TIMBER JOINTS WITH RESILIENT PROFILES

INTERACTION BETWEEN STRUCTURAL AND ACOUSTIC PERFORMANCE

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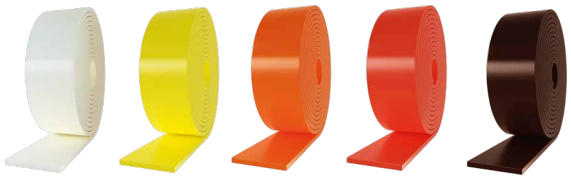
Solutions for Building Technology

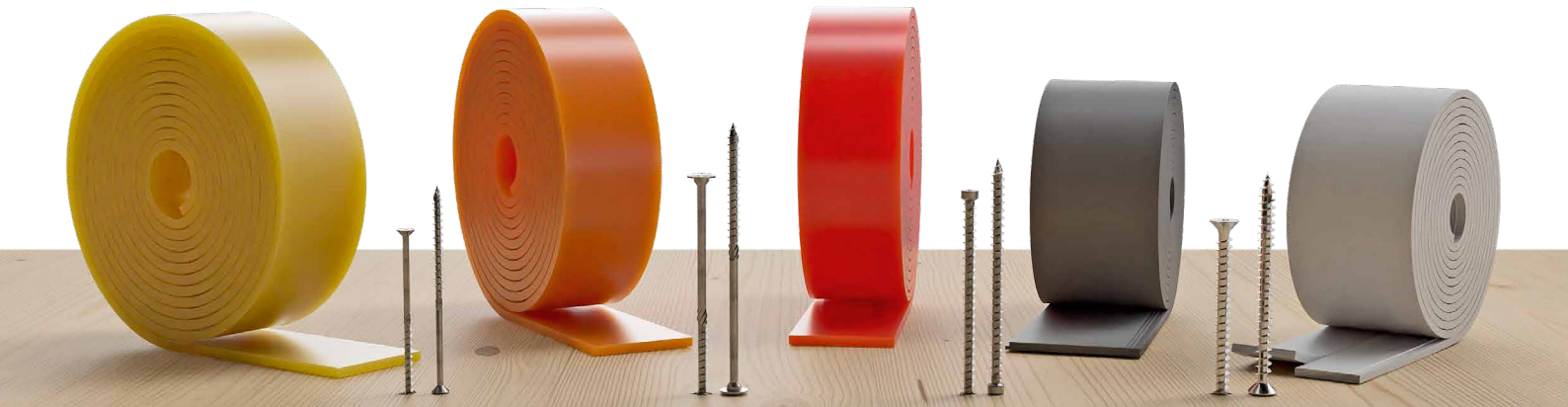
PRODUCTS

CONNECTORS

HBS	COUNTERSUNK SCREW	Zn ELECTRO PLATED	
HBS EVO		C4 EVO COATING	
TBS	FLANGE HEAD SCREW	Zn ELECTRO PLATED	
TBS EVO		C4 EVO COATING	
VGZ	FULLY THREADED SCREW WITH CYLINDRICAL HEAD	Zn ELECTRO PLATED	
VGZ EVO		C4 EVO COATING	
VGS	FULLY THREADED SCREW WITH COUNTERSUNK OR HEXAGONAL HEAD	Zn ELECTRO PLATED	
VGS EVO		C4 EVO COATING	

RESILIENT PROFILES

XYLOFON	HIGH PERFORMANCE RESILIENT SOUNDPROOFING PROFILE	
PIANO	RESILIENT SOUNDPROOFING PROFILE	



RESEARCH & DEVELOPMENT

STRUCTURAL DESIGN AND ACOUSTICS

The mechanical behaviour of timber-to-timber shear connections with a resilient sound insulation profile in between was studied in depth, both in terms of strength and stiffness, through an extensive experimental campaign.

EXPERIMENTAL INVESTIGATION

1 ANALYTICAL CHARACTERISATION OF A GAP CONNECTION USING PREDICTIVE MODELS

For the analytical evaluation of the mechanical parameters of the connection (strength and stiffness), models available in the literature were applied, which modify Johansen's basic theory.

2 APPLICATION OF THE MODEL TO CONNECTIONS WITH AN INTERPOSED RESILIENT PROFILE

Over 50 configurations considered by varying numerous parameters.

RESILIENT PROFILES

Thickness investigated: 6 mm, 2 x 6 mm, 3 x 6 mm

XYLOFON 35-50-70-80-90

Polyurethane
(monolithic and deformable)

PIANO A-B

EPDM
(expanded and compressible)

PIANO C-D-E

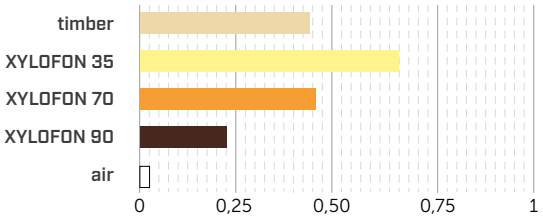
EPDM
(monolithic and deformable)

CONNECTORS

HBS Ø6 | HBS Ø8 | HBS Ø10

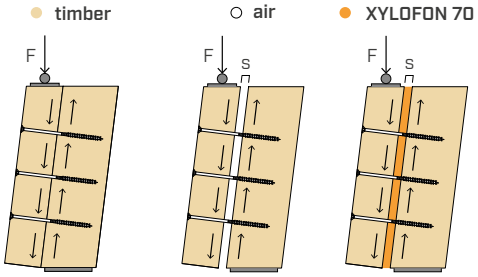
3 ASSESSMENT OF THE FRICTION COEFFICIENT μ FOR XYLOFON ACOUSTIC PROFILES

The tests carried out revealed interface properties of a frictional nature that seem to particularly influence the behaviour of the timber connections, especially in terms of strength.



