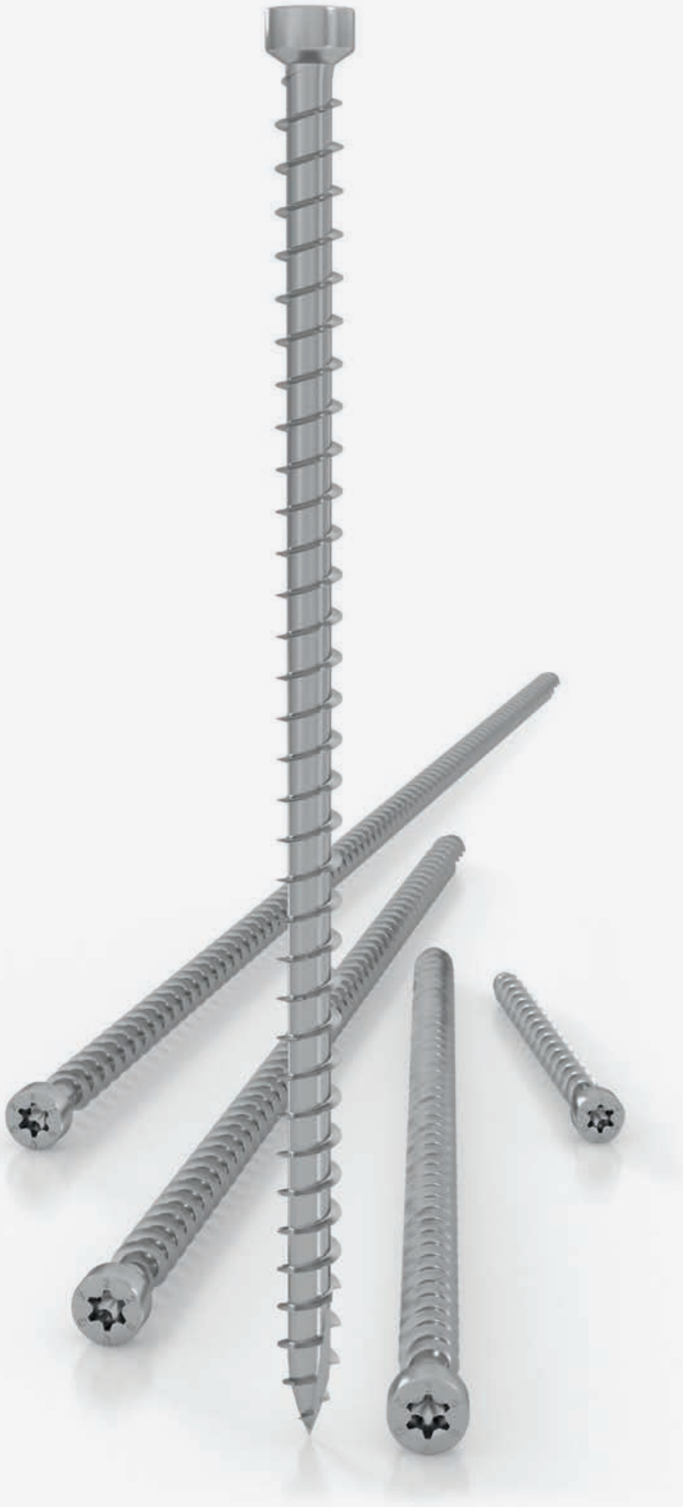
VGZ

ETA 11/0030

Total thread connector with cylindrical head

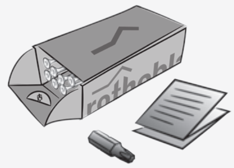
Carbon steel with white galvanic zinc coating

software myProject



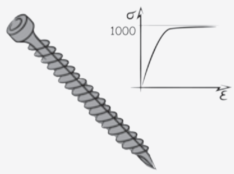
PACKAGING

Box + CE paper + BIT



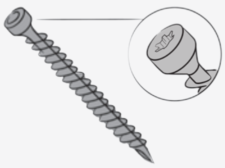
SPECIAL STEEL

Deep thread and high resistance steel ($f_{y,k}$ = 1000 N/mm^2) for excellent tensile performance



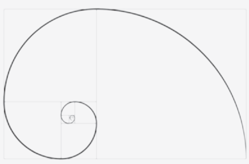
CYLINDRICAL HEAD

Cylindrical head that is hidden in the wood



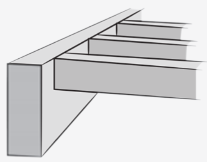
DIAMETERS Ø7 and Ø9

Optimise the minimum dimensions of the beams to be joined



FIELDS OF USE

Solid-wood, glulam, X-Lam, LVL, wood-based-panel joints, reinforcements and couplings. Service classes 1 and 2



CONCEALED JUNCTION

The pair of connectors at a 45° angle guarantees a highly resistant and rigid retractable junction, protected from fire and appropriate for earthquakes

COUPLING

The total thread of the connector placed at an angle guarantees high rigidity for the joint, ideal for coupling beams and floors

REINFORCEMENT

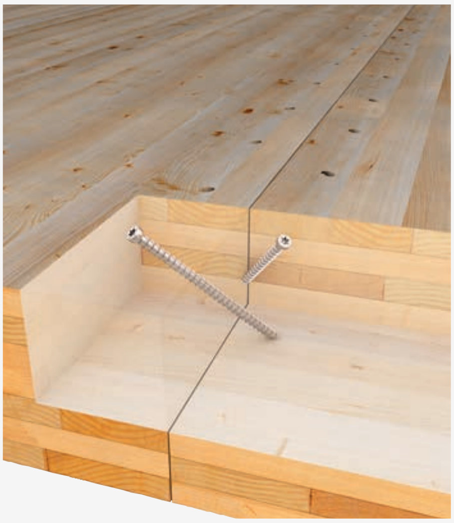
The total thread distributes the perpendicular tensile stress to the fibres along the height of the beam, guaranteeing reinforcement

