HBS

COUNTERSUNK SCREW

SUPERIOR STRENGTH

Steel with superb yield and failure strength ($f_{y,k}$ = 1000 N/mm²). Very high torsional strength $f_{tor,k}$ for safer screwing.

STRUCTURAL APPLICATIONS

Approved for structural applications subject to stresses in any direction vs. the grain (α = 0° - 90°). Asymmetric "umbrella" threading for better wood pull-through.

DUCTILITY

Bending angle 20° greater than standard, certified according to ETA 11/0030, Cyclical SEISMIC-REV tests according to EN 12512. Seismic performance tested according to EN 14592.

CHROMIUM (VI) FREE

Total absence of hexavalent chromium. Compliance with the strictest regulations governing chemical substances (SVHC).
REACH information available.

PROPERTIES

FOCUS	extremely complete range
HEAD	countersunk with under-head ribs
DIAMETER	from 3,5 mm to 12,0 mm
LENGTH	from 30 mm to 600 mm

MATERIAL

Galvanized carbon steel.

FIELDS OF USE

- wood based panels
- solid timber
- glulam (Glued Laminated Timber)
- CLT, LVL
- high density woods

Service classes 1 and 2.

CLT

Values also tested, certified and calculated for CLT. Calculation tables and dimensioning software (MyProject) for CLT available in the catalogue and online.

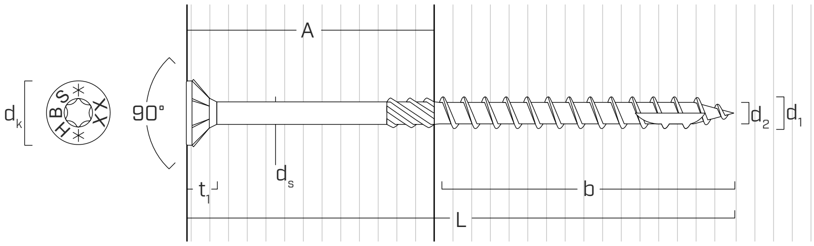
LVL

Values also tested, certified and calculated for CLT and high density woods such as Microllam® LVL.

Valley jack rafter joint with HBS screws, diameter 8 mm.

Fastening CLT walls
with 6 mm diameter HBS screws.

GEOMETRY AND MECHANICAL CHARACTERISTICS



Nominal diameter	d_1	[mm]	3,5	4	4,5	5	6	8	10	12
Head diameter	d_K	[mm]	7,00	8,00	9,00	10,00	12,00	14,50	18,25	20,75
Tip diameter	d_2	[mm]	2,25	2,55	2,80	3,40	3,95	5,40	6,40	6,80
Shank diameter	d_S	[mm]	2,45	2,75	3,15	3,65	4,30	5,80	7,00	8,00
Head thickness	t_1	[mm]	2,20	2,80	2,80	3,10	4,50	4,50	5,80	7,20
Pre-drilling hole diameter	d_V	[mm]	2,0	2,5	3,0	3,0	4,0	5,0	6,0	7,0
Characteristic yield moment	$M_{y,k}$	[Nmm]	2143	3033	4119	5417	9494	20057	35830	47966
Characteristic withdrawal-resistance parameter	$f_{ax,k}$	[N/mm²]	11,7	11,7	11,7	11,7	11,7	11,7	11,7	11,7
Characteristic head-pull-through parameter	$f_{head,k}$	[N/mm²]	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5
Characteristic tensile strength	$f_{tens,k}$	[kN]	3,8	5,0	6,4	7,9	11,3	20,1	31,4	33,9

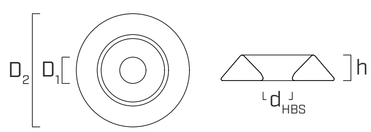
CODES AND DIMENSIONS

d_1 [mm]	CODE	L [mm]	b [mm]	A [mm]	pcs
3,5 TX 15	HBS3540	40	18	22	500
	HBS3545	45	24	21	400
	HBS3550	50	24	26	400
4 TX 20	HBS430	30	18	12	500
	HBS435	35	18	17	500
	HBS440	40	24	16	500
	HBS445	45	30	15	400
	HBS450	50	30	20	400
	HBS460	60	35	25	200
	HBS470	70	40	30	200
	HBS480	80	40	40	200
4,5 TX 20	HBS4540	40	24	16	400
	HBS4545	45	30	15	400
	HBS4550	50	30	20	200
	HBS4560	60	35	25	200
	HBS4570	70	40	30	200
	HBS4580	80	40	40	200
5 TX 25	HBS540	40	24	16	200
	HBS545	45	24	21	200
	HBS550	50	24	26	200
	HBS560	60	30	30	200
	HBS570	70	35	35	100
	HBS580	80	40	40	100
	HBS590	90	45	45	100
	HBS5100	100	50	50	100
	HBS5120	120	60	60	100
6 TX 30	HBS640	40	35	8	100
	HBS650	50	35	15	100
	HBS660	60	30	30	100
	HBS670	70	40	30	100
	HBS680	80	40	40	100
	HBS690	90	50	40	100
	HBS6100	100	50	50	100
	HBS6110	110	60	50	100
	HBS6120	120	60	60	100
	HBS6130	130	60	70	100
	HBS6140	140	75	65	100
	HBS6150	150	75	75	100
	HBS6160	160	75	85	100
	HBS6180	180	75	105	100
	HBS6200	200	75	125	100
	HBS6220	220	75	145	100
	HBS6240	240	75	165	100
	HBS6260	260	75	185	100
	HBS6280	280	75	205	100
	HBS6300	300	75	225	100

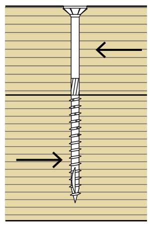
d_1 [mm]	CODE	L [mm]	b [mm]	A [mm]	pcs
8 TX 40	HBS880	80	52	28	100
	HBS8100	100	52	48	100
	HBS8120	120	60	60	100
	HBS8140	140	60	80	100
	HBS8160	160	80	80	100
	HBS8180	180	80	100	100
	HBS8200	200	80	120	100
	HBS8220	220	80	140	100
	HBS8240	240	80	160	100
	HBS8260	260	80	180	100
	HBS8280	280	80	200	100
	HBS8300	300	100	200	100
	HBS8320	320	100	220	100
	HBS8340	340	100	240	100
	HBS8360	360	100	260	100
	HBS8380	380	100	280	100
	HBS8400	400	100	300	100
	HBS8440	440	100	340	100
	HBS8480	480	100	380	100
	HBS8520	520	100	420	100
10 TX 40	HBS1080	80	52	28	50
	HBS10100	100	52	48	50
	HBS10120	120	60	60	50
	HBS10140	140	60	80	50
	HBS10160	160	80	80	50
	HBS10180	180	80	100	50
	HBS10200	200	80	120	50
	HBS10220	220	80	140	50
	HBS10240	240	80	160	50
	HBS10260	260	80	180	50
	HBS10280	280	80	200	50
	HBS10300	300	100	200	50
	HBS10320	320	100	220	50
	HBS10340	340	100	240	50
	HBS10360	360	100	260	50
	HBS10380	380	100	280	50
	HBS10400	400	100	300	50
12 TX 50	HBS12120	120	80	40	25
	HBS12160	160	80	80	25
	HBS12200	200	80	120	25
	HBS12240	240	80	160	25
	HBS12280	280	80	200	25
	HBS12320	320	120	200	25
	HBS12360	360	120	240	25
	HBS12400	400	120	280	25
	HBS12440	440	120	320	25
	HBS12480	480	120	360	25
	HBS12520	520	120	400	25
	HBS12560	560	120	440	25
	HBS12600	600	120	480	25

HUS TURNED WASHER

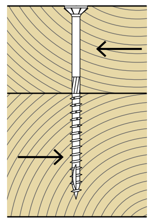
d_{HBS} [mm]	CODE	D_1 [mm]	D_2 [mm]	h [mm]	pcs
6	HUS6	7,5	20,0	4,0	100
8	HUS8	8,5	25,0	5,0	50
10	HUS10	11	32,0	6,0	50
12	HUS12	14,0	37,0	7,5	25