4 EXECUTION OF MONOTONIC TESTS

For the validation of the predictive model studied, samples with one and two shear planes were tested.

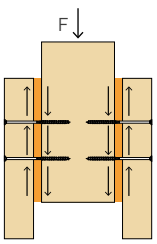


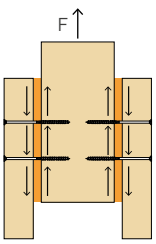
5 EXECUTION OF CYCLIC TESTS

For the comparison of the behaviour under monotonic and cyclic loads, samples with two shear planes were tested.

over **250 TESTS**

Experimental campaign carried out in cooperation with:
CIRI Edilizia e Costruzioni
Interdepartmental Centre for Industrial Research
Alma Mater Studiorum - Università di Bologna





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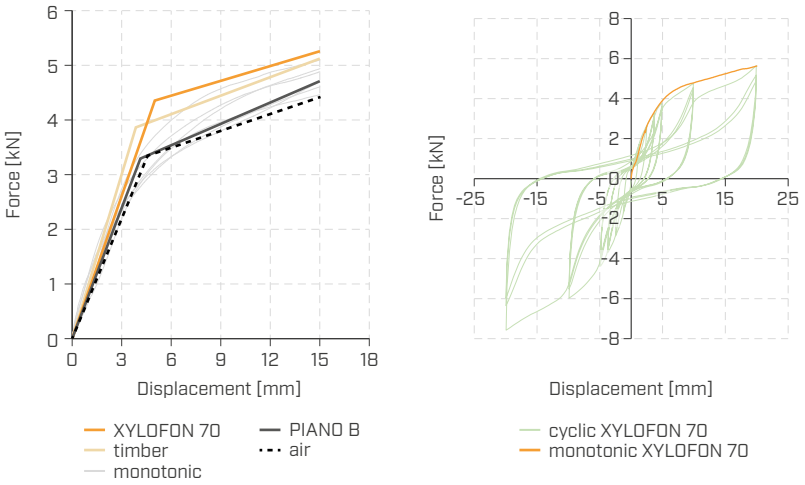
6 CAMPAIGN RESULTS

The results were analysed by bi-linearising the experimental curves. It can be seen that the cyclic behaviour is consistent with the monotonic behaviour.



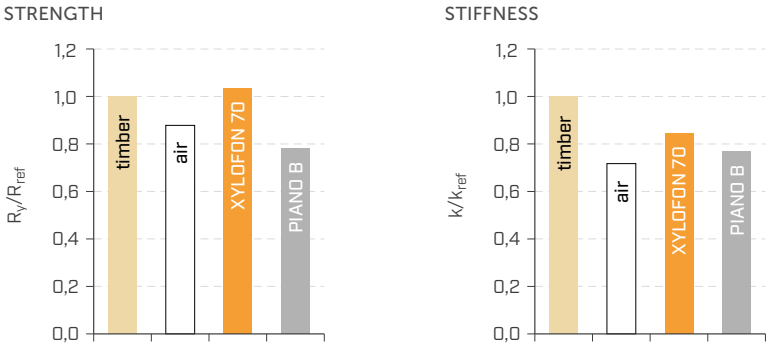
Graphical representation of experimental data from monotonic tests (left) and cyclic tests (right).

7 INTERPRETATION OF RESULTS

The comparative analysis focused mainly on strength and stiffness parameters.
The values obtained in the various configurations were dimensioned with respect to the TIMBER case.

Monolithic, deformable **polyurethane and EPDM** profiles (represented by XYLOFON 70 in the graphs) do not significantly change the strength **of the connection when the elastic modulus** of the material changes compared to the timber-to-timber case.

With expanded **and compressible profiles** (represented by PLAN B in the graphs), on the other hand, the variation from the reference configuration is more significant.



parameter	influence on strength		influence on stiffness
profile structure	**medium-high**	R_y ↓ as compressibility increases(*)	**medium**
s [profile thickness	**significant**	R_y ↓ as thickness increases (for s > 6 mm)	**significant**
d [connector diameter	**medium**	ΔR_y ↓ as the diameter increases	**medium**
interface properties	**significant**	R_y ↑ as the profile hardness decreases (shore)	**low**

(*) Directly proportional to the % of air contained in the material.

According to the analytical model, the use of **large thickness values (s > 6 mm)** leads to a progressive degradation of strength and stiffness regardless of the type of profile interposed.

Mechanical stiffness, on the other hand, shows a more or less marked degradation trend depending on the different parameters investigated and their interconnection.

In conclusion, the mechanical behaviour of the investigated connections under monotonic and cyclic loading conditions is not particularly influenced by the presence of the monolithic XYLOFON and PIANO acoustic profiles.

The strength values, as a first approximation, can, in the case of profiles with a thickness not exceeding 6 mm, always be traced back to the case of direct timber-to-timber connection, thus neglecting the presence of the acoustic profile.