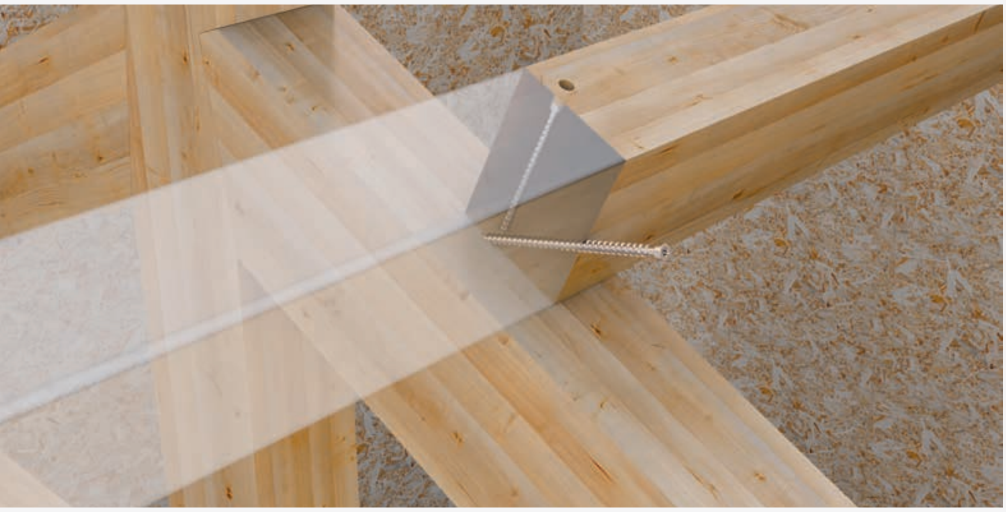
Applications

High performance fastening of X-Lam flooring placed side by side

Fastening of X-Lam flooring to X-Lam walls for major stresses

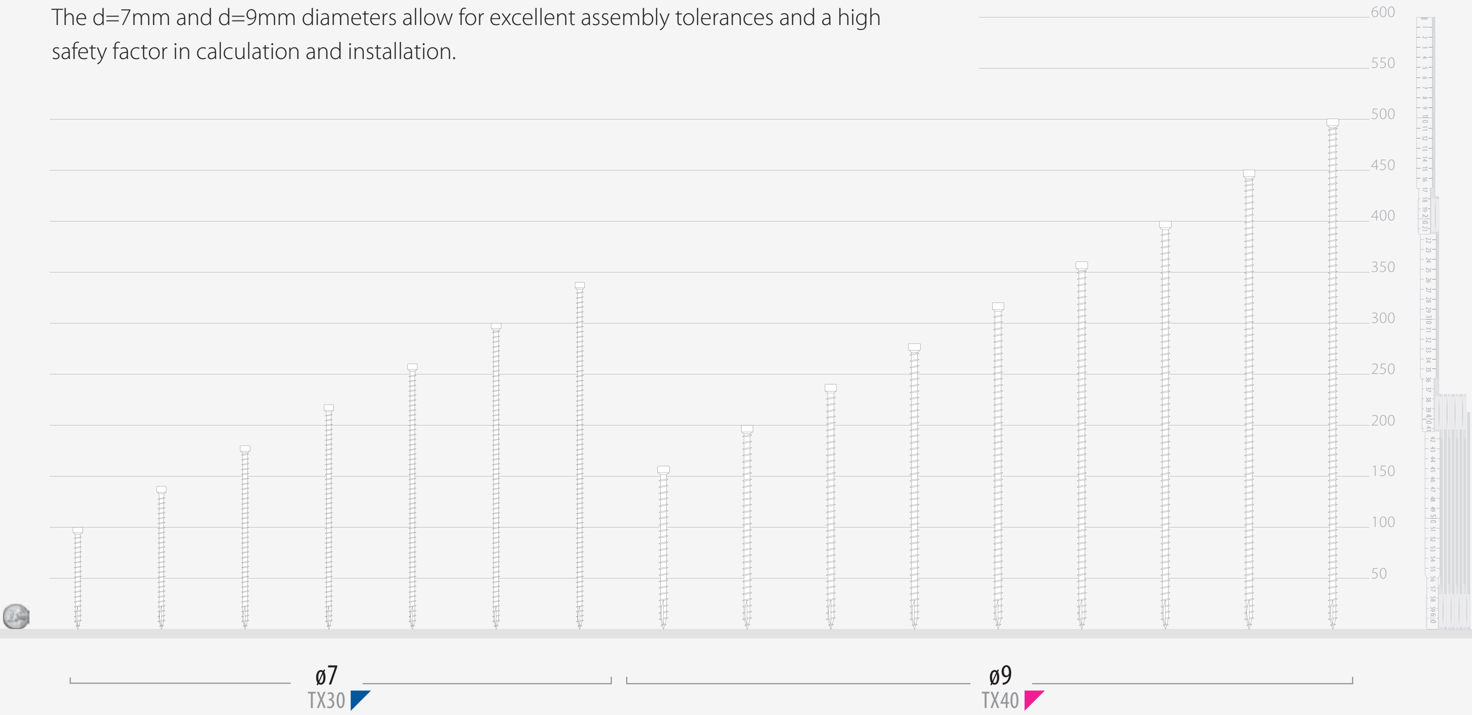
Inclined fastening of the secondary rafter on the main beam



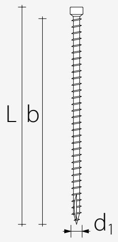


Range

The cylindrical head is ideal for invisible insertion of the screw in wood, using long bits. The d=7mm and d=9mm diameters allow for excellent assembly tolerances and a high safety factor in calculation and installation.