MINIMUM DISTANCES FOR SHEAR LOADS



Load-to-grain angle α = 0°

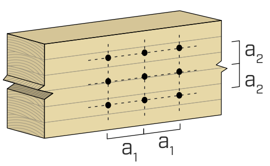


Load-to-grain angle α = 90°

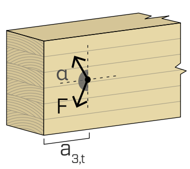
		SCREWS INSERTED WITH PRE-DRILLING HOLES										SCREWS INSERTED WITH PRE-DRILLING HOLES									
			3,5	4	4,5		5	6	8	10	12		3,5	4	4,5		5	6	8	10	12
a_1	[mm]	**5d**	18	20	23	**5d**	25	30	40	50	60	**4d**	14	16	18	**4d**	20	24	32	40	48
a_2	[mm]	**3d**	11	12	14	**3d**	15	18	24	30	36	**4d**	14	16	18	**4d**	20	24	32	40	48
$a_{3,t}$	[mm]	**12d**	42	48	54	**12d**	60	72	96	120	144	**7d**	25	28	32	**7d**	35	42	56	70	84
$a_{3,c}$	[mm]	**7d**	25	28	32	**7d**	35	42	56	70	84	**7d**	25	28	32	**7d**	35	42	56	70	84
$a_{4,t}$	[mm]	**3d**	11	12	14	**3d**	15	18	24	30	36	**5d**	18	20	23	**7d**	35	42	56	70	84
$a_{4,c}$	[mm]	**3d**	11	12	14	**3d**	15	18	24	30	36	**3d**	11	12	14	**3d**	15	18	24	30	36

		SCREWS INSERTED WITHOUT PRE-DRILLING HOLE										SCREWS INSERTED WITHOUT PRE-DRILLING HOLE									
			3,5	4	4,5		5	6	8	10	12		3,5	4	4,5		5	6	8	10	12
a_1	[mm]	**10**	35	40	45	**12d**	60	72	96	120	144	**5d**	18	20	23	**5d**	25	30	40	50	60
a_2	[mm]	**5**	18	20	23	**5d**	25	30	40	50	60	**5d**	18	20	23	**5d**	25	30	40	50	60
$a_{3,t}$	[mm]	**15**	53	60	68	**15d**	75	90	120	150	180	**10d**	35	40	45	**10d**	50	60	80	100	120
$a_{3,c}$	[mm]	**10**	35	40	45	**10d**	50	60	80	100	120	**10d**	35	40	45	**10d**	50	60	80	100	120
$a_{4,t}$	[mm]	**5**	18	20	23	**5d**	25	30	40	50	60	**7d**	25	28	32	**10d**	50	60	80	100	120
$a_{4,c}$	[mm]	**5**	18	20	23	**5d**	25	30	40	50	60	**5d**	18	20	23	**5d**	25	30	40	50	60

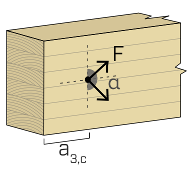
d = nominal screw diameter



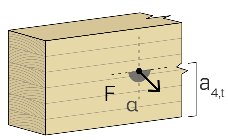
stressed end
-90° < α < 90°



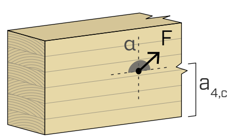
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°



unload edge
180° < α < 360°



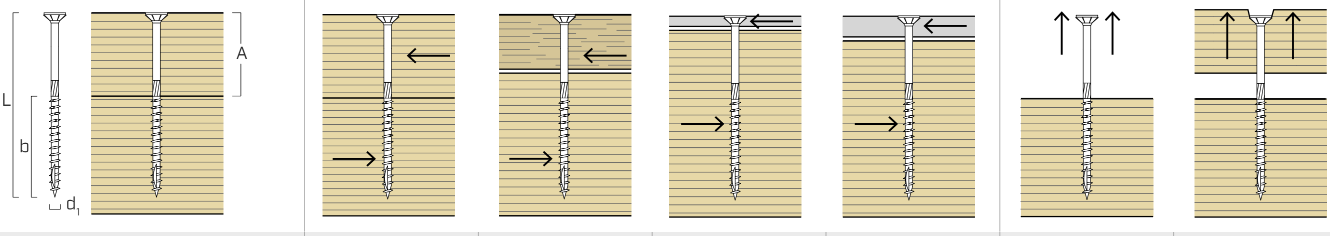
NOTES:

- The minimum distances are compliant with EN 1995:2014, according to ETA-11/0030, considering a wood characteristic density of $\rho_k \leq 420\ kg/m^3$ and calculation diameter of d = nominal screw diameter.
- The minimum spacing for all steel-to-timber connections (a_1, a_2) can be multiplied by a coefficient of 0,7.
- The minimum spacing for all panel-to-timber connections (a_1, a_2) can be multiplied by a coefficient of 0,85.
- In the case of joints with elements in Douglas fir (Pseudotsuga menziesii), the minimum spacing and distances parallel to the grain must be multiplied by a coefficient of 1,5.

STATIC VALUES

CHARACTERISTIC VALUES
EN 1995:2014

				SHEAR							TENSION	
geometry				timber-to-timber	panel-timber [1]		thin steel-timber plate [2]		thick steel-timber plate [3]		thread withdrawal[4]	head pull-through [5]
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]		$R_{V,k}$ [kN]		$R_{V,k}$ [kN]		$R_{V,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]
3,5	40	18	22	0,73	S_{PAN} = 12 mm	0,72	$S_{PLATE} \le$ 1,8 mm	0,85	$S_{PLATE} \le$ 3,5 mm	1,13	0,80	0,56
3,5	45	24	21	0,79		0,72		0,92		1,19	1,06	0,56
3,5	50	24	26	0,79		0,72		0,92		1,19	1,06	0,56
4	30	16	14	0,70	S_{PAN} = 12 mm	0,76	$S_{PLATE} \le$ 2 mm	0,93	$S_{PLATE} \le$ 4 mm	1,26	0,81	0,73
4	35	16	19	0,79		0,84		1,02		1,36	0,81	0,73
4	40	24	16	0,83		0,84		1,12		1,46	1,21	0,73
4	45	24	21	0,94		0,84		1,12		1,46	1,21	0,73
4	50	24	26	1,00		0,84		1,12		1,46	1,21	0,73
4	60	30	30	1,00		0,84		1,20		1,53	1,52	0,73
4	70	35	35	1,00		0,84		1,26		1,60	1,77	0,73
4	80	40	40	1,00		0,84		1,32		1,66	2,02	0,73
4,5	40	24	16	0,98	S_{PAN} = 15 mm	1,06	$S_{PLATE} \le$ 2,3 mm	1,33	$S_{PLATE} \le$ 4,5 mm	1,75	1,36	0,92
4,5	45	30	15	0,96		1,06		1,42		1,83	1,70	0,92
4,5	50	30	20	1,06		1,06		1,42		1,83	1,70	0,92
4,5	60	35	25	1,19		1,06		1,49		1,90	1,99	0,92
4,5	70	40	30	1,22		1,06		1,56		1,97	2,27	0,92
4,5	80	40	40	1,22		1,06		1,56		1,97	2,27	0,92
5	40	24	16	1,12	S_{PAN} = 15 mm	1,16	$S_{PLATE} \le$ 2,5 mm	1,46	$S_{PLATE} \le$ 5 mm	2,00	1,52	1,13
5	45	24	21	1,19		1,20		1,56		2,05	1,52	1,13
5	50	24	26	1,29		1,20		1,56		2,05	1,52	1,13
5	60	30	30	1,46		1,20		1,65		2,14	1,89	1,13
5	70	35	35	1,46		1,20		1,73		2,22	2,21	1,13
5	80	40	40	1,46		1,20		1,81		2,30	2,53	1,13
5	90	45	45	1,46		1,20		1,89		2,38	2,84	1,13
5	100	50	50	1,46		1,20		1,97		2,46	3,16	1,13
5	120	50	70	1,46		1,20		1,97		2,46	3,16	1,13



NOTES:

[1] The characteristic shear resistances are calculated considering an OSB3 or OSB4 panel, as per EN 300, or a particle board panel, as per EN 312, with thickness S_{PAN}.