COMPLETE SCIENTIFIC REPORT

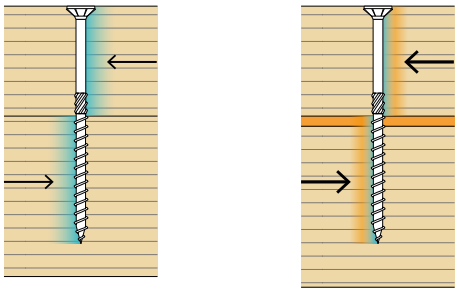
CATALOGUE SOUNDPROOFING SOLUTIONS

INTERACTION BETWEEN STRUCTURAL AND ACOUSTIC PERFORMANCE

How does a thin, resilient layer, designed for soundproofing, modify the mechanical behaviour of connections between timber elements?
Timber structures require appropriate soundproofing strategies in order to comply with increasingly stringent performance standards. Joints appear to be among the most critical aspects from both an acoustic and structural standpoint.

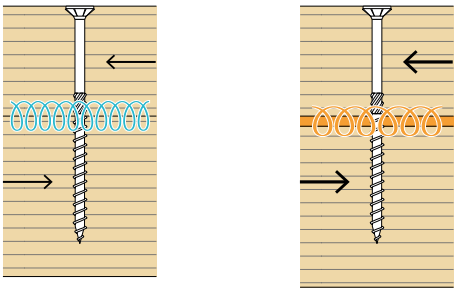
PARTIALLY THREADED SCREWS | HBS - HBS EVO - TBS - TBS EVO

STRENGTH



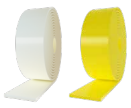
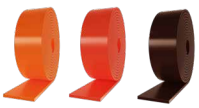
$R_{V,k} \approx R_{V,ACU,k}$

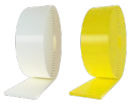
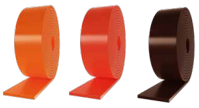
STIFFNESS



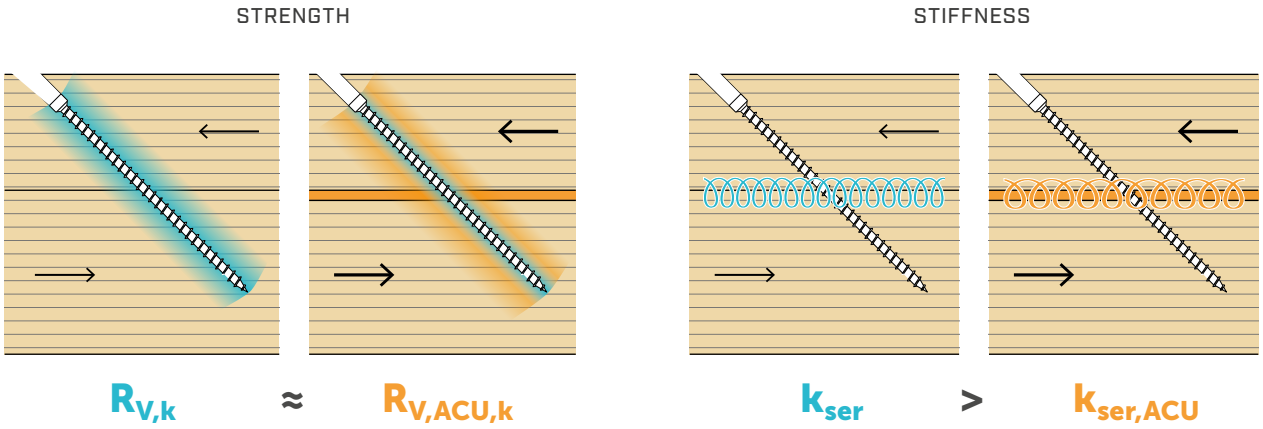
$k_{ser} > k_{ser,ACU}$

Monolithic, deformable polyurethane and EPDM profiles do not significantly change the **strength** of the connection when the elastic modulus of the material changes compared to the timber-to-timber case.
By contrast, the **stiffness** of the connection is significantly affected when a resilient profile is placed in between, which alters the system's behaviour under service conditions. Smaller diameters show greater deviations than larger diameters.

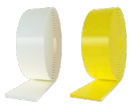
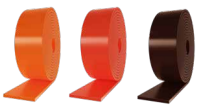
	STRENGTH				
	without profile	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
					
Δ% mean	**0%**	**+ 25%**	**- 1%**	**- 1%**	**- 45%**
range	-	110-135%	90-110%	90-110%	50-60%

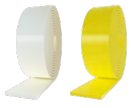
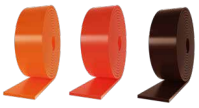
	STIFFNESS				
	without profile	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
					
Δ% mean	**0%**	**- 40%**	**- 45%**	**- 45%**	**- 70%**
range	-	50-80%	40-75%	40-75%	25-40%

FULLY THREADED SCREW | VGZ - VGZ EVO - VGS - VGS EVO



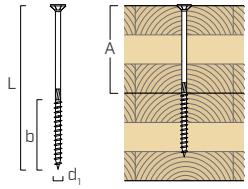
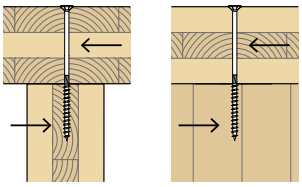
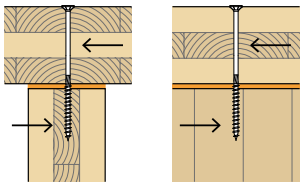
The profiles do not significantly affect the **strength** of the connection compared with the timber-to-timber case. The reduction is due to a smaller portion of the load-bearing thread within the timber element.
By contrast, the **stiffness** of the connection is significantly affected when a resilient profile is placed in between, which alters the system's behaviour under service conditions.

