Fastening Technology

WT/WR

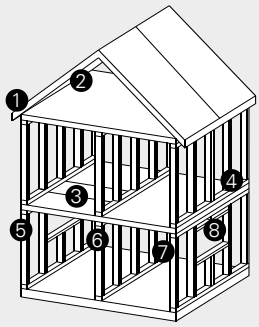
Technical manual for timber construction
According to European design principles (EN1995/ETA)

Content

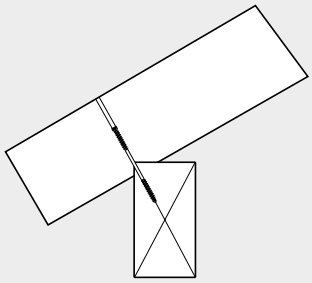
3 Fastening system WT/WR

General WT

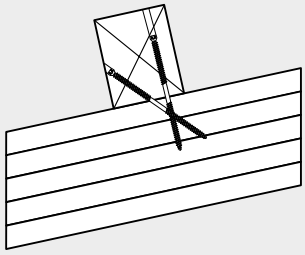
Design basis system WT



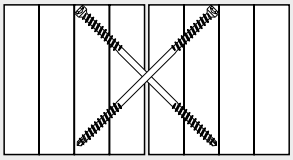
1 Rafter



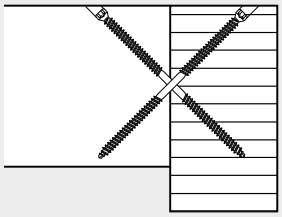
2 Rafter-Purlin



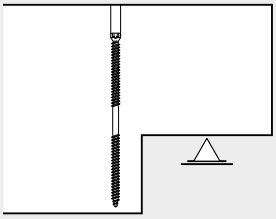
3 Element-push



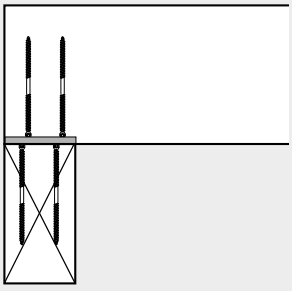
4 Main-secondary-beam



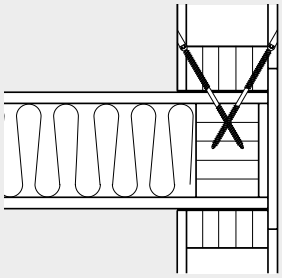
5 Notch



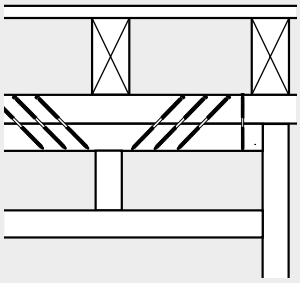
6 Compression reinforcement



7 Wall connection



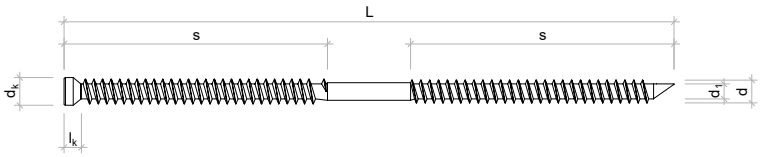
8 Reinforcement



Convincing advantages

- High load bearing capacity
- Easy processing
- Any countersinking depth possible without pre-drilling
- High fire resistance of the joint
- Fast installation without pre-drilling
- Transmission of transverse and normal forces
- Fasteners not visible
- ETA-12/0063 (WT)

General WT



3

Basic information about the fastener WT

	WT-S-6,5	WT-T-6,5	WT-T-8,2	Unit
d	6.5	6.5	8.2	[mm]
d_1	4.0	4.0	5.4	[mm]
d_k	8.0	8.0	10.0	[mm]
l_k	5.2	5.2	6.5	[mm]
$M_{y,k}$	8.0	12.5	25.0	[Nm]
$f_{tens,k}$	8.5	12.5	22.0	[kN]
$f_{tor,k}$	8.5	12.5	25.0	[Nm]

l_{ef} = min {4·d/sin α ; 20·d}

d Outer thread diameter of the screw [mm]
α Angle between screw axis and grain direction
l_{ef} Embedment depth of the threaded part of the screw in the wood component [mm]

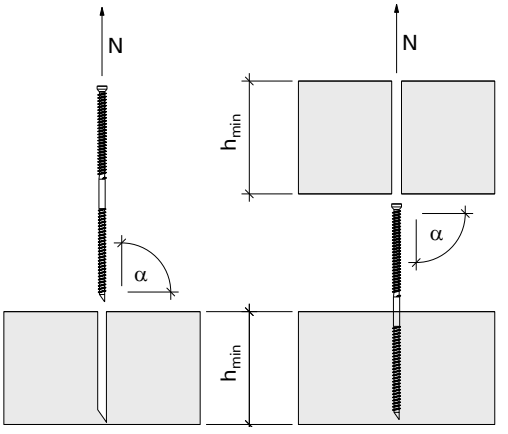
$f_{ax,k}$ = 12.8 [N/mm2] for solid wood (C24) and glulam (GL24h) other wood building materials see ETA-12/
k_{ax} = 1 at 45° ≤ α ≤ 90°
k_{ax} = 0.3 + (0.7·α/45°) at 0° ≤ α < 45°
α Angle between screw axis and grain direction

