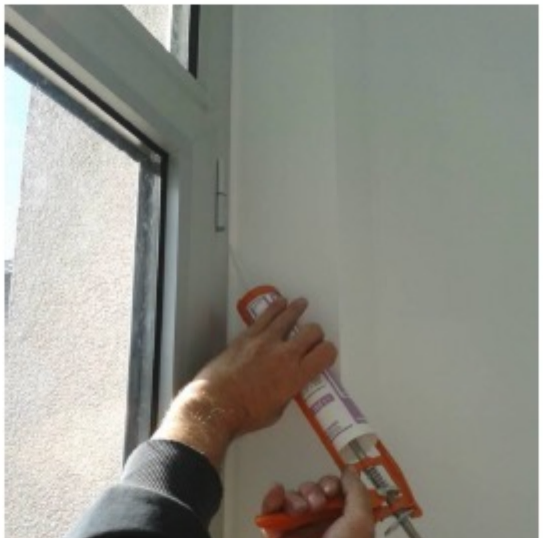
✗ NO!





✓ YES!

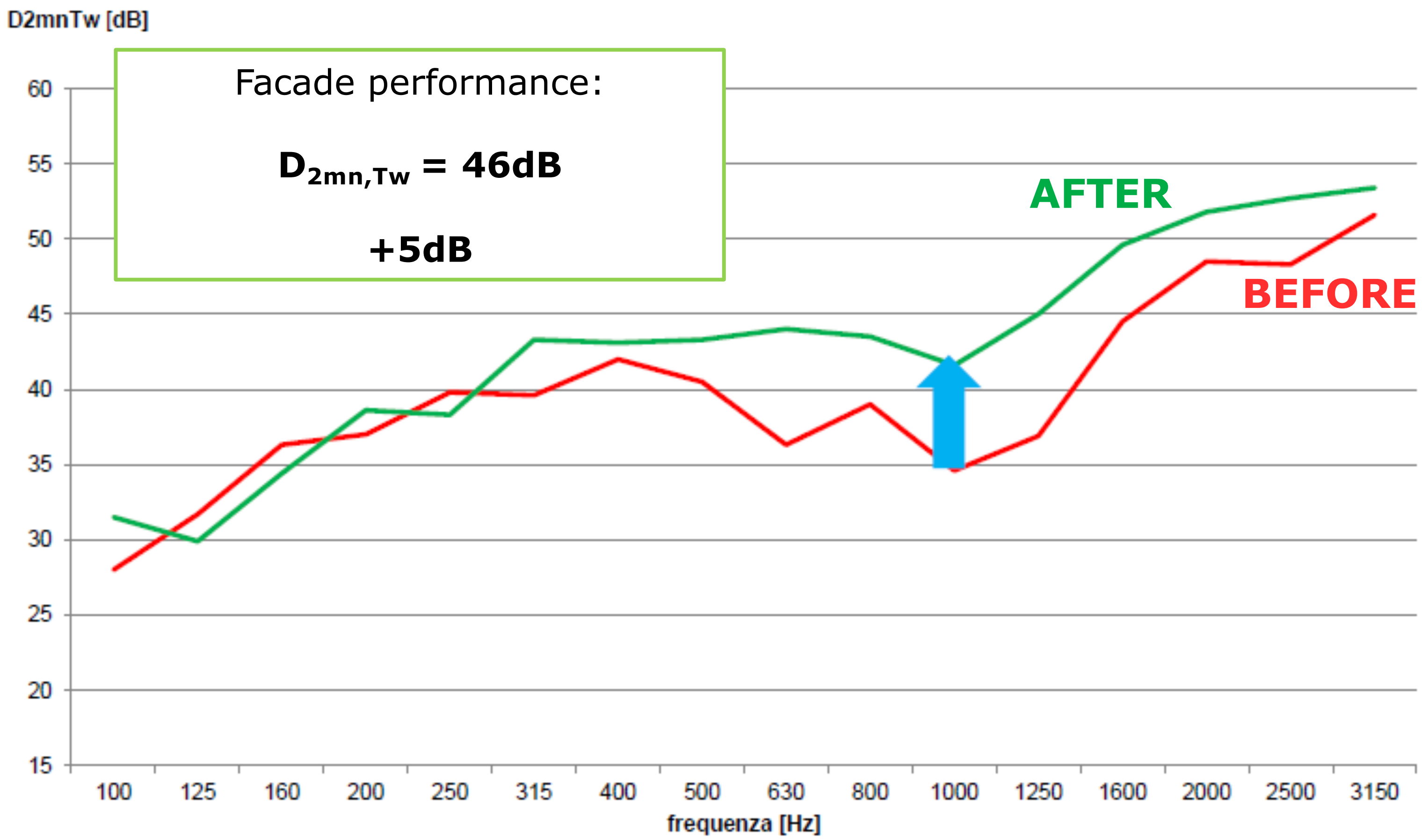
Rehabilitation of a facade



property	standard	value
Thermal conductivity	EN 12667	$\lambda_{10,tr} \leq 0.048$ W/mK
60 mm Frame U value	DIN 4108/3	0.8 W/m^{2}K
70 mm Frame U value	DIN 4108/3	0.7 W/m^{2}K
80 mm Frame U value	DIN 4108/3	0.6 W/m^{2}K
Resistance to heavy rain	EN 1027	$\geq$ 1000 Pa
Leakage transmission coefficient	EN 12114	$\alpha = 0.00$ m^3/[hm(daPa)^n]
Acoustic insulation $R_{ST,W}$ (C;Ctr) (2)	IFT Rosenheim	45 (-2; -6) dB
Temperature resistance	DIN 18542	-30 / +80 °C