	STRENGTH				
	without profile	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
					
Δ% mean	**0%**	**- 5%**	**- 5%**	**- 5%**	**- 5%**
range	-	90-100%	90-100%	90-100%	90-100%

	STIFFNESS				
	without profile	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
					
Δ% mean	**0%**	**- 60%**	**- 60%**	**- 60%**	**- 60%**
range	-	35-45%	35-45%	35-45%	35-45%

HBS | HBS EVO

SHEAR CONNECTION

geometry				CLT-CLT lateral face-narrow face				
								
STRENGTH								
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]			
profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
8	120 ÷ 140	60	≥ 60	2,26	2,92	2,26	2,26	1,37
	160 ÷ 280	80	≥ 80	2,58	3,09	2,43	2,43	1,55
	300 ÷ 600	100	≥ 200	2,58	3,09	2,43	2,43	1,55
10	120 ÷ 140	60	≥ 60	3,03	3,42	3,17	3,17	1,77
	160 ÷ 280	80	≥ 80	3,37	4,54	3,49	3,49	2,09
	300 ÷ 600	100	≥ 200	3,76	4,71	3,66	3,66	2,26
12	160 ÷ 280	80	≥ 80	4,00	5,13	4,22	4,22	2,42
	320 ÷ 1000	120	≥ 200	4,65	5,94	4,59	4,59	2,78
Δ% mean				0%	+ 25%	0%	0%	- 40%

STIFFNESS								
d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
8	120 ÷ 140	60	≥ 60	1514	687	564	564	343
	160 ÷ 280	80	≥ 80	1514	773	608	608	387
	300 ÷ 600	100	≥ 200	1514	773	608	608	387
10	120 ÷ 140	60	≥ 60	1810	854	793	793	443
	160 ÷ 280	80	≥ 80	1810	1045	872	872	523
	300 ÷ 600	100	≥ 200	1810	1129	914	914	565
12	160 ÷ 280	80	≥ 80	2095	1208	1056	1056	604
	320 ÷ 1000	120	≥ 200	2095	1389	1147	1147	695
Δ% mean				0%	- 45%	- 54%	- 54%	-72%

NOTES and GENERAL PRINCIPLES on page 17.

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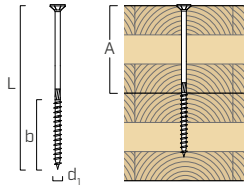
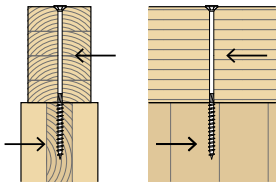
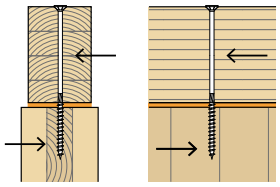
HBS | HBS EVO

SHEAR CONNECTION

geometry				timber-CLT narrow face				
								
	d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]		
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STRENGTH	8	120 ÷ 140	60	≥ 60	2,32	3,05	2,34	2,34	1,39
		160 ÷ 280	80	≥ 80	2,66	3,24	2,52	2,52	1,57
		300 ÷ 600	100	≥ 200	2,66	3,24	2,52	2,52	1,57
	10	120 ÷ 140	60	≥ 60	3,12	3,42	3,30	3,30	1,79
		160 ÷ 280	80	≥ 80	3,46	4,68	3,62	3,62	2,11
		300 ÷ 600	100	≥ 200	3,86	4,93	3,80	3,80	2,29
	12	160 ÷ 280	80	≥ 80	4,11	5,13	4,39	4,39	2,44
		320 ÷ 1000	120	≥ 200	4,78	6,23	4,76	4,76	2,81
	Δ% mean				0%	+ 25%	+ 1%	+ 1%	- 41%

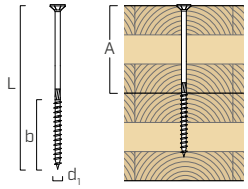
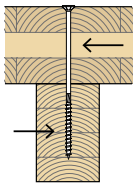
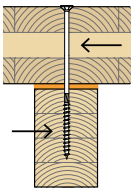
	d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STIFFNESS	8	120 ÷ 140	60	≥ 60	1514	693	585	585	347
		160 ÷ 280	80	≥ 80	1514	784	630	630	392
		300 ÷ 600	100	≥ 200	1514	784	630	630	392
	10	120 ÷ 140	60	≥ 60	1810	854	825	825	448
		160 ÷ 280	80	≥ 80	1810	1055	905	905	527
		300 ÷ 600	100	≥ 200	1810	1144	949	949	572
	12	160 ÷ 280	80	≥ 80	2095	1219	1098	1098	610
		320 ÷ 1000	120	≥ 200	2095	1407	1191	1191	703
	Δ% mean				0%	- 45%	- 53%	- 53%	-72%

NOTES and GENERAL PRINCIPLES on page 17.