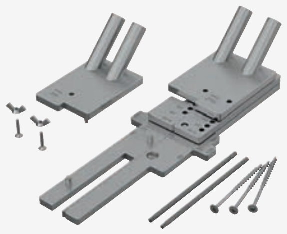


Codes and dimensions

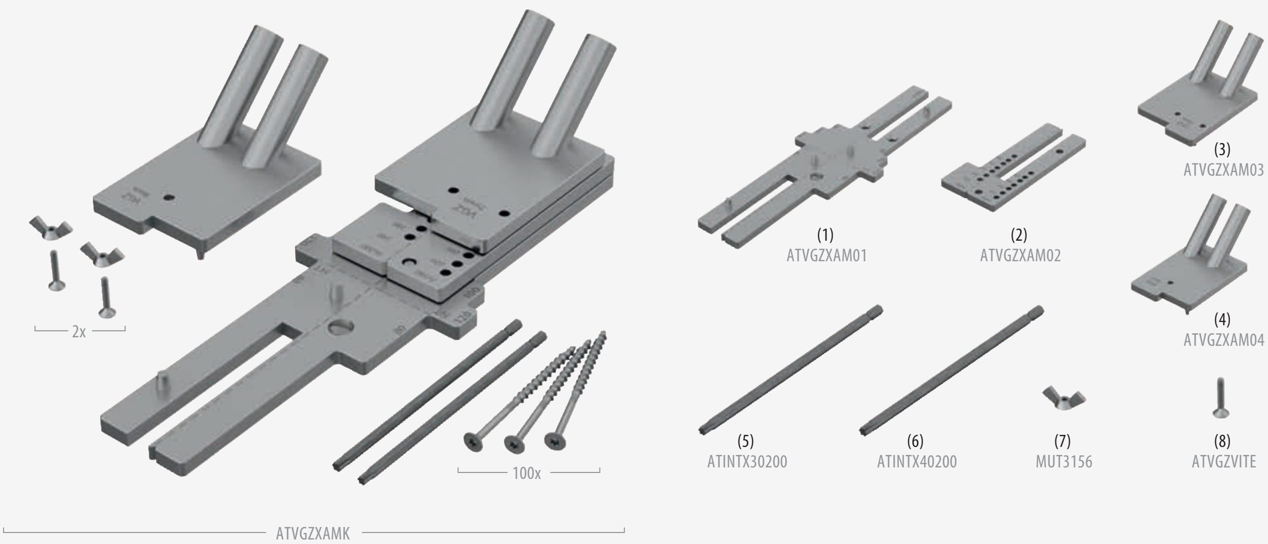


d_1 [mm]	code	L [mm]	b [mm]	pcs/pckg
7 *TX30*	**VGZ7100**	100	90	25
	VGZ7140	140	130	
	VGZ7180	180	170	
	VGZ7220	220	210	
	VGZ7260	260	250	
	VGZ7300	300	290	
	VGZ7340	340	330	
9 *TX40*	**VGZ9160**	160	150	25
	VGZ9200	200	190	
	VGZ9240	240	230	
	VGZ9280	280	270	
	VGZ9320	320	310	
	VGZ9360	360	350	
	VGZ9400	400	390	
	VGZ9450	450	440	
	VGZ9500	500	490	

Template VGZ

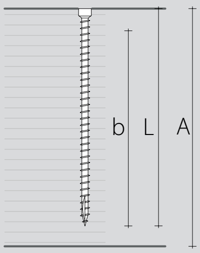


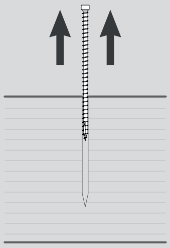
code	description	pcs/pckg
ATVGZXAMK	COMPLETE KIT	1
ATVGZXAM01	(1) template VGZ BASIC KIT	1
ATVGZXAM02	(2) template VGZ CENTRAL KIT	1
ATVGZXAM03	(3) template VGZ 7mm	1
ATVGZXAM04	(4) template VGZ 9mm	1
HBS680	template fastening screws	100
ATINTX30200	(5) bit TX 30 200mm	1
ATINTX40200	(6) bit TX 40 200mm	1
MUT3156	(7) wingnut DIN315 M6	2
ATVGZVITE	(8) screws for assembly BASIC KIT	2



Carpenter statics

THREAD WITHDRAWAL N_{adm}

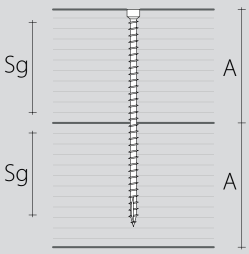


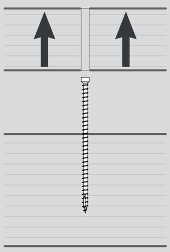


TOTAL THREAD WITHDRAWAL N_{adm}

d_1 [mm]	L [mm]	b [mm]	A_{min} [mm]	N_{adm}
7	**100**	90	110	315 kg
	140	130	150	455 kg
	180	170	190	595 kg
	220	210	230	735 kg
	260	250	270	776 kg (1)
	300	290	310	776 kg (1)
	340	330	350	776 kg (1)

d_1 [mm]	L [mm]	b [mm]	A_{min} [mm]	N_{adm}
9	**160**	150	170	675 kg
	200	190	210	855 kg
	240	230	250	1035 kg
	280	270	290	1215 kg
	320	310	330	1277 kg (1)
	360	350	370	1277 kg (1)
	400	390	410	1277 kg (1)
	450	440	460	1277 kg (1)
	500	490	510	1277 kg (1)





PARTIAL THREAD WITHDRAWAL N_{adm}

d_1 [mm]	L [mm]	s_g [mm]	A_{min} [mm]	N_{adm}
7	**100**	35	55	123 kg
	140	55	75	193 kg
	180	75	95	263 kg
	220	95	115	333 kg
	260	115	135	403 kg
	300	135	155	473 kg
	340	155	175	543 kg

d_1 [mm]	L [mm]	s_g [mm]	A_{min} [mm]	N_{adm}
9	**160**	65	85	293 kg
	200	85	105	383 kg
	240	105	125	473 kg
	280	125	145	563 kg
	320	145	165	653 kg
	360	165	185	743 kg
	400	185	205	833 kg
	450	210	230	945 kg
	500	235	255	1058 kg

1kN = 100 kg

CALCULATION FORMULAS DIN 1052-2:1988

WOOD-WOOD

$N_{adm} = 0{,}5 \cdot s_g \cdot d_1$

d_1 [mm]
s_g [mm]
N_{adm} [kg]

EXAMPLE WOOD-WOOD

VGZ 9 x 240 mm

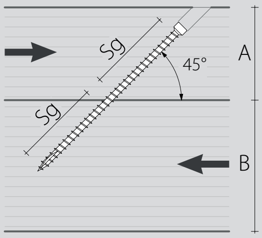
$d_1 = 9$ mm
$s_g = 105$ mm

$N_{adm} = 0{,}5 \cdot s_g \cdot d_1$
$N_{adm} = 0{,}5 \cdot 105 \cdot 9 = 473$ kg

Carpenter statics

ALLOWABLE VALUES
DIN 1052:1988

SLIDING V_{adm}

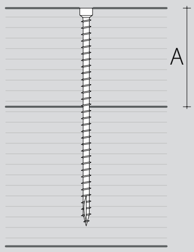


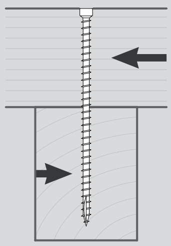
WOOD - WOOD

d_1 [mm]	L [mm]	s_g [mm]	A_{min} [mm]	B_{min} [mm]	V_{adm}
7	**100**	35	40	55	87 kg
	140	55	55	70	136 kg
	180	75	65	85	186 kg
	220	95	80	100	235 kg
	260	115	95	110	285 kg
	300	135	110	125	334 kg
	340	155	125	140	384 kg

d_1 [mm]	L [mm]	s_g [mm]	A_{min} [mm]	B_{min} [mm]	V_{adm}
9	**160**	65	60	75	207 kg
	200	85	75	90	270 kg
	240	105	90	105	334 kg
	280	125	105	120	398 kg
	320	145	115	135	461 kg
	360	165	130	145	525 kg
	400	185	145	160	589 kg
	450	210	165	180	668 kg
	500	235	180	195	748 kg

SHEAR V_{adm}





WOOD - WOOD

d_1 [mm]	L [mm]	s_g [mm]	A [mm]	V_{adm}
7	**100**	35*	50	83 kg
	140	55	70	83 kg
	180	75	90	83 kg
	220	95	110	83 kg
	260	115	130	83 kg
	300	135	150	83 kg
	340	155	170	83 kg

d_1 [mm]	L [mm]	s_g [mm]	A [mm]	V_{adm}
9	**160**	65*	80	138 kg
	200	85	100	138 kg
	240	105	120	138 kg
	280	125	140	138 kg
	320	145	160	138 kg
	360	165	180	138 kg
	400	185	200	138 kg
	450	210	225	138 kg
	500	235	250	138 kg

NOTE

- Allowable values in accordance with DIN 1052:1988.
- The allowable shear values are calculated considering a fixing length of 8 d_1 with the exception of (*).
- The allowable extraction values are calculated considering the threaded part (b or s_g) as being completely inserted into the wood.