[2] The shear resistance characteristics are calculated considering the case of a thin plate ($S_{PLATE} \le 0,5\, d_1$).

[3] The shear resistance characteristics are calculated considering the case of a thick plate ($S_{PLATE} \ge d_1$).

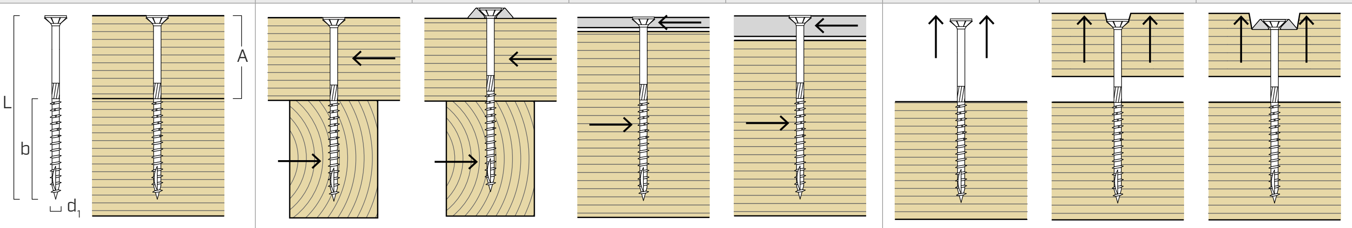
[4] The axial thread withdrawal resistance was calculated considering a 90° angle between the grain and the connector and for a fixing length of b.

[5] The axial resistance to head pull-through, with and without a washer, was calculated using wood elements.

In the case of steel-timber connections, generally the steel tensile strength is binding with respect to head separation or pull-through.

STATIC VALUES

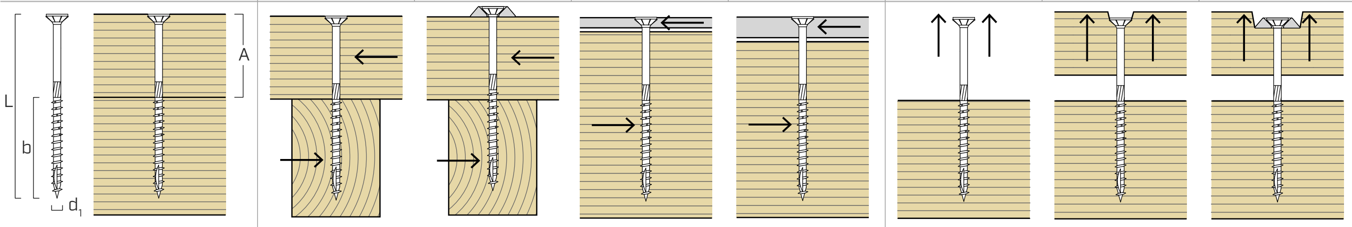
CHARACTERISTIC VALUES
EN 1995:2014



geometry				SHEAR						TENSION		
				timber-to-timber	timber-to-timber with washer	thin steel-timber plate (1)		thick steel-timber plate (2)		thread withdrawal(3)	head pull-through (4)	head pull-through with washer (4)
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]		$R_{V,k}$ [kN]		$R_{V,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]	$R_{head,k}$ [kN]
	40	35	8	0,89	0,89		1,64		2,60	2,65	1,63	4,53
	50	35	15	1,53	1,66		2,08		2,98	2,65	1,63	4,53
	60	30	30	1,78	1,94		2,24		2,93	2,27	1,63	4,53
	70	40	30	1,88	2,23		2,42		3,12	3,03	1,63	4,53
	80	40	40	2,07	2,42		2,42		3,12	3,03	1,63	4,53
	90	50	40	2,07	2,61		2,61		3,30	3,79	1,63	4,53
	100	50	50	2,07	2,61		2,61		3,30	3,79	1,63	4,53
	110	60	50	2,07	2,80		2,80		3,49	4,55	1,63	4,53
	120	60	60	2,07	2,80		2,80		3,49	4,55	1,63	4,53
6	130	60	70	2,07	2,80	$S_{PLATE} \le 3$ mm	2,80	$S_{PLATE} \le 6$ mm	3,49	4,55	1,63	4,53
	140	75	65	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	150	75	75	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	160	75	85	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	180	75	105	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	200	75	125	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	220	75	145	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	240	75	165	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	260	75	185	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	280	75	205	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	300	75	225	2,07	2,80		3,09		3,78	5,68	1,63	4,53
	80	52	28	2,59	3,31		3,99		5,10	5,25	2,38	7,08
	100	52	48	3,28	3,99		3,99		5,10	5,25	2,38	7,08
	120	60	60	3,28	4,19		4,19		5,30	6,06	2,38	7,08
	140	60	80	3,28	4,19		4,19		5,30	6,06	2,38	7,08
	160	80	80	3,28	4,45		4,70		5,81	8,08	2,38	7,08
	180	80	100	3,28	4,45		4,70		5,81	8,08	2,38	7,08
	200	80	120	3,28	4,45		4,70		5,81	8,08	2,38	7,08
	220	80	140	3,28	4,45		4,70		5,81	8,08	2,38	7,08
	240	80	160	3,28	4,45		4,70		5,81	8,08	2,38	7,08
8	260	80	180	3,28	4,45	$S_{PLATE} \le 4$ mm	4,70	$S_{PLATE} \le 8$ mm	5,81	8,08	2,38	7,08
	280	80	200	3,28	4,45		4,70		5,81	8,08	2,38	7,08
	300	100	200	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	320	100	220	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	340	100	240	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	360	100	260	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	380	100	280	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	400	100	300	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	440	100	340	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	480	100	380	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	520	100	420	3,28	4,45		5,20		6,31	10,10	2,38	7,08
	80	52	28	3,63	4,33		4,75		6,94	6,57	3,77	11,60
	100	52	48	4,22	4,92		5,51		7,12	6,57	3,77	11,60
	120	60	60	4,82	5,77		5,77		7,37	7,58	3,77	11,60
	140	60	80	4,82	5,77		5,77		7,37	7,58	3,77	11,60
	160	80	80	4,82	6,40		6,40		8,00	10,10	3,77	11,60
	180	80	100	4,82	6,40		6,40		8,00	10,10	3,77	11,60
	200	80	120	4,82	6,40		6,40		8,00	10,10	3,77	11,60
	220	80	140	4,82	6,40		6,40		8,00	10,10	3,77	11,60
10	240	80	160	4,82	6,40	$S_{PLATE} \le 5$ mm	6,40	$S_{PLATE} \le 10$ mm	8,00	10,10	3,77	11,60
	260	80	180	4,82	6,40		6,40		8,00	10,10	3,77	11,60
	280	80	200	4,82	6,40		6,40		8,00	10,10	3,77	11,60
	300	100	200	4,82	6,77		7,03		8,63	12,63	3,77	11,60
	320	100	220	4,82	6,77		7,03		8,63	12,63	3,77	11,60
	340	100	240	4,82	6,77		7,03		8,63	12,63	3,77	11,60
	360	100	260	4,82	6,77		7,03		8,63	12,63	3,77	11,60
	380	100	280	4,82	6,77		7,03		8,63	12,63	3,77	11,60
	400	100	300	4,82	6,77		7,03		8,63	12,63	3,77	11,60

STATIC VALUES

CHARACTERISTIC VALUES
EN 1995:2014



geometry				SHEAR						TENSION		
geometry				timber-to-timber	timber-to-timber with washer	thin steel-timber plate [1]		thick steel-timber plate [2]		thread withdrawal[3]	head pull-through [4]	head pull-through with washer [4]
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]		$R_{V,k}$ [kN]		$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]	$R_{head,k}$ [kN]
	120	80	40	4,87	6,68		7,81		9,78	12,12	4,88	15,51
	160	80	80	6,00	7,81		7,81		9,78	12,12	4,88	15,51
	200	80	120	6,00	7,81		7,81		9,78	12,12	4,88	15,51
	240	80	160	6,00	7,81		7,81		9,78	12,12	4,88	15,51
	280	80	200	6,00	7,81		7,81		9,78	12,12	4,88	15,51
	320	120	200	6,00	8,65		9,32		11,30	18,18	4,88	15,51
12	360	120	240	6,00	8,65	$S_{PLATE} \leq 6$ mm	9,32	$S_{PLATE} \leq 12$ mm	11,30	18,18	4,88	15,51
	400	120	280	6,00	8,65		9,32		11,30	18,18	4,88	15,51
	440	120	320	6,00	8,65		9,32		11,30	18,18	4,88	15,51
	480	120	360	6,00	8,65		9,32		11,30	18,18	4,88	15,51
	520	120	400	6,00	8,65		9,32		11,30	18,18	4,88	15,51
	560	120	440	6,00	8,65		9,32		11,30	18,18	4,88	15,51
	600	120	480	6,00	8,65		9,32		11,30	18,18	4,88	15,51

NOTES:

(1) The shear resistance characteristics are calculated considering the case of a thin plate ($S_{PLATE} \leq 0,5\ d_1$).