HBS | HBS EVO

SHEAR CONNECTION

STRENGTH

geometry				CLT - timber lateral face				
								
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]			
profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
6	110 ÷ 130	60	≥ 50	2,01	2,19	1,74	1,74	1,13
	140 ÷ 400	75	≥ 65	2,01	2,19	1,74	1,74	1,13
8	120 ÷ 140	60	≥ 60	3,17	3,47	2,81	2,81	1,92
	160 ÷ 280	80	≥ 80	3,17	3,47	2,81	2,81	1,92
	300 ÷ 600	100	≥ 200	3,17	3,47	2,81	2,81	1,92
10	120 ÷ 140	60	≥ 60	4,55	5,31	4,26	4,26	2,86
	160 ÷ 280	80	≥ 80	4,65	5,31	4,26	4,26	2,86
	300 ÷ 600	100	≥ 200	4,65	5,31	4,26	4,26	2,86
12	160 ÷ 280	80	≥ 80	5,79	6,74	5,38	5,38	3,57
	320 ÷ 1000	120	≥ 200	5,79	6,74	5,38	5,38	3,57
Δ% mean				0%	+ 12%	- 10%	- 10%	- 40%

STIFFNESS

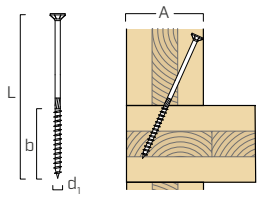
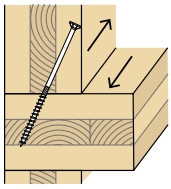
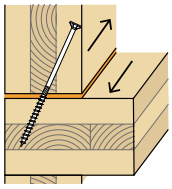
d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
6	110 ÷ 130	60	≥ 50	1203	548	435	435	283
	140 ÷ 400	75	≥ 65	1203	548	435	435	283
8	120 ÷ 140	60	≥ 60	1514	867	701	701	481
	160 ÷ 280	80	≥ 80	1514	867	701	701	481
	300 ÷ 600	100	≥ 200	1514	867	701	701	481
10	120 ÷ 140	60	≥ 60	1810	1328	1066	1066	716
	160 ÷ 280	80	≥ 80	1810	1328	1066	1066	716
	300 ÷ 600	100	≥ 200	1810	1328	1066	1066	716
12	160 ÷ 280	80	≥ 80	2095	1684	1345	1345	893
	320 ÷ 1000	120	≥ 200	2095	1684	1345	1345	893
Δ% mean				0%	- 36%	- 48%	- 48%	-65%

NOTES and GENERAL PRINCIPLES on page 17.

rothoblaas

HBS | HBS EVO

SHEAR CONNECTION

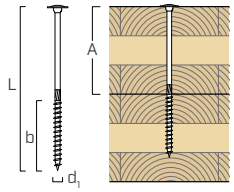
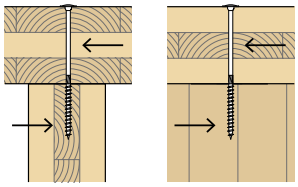
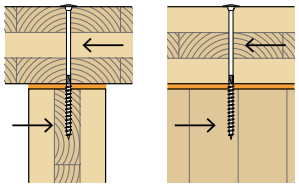
geometry				CLT-CLT narrow face - wide face				
								
	d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]		
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STRENGTH	6	180	75	60	1,97	2,17	1,72	1,72	1,11
		200	75	80	1,97	2,17	1,72	1,72	1,11
		220	75	100	1,97	2,17	1,72	1,72	1,11
		240	75	120	1,97	2,17	1,72	1,72	1,11
	8	220	80	80	3,11	3,43	2,77	2,77	1,89
		240	80	100	3,11	3,43	2,77	2,77	1,89
		260	80	120	3,11	3,43	2,77	2,77	1,89
		280	60	140	3,11	3,43	2,77	2,77	1,89
		320	100	160	3,11	3,43	2,77	2,77	1,89
	10	260	80	120	4,56	5,25	4,21	4,21	2,81
		280	80	140	4,56	5,25	4,21	4,21	2,81
		320	100	160	4,56	5,25	4,21	4,21	2,81
	Δ% mean				0%	+ 12%	- 11%	- 11%	- 41%

	d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STIFFNESS	6	180	75	60	1203	543	430	430	278
		200	75	80	1203	543	430	430	278
		220	75	100	1203	543	430	430	278
		240	75	120	1203	543	430	430	278
	8	220	80	80	1514	858	692	692	471
		240	80	100	1514	858	692	692	471
		260	80	120	1514	858	692	692	471
		280	60	140	1514	858	692	692	471
		320	100	160	1514	858	692	692	471
	10	260	80	120	1810	1314	1051	1051	702
		280	80	140	1810	1314	1051	1051	702
		320	100	160	1810	1314	1051	1051	702
	Δ% mean				0%	- 43%	- 55%	- 55%	-70%

NOTES and GENERAL PRINCIPLES on page 17.