Proper sealing of the joint between structure and window

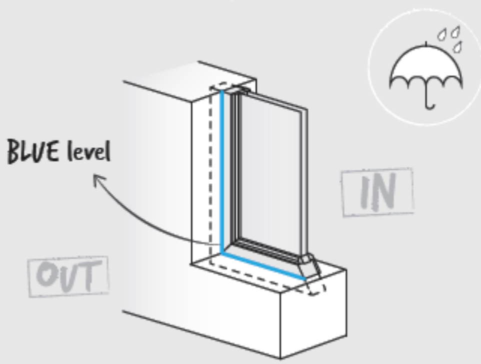
Rehabilitation of a facade



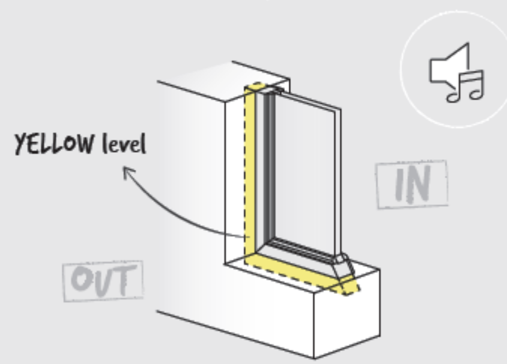
THREE LEVELS OF PROTECTION

The **three level method**, which is used often in most European countries, identifies thermal and acoustic insulation levels for proper placement of doors and windows. To obtain maximum performance, it is important to take care in all design stages.

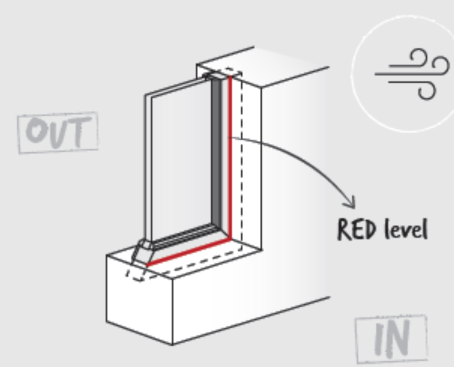
BLUE LEVEL



YELLOW LEVEL

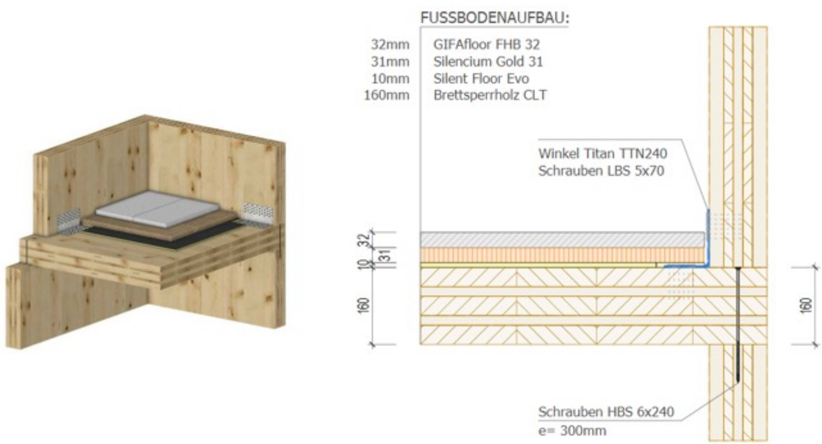


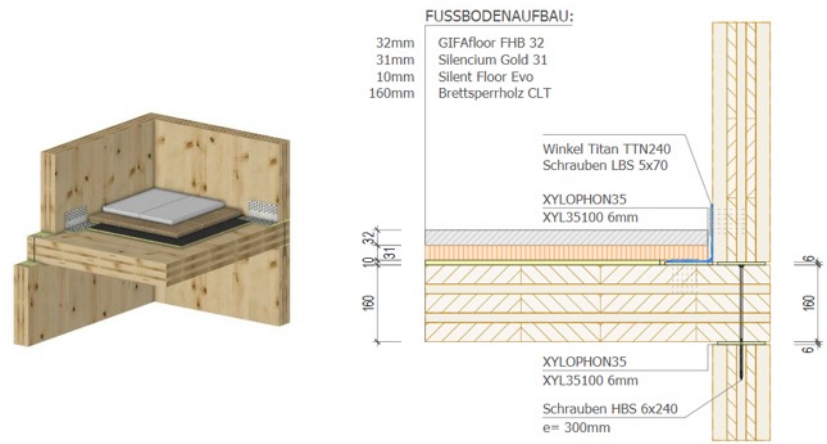
RED LEVEL



New measurement

ON GOING PROJECT

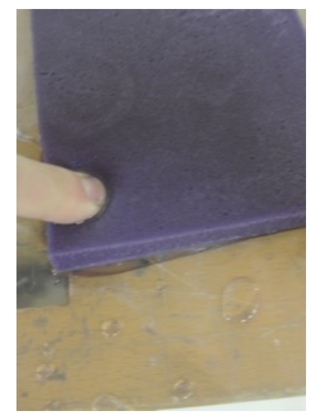




$R'_w = 47$ dB	$R'_w = 51$ dB	+ 4dB
$R'_{w\,(SF)} = 57$ dB	$R'_{w\,(SF)} = 67$ dB	+ 10dB