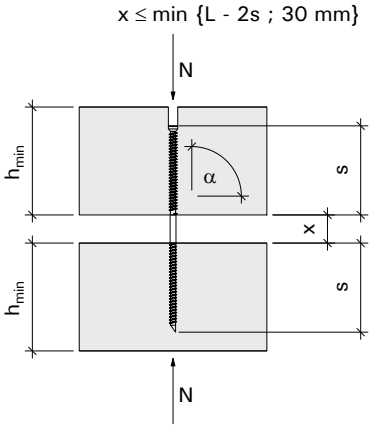
Displacement modulus when loaded in the axial direction:
K_{ser} = 25 · l_{ef} · d (Softwood)
K_{ser} = 30 · l_{ef} · d (Softwood ash,beech,oak)
d Outer thread diameter of the screw [mm].
l_{ef} Embedment depth of the threaded part of the screw in the wood component [mm]

Use in hardwood (ash, oak, beech, BauBuche) possible → see ETA-12/0063

For execution planning, all designs in ETA-12/0063 must be taken into account

Tension/compression connection





General WT

Tension/compression connection												**C24**	Decrese-
												ρ_k = 350 [kg/m³]	factor [1]
												$R_{N,d}$ [kN]	
Fastener d x L	s [mm]	h_{min} [mm]	< 15°	15°	20°	25°	30°	35°	40°	45°	90°	generell	
WT-T/S-6,5x90	40	50	–	–	–	–	–	–	–	2.05	2.05	0.87	
WT-T/S-6,5x130	55	70	–	–	–	–	2.16	2.38	2.60	2.82	2.82	0.91	
WT-T-6,5x160	65	85	–	–	–	2.29	2.55	2.81	3.07	3.33	3.33	0.92	
WT-T-6,5x190	80	100	–	–	2.50	2.82	3.14	3.46	3.78	4.10	4.10	0.94	
WT-T-6,5x220	95	115	–	–	2.97	3.35	3.73	4.11	4.49	4.86	4.86	0.95	
WT-T-8,2x160	65	85	–	–	–	–	–	3.55	3.87	4.20	4.20	0.90	
WT-T-8,2x190	80	100	–	–	–	3.56	3.96	4.36	4.77	5.17	5.17	0.92	
WT-T-8,2x220	95	115	–	–	–	4.23	4.70	5.18	5.66	6.14	6.14	0.93	
WT-T-8,2x245	107	125	–	–	4.22	4.76	5.30	5.84	6.37	6.91	6.91	0.94	
WT-T-8,2x275	122	140	–	–	4.82	5.43	6.04	6.65	7.27	7.88	7.88	0.95	
WT-T-8,2x300	135	155	–	4.65	5.33	6.01	6.69	7.36	8.04	8.72	8.72	0.95	
WT-T-8,2x330	135	170	–	4.65	5.33	6.01	6.69	7.36	8.04	8.72	8.72	0.95	

$n_{ef} = n^{0.9}$, where n = total number of fasteners of the joint
[1] Reduction factor for compressive stress

General remarks see page 6

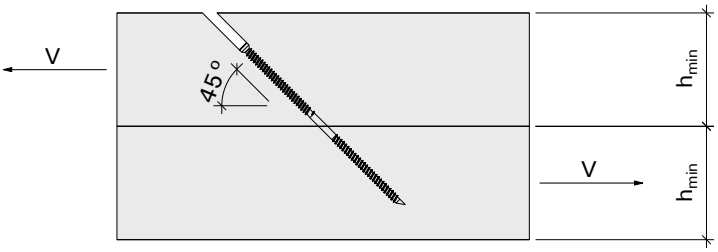
Tension/compression connection												**GL24h**	Decrese-
												ρ_k = 385 [kg/m³]	factor [1]
												$R_{N,d}$ [kN]	
Fastener d x L	s [mm]	h_{min} [mm]	< 15°	15°	20°	25°	30°	35°	40°	45°	90°	generell	
WT-T/S-6,5x90	40	50	–	–	–	–	–	–	–	2.21	2.21	0.87	
WT-T/S-6,5x130	55	70	–	–	–	–	2.33	2.57	2.80	3.04	3.04	0.91	
WT-T-6,5x160	65	85	–	–	–	2.47	2.75	3.03	3.31	3.59	3.59	0.92	
WT-T-6,5x190	80	100	–	–	2.70	3.05	3.39	3.73	4.08	4.42	4.42	0.94	
WT-T-6,5x220	95	115	–	–	3.21	3.62	4.02	4.43	4.84	5.25	5.25	0.95	
WT-T-8,2x160	65	85	–	–	–	–	–	3.83	4.18	4.53	4.53	0.90	
WT-T-8,2x190	80	100	–	–	–	3.84	4.28	4.71	5.14	5.58	5.58	0.92	
WT-T-8,2x220	95	115	–	–	–	4.56	5.08	5.59	6.11	6.62	6.62	0.93	
WT-T-8,2x245	107	125	–	–	4.56	5.14	5.72	6.30	6.88	7.46	7.46	0.94	
WT-T-8,2x275	122	140	–	–	5.20	5.86	6.52	7.18	7.84	8.50	8.50	0.95	
WT-T-8,2x300	135	155	–	5.02	5.75	6.48	7.21	7.95	8.68	9.41	9.41	0.95	
WT-T-8,2x330	135	170	–	5.02	5.75	6.48	7.21	7.95	8.68	9.41	9.41	0.95	