(1) Reaching tensile strength for steel failure.

Carpenter statics

SHEAR CONNECTION WITH CROSSED CONNECTORS

RIGHT-ANGLE JOINT - MAIN BEAM / SECONDARY BEAM

d_1 [mm]	L [mm]	s_g [mm]	$B_{HT\,min}$ [mm]	$H_{HT\,min} = h_{NT\,min}$ [mm]	$b_{NT\,min}$ [mm] without pre-bored hole	$b_{NT\,min}$ [mm] without pre-bored hole (3)	No. pairs	V_{adm} (1) [kg]	m (2) [mm]
7	140	55	65	120	67	53	1	272 kg	53
					102	88	2	544 kg	
					137	123	3	817 kg	
	180	75	80	150	67	53	1	371 kg	67
					102	88	2	742 kg	
					137	123	3	1114 kg	
	220	95	95	175	67	53	1	470 kg	81
					102	88	2	940 kg	
					137	123	3	1411 kg	
	260	115	110	205	67	53	1	569 kg	95
					102	88	2	1138 kg	
					137	123	3	1708 kg	
	300	135	125	235	67	53	1	668 kg	109
					102	88	2	1336 kg	
					137	123	3	2005 kg	
	340	155	140	260	67	53	1	767 kg	124
					102	88	2	1534 kg	
					137	123	3	2302 kg	
9	160	65	75	135	86	68	1	414 kg	61
					131	113	2	827 kg	
					176	158	3	1241 kg	
	200	85	90	165	86	68	1	541 kg	75
					131	113	2	1082 kg	
					176	158	3	1623 kg	
	240	105	100	190	86	68	1	668 kg	89
					131	113	2	1336 kg	
					176	158	3	2005 kg	
	280	125	115	220	86	68	1	795 kg	103
					131	113	2	1591 kg	
					176	158	3	2386 kg	
	320	145	130	250	86	68	1	923 kg	117
					131	113	2	1846 kg	
					176	158	3	2768 kg	
	360	165	145	275	86	68	1	1050 kg	131
					131	113	2	2100 kg	
					176	158	3	3150 kg	
	400	185	160	305	86	68	1	1177 kg	145
					131	113	2	2355 kg	
					176	158	3	3532 kg	
	450	210	175	340	86	68	1	1336 kg	163
					131	113	2	2673 kg	
					176	158	3	4009 kg	
	500	235	195	375	86	68	1	1496 kg	181
					131	113	2	2991 kg	
					176	158	3	4487 kg	

NOTE

(1) The axial resistance of the thread to extraction was calculated considering an effective thread length equal to sg.
The connectors must be inserted at 45° with respect to the shear plane.
The centre of gravity of the connectors must be placed in correspondence with the shear plane.

(2) The assembly figure (m) is valid in the case of laying the connectors flush over the elements.

(3) In practice it is possible to reduce the minimum distances by inserting the connectors with a pre-bored hole.

- Allowable values in accordance with DIN 1052:1988.

Carpenter statics

SHEAR CONNECTION WITH CROSSED CONNECTORS

RIGHT-ANGLE JOINT - MAIN BEAM / SECONDARY BEAM

d_1 [mm]	L [mm]	s_g [mm]	$B_{HT\,min}$ [mm]	$H_{HT\,min} = h_{NT\,min}$ [mm]	$b_{NT\,min}$ [mm] without pre-bored hole	without pre-bored hole (3)	No. pairs	V_{adm} (1) [kg]	m (2) [mm]
11					105	83	1	661 kg	
	200	85	90	**165**	160	138	2	1322 kg	78
					215	193	3	1983 kg	
					105	83	1	856 kg	
	250	110	105	**200**	160	138	2	1711 kg	95
					215	193	3	2567 kg	
					105	83	1	1050 kg	
	300	135	125	**235**	160	138	2	2100 kg	113
					215	193	3	3150 kg	
					105	83	1	1245 kg	
	350	160	140	**270**	160	138	2	2489 kg	131
					215	193	3	3734 kg	
					105	83	1	1439 kg	
	400	185	160	**305**	160	138	2	2878 kg	148
					215	193	3	4317 kg	
					105	83	1	1633 kg	
	450	210	175	**340**	160	138	2	3267 kg	166
					215	193	3	4900 kg	
					105	83	1	1828 kg	
	500	235	195	**380**	160	138	2	3656 kg	184
					215	193	3	5484 kg	
					105	83	1	2022 kg	
	550	260	210	**415**	160	138	2	4045 kg	201
					215	193	3	6067 kg	
					105	83	1	2217 kg	
	600	285	230	**450**	160	138	2	4434 kg	219
					215	193	3	6650 kg	

VGS connectors, countersunk head Ø9 and Ø11: see pg. 136

MINIMUM RECOMMENDED DISTANCES [mm]

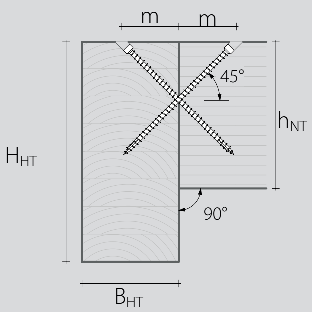
without pre-bored hole	$a_{2,c}$	a_{cross}	e
7	28	11	25
9	36	14	32
11	44	17	39

with pre-bored hole	$a_{2,c}$	a_{cross}	e
7	21	11	25
9	27	14	32
11	33	17	39

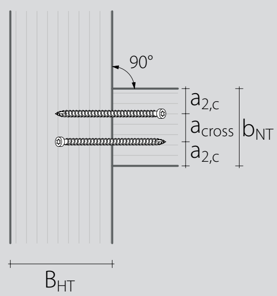
	pre-bored hole d_v [mm]
7	4,0
9	5,0
11	6,0

pre-bored hole required for connectors Ø11 ≥ 400 mm

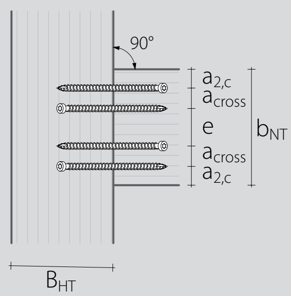
Section:



Plan - 1 pair

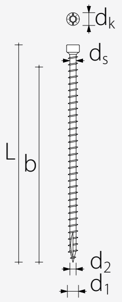


Plan - 2 or more pairs



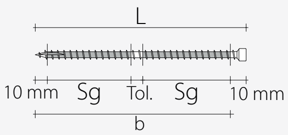
Geometry and minimum distances

GEOMETRY AND MECHANICAL CHARACTERISTICS



VGZ CONNECTOR			
Nominal diameter	**d_1 [mm]**	**7**	**9**
Head diameter	d_K [mm]	9,50	11,50
Tip diameter	d_2 [mm]	4,60	5,90
Shank diameter	d_S [mm]	5,00	6,50
Pre-bored hole diameter	d_V [mm]	4,0	5,0
Characteristic yield moment	$M_{y,k}$ [Nmm]	14174,2	27244,1
Characteristic extraction-resistance parameter	$f_{ax,k}$ [N/mm^2]	11,7	11,7
Characteristic tensile strength	$f_{tens,k}$ [kN]	15,4	25,4
Characteristic yield strength	$f_{y,k}$ [N/mm^2]	1000	1000

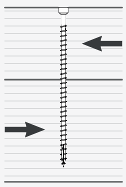
EFFECTIVE THREAD USED IN CALCULATION



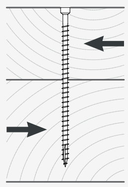
b = L - 10 mm represents the entire length of the threaded part.
s_g = (L - 10 mm - 10 mm - Tol.) / 2 represents the partial length of the threaded part net of a laying tolerance (Tol.) di posa di 10 mm.

The extraction, shear and sliding values were calculated placing the centre of gravity of the connector in correspondence with the shear plane and considering an effective thread of s_g.

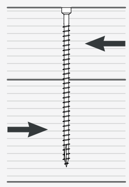
MINIMUM DISTANCES FOR SHEAR LOADS (1)



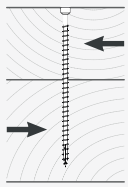
Angle between strength and grain α = 0°



Angle between strength and grain α = 90°

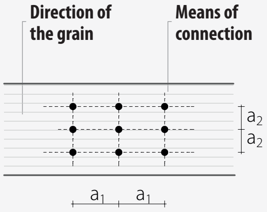


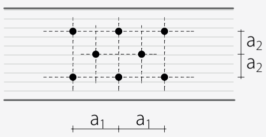
Angle between strength and grain α = 0°



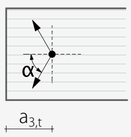
Angle between strength and grain α = 90°

		SCREWS INSERTED WITHOUT PRE-BORED HOLES				SCREWS INSERTED WITH PRE-BORED HOLES			
		α = 0°		α = 90°		α = 0°		α = 90°	
		7	**9**	**7**	**9**	**7**	**9**	**7**	**9**
a_1	[mm]	84	108	35	45	35	45	28	36
a_2	[mm]	35	45	35	45	21	27	28	36
$a_{3,t}$	[mm]	105	135	70	90	84	108	49	63
$a_{3,c}$	[mm]	70	90	70	90	49	63	49	63
$a_{4,t}$	[mm]	35	45	70	90	21	27	49	63
$a_{4,c}$	[mm]	35	45	35	45	21	27	21	27

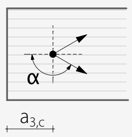




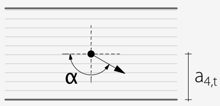
stressed end
-90° < α < 90°



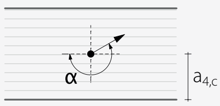
discharged end
90° < α < 270°



stressed edge
0° < α < 180°

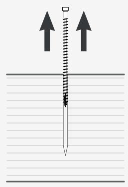


unload edge
180° < α < 360°



Geometry and minimum distances

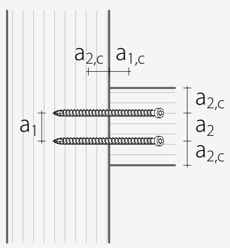
MINIMUM DISTANCES FOR AXIAL STRESSES (2)



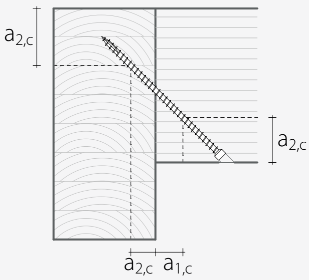
		SCREWS INSERTED WITHOUT PRE-BORED HOLES		SCREWS INSERTED WITH PRE-BORED HOLES	
		7	9	7	9
a_1	[mm]	35	45	35	45
a_2	[mm]	35	45	35	45
$a_{2,LIM}$ (3)	[mm]	18	23	18	23
$a_{1,C}$	[mm]	70	90	70	90
$a_{2,C}$	[mm]	28	36	21	27
a_{CROSS}	[mm]	11	14	11	14

SCREWS UNDER TRACTION INSERTED WITH AN ANGLE α WITH RESPECT TO THE GRAIN

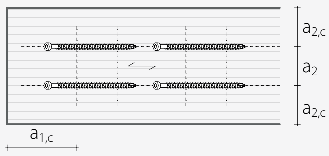
Plan



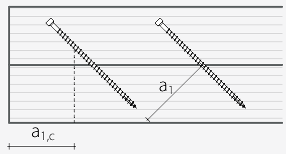
Front



Plan

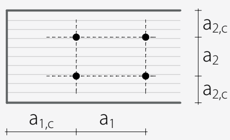


Front

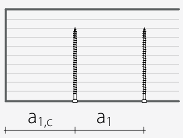


SCREWS INSERTED WITH A 90° ANGLE WITH RESPECT TO THE GRAIN

Plan

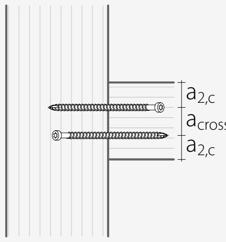


Front

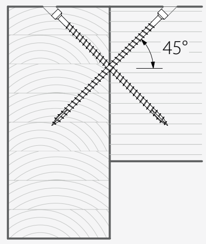


CROSS SCREWS INSERTED WITH AN ANGLE α WITH RESPECT TO THE GRAIN

Plan



Front



NOTE

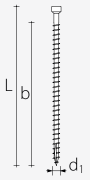
(1) The minimum distances are in accordance with EN 1995:2008, according to ETA-11/0030, considering a mass density of the wood elements of $\rho_k \leq 420$ kg/m³.

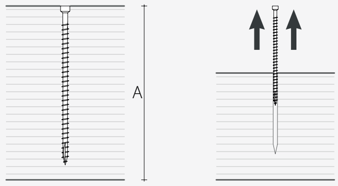
(2) The minimum distances for connectors stressed axially are independent of the insertion angle of the connector and the angle of the force with respect to the grain, in accordance with ETA-11/0030.