TBS | TBS EVO

SHEAR CONNECTION

geometry				CLT - timber lateral face				
								
	d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]		
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STRENGTH	8	120 ÷ 140	80	≥ 40	2,80	4,19	3,06	3,06	1,55
		160 ÷ 280	100	≥ 60	2,98	4,20	3,06	3,06	1,55
		300 ÷ 600	100	≥ 200	2,98	4,20	3,06	3,06	1,55
	10	120 ÷ 140	60	≥ 60	3,41	3,42	3,42	3,42	1,77
		160 ÷ 180	80	≥ 80	4,12	4,68	4,52	4,52	2,09
		200 ÷ 300	100	≥ 100	4,52	5,95	4,88	4,88	2,26
		320 ÷ 600	120	≥ 200	4,52	6,85	4,88	4,88	2,26
	12	200 ÷ 360	120	≥ 80	5,72	7,90	6,31	6,31	2,78
		400 ÷ 600	140	≥ 260	5,72	8,96	6,31	6,31	2,78
	Δ% mean				0%	+ 36%	+ 7%	+ 7%	- 49%

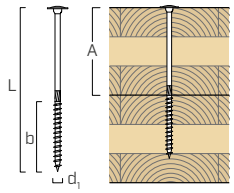
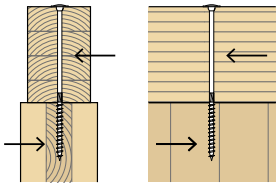
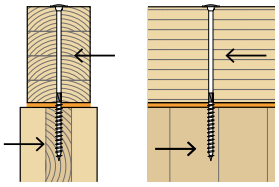
	d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STIFFNESS	8	120 ÷ 140	80	≥ 40	1514	774	766	766	387
		160 ÷ 280	100	≥ 60	1514	774	766	766	387
		300 ÷ 600	100	≥ 200	1514	774	766	766	387
	10	120 ÷ 140	60	≥ 60	1810	854	854	854	443
		160 ÷ 180	80	≥ 80	1810	1045	1045	1045	523
		200 ÷ 300	100	≥ 100	1810	1129	1129	1129	565
		320 ÷ 600	120	≥ 200	1810	1129	1129	1129	565
	12	200 ÷ 360	120	≥ 80	2095	1389	1389	1389	695
		400 ÷ 600	140	≥ 260	2095	1389	1389	1389	695
	Δ% mean				0%	- 43%	- 43%	- 43%	-71%

NOTES and GENERAL PRINCIPLES on page 17.

rothoblaas

TBS | TBS EVO

SHEAR CONNECTION

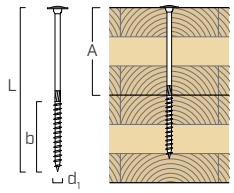
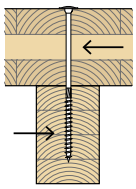
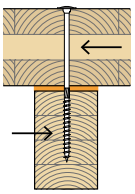
geometry				CLT-CLT narrow face - wide face				
								
	d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]		
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STRENGTH	8	120 ÷ 140	80	≥ 40	2,98	4,19	3,20	3,20	1,57
		160 ÷ 280	100	≥ 60	3,08	4,43	3,20	3,20	1,57
		300 ÷ 600	100	≥ 200	3,08	4,43	3,20	3,20	1,57
	10	120 ÷ 140	60	≥ 60	3,43	3,42	3,42	3,42	1,79
		160 ÷ 180	80	≥ 80	4,15	4,68	4,54	4,54	2,11
		200 ÷ 300	100	≥ 100	4,69	5,88	5,09	5,09	2,25
		320 ÷ 600	120	≥ 200	4,71	7,08	5,05	5,05	2,21
	12	200 ÷ 360	120	≥ 80	5,95	7,90	6,63	6,63	2,81
		400 ÷ 600	140	≥ 260	5,95	9,28	6,63	6,63	2,81
	Δ% mean				0%	+ 34%	+ 7%	+ 7%	- 50%

	d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STIFFNESS	8	120 ÷ 140	80	≥ 40	1514	784	784	784	392
		160 ÷ 280	100	≥ 60	1514	784	784	784	392
		300 ÷ 600	100	≥ 200	1514	784	784	784	392
	10	120 ÷ 140	60	≥ 60	1810	854	854	854	448
		160 ÷ 180	80	≥ 80	1810	1055	1055	1055	527
		200 ÷ 300	100	≥ 100	1810	1124	1124	1124	562
		320 ÷ 600	120	≥ 200	1810	1105	1105	1105	552
	12	200 ÷ 360	120	≥ 80	2095	1407	1407	1407	703
		400 ÷ 600	140	≥ 260	2095	1407	1407	1407	703
	Δ% mean				0%	- 42%	- 42%	- 42%	-71%

NOTES and GENERAL PRINCIPLES on page 17.

TBS | TBS EVO

SHEAR CONNECTION

geometry				CLT - timber lateral face				
								
	d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]		
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STRENGTH	6	120 ÷ 200	75	≥ 45	2,26	2,90	2,14	2,14	1,13
		220 ÷ 400	100	≥ 120	2,26	2,90	2,14	2,14	1,13
	8	120 ÷ 140	80	≥ 40	3,20	4,54	3,40	3,40	1,88
		160 ÷ 280	100	≥ 60	3,57	4,58	3,44	3,44	1,92
		300 ÷ 600	100	≥ 200	3,57	4,58	3,44	3,44	1,92
	10	120 ÷ 140	60	≥ 60	5,32	7,46	5,49	5,49	2,86
		160 ÷ 180	80	≥ 80	5,42	7,46	5,49	5,49	2,86
		200 ÷ 300	100	≥ 100	5,42	7,46	5,49	5,49	2,86
		320 ÷ 600	120	≥ 200	5,42	7,46	5,49	5,49	2,86
	12	200 ÷ 360	120	≥ 80	6,87	9,75	7,11	7,11	3,57
		400 ÷ 600	140	≥ 260	6,87	9,75	7,11	7,11	3,57
	Δ% mean				**0%**	**+ 36%**	**0%**	**0%**	**- 47%**