(2) The shear resistance characteristics are calculated considering the case of a thick plate ($S_{PLATE} \geq d_1$).

(3) The axial thread withdrawal resistance was calculated considering a 90° angle between the grain and the connector and for a fixing length of b.

(4) The axial resistance to head pull-through, with and without a washer, was calculated using wood elements.

In the case of steel-timber connections, generally the steel tensile strength is binding with respect to head separation or pull-through.

GENERAL PRINCIPLES:

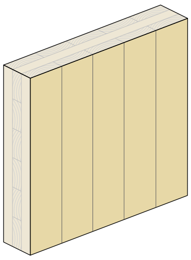
- Characteristic values comply with the EN 1995:2014 standard in accordance with ETA-11/0030.
- Design values can be obtained from characteristic values as follows:

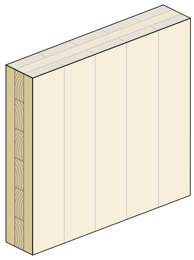
$$R_d = \frac{R_k \cdot k_{mod}}{\gamma_m}$$

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

- For the mechanical strength values and the geometry of the screws, reference was made to ETA-11/0030.
- For the calculation process a timber characteristic density ρ_k = 385 kg/m³ has been considered.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements, panels and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-drilling holes. In the case of screws inserted with pre-drilling holes, greater resistance values can be obtained.
- For different calculation configurations, the MyProject software is available (www.rothoblaas.com).

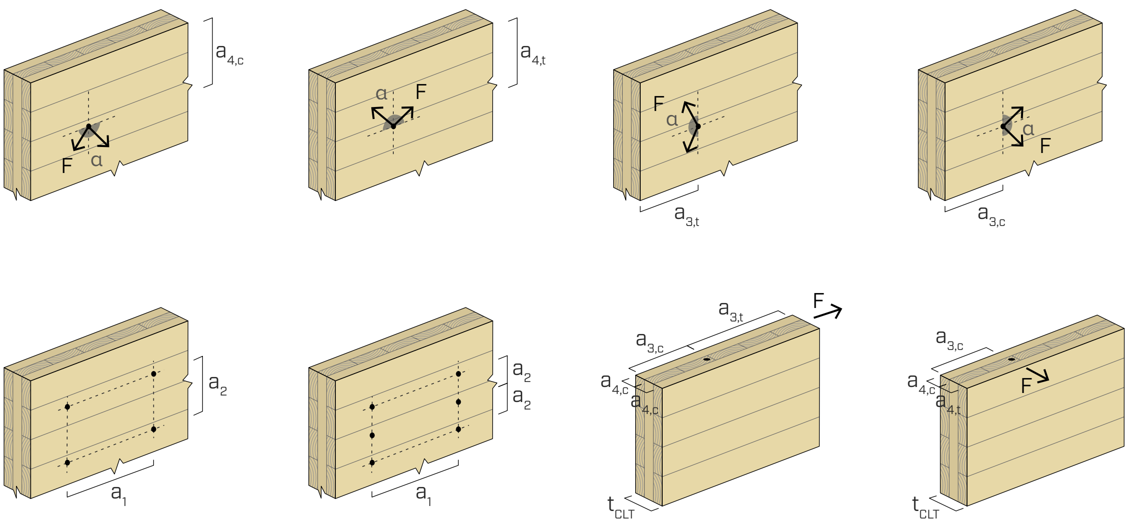
MINIMUM DISTANCES FOR SHEAR AND AXIAL LOADS | CLT





		SCREWS INSERTED WITHOUT PRE-DRILLING HOLE lateral face [(1)]					SCREWS INSERTED WITHOUT PRE-DRILLING HOLE narrow face [(2)]				
			6	**8**	**10**	**12**		**6**	**8**	**10**	**12**
a_1	[mm]	**4·d**	24	32	40	48	**10·d**	60	80	100	120
a_2	[mm]	**2,5·d**	15	20	25	30	**4·d**	24	32	40	48
$a_{3,t}$	[mm]	**6·d**	36	48	60	72	**12·d**	72	96	120	144
$a_{3,c}$	[mm]	**6·d**	36	48	60	72	**7·d**	42	56	70	84
$a_{4,t}$	[mm]	**6·d**	36	48	60	72	**6·d**	36	48	60	72
$a_{4,c}$	[mm]	**2,5·d**	15	20	25	30	**3·d**	18	24	30	36

d = nominal screw diameter



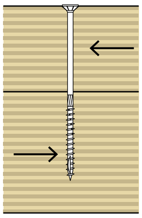
NOTES:

The minimum distances are compliant with ETA-11/0030 and are to be considered valid unless otherwise specified in the technical documents for the CLT panels.

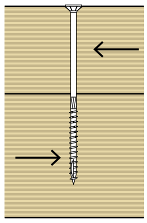
(1) Minimum CLT thickness t_{min} = 10·d

(2) Minimum CLT thickness t_{min} = 10·d and minimum screw penetration depth t_{pen} = 10·d

MINIMUM DISTANCES FOR SHEAR LOADS | LVL



Load-to-grain angle α = 0°

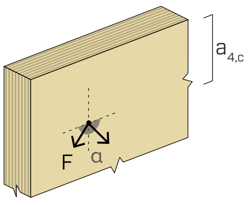


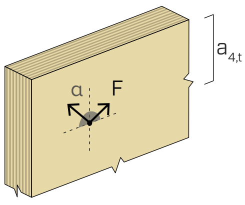
Load-to-grain angle α = 90°

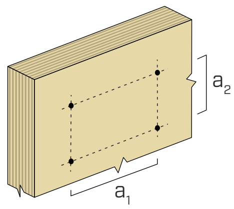
		SCREWS INSERTED WITHOUT PRE-DRILLING HOLES [(1)]					SCREWS INSERTED WITHOUT PRE-DRILLING HOLES [(1)]				
			5	6	8	10		5	6	8	10
a_1	[mm]	**12·d**	60	72	96	120	**5·d**	25	30	40	50
a_2	[mm]	**5,0·d**	25	30	40	50	**5,0·d**	25	30	40	50
$a_{3,t}$	[mm]	**15·d**	75	90	120	150	**10·d**	50	60	80	100
$a_{3,c}$	[mm]	**10·d**	50	60	80	100	**10·d**	50	60	80	100
$a_{4,t}$	[mm]	**5·d**	25	30	40	50	**10·d**	50	60	80	100
$a_{4,c}$	[mm]	**5,0·d**	25	30	40	50	**5,0·d**	25	30	40	50

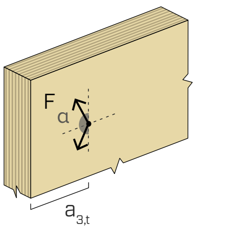
		SCREWS INSERTED WITH PRE-DRILLING HOLES					SCREWS INSERTED WITH PRE-DRILLING HOLES				
			5	6	8	10		5	6	8	10
a_1	[mm]	**5·d**	25	30	40	50	**4·d**	20	24	32	40
a_2	[mm]	**3·d**	15	18	24	30	**4·d**	20	24	32	40
$a_{3,t}$	[mm]	**12·d**	60	72	96	120	**7·d**	35	42	56	70
$a_{3,c}$	[mm]	**7·d**	35	42	56	70	**7·d**	35	42	56	70
$a_{4,t}$	[mm]	**3·d**	15	18	24	30	**7·d**	35	42	56	70
$a_{4,c}$	[mm]	**3·d**	15	18	24	30	**3·d**	15	18	24	30

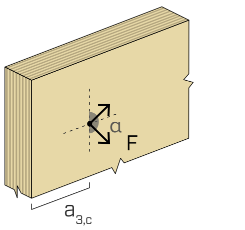
d = nominal screw diameter

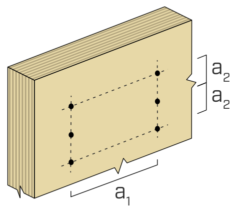












NOTES:

[(1)] Minimum distances are obtained from experimental tests carried out at Eurofins Expert Services Oy, Espoo, Finland (Report EUFI29-19000819-T1/T2).