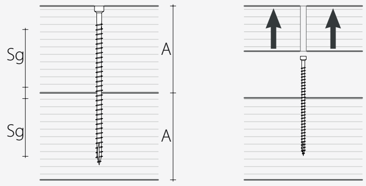
(3) The axial distance a2 can be reduced down to $2.5 \cdot d_1$ if for each connector a "joint surface" $a_1 \cdot a_2 = 25 \cdot d_1^2$ is maintained.

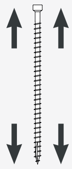
Designer statics

TRACTION [1]



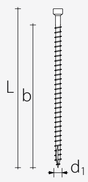


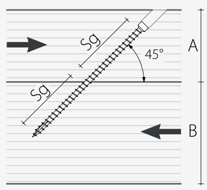




geometry		total thread withdrawal [2]			partial thread withdrawal [2]			steel traction
				wood			wood	steel
d_1 [mm]	L [mm]	b [mm]	A_{min} [mm]	$R_{ax,k}$ [kN]	s_g [mm]	A_{min} [mm]	$R_{ax,k}$ [kN]	$R_{tens,k}$ [kN]
7	100	90	110	7,87	35	55	3,06	15,40
	140	130	150	11,37	55	75	4,81	
	180	170	190	14,87	75	95	6,56	
	220	210	230	18,37	95	115	8,31	
	260	250	270	21,87	115	135	10,06	
	300	290	310	25,37	135	155	11,81	
	340	330	350	28,86	155	175	13,56	
9	160	150	170	16,87	65	85	7,31	25,40
	200	190	210	21,37	85	105	9,56	
	240	230	250	25,87	105	125	11,81	
	280	270	290	30,36	125	145	14,06	
	320	310	330	34,86	145	165	16,31	
	360	350	370	39,36	165	185	18,56	
	400	390	410	43,86	185	205	20,81	
	450	440	460	49,48	210	230	23,62	
	500	490	510	55,11	235	255	26,43	

SLIDING

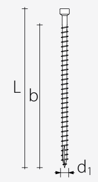


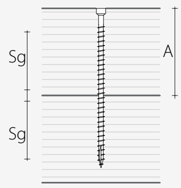


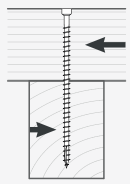
geometry			wood - wood [3]		
d_1 [mm]	L [mm]	S_g [mm]	A_{MIN} [mm]	B_{MIN} [mm]	$R_{V,k}$ [kN]
7	100	35	40	55	1,97
	140	55	55	70	3,09
	180	75	65	85	4,22
	220	95	80	100	5,34
	260	115	95	110	6,47
	300	135	110	125	7,59
	340	155	125	140	8,72
9	160	65	60	75	4,70
	200	85	75	90	6,14
	240	105	90	105	7,59
	280	125	105	120	9,04
	320	145	115	135	10,48
	360	165	130	145	11,93
	400	185	145	160	13,37
	450	210	165	180	15,18
	500	235	180	195	16,99

Designer statics

SHEAR







geometry				wood-wood
d_1 [mm]	L [mm]	S_g [mm]	A_{MIN} [mm]	$R_{V,k}$ [kN]
7	100	35	50	2,65
	140	55	70	3,34
	180	75	90	3,78
	220	95	110	4,21
	260	115	130	4,27
	300	135	150	4,27
	340	155	170	4,27
9	160	65	80	5,06
	200	85	100	5,62
	240	105	120	6,19
	280	125	140	6,47
	320	145	160	6,47
	360	165	180	6,47
	400	185	200	6,47
	450	210	225	6,47
	500	235	250	6,47

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- Design values are obtained from the following characteristic values:

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

  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.
- In the calculations, the density of the wood elements was considered equal to $\rho_k = 380\ kg/m^3$. Characteristic resistances can also be considered as valid for larger densities, for the purposes of safety.
- Sizing and verification of the wooden elements must be done separately.
- The shear characteristic resistances are calculated for screws inserted without a pre-bored hole. In the case of screws inserted with a pre-bored hole, greater resistance values can be obtained.
- The extraction, shear and sliding values were calculated considering the centre of gravity of the connector placed in correspondence with the shear plane.
- The characteristic resistances were calculated using solid wood or glulam. In the case of joints with X-Lam elements, the resistance values may be different and should be calculated on the basis of the characteristics of the panel and the connection configuration.

NOTE

(1) The design strength of the connector is the lower between the wood-side design strength ($R_{ax,d}$) and the steel-side design strength ($R_{tens,d}$).

$$R_{ax,d} = min \begin{cases} R_{ax,k} \cdot k_{mod} \ / \ \gamma_m \\ R_{tens,k} \ / \ \gamma_{m2} \end{cases}$$

(2) The axial resistance of the thread to extraction was calculated considering a 90° angle between the fibres and the connector and for a effective thread length of b or s_g.
For intermediate s_g values it is possible to interpolate linearly.

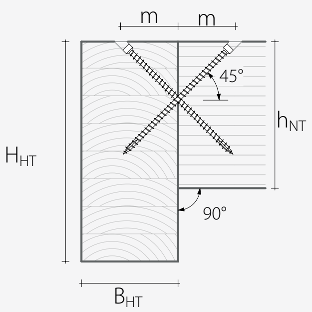
(3) The axial resistance of the thread to extraction was calculated considering a 45° angle between the fibres and the connector and for an effective thread length of s_g.