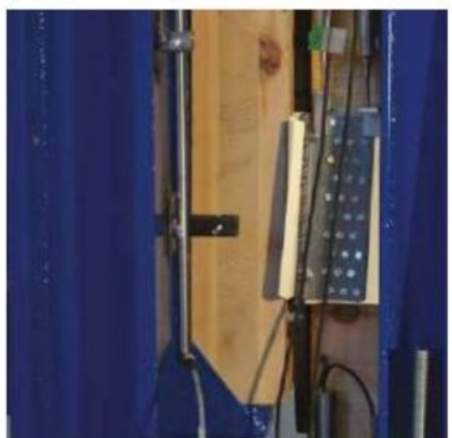
Characterization of resilient interlayers

Additional testing
fire resistance, mechanical resistance of the junction, water uptake



INTERACTION STRUCTURAL BEHAVIOUR

Variation in mechanical shear resistance based on the soundproofing profile

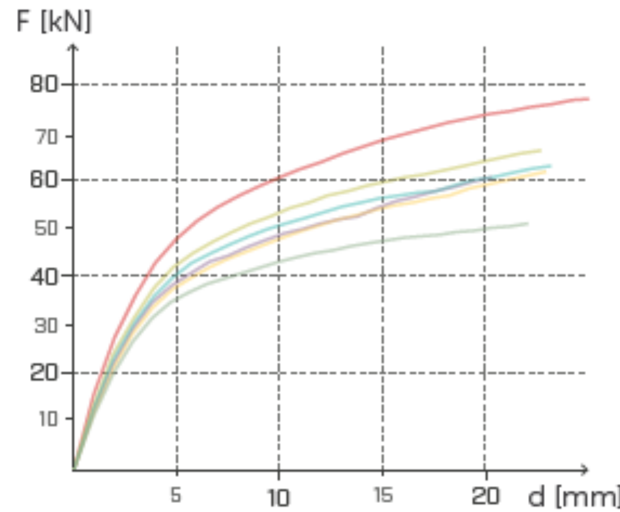


Variation in mechanical shear resistance based on the soundproofing profile

TITAN TTF200

Configurations	sp [mm]	$F_{15\,mm}$ [kN]	$\Delta F_{15\,mm}$	$K_{5\,mm}$ [kN/mm]	$\Delta K_{5\,mm}$
TTF200	-	68,4	-	9,55	-
TTF200 + ALADIN STRIPE SOFT red.*	3	59,0	-14 %	8,58	-10 %
TTF200 + ALADIN STRIPE EXTRA SOFT red.*	4	56,4	-18 %	8,25	-14 %
TTF200 + ALADIN STRIPE SOFT	5	55,0	-20 %	7,98	-16 %
TTF200 + XYLOFON PLATE	6	54,3	-21 %	7,79	-18 %
TTF200 + ALADIN STRIPE EXTRA SOFT	7	47,0	-31 %	7,30	-24 %

*reduced thickness: profile height reduced due to the corrugated section and consequent crushing induced by the nail head during use.



The results obtained indicate a reduction in the resistance and stiffness of the devices following the insertion of the sound-insulating profiles. This change is heavily dependent on the thickness of the profile. To limit the reduction in force and stiffness to around 20%, profiles must be selected with real thicknesses less than or equal to 6 mm, approximately.

Table B.4: Force $F_{2/3}$, 1 angle bracket / connection timber to timber

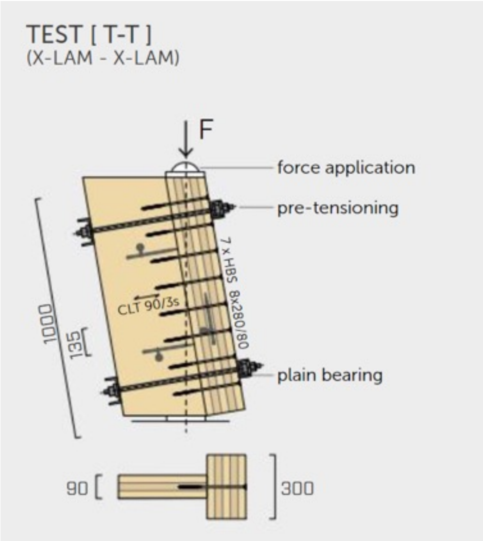
TITAN Type	Number of fasteners		Timber			
			$F_{2/3,Rk}$ [kN]			$K_{2/3,ser}$ [kN/mm]
	number n_V	number n_H	Nails Ø4 x 60	Screws Ø5 x 50	Screws Ø8 x 80	
TTN160	24	24	19,3	24,0	-	-
TTN200	30	30	28,0	34,7	-	-
TTN240	36	36	37,9	46,7	-	-
TTN240 + Xylofonplate	36	36	24,8	22,8	-	-
TTN240 + Aladin Stripe Soft	36	36	28,9	27,5	-	-
TTN240 + Aladin Stripe Extrasoft	36	36	27,5	25,8	-	-
TTS140	8	8	-	-	10,7	-
TTS195	11	11	-	-	17,1	-
TTS240	14	14	-	-	60,0	5,6
TTS240 + Xylofonplate	14	14	-	-	12,5	-
TTS240 + Aladin Stripe Soft	14	14	-	-	14,7	-
TTS240 + Aladin Stripe Extrasoft	14	14	-	-	13,9	-
TTF200, h=9cm[1)]	30	30	35,5	42,5	-	-
TTF200, h=8cm[1)]	25	25	31,0	37,2	-	-
TTF200, h=7cm[1)]	15	15	20,9	25,1	-	-
TTF200, h=6cm[1)]	10	10	15,1	18,1	-	-
TTF200 + Xylofonplate	30	30	17,2	15,8	-	-
TTF200 + Aladin Stripe Soft	30	30	20,0	19,0	-	-
TTF200 + Aladin Stripe Extrasoft	30	30	19,0	17,9	-	-
TTV240 full	36	30 + 2[2)]	59,7	59,7	-	Full nailing: 6,6
TTV240 partial	24	24 + 2[3)]	51,5	51,5	-	Partial nailing: 4,8