- Minimum distances in accordance with EN 1995:2014.
- The minimum distances are applicable when using both parallel and cross grain LVL.
- The minimum distances without pre-drilling hole are valid for minimum thickness of LVL elements t_{min}:

$$t_1 \geq 8{,}4d - 9$$

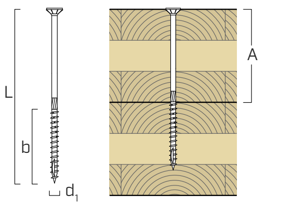
$$t_2 \geq \begin{cases} 11{,}4d \\ 75 \end{cases}$$

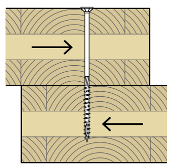
where:

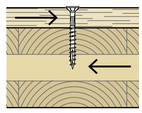
t_1 is the thickness in mm of the LVL element in a connection with 2 wooden elements. For connections with 3 or more elements, t_1 represents the thickness of the most external LVL;

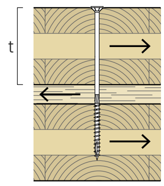
t_2 is the thickness in mm of the central element in a connection with 3 or more elements.

STATIC VALUES | CLT

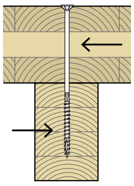
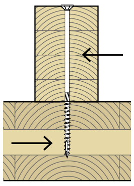
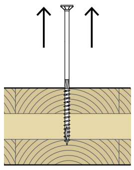
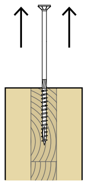
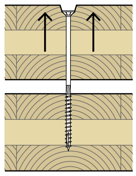
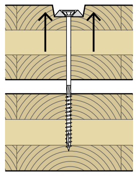




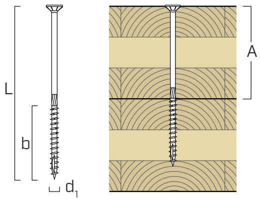


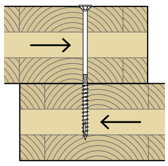


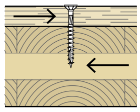
geometry				SHEAR										
				CLT - CLT lateral face	panel - CLT (1) lateral face				CLT - panel - CLT (1) lateral face					
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]		$R_{V,k}$ [kN]		$R_{V,k}$ [kN]		t [mm]	$R_{V,k}$ [kN]		t [mm]	$R_{V,k}$ [kN]
6	40	35	8	0,80	S_{PAN} = 12 mm	1,33	S_{PAN} = 15 mm	1,38	S_{PAN} = 12 mm	-	-	S_{PAN} = 15 mm	-	-
	50	35	15	1,44		1,46		1,53		-	-		-	-
	60	30	30	1,63		1,46		1,53		-	-		-	-
	70	40	30	1,74		1,46		1,53		30	1,71		30	2,19
	80	40	40	1,97		1,46		1,53		35	1,71		35	2,19
	90	50	40	1,97		1,46		1,53		40	1,71		40	2,19
	100	50	50	1,97		1,46		1,53		45	1,71		45	2,19
	110	60	50	1,97		1,46		1,53		50	1,71		50	2,19
	120	60	60	1,97		1,46		1,53		55	1,71		55	2,19
	130	60	70	1,97		1,46		1,53		60	1,71		60	2,19
	140	75	65	1,97		1,46		1,53		65	1,71		65	2,19
	150	75	75	1,97		1,46		1,53		70	1,71		70	2,19
	160	75	85	1,97		1,46		1,53		75	1,71		75	2,19
	180	75	105	1,97		1,46		1,53		85	1,71		85	2,19
	200	75	125	1,97		1,46		1,53		95	1,71		95	2,19
	220	75	145	1,97		1,46		1,53		105	1,71		105	2,19
	240	75	165	1,97		1,46		1,53		115	1,71		115	2,19
	260	75	185	1,97		1,46		1,53		125	1,71		125	2,19
	280	75	205	1,97		1,46		1,53		135	1,71		135	2,19
	300	75	225	1,97		1,46		1,53		145	1,71		145	2,19
8	80	52	28	2,42	S_{PAN} = 15 mm	2,23	S_{PAN} = 18 mm	2,30	S_{PAN} = 15 mm	-	-	S_{PAN} = 18 mm	-	18,00
	100	52	48	3,04		2,23		2,30		45	2,39		40	2,92
	120	60	60	3,11		2,23		2,30		55	2,39		50	2,92
	140	60	80	3,11		2,23		2,30		65	2,39		60	2,92
	160	80	80	3,11		2,23		2,30		75	2,39		70	2,92
	180	80	100	3,11		2,23		2,30		85	2,39		80	2,92
	200	80	120	3,11		2,23		2,30		95	2,39		90	2,92
	220	80	140	3,11		2,23		2,30		105	2,39		100	2,92
	240	80	160	3,11		2,23		2,30		115	2,39		110	2,92
	260	80	180	3,11		2,23		2,30		125	2,39		120	2,92
	280	80	200	3,11		2,23		2,30		135	2,39		130	2,92
	300	100	200	3,11		2,23		2,30		145	2,39		140	2,92
	320	100	220	3,11		2,23		2,30		155	2,39		150	2,92
	340	100	240	3,11		2,23		2,30		165	2,39		160	2,92
	360	100	260	3,11		2,23		2,30		175	2,39		170	2,92
	380	100	280	3,11		2,23		2,30		185	2,39		180	2,92
	400	100	300	3,11		2,23		2,30		195	2,39		190	2,92
	440	100	340	3,11		2,23		2,30		215	2,39		210	2,92
	480	100	380	3,11		2,23		2,30		235	2,39		230	2,92
	520	100	420	3,11		2,23		2,30		255	2,39		250	2,92

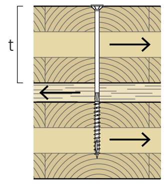
SHEAR		TENSION			
CLT - timber lateral face	timber - CLT lateral face	thread withdrawal lateral face (2)	thread withdrawal narrow face (3)	head pull-through (4)	head pull-through with washer (4)
					
$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]	$R_{head,k}$ [kN]
0,80	0,89	2,46	-	1,51	4,20
1,46	1,50	2,46	-	1,51	4,20
1,69	1,72	2,11	-	1,51	4,20
1,77	1,85	2,81	-	1,51	4,20
2,00	2,03	2,81	-	1,51	4,20
2,00	2,03	3,51	-	1,51	4,20
2,00	2,03	3,51	-	1,51	4,20
2,00	2,03	4,21	-	1,51	4,20
2,00	2,03	4,21	-	1,51	4,20
2,00	2,03	4,21	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,00	2,03	5,27	-	1,51	4,20
2,45	2,55	4,87	3,70	2,21	6,56
3,08	3,21	4,87	3,70	2,21	6,56
3,17	3,21	5,62	4,21	2,21	6,56
3,17	3,21	5,62	4,21	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	7,49	5,45	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56
3,17	3,21	9,36	6,66	2,21	6,56