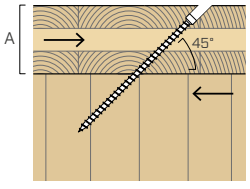
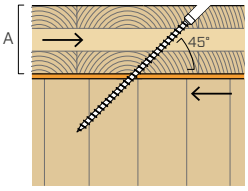
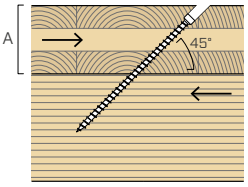
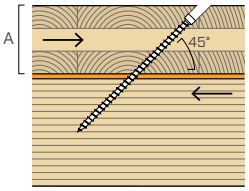
	d_1 [mm]	L [mm]	b [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]			
	profile				-	XYLOFON 35-50	XYLOFON 70-80-90	PIANO C-D-E	PIANO A-B
STIFFNESS	6	120 ÷ 200	75	≥ 45	1203	567	536	536	283
		220 ÷ 400	100	≥ 120	1203	567	536	536	283
	8	120 ÷ 140	80	≥ 40	1514	942	850	850	471
		160 ÷ 280	100	≥ 60	1514	961	860	860	481
		300 ÷ 600	100	≥ 200	1514	961	860	860	481
	10	120 ÷ 140	60	≥ 60	1810	1432	1372	1372	716
		160 ÷ 180	80	≥ 80	1810	1432	1372	1372	716
		200 ÷ 300	100	≥ 100	1810	1432	1372	1372	716
		320 ÷ 600	120	≥ 200	1810	1432	1372	1372	716
	12	200 ÷ 360	120	≥ 80	2095	1786	1776	1776	893
		400 ÷ 600	140	≥ 260	2095	1786	1776	1776	893
	Δ% mean				**0%**	**- 25%**	**- 29%**	**- 29%**	**-62%**

NOTES and GENERAL PRINCIPLES on page 17.

rothoblaas

VGZ | VGZ EVO

SLIDING CONNECTION

geometry			CLT - CLT		CLT - timber	
						

STRENGTH

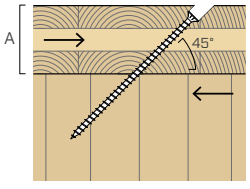
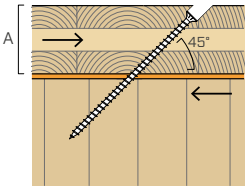
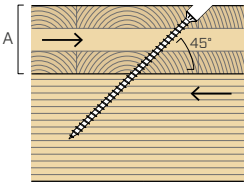
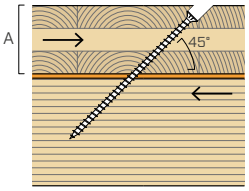
d_1 [mm]	L [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]
profile			-	XYLOFON/PIANO	-	XYLOFON/PIANO
7	220	80	4,23	3,90	5,22	5,22
	280	100	5,42	5,10	6,86	6,86
	320	120	5,85	5,54	8,50	8,43
	380	140	7,00	6,70	10,13	10,13
9	260	100	5,80	5,41	8,67	8,45
	320	120	7,24	6,86	10,77	10,77
	380	140	8,65	8,28	12,88	12,88
	440	160	10,04	9,67	14,99	14,99
	480	180	10,54	10,17	17,09	17,03
	520	200	11,04	10,68	18,66	17,97
11	325	120	8,77	8,32	13,17	13,17
	375	140	9,90	9,46	15,74	15,74
	425	160	11,02	10,58	18,32	18,19
	500	180	13,38	12,96	20,89	20,89
	550	200	14,47	14,04	23,46	23,46
	600	220	15,54	15,12	26,04	26,04
	650	240	16,61	16,19	28,61	28,61
	700	260	17,66	17,25	31,19	31,19
	750	280	18,72	18,31	33,76	33,45
Δ% mean			0%	- 4%	0%	0%

STIFFNESS

d_1 [mm]	L [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]
profile			-	XYLOFON/PIANO	-	XYLOFON/PIANO
7	220	80	5127	2296	7887	3071
	280	100	6735	3002	10362	4034
	320	120	7667	3258	11796	4956
	380	140	9471	3940	14571	5961
9	260	100	7685	3183	11823	4968
	320	120	10004	4036	15391	6338
	380	140	12323	4869	18959	7577
	440	160	14643	5687	22527	8816
	480	180	15499	5985	23845	10019
	520	200	16356	6282	25163	10573
11	325	120	12674	4895	19499	7746
	375	140	14615	5564	22485	9261
	425	160	16556	6225	25471	10702
	500	180	20517	7622	31564	12289
	550	200	22672	8261	34880	13803
	600	220	24613	8895	37866	15317
	650	240	26554	9524	40852	16831
	700	260	28494	10148	43838	18345
	750	280	30435	10768	46824	19674
Δ% mean			0%	- 61%	0%	- 59%