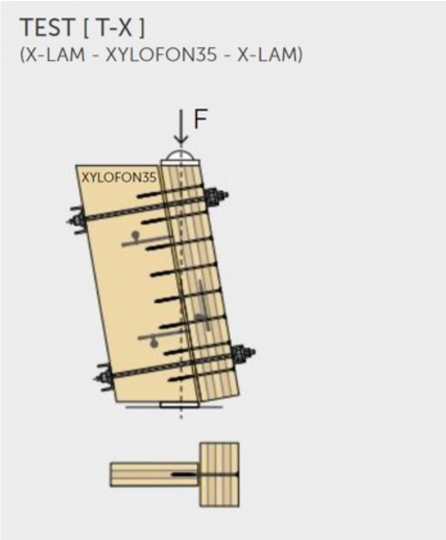
CE
ETA 11/0496

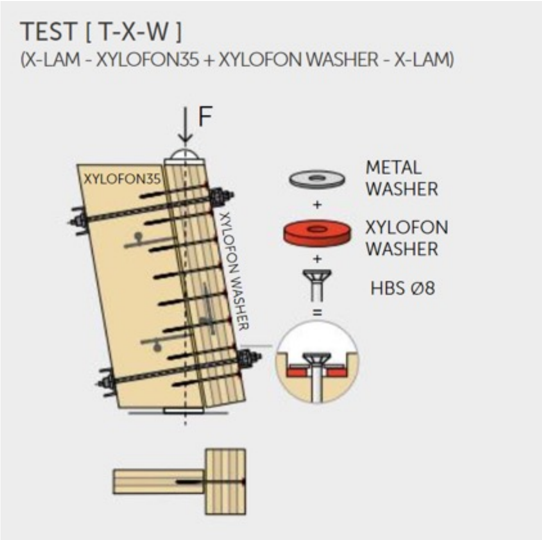
*Calculated values

LOAD-BEARING CAPACITY AND STIFFNESS OF CONNECTIONS BETWEEN CLT PANELS MADE WITH HBS PARTIALLY THREAD SCREWS AND XYLOFON WASHERS

Through experimental testing and analytical approaches, the mechanical and deformation performance of connections between CLT panels — made with 8x280 HBS screws installed with/without XYLOFON WASHER separating washers — was analysed with and without the use of resilient, intermediate XYLOFON35 decoupling profiles.







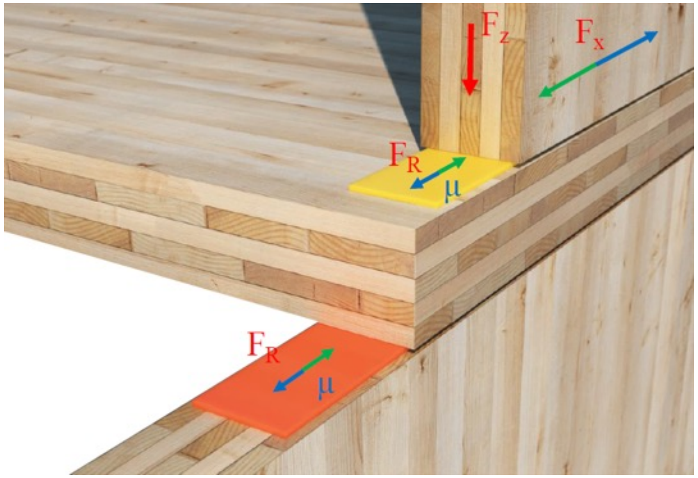
SERIES	F_{mean} [1] [kN]	$F_{R,k}$ [kN]	pre-tens. [2] [kN]	K_{ser} [N/mm]	K_u [N/mm]
T-T	52,9	44,0	0	30252	3524
	61,4	52,4	30	42383	4090
T-X	54,4	40,1	0	7114	3629
	70,9	60,5	30	9540	4726
T-X-W	65,0	48,3	0	6286	4330
	76,2	63,4	30	7997	5080