STATIC VALUES | CLT









geometry				SHEAR						
				CLT - CLT lateral face	panel - CLT [(1)] lateral face		CLT - panel - CLT [(1)] lateral face			
					S_{PAN} = 18 mm	S_{PAN} = 22 mm	S_{PAN} = 18 mm		S_{PAN} = 22 mm	
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	t [mm]	$R_{V,k}$ [kN]	t [mm]	$R_{V,k}$ [kN]
10	80	52	28	3,40	3,12	3,31	-	-	-	22,00
	100	52	48	3,86	3,12	3,31	40	3,12	-	22,00
	120	60	60	4,45	3,12	3,31	50	3,12	50	3,89
	140	60	80	4,49	3,12	3,31	60	3,12	60	3,89
	160	80	80	4,57	3,12	3,31	70	3,12	70	3,89
	180	80	100	4,57	3,12	3,31	80	3,12	80	3,89
	200	80	120	4,57	3,12	3,31	90	3,12	90	3,89
	220	80	140	4,57	3,12	3,31	100	3,12	100	3,89
	240	80	160	4,57	3,12	3,31	110	3,12	110	3,89
	260	80	180	4,57	3,12	3,31	120	3,12	120	3,89
	280	80	200	4,57	3,12	3,31	130	3,12	130	3,89
	300	100	200	4,57	3,12	3,31	140	3,12	140	3,89
	320	100	220	4,57	3,12	3,31	150	3,12	150	3,89
	340	100	240	4,57	3,12	3,31	160	3,12	160	3,89
	360	100	260	4,57	3,12	3,31	170	3,12	170	3,89
	380	100	280	4,57	3,12	3,31	180	3,12	180	3,89
	400	100	300	4,57	3,12	3,31	190	3,12	190	3,89
12	120	80	40	4,54	-	-	-	-	-	-
	160	80	80	5,68	-	-	-	-	-	-
	200	80	120	5,68	-	-	-	-	-	-
	240	80	160	5,68	-	-	-	-	-	-
	280	80	200	5,68	-	-	-	-	-	-
	320	120	200	5,68	-	-	-	-	-	-
	360	120	240	5,68	-	-	-	-	-	-
	400	120	280	5,68	-	-	-	-	-	-
	440	120	320	5,68	-	-	-	-	-	-
	480	120	360	5,68	-	-	-	-	-	-
	520	120	400	5,68	-	-	-	-	-	-
	560	120	440	5,68	-	-	-	-	-	-
	600	120	480	5,68	-	-	-	-	-	-

NOTES:

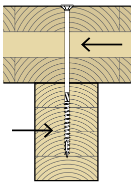
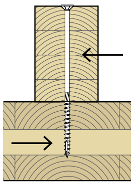
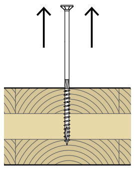
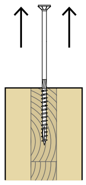
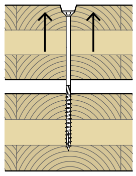
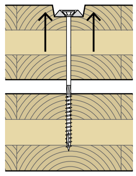
[(1)] The characteristic shear resistances are calculated considering an OSB3 or OSB4 panel, as per EN 300, or a particle board panel, as per EN 312, with thickness S_{PAN}.

[(2)] The axial thread withdrawal resistance was calculated considering a 90° angle between the grain and the connector and for a fixing length of b.

[(3)] The axial thread withdrawal resistance is valid for minimum thickness of the element of $t_{min} = 10 \cdot d_1$ and minimum screw pull-through depth $t_{pen} = 10 \cdot d_1$.

[(4)] The axial resistance to head pull-through, with and without a washer, was calculated using wood elements.

In the case of steel-timber connections, generally the steel tensile strength is binding with respect to head separation or pull-through.

	SHEAR		TENSION			
	CLT - timber lateral face	timber - CLT lateral face	thread withdrawal lateral face (2)	thread withdrawal narrow face (3)	head pull-through (4)	head pull-through with washer (4)
						
	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]	$R_{head,k}$ [kN]
	3,46	3,57	6,08	4,42	3,50	10,75
	4,02	4,06	6,08	4,42	3,50	10,75
	4,55	4,62	7,02	5,03	3,50	10,75
	4,65	4,62	7,02	5,03	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	9,36	6,51	3,50	10,75
	4,65	4,72	11,70	7,96	3,50	10,75
	4,65	4,72	11,70	7,96	3,50	10,75
	4,65	4,72	11,70	7,96	3,50	10,75
	4,65	4,72	11,70	7,96	3,50	10,75
	4,65	4,72	11,70	7,96	3,50	10,75
	4,65	4,72	11,70	7,96	3,50	10,75
	4,60	4,80	11,23	7,54	4,52	14,37
	5,79	5,88	11,23	7,54	4,52	14,37
	5,79	5,88	11,23	7,54	4,52	14,37
	5,79	5,88	11,23	7,54	4,52	14,37
	5,79	5,88	11,23	7,54	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37
	5,79	5,88	16,85	10,86	4,52	14,37

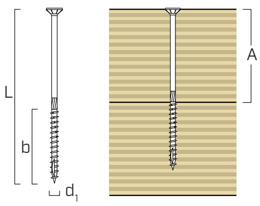
GENERAL PRINCIPLES:

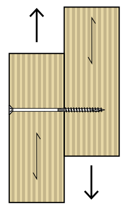
- Characteristic values comply with the EN 1995:2014 standard and national specification ÖNORM EN 1995 - Annex K in accordance with ETA-11/0030.
- Design values can be obtained from characteristic values as follows:

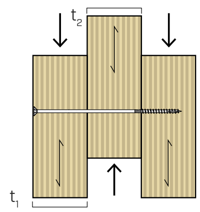
$$R_d = \frac{R_k \cdot k_{mod}}{\gamma_m}$$

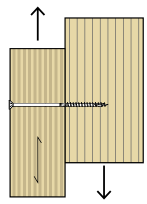
  The coefficients γ_m and k_{mod} should be taken according to the current regulations used for the calculation.
- For the mechanical strength values and the geometry of the screws, reference was made to ETA-11/0030.
- For the calculation process a timber density ρ_k = 350 kg/m^3 has been considered.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements, panels and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-drilling holes. In the case of screws inserted with pre-drilling holes, greater resistance values can be obtained.
- The shear resistance characteristics are calculated considering a minimum fixing length of 4 d_1.

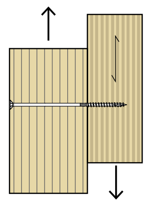
STATIC VALUES | LVL











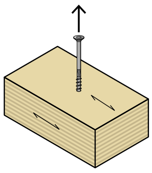
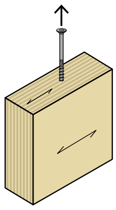
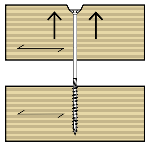
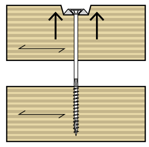
				SHEAR					
geometry				LVL - LVL	LVL - LVL - LVL			LVL - timber	timber - LVL
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	t_1 [mm]	t_2 [mm]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]
	40	24	16	1,53	-	-	-	1,30	1,12
	45	24	21	1,67	-	-	-	1,41	1,21
	50	24	26	1,78	-	-	-	1,47	1,33
	60	30	30	1,94	20,00	20,00	2,43	1,74	1,43
5	70	35	35	1,94	20,00	30,00	3,53	1,83	1,47
	80	40	40	1,94	25,00	30,00	3,64	1,83	1,47
	90	45	45	1,94	30,00	30,00	3,64	1,83	1,47
	100	50	50	1,94	35,00	30,00	3,64	1,83	1,47
	120	60	60	1,94	40,00	40,00	3,88	1,83	1,47
	40	35	5	0,69	-	-	-	0,69	0,50
	50	35	15	2,03	-	-	-	1,94	1,51
	60	30	30	2,43	25,00	10,00	1,38	2,12	1,82
	70	40	30	2,52	25,00	20,00	2,76	2,41	1,82
	80	40	40	2,61	30,00	20,00	2,76	2,46	2,09
	90	50	40	2,61	30,00	30,00	4,14	2,46	2,09
	100	50	50	2,61	30,00	40,00	5,15	2,46	2,09
	110	60	50	2,61	30,00	50,00	5,15	2,46	2,09
	120	60	60	2,61	40,00	40,00	5,23	2,46	2,09
	130	60	70	2,61	40,00	50,00	5,23	2,46	2,09
6	140	75	65	2,61	40,00	60,00	5,23	2,46	2,09
	150	75	75	2,61	40,00	70,00	5,23	2,46	2,09
	160	75	85	2,61	40,00	80,00	5,23	2,46	2,09
	180	75	105	2,61	60,00	60,00	5,23	2,46	2,09
	200	75	125	2,61	60,00	80,00	5,23	2,46	2,09
	220	75	145	2,61	60,00	100,00	5,23	2,46	2,09
	240	75	165	2,61	80,00	80,00	5,23	2,46	2,09
	260	75	185	2,61	80,00	100,00	5,23	2,46	2,09
	280	75	205	2,61	80,00	120,00	5,23	2,46	2,09
	300	75	225	2,61	100,00	100,00	5,23	2,46	2,09