VGS | VGS EVO

SLIDING CONNECTION

geometry			CLT - CLT		CLT - timber	
						
d_1 [mm]	L [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]	$R_{V,k}$ [kN]	$R_{V,ACU,k}$ [kN]
profile			-	XYLOFON/PIANO	-	XYLOFON/PIANO
9	260	100	5,90	5,50	8,52	8,52
	320	120	7,33	6,95	10,63	10,63
	380	140	8,74	8,37	12,73	12,73
	440	160	10,12	9,75	14,84	14,84
	480	180	10,63	10,26	16,94	16,94
	520	200	11,13	10,77	18,82	18,13
11	325	120	8,98	8,53	12,80	12,80
	375	140	10,11	9,67	15,38	15,38
	425	160	11,22	10,79	17,95	17,95
	500	180	13,58	13,16	20,53	20,53
	550	200	14,66	14,24	23,10	23,10
13	400	140	13,14	12,64	17,96	17,96
	450	160	14,39	13,90	21,00	21,00
	500	180	15,64	15,15	24,04	24,04
	550	200	16,87	16,39	27,09	27,09
Δ% mean			0%	- 4%	0%	0%

STRENGTH

d_1 [mm]	L [mm]	A [mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]	k_{ser} [N/mm]	$k_{ser,ACU}$ [N/mm]
profile			-	XYLOFON/PIANO	-	XYLOFON/PIANO
9	260	100	7831	3238	12048	5012
	320	120	10150	4089	15616	6250
	380	140	12470	4921	19184	7489
	440	160	14572	5738	22418	8728
	480	180	15646	6036	24070	9967
	520	200	16502	6333	25388	10667
11	325	120	12576	5019	19347	7532
	375	140	14973	5687	23035	9046
	425	160	16913	6346	26021	10561
	500	180	20159	7740	31014	12075
	550	200	22687	8378	34903	13589
13	400	140	17638	7435	27136	10565
	450	160	20626	8178	31732	12354
	500	180	23613	8914	36328	14143
	550	200	26601	9643	40924	15933
Δ% mean			0%	- 61%	0%	- 60%

STIFFNESS

NOTES and GENERAL PRINCIPLES on page 17.

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STRUCTURAL VALUES

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2014 standard in accordance with ETA-11/0030.
- The characteristic values (CLT) are according to the national specifications ÖNORM EN 1995 - Annex K.
- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- Dimensioning and verification of the timber elements must be carried out separately.
- The screws must be positioned in accordance with the minimum distances.
- For the calculation process, a mass density of ρ_k = 350 kg/m^3 has been considered for CLT elements and a mass density of ρ_k = 385 kg/m^3 has been considered for timber elements.
- The reported deviation values with respect to the case without a profile in between (Δ%mean) are to be understood as mean values of the tabulated cases.
- The axial thread withdrawal resistance in the narrow face is valid for minimum CLT thickness $t_{CLT,min} = 10 \cdot d_1$ and minimum screw pull-through depth $t_{pen} = 10 \cdot d_1$.
- For further information, please refer to the catalogue "Timber Screws and Deck Fastening" and/or the website www.rothoblaas.com.

NOTES | HBS AND TBS

- The design shear strength of the connector is obtained from the characteristic value as follows:

$$R_d = \frac{R_k \cdot k_{mod}}{\gamma_M}$$

The coefficients γ_M and k_{mod} should be taken according to the current regulations used for the calculation.

- The characteristic shear resistances are calculated for screws inserted without pre-drilling hole. In the case of screws inserted with pre-drilling hole, greater resistance values can be obtained.
- The characteristic shear strength is independent from the direction of the grain of the CLT panels outer layer.
- The characteristics shear resistance are calculated considering a minimum fixing length of 4 d_1.
- The stiffness of connections with a resilient profile was evaluated by limiting the influence of the frictional component, in order to more accurately represent the actual behaviour under serviceability limit state conditions.

NOTES | VGZ AND VGS

- The design sliding strength of the joint is either the timber-side design strength ($R_{V,d}$) and the design strength on the steel side projected at 45°. ($R_{tens,45,d}$), whichever is lower:

$$R_{V,d} = min \begin{cases} \frac{R_{V,k} \cdot k_{mod}}{\gamma_M} \\ \frac{R_{tens,45,k}}{\gamma_{M2}} \end{cases}$$

The coefficients γ_M and k_{mod} should be taken according to the current regulations used for the calculation.

- The characteristic strength on the steel side projected at 45° ($R_{tens,45,k}$) is equal to:

screw	d_1 [mm]	$R_{tens,45,k}$ [kN]
VGZ	7	10,89
VGS/VGZ	9	17,96
VGS/VGZ	11	26,87
VGS	13	37,48

- The characteristic sliding strengths of the connectors inserted in the lateral face of the CLT panel were evaluated considering an angle ε of 45° between the grains and the connector, since it was not possible to define the thickness and orientation of the individual layers in advance.
- Connectors' instability must be verified separately.
- The stiffness of connections with the thread inserted into the narrow face was limited, in order to more accurately represent the actual behaviour under serviceability limit state conditions.
- The tabulated strength and stiffness values are not dependent on the type of resilient profile used.

For further information
on **timber screws**,
please consult the catalogue
"TIMBER SCREWS AND DECK FASTENING"

Visit www.rothoblaas.com.

For further information
on **resilient profiles**,
please consult the catalogue
"SOUNDPROOFING SOLUTIONS"

Visit www.rothoblaas.com.

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