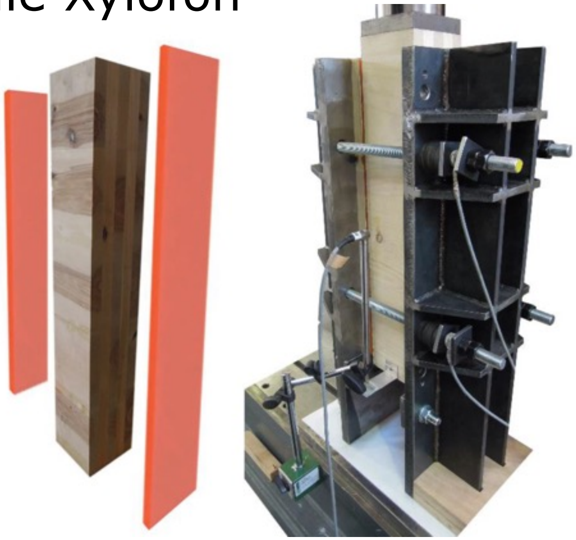
[1] Average value for 3 tests.
[2] Preload forces of 30 kN were applied to simulate the operating load.

The experimental test results show that fastener load-bearing capacity is affected by the presence of the resilient XYLOFON35 profile (T-X series), recording a reduction of about 9% in $F_{R,k}$. However, adding the XYLOFON WASHER (T-X-W series) separating washers recorded a 10% increase in $F_{R,k}$ due to the increase in the axial strength of the connection (cable effect).

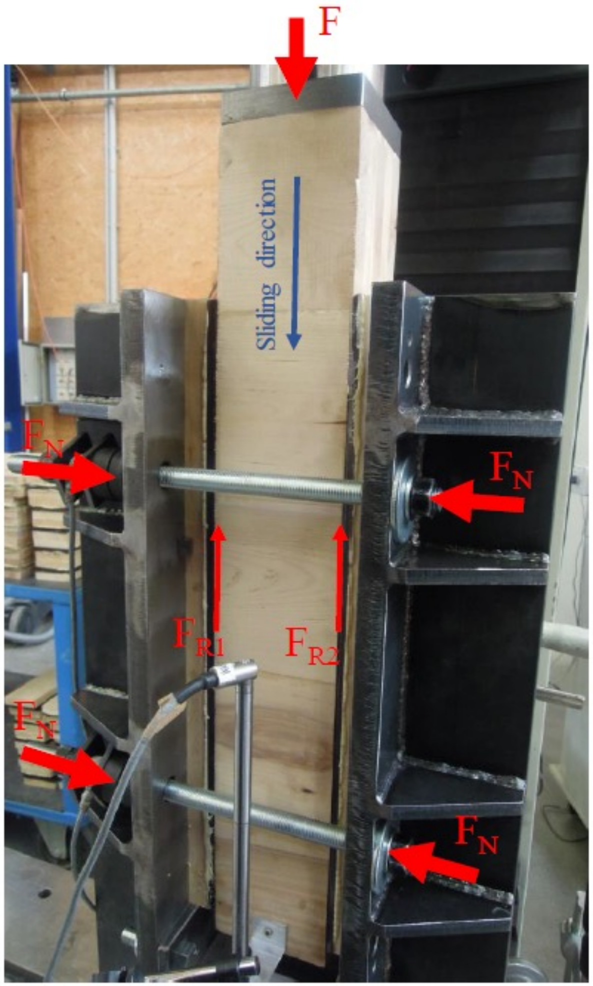
Friction

Test c/o TU Graz and UIBK to evaluate the friction of the junction with/without the resilient profile Xylofon





Friction



We investigated the friction between Xylofon and CLT and the influence of the following parameters:

- Wood moisture (12% and 14)
- CLT surface (narrow and side face
- Counter material (spruce and birch
- Normal force:
- Xylofon hardness

The coefficient can be considered only if the perfect contact between wood and Xylofon is guarantee.

Friction

Results:

- Wood moisture (12% and 14%): the coefficient of static friction has no significant difference

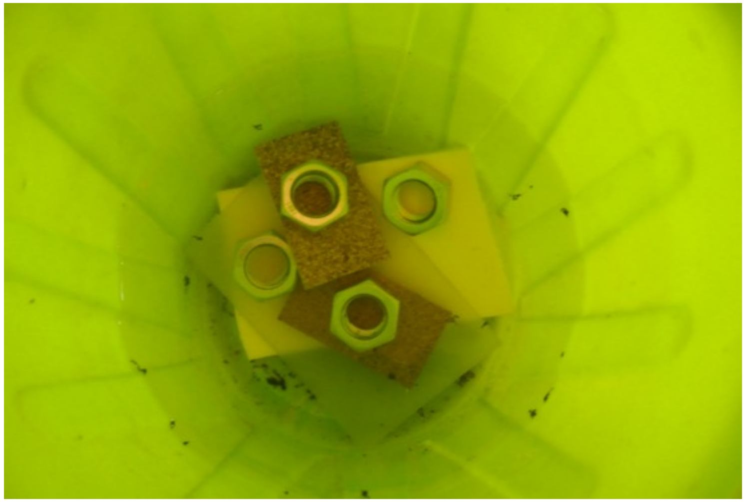
- CLT surface (narrow and side face): no clearly distinguishable difference on static friction coefficient