NOTES:

(1) The axial thread withdrawal resistance $R_{ax,90,flat,k}$ was calculated considering a 90° angle between the grain and the connector and for a fixing length of b in applications with both parallel and cross grain LVL.

(2) The axial thread withdrawal resistance $R_{ax,90,edge,k}$ was calculated considering a 90° angle between the grain and the connector and for a fixing length of b in applications with parallel grain LVL.

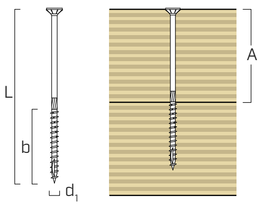
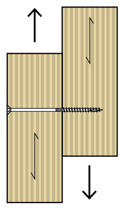
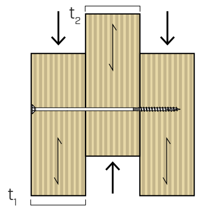
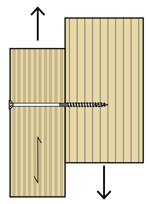
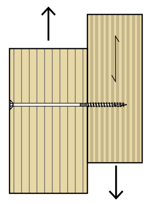
(3) The axial resistance to head pull-through $R_{head,k}$, with and without a washer, was calculated using parallel or cross grain LVL elements with t_{min} thickness.

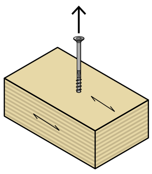
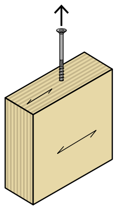
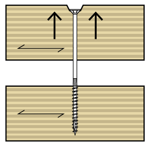
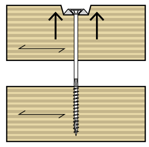
TENSION			
thread withdrawal flat (1)	thread withdrawal edge (2)	head pull-through flat (3)	head pull-through with washer flat (3)
			
$R_{ax,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]	$R_{head,k}$ [kN]
2,14	1,62	2,48	-
2,14	1,62	2,48	-
2,14	1,62	2,48	-
2,67	2,03	2,48	-
3,12	2,36	2,48	-
3,56	2,70	2,48	-
4,01	3,04	2,48	-
4,45	3,38	2,48	-
5,34	4,05	2,48	-
3,34	2,69	3,01	8,36
3,34	2,69	3,01	8,36
2,86	2,30	3,01	8,36
3,82	3,07	3,01	8,36
3,82	3,07	3,01	8,36
4,77	3,84	3,01	8,36
4,77	3,84	3,01	8,36
5,72	4,61	3,01	8,36
5,72	4,61	3,01	8,36
5,72	4,61	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36
7,16	5,76	3,01	8,36

GENERAL PRINCIPLES:

- Characteristic values comply with the EN 1995:2014 standard in accordance with ETA-11/0030.
- Design values can be obtained from characteristic values 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.
- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030 and experimental tests carried out at Eurofins Expert Services Oy, Espoo, Finland (Report EUFI29-19000819-T1/T2).
- For the calculation process a LVL density of ρ_k = 480 kg/m³ and timber density of 350 kg/m³ have been considered.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements, panels and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-drilling holes. In the case of screws inserted with pre-drilling holes, greater resistance values can be obtained.

STATIC VALUES | LVL

geometry				SHEAR					
geometry				LVL - LVL	LVL - LVL - LVL			LVL - timber	timber - LVL
									
d_1 [mm]	L [mm]	b [mm]	A [mm]	$R_{V,k}$ [kN]	t_1 [mm]	t_2 [mm]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]	$R_{V,k}$ [kN]
8	80	52	28	3,30	32,00	16,00	2,70	3,15	2,53
	100	52	48	3,95	40,00	20,00	3,37	3,71	3,17
	120	60	60	3,95	40,00	40,00	6,75	3,71	3,30
	140	60	80	3,95	40,00	60,00	7,91	3,71	3,30
	160	80	80	3,95	40,00	80,00	7,91	3,71	3,30
	180	80	100	3,95	60,00	60,00	7,91	3,71	3,30
	200	80	120	3,95	60,00	80,00	7,91	3,71	3,30
	220	80	140	3,95	60,00	100,00	7,91	3,71	3,30
	240	80	160	3,95	80,00	80,00	7,91	3,71	3,30
	260	80	180	3,95	80,00	100,00	7,91	3,71	3,30
	280	80	200	3,95	80,00	120,00	7,91	3,71	3,30
	300	100	200	3,95	100,00	100,00	7,91	3,71	3,30
	320	100	220	3,95	100,00	120,00	7,91	3,71	3,30
	340	100	240	3,95	100,00	140,00	7,91	3,71	3,30
	360	100	260	3,95	120,00	120,00	7,91	3,71	3,30
	380	100	280	3,95	120,00	140,00	7,91	3,71	3,30
	400	100	300	3,95	120,00	160,00	7,91	3,71	3,30
	440	100	340	3,95	140,00	160,00	7,91	3,71	3,30
	480	100	380	3,95	140,00	200,00	7,91	3,71	3,30
	520	100	420	3,95	140,00	240,00	7,91	3,71	3,30
10	80	52	28	4,62	-	-	-	4,32	3,57
	100	52	48	5,57	40,00	20,00	3,95	4,99	4,20
	120	60	60	5,84	40,00	40,00	7,89	5,33	4,69
	140	60	80	5,84	40,00	60,00	11,37	5,33	4,85
	160	80	80	5,84	40,00	80,00	11,37	5,49	4,85
	180	80	100	5,84	60,00	60,00	11,68	5,49	4,85
	200	80	120	5,84	60,00	80,00	11,68	5,49	4,85
	220	80	140	5,84	60,00	100,00	11,68	5,49	4,85
	240	80	160	5,84	80,00	80,00	11,68	5,49	4,85
	260	80	180	5,84	80,00	100,00	11,68	5,49	4,85
	280	80	200	5,84	80,00	120,00	11,68	5,49	4,85
	300	100	200	5,84	100,00	100,00	11,68	5,49	4,85
	320	100	220	5,84	100,00	120,00	11,68	5,49	4,85
	340	100	240	5,84	100,00	140,00	11,68	5,49	4,85
	360	100	260	5,84	120,00	120,00	11,68	5,49	4,85
	380	100	280	5,84	120,00	140,00	11,68	5,49	4,85
	400	100	300	5,84	120,00	160,00	11,68	5,49	4,85

TENSION			
thread withdrawal flat (1)	**thread withdrawal edge** (2)	**head pull-through flat** (3)	**head pull-through with washer flat** (3)
			