SHEAR CONNECTION WITH CROSSED CONNECTORS

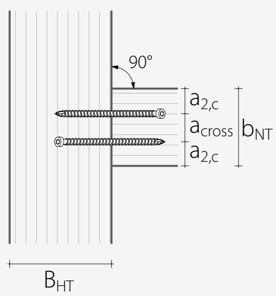
RIGHT-ANGLE JOINT - MAIN BEAM / SECONDARY BEAM

d_1 [mm]	L [mm]	s_g [mm]	$B_{HT\,min}$ [mm]	$H_{HT\,min} = h_{NT\,min}$ [mm]	$b_{NT\,min}$ [mm]		No. pairs	$R_{1\,V,k}$ (1) [kN]	$R_{2\,V,k}$ (1) [kN]	m (2) [mm]
					without pre-bored hole	with pre-bored hole (3)		extraction (4)	instability	
7	**140**	55	65	**120**	67	53	1	6,2	13,6	53
					102	88	2	11,5	25,4	
					137	123	3	16,6	36,5	
	180	75	80	**150**	67	53	1	8,4	13,6	67
					102	88	2	15,7	25,4	
					137	123	3	22,7	36,5	
	220	95	95	**175**	67	53	1	10,7	13,6	81
					102	88	2	19,9	25,4	
					137	123	3	28,7	36,5	
	260	115	110	**205**	67	53	1	12,9	13,6	95
					102	88	2	24,1	25,4	
					137	123	3	34,8	36,5	
	300	135	125	**235**	67	53	1	15,2	13,6	109
					102	88	2	28,3	25,4	
					137	123	3	40,8	36,5	
	340	155	140	**260**	67	53	1	17,4	13,6	124
					102	88	2	32,5	25,4	
					137	123	3	46,9	36,5	
9	**160**	65	75	**135**	86	68	1	9,4	22,8	61
					131	113	2	17,5	42,6	
					176	158	3	25,3	61,3	
	200	85	90	**165**	86	68	1	12,3	22,8	75
					131	113	2	22,9	42,6	
					176	158	3	33,0	61,3	
	240	105	100	**190**	86	68	1	15,2	22,8	89
					131	113	2	28,3	42,6	
					176	158	3	40,8	61,3	
	280	125	115	**220**	86	68	1	18,1	22,8	103
					131	113	2	33,7	42,6	
					176	158	3	48,6	61,3	
	320	145	130	**250**	86	68	1	21,0	22,8	117
					131	113	2	39,1	42,6	
					176	158	3	56,4	61,3	
	360	165	145	**275**	86	68	1	23,9	22,8	131
					131	113	2	44,5	42,6	
					176	158	3	64,1	61,3	
	400	185	160	**305**	86	68	1	26,7	22,8	145
					131	113	2	49,9	42,6	
					176	158	3	71,9	61,3	
	450	210	175	**340**	86	68	1	30,4	22,8	163
					131	113	2	56,7	42,6	
					176	158	3	81,6	61,3	
	500	235	195	**375**	86	68	1	34,0	22,8	181
					131	113	2	63,4	42,6	
					176	158	3	91,3	61,3	

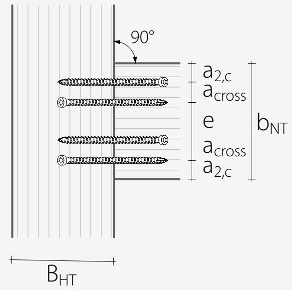
Section:



Plan - 1 pair



Plan - 2 or more pairs



Designer statics

SHEAR CONNECTION WITH CROSSED CONNECTORS

RIGHT-ANGLE JOINT - MAIN BEAM / SECONDARY BEAM

d_1 [mm]	L [mm]	s_g [mm]	$B_{HT\,min}$ [mm]	$H_{HT\,min} = h_{NT\,min}$ [mm]	$b_{NT\,min}$ [mm] without pre-bored hole	$b_{NT\,min}$ [mm] with pre-bored hole (3)	No. pairs	$R_{1\,V,k}$ (1) [kN] extraction (4)	$R_{2\,V,k}$ (1) [kN] instability	m (2) [mm]
11	**200**	85	90	**165**	105	83	1	15,0	29,1	78
					160	138	2	28,0	54,2	
					215	193	3	40,4	78,1	
	250	110	105	**200**	105	83	1	19,4	29,1	95
					160	138	2	36,3	54,2	
					215	193	3	52,2	78,1	
	300	135	125	**235**	105	83	1	23,9	29,1	113
					160	138	2	44,5	54,2	
					215	193	3	64,1	78,1	
	350	160	140	**270**	105	83	1	28,3	29,1	131
					160	138	2	52,8	54,2	
					215	193	3	76,0	78,1	
	400	185	160	**305**	105	83	1	32,7	29,1	148
					160	138	2	61,0	54,2	
					215	193	3	87,9	78,1	
	450	210	175	**340**	105	83	1	37,1	29,1	166
					160	138	2	69,2	54,2	
					215	193	3	99,7	78,1	
	500	235	195	**380**	105	83	1	41,5	29,1	184
					160	138	2	77,5	54,2	
					215	193	3	111,6	78,1	
	550	260	210	**415**	105	83	1	45,9	29,1	201
					160	138	2	85,7	54,2	
					215	193	3	123,5	78,1	
	600	285	230	**450**	105	83	1	50,4	29,1	219
					160	138	2	94,0	54,2	
					215	193	3	135,4	78,1	

VGS connectors, countersunk head Ø9 and Ø11: see pg. 136

MINIMUM RECOMMENDED DISTANCES [mm]

without pre-bored hole	$a_{2,c}$	a_{cross}	e
7	28	11	25
9	36	14	32
11	44	17	39

with pre-bored hole	$a_{2,c}$	a_{cross}	e
7	21	11	25
9	27	14	32
11	33	17	39

	pre-bored hole d_v [mm]
7	4,0
9	5,0
11	6,0

pre-bored hole required for connectors Ø11 ≥ 400 mm

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- In the calculations, the density of the wood elements was considered equal to $\rho_k = 380$ kg/m³.
- Sizing and verification of the wooden elements must be done separately.

NOTE

(1) The design strength of the connector is the lower between the extraction-side design strength ($R_{1\,V,d}$) and the instability design strength ($R_{2\,V,d}$).

$$R_{V,d} = min \begin{cases} R_{1\,V,k} \cdot k_{mod} \;/\; \gamma_m \\ R_{2\,V,k} \;/\; \gamma_{m1} \end{cases}$$

(2) The assembly figure (m) is valid in the case of laying of the connectors flush over the elements.

(3) In practice it is possible to reduce the minimum distances by inserting the connectors with a pre-bored hole.

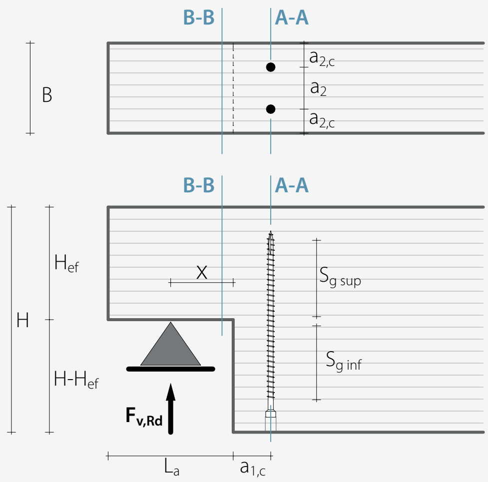
(4) The axial resistance of the thread to extraction was calculated considering an effective thread length equal to s_g. The connectors must be inserted at 45° with respect to the shear plane. The centre of gravity of the connectors must be placed in correspondence with the shear plane.

- For different calculation methods, the myProject software is available (www.rothoblaas.com).