- Counter material (spruce and birch): the material of CLT does not give a clear difference between static friction coefficient

- Normal force: the coefficient of static friction increases with the normal force

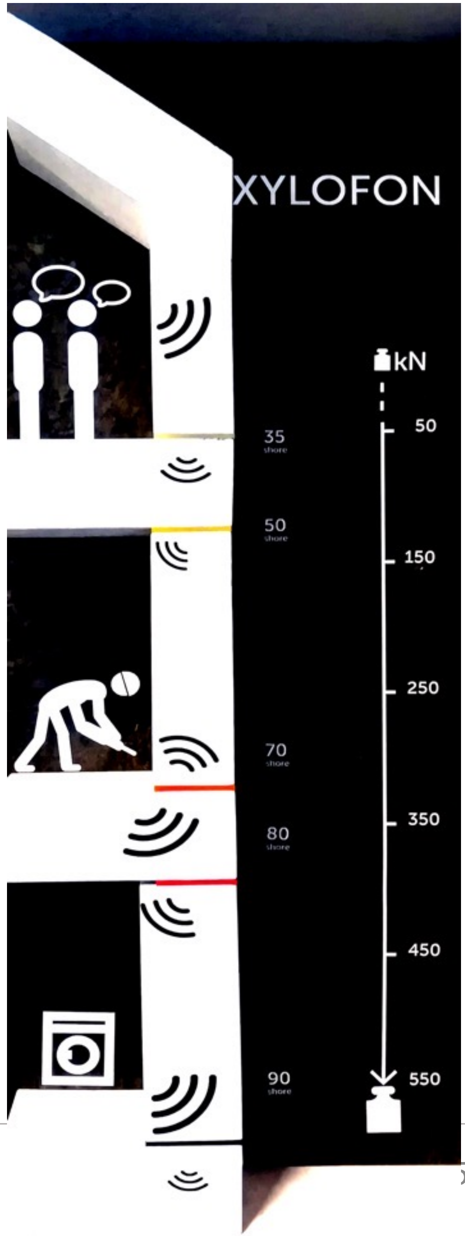
- Xylofon hardness: the coefficient of the static friction decreases with Xylofon hardness.

The whole investigation of the parameter's combination was not possible and not investigated parameters could also have some influence on the friction coefficient.



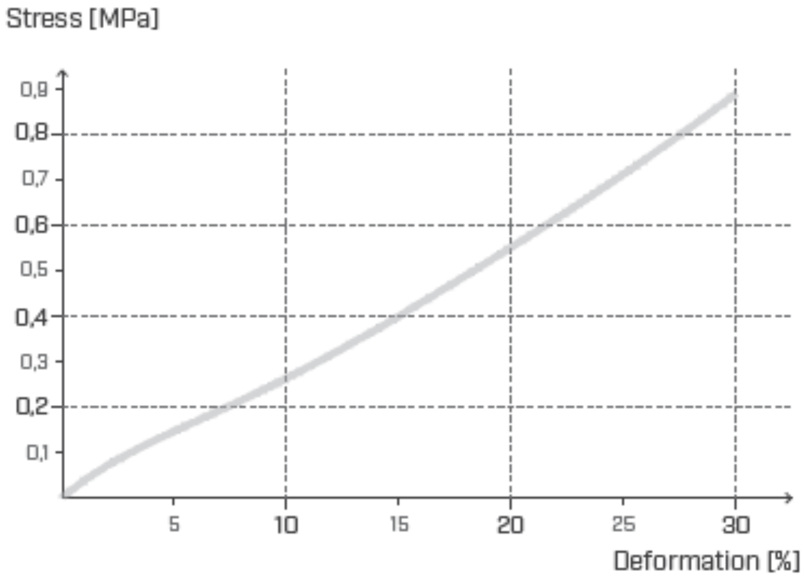
MATERIAL

Wooden structures, like all lightweight constructions, do not have a high acoustic performance at **low frequencies**. This is particularly true concerning impact sounds and the transmission of structural vibration through the structure. For this purpose, we must stop the propagation of vibrations in order to obtain a **reduction of noise** transmission using resilient products employed according to the principle of **desolidarisation**.