$R_{ax,k}$ [kN]	$R_{ax,k}$ [kN]	$R_{head,k}$ [kN]	$R_{head,k}$ [kN]
5,78	5,20	3,85	11,44
5,78	5,20	3,85	11,44
6,67	6,00	3,85	11,44
6,67	6,00	3,85	11,44
8,90	8,00	3,85	11,44
8,90	8,00	3,85	11,44
8,90	8,00	3,85	11,44
8,90	8,00	3,85	11,44
8,90	8,00	3,85	11,44
8,90	8,00	3,85	11,44
8,90	8,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
11,12	10,00	3,85	11,44
7,07	6,86	6,06	18,64
7,07	6,86	6,06	18,64
8,16	7,92	6,06	18,64
8,16	7,92	6,06	18,64
10,88	10,56	6,06	18,64
10,88	10,56	6,06	18,64
10,88	10,56	6,06	18,64
10,88	10,56	6,06	18,64
10,88	10,56	6,06	18,64
10,88	10,56	6,06	18,64
10,88	10,56	6,06	18,64
13,60	13,20	6,06	18,64
13,60	13,20	6,06	18,64
13,60	13,20	6,06	18,64
13,60	13,20	6,06	18,64
13,60	13,20	6,06	18,64
13,60	13,20	6,06	18,64

CALCULATION EXAMPLES: VALLEY JACK RAFTER JOINT

MY PROJECT SOFTWARE

CONNECTION TIMBER-TO-TIMBER / SINGLE SHEAR

ELEMENT 1	1
B1 = 120 mm	
H1 = 160 mm	
Slope 30% (16,7°)	
Glulam GL24h	

ELEMENT 2	2
B2 = 160 mm	
H2 = 240 mm	
Slope 21% (12,0°)	
Glulam GL24h	

PROJECT DATA
$F_{v,Rd}$ = 7,17 kN
Service class = 1
Load duration = short

SCREW SELECTION
HBS = 10x180 mm
Pre-drilling hole = no
Washer = no

CONNECTION GEOMETRY
t_1 = 60 mm
α_1 = 73,3° (90° - 16,7°)
t_2 = 120 mm (fixing length in element 2)
α_2 = 78,0° (90° - 12,0°)

SHEAR RESISTANCE CALCULATION (EN 1995:2014 and ETA-11/0030)

d_1 = 10,0 mm
$f_{h,1,k}$ = 15,82 N/mm²
$f_{h,2,k}$ = 15,82 N/mm²
β = 1,00

$M_{y,k}$ = 35830 Nmm
$R_{ax,Rk}$ = min {resistance to thread withdrawal; resistance to head pull-through} = min {$R_{ax,Rk}$; $R_{head,Rk}$}
= 3,77 kN
$R_{ax,Rk}/4$ = 0,94 kN (cable effect)

$$R_{v,Rk} = \min \begin{cases} f_{h,1,k}\, t_1\, d \\ f_{h,2,k}\, t_2\, d \\ \dfrac{f_{h,1,k}\, t_1\, d}{1+\beta}\left[\sqrt{\beta + 2\beta^2\left[1+\dfrac{t_2}{t_1}+\left(\dfrac{t_2}{t_1}\right)^2\right]+\beta^3\left(\dfrac{t_2}{t_1}\right)^2} - \beta\left(1+\dfrac{t_2}{t_1}\right)\right] + \dfrac{R_{ax,Rk}}{4} \\ 1{,}05\,\dfrac{f_{h,1,k}\, t_1\, d}{2+\beta}\left[\sqrt{2\beta(1+\beta)+\dfrac{4\beta(2+\beta)M_{y,RK}}{f_{h,1,k}\, d\, t_1^2}} - \beta\right] + \dfrac{R_{ax,Rk}}{4} \\ 1{,}05\,\dfrac{f_{h,1,k}\, t_2\, d}{1+2\beta}\left[\sqrt{2\beta^2(1+\beta)+\dfrac{4\beta(1+2\beta)M_{y,RK}}{f_{h,1,k}\, d\, t_2^2}} - \beta\right] + \dfrac{R_{ax,Rk}}{4} \\ 1{,}15\sqrt{\dfrac{2\beta}{(1+\beta)}}\sqrt{2M_{y,RK}\, f_{h,1,k}\, d} + \dfrac{R_{ax,Rk}}{4} \end{cases}$$

(a) = 9,49 kN
(b) = 18,99 kN
(c) = 7,39 kN
(d) = 4,87 kN
(e) = 7,90 kN
(f) = 4,82 kN

$R_{v,Rk}$ = 4,82 kN

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

EN 1995:2014	Italy - NTC 2018
k_{mod} = 0,9	k_{mod} = 0,9
γ_m = 1,3	γ_m = 1,5
$R_{v,Rd}$ = 3,33 kN	$R_{v,Rd}$ = 2,89 kN
Minimum number of screws	Minimum number of screws
$F_{v,Rd}$ / $R_{v,Rd}$ = 2,15	$F_{v,Rd}$ / $R_{v,Rd}$ = 2,48

3 screws are hypothesized

$n_{ef,SHEAR}$ 3 (screws perpendicular to the grain)
$n_{ef,TENSION}$ $3^{0,9}$ = 2,69

Recalculating the shear resistance, for the cable effect, a tensile strength for the individual screws is assumed at:
$R_{ax,Rk}$ = 3,74 · 2,69 / 3 = 3,38 kN (head pull-through)
$R_{ax,Rk}/4$ = 0,85 kN (cable effect)

Individual screw shear resistance:
$R_{v,Rk}$ = 4,71 kN

$$R_{v,Rd} \geq F_{v,Rd}$$

EN 1995:2014	Italy - NTC 2018
$R_{v,Rd}$ = 3,33 kN	$R_{v,Rd}$ = 2,89 kN
Connection shear resistance:	**Connection shear resistance:**
$R_{v,Rd}$ = 3,33 x 3 = 9,99 kN > 7,17 kN **OK**	$R_{v,Rd}$ = 2,89 x 3 = 8,67 kN > 7,17 kN **OK**

CALCULATION EXAMPLES: VALLEY JACK RAFTER JOINT WITH MYPROJECT

MY PROJECT SOFTWARE

CONNECTION TIMBER-TO-TIMBER / SINGLE SHEAR

ELEMENT 1 [1]

B1 = 120 mm
H1 = 160 mm
Slope 30% (16,7°)
Glulam GL24h

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B2 = 160 mm
H2 = 240 mm
Slope 21% (12,0°)
Glulam GL24h

PROJECT DATA

$F_{v,Rd}$ = 7,17 kN
Service class = 1
Load duration = short

SCREW SELECTION

HBS = 10x180 mm
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Washer = no

CONNECTION GEOMETRY

t_1 = 60 mm
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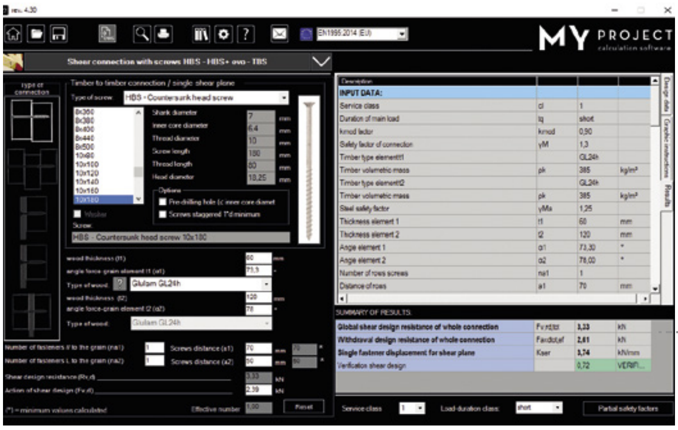
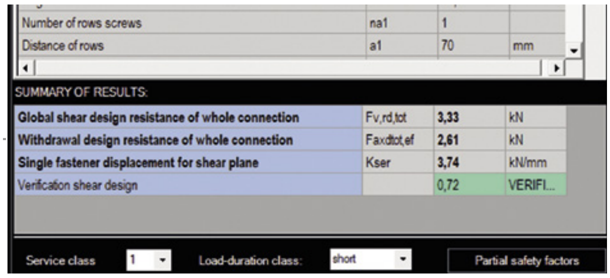
t_2 = 120 mm
(fixing length in element 2)
α_2 = 78,0° (90° - 12,0°)

SHEAR RESISTANCE CALCULATION WITH MYPROJECT SOFTWARE (EN 1995:2014 and ETA-11/0030)





CALCULATION REPORT