Calculation example: reinforcement of notched beam with traction perpendicular

PROJECT DATA

B = 200 mm	Wood GL24h (ρ_k = 380 kg/m^3)
H = 400 mm	$F_{v,Rd}$ = 29,5 kN
H_{ef} = 200 mm	Service class = 1
H - H_{ef} = 200 mm	Load duration = short
L_a = 150 mm	
i_a = 0 notch slope	



SHEAR STRESS VERIFICATION - BEAM WITHOUT REINFORCEMENT - Section A-A (EN 1995:2008): $\tau_d \leq k_v \cdot f_{v,d}$

$$\tau_d = \frac{1,5 \cdot F_{v,Rd}}{B \cdot H_{ef}} \qquad x = \frac{L_a}{2} \qquad \alpha = \frac{H_{ef}}{H}$$

$$k_v = min \begin{cases} 1 \\ \dfrac{k_n\left(1 + \dfrac{1,1 \cdot i_a^{1,5}}{\sqrt{H}}\right)}{\sqrt{h}\left(\sqrt{\alpha(1-\alpha)} + 0,8\,\dfrac{x}{H}\sqrt{\dfrac{1}{\alpha} - \alpha^2}\right)} \end{cases}$$

τ_d = 1,11 N/mm^2
x = 75 mm
α = 0,5
k_n = 6,50 (GL24h)
k_v = 0,47
$f_{v,k}$ = 2,70 N/mm^2

EN 1995:2008
k_{mod} = 0,9
γ_m = 1,25
$f_{v,d}$ = 1,94 N/mm^2
$k_v \cdot f_{v,d}$ = 0,90 N/mm^2

$\tau_d \leq k_v \cdot f_{v,d}$ → 1,11 > 0,90 N/mm^2 Verification not passed
Requires reinforcement

Italia - NTC 2008
k_{mod} = 0,9
γ_m = 1,45
$f_{v,d}$ = 1,68 N/mm^2
$k_v \cdot f_{v,d}$ = 0,78 N/mm^2

$\tau_d \leq k_v \cdot f_{v,d}$ → 1,11 > 0,78 N/mm^2 Verification not passed
Requires reinforcement

SHEAR STRESS VERIFICATION - Section B-B (EN 1995:2008): $\tau_d \leq f_{v,d}$

$$\tau_d = \frac{1,5 \cdot F_{v,Rd}}{B \cdot H_{ef}}$$

τ_d = 1,11 N/mm^2

EN 1995:2008
$\tau_d \leq f_{v,d}$ → 1,11 < 1,94 N/mm^2 Verification passed

Italia - NTC 2008
$\tau_d \leq f_{v,d}$ → 1,11 < 1,68 N/mm^2 Verification passed

REINFORCEMENT Section A-A - CALCULATION OF TRACTION STRESS PERPENDICULAR TO THE FIBRES (DIN 1052:2008)

$$F_{t,90,d} = 1,3 \cdot F_{v,Rd} \cdot [3 \cdot (1-\alpha)^2 - 2 \cdot (1-\alpha)^3]$$

$F_{t,90,d}$ = 19,18 kN

REINFORCEMENT CONNECTOR SELECTION

VGZ 9 x 360 mm
$s_{g\ sup}$ = 165 mm
$s_{g\ inf}$ = 165 mm

To optimise the resistance, the connector is placed with the centre of gravity in correspondence with the possible crack line.

CONNECTOR TENSILE STRENGTH CALCULATION (EN 1995:2008 and ETA-11/0030)

$$R_{ax,Rd} = min \begin{cases} \frac{R_{ax,\alpha,Rk} \cdot k_{mod}}{\gamma_m} \\ \frac{R_{tens,k}}{\gamma_{m2}} \end{cases}$$

The tensile strength of the connectors calculated here is shown in the table on pg. 108.
The minimum distances for placement of the connectors are found in the table on pg. 107.

$$R_{ax,\alpha,Rk} = \frac{n_{ef} \cdot 11{,}7 \cdot d_1 \cdot Sg}{1{,}2 \cdot cos^2\alpha + sin^2\alpha} \cdot \left(\frac{\rho_k}{350}\right)^{0{,}8}$$

$R_{ax,90°,Rk} = 18{,}56$ kN

$R_{tens,k} = 25{,}40$ kN

EN 1995:2008	Italia - NTC 2008
$k_{mod} = 0{,}9$	$k_{mod} = 0{,}9$
$\gamma_m = 1{,}3$	$\gamma_m = 1{,}5$
$\gamma_{m2} = 1{,}25$	$\gamma_{m2} = 1{,}25$
$R_{ax,90°,Rd} = 12{,}85$ kN	$R_{ax,90°,Rd} = 11{,}13$ kN
$R_{tens,d} = 20{,}32$ kN	$R_{tens,d} = 20{,}32$ kN
$R_{ax,Rd} = 12{,}85$ kN	**$R_{ax,Rd} = 11{,}13$ kN**

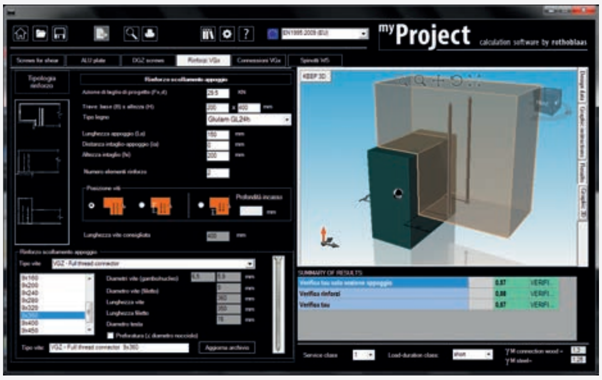
MINIMUM NUMBER OF CONNECTORS

$F_{t,90,d} / R_{ax,Rd} = 1{,}49$	$F_{t,90,d} / R_{ax,Rd} = 1{,}72$

2 connectors are hypothesized $n_{ef,ax}$ $2^{0{,}9} = 1{,}87$

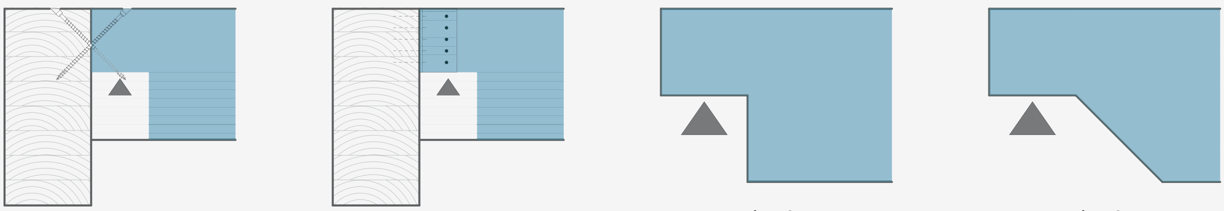
CONNECTION RESISTANCE TO TRACTION PERPENDICULAR TO THE FIBRES:

$R_{ax,Rd} = 1{,}87 \cdot 12{,}85 =$ **24,02 kN** > 19,18 kN OK	$R_{ax,Rd} = 1{,}87 \cdot 11{,}13 =$ **20,82 kN** > 19,18 kN OK



For different calculation configurations, the myProject software is available (www.rothoblaas.com).

EXAMPLE OF JOINTS THAT REQUIRE VERIFICATION OF PERPENDICULAR TRACTION AND POSSIBLE REINFORCEMENT



$i_a = 0$ $i_a > 0$