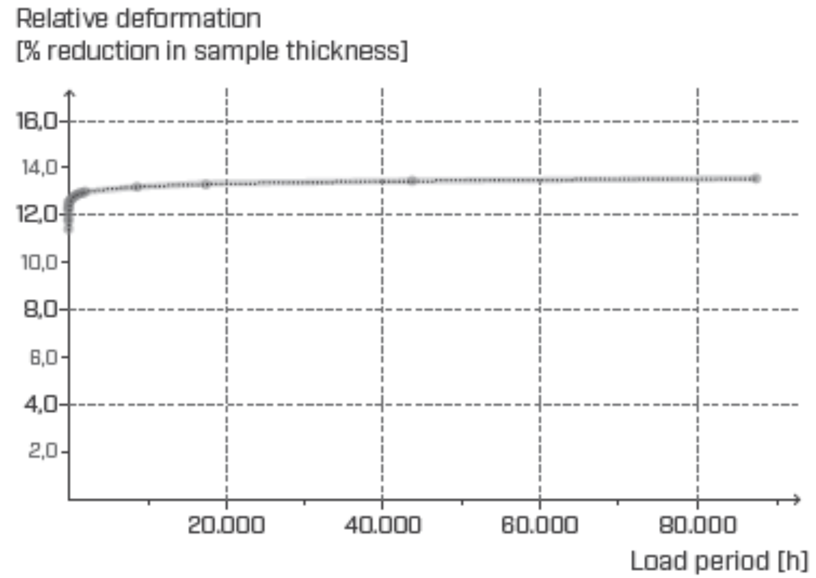


Mechanical performance

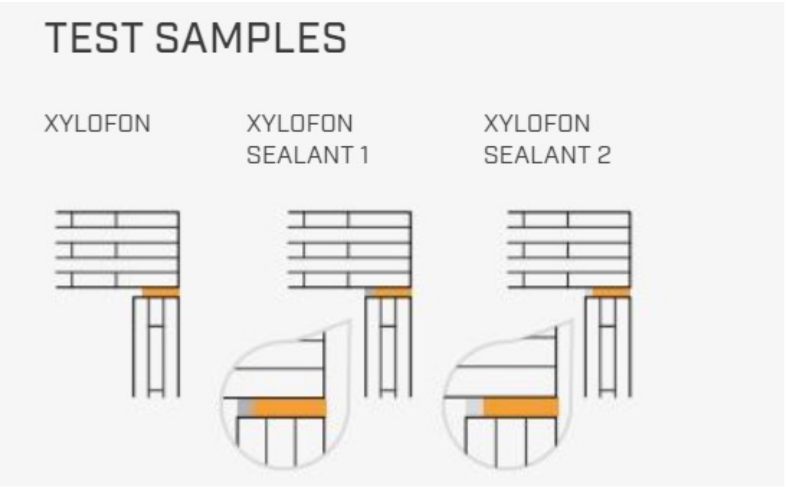
STRESS | DEFORMATION
COMPRESSION



CREEP
COMPRESSION



Fire resistance



Fire resistance

Fire resistance

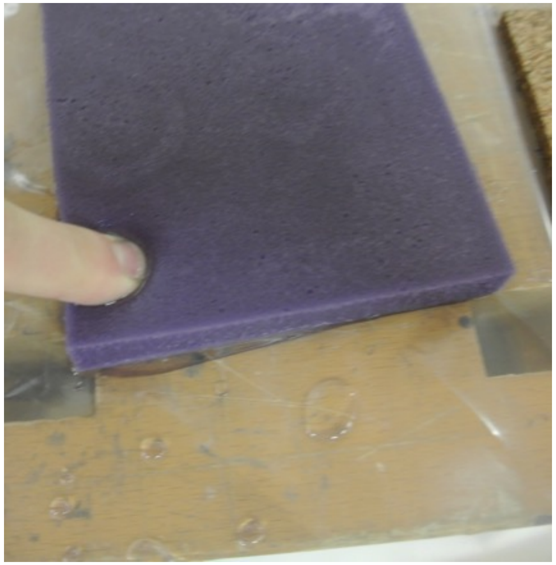
5 Conclusions

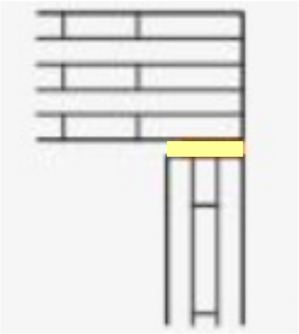
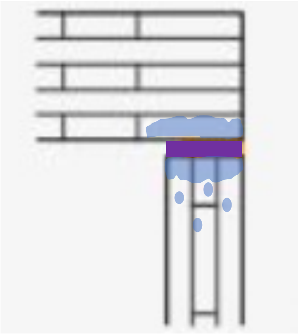
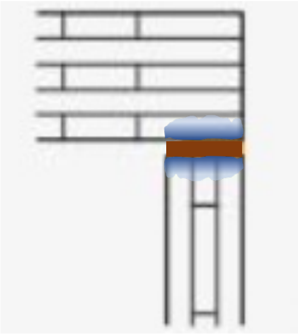
The following conclusions can be drawn on the basis of the fire test carried out for the purpose to test and assess the performance in fire of a joint with XYLOFON stripe from the company Rotho Blass AG:

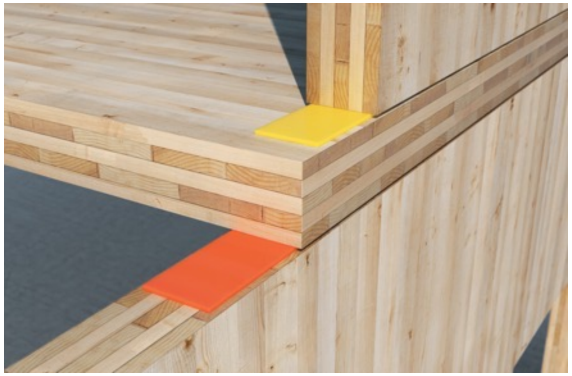
- The fire unexposed surface at all did not show any temperature increase until the fire test was stopped after 60 minutes of standard ISO/EN fire exposure (criteria I fulfilled).
- The fire unexposed side of the specimen did not show any change in colour nor any integrity failure. Moreover, no burn-through was observed until the fire test was stopped after 60 minutes (criteria E fulfilled).

Durability

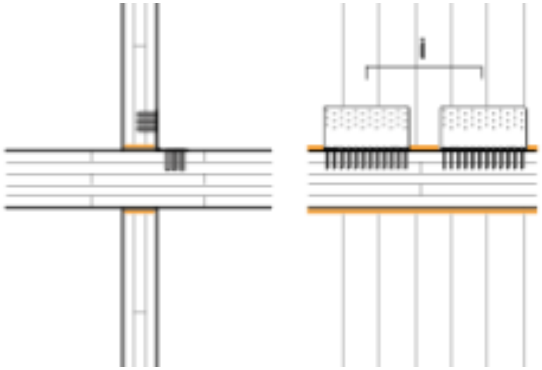
Durability

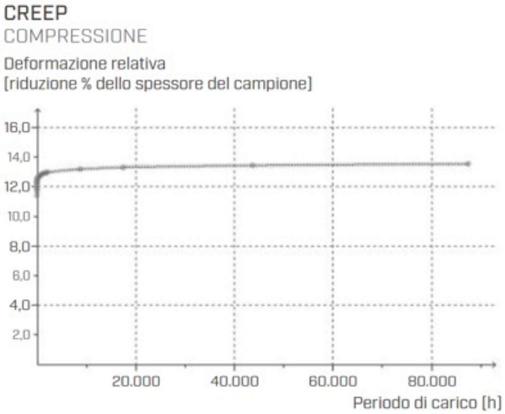






ACOUSTIC PERFORMANCE

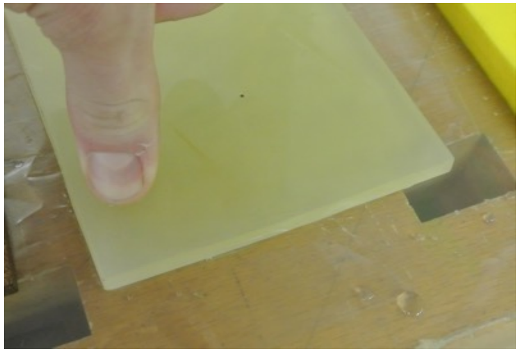


INTERACTION WITH CONNECTORS

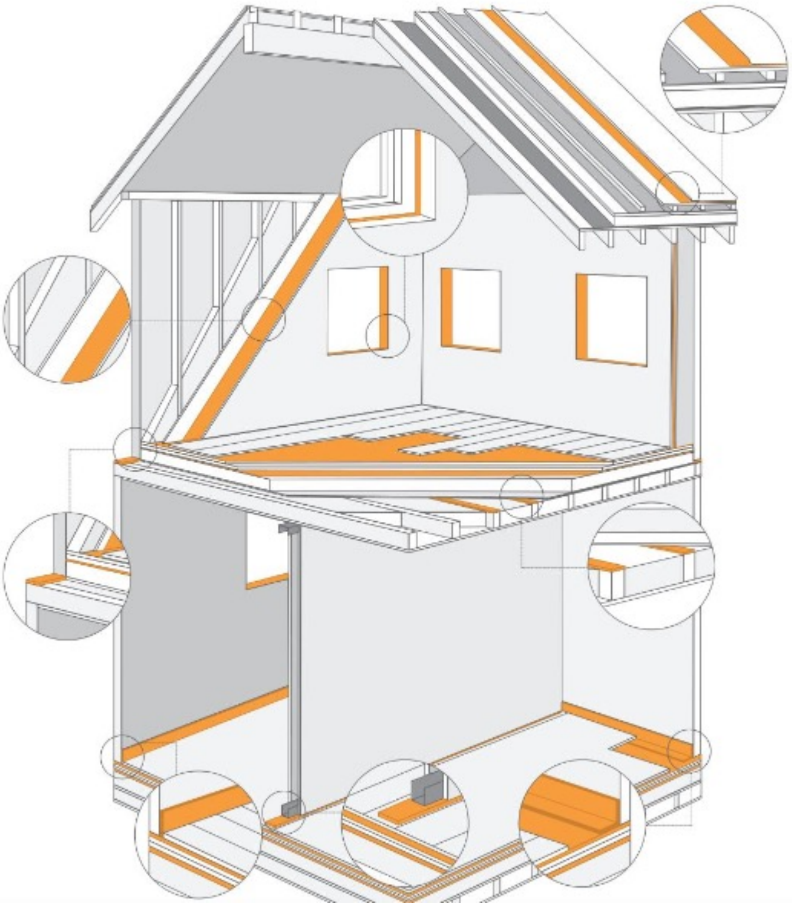


MECHANICAL PERFORMANCE

FIRE RESISTANCE



DURABILITY



THANK YOU FOR YOUR KIND ATTENTION

Pauli Paintola

RothoBlaas, Technical Sales Finland

Pauli.paintola@rothoblaas.com

Tel. +358 40 65 744 42

Rothoschool first time in Finland 3.10.2023 Helsinki, please note to your calender !

Days program will be published soon – please follow up www.rothoblaas.com