$n_{ef} = n^{0.9}$, where n = total number of fasteners of the joint
[2] Reduction factor for compressive stress

General remarks see page 6

General WT

Shear connection



Attention:
In case of one-sided inclination, forces can only be absorbed from one direction (cf. fig.)

Shear connection			**C24**	**GL24h**
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
			$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
Fastener dxL	s [mm]	h_{min} [mm]	α = 45°	α = 45°
WT-T/S-6,5x90	40	65 [1)]	1.45	1.56
WT-T/S-6,5x130	55	65 [1)]	1.99	2.15
WT-T-6,5x160	65	65 [1)]	2.35	2.54
WT-T-6,5x190	80	70	2.90	3.13
WT-T-6,5x220	95	80	3.44	3.71
WT-T-8,2x160	65	82 [1)]	2.97	3.20
WT-T-8,2x190	80	82 [1)]	3.65	3.94
WT-T-8,2x220	95	82 [1)]	4.34	4.68
WT-T-8,2x245	107	90	4.89	5.27
WT-T-8,2x275	122	100	5.57	6.01
WT-T-8,2x300	135	110	6.17	6.65
WT-T-8,2x330	135	120	6.17	6.65

$n_{ef} = n^{0.9}$, where n = total number of fasteners of the connection
Exception: doweled beam → n_{ef} = n

[1)] With pre-drilling, smaller minimum wood thicknesses are also possible

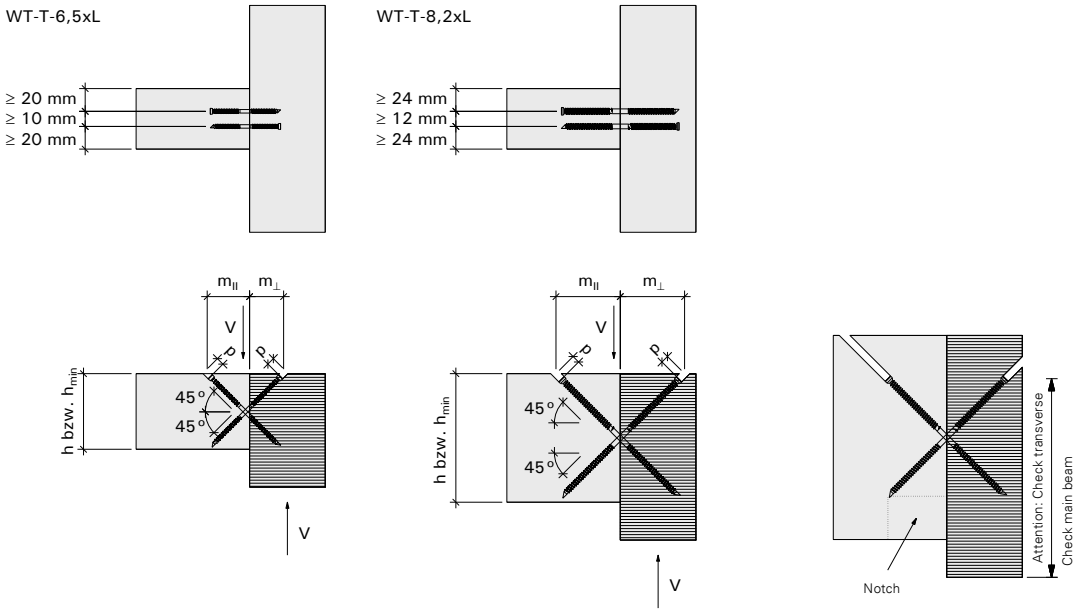
General remarks see below

General remarks

- Transverse tensile stresses must be verified separately
- In the case of several fasteners or pairs of fasteners acting together in a connection, the resistances given must be multiplied by a factor of n_{ef}
- Values apply to connections where half of the fasteners are located in each component (for a few exceptions, see "Connection of main/ secondary beams")
- Connection geometries according to drawings must be observed
- For WT screws subjected to axial compression, where the screw head is pressed out of the wood and therefore does not carry, 5.2 mm (d = 6.5 mm) must be shortened on the screw head side and 6.5 mm (d = 8.2 mm) on the screw head side
- Table values for k_{mod} = 0.8 and γ_M= 1.3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible planner**

General WT

Connection main/secondary beam



Connection main/secondary beam						C24	GL24h
						ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
						$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
Fastener dxL	s [mm]	h_{min} [mm]	$m_{\parallel}$ [mm]	$m_{\perp}$ [mm]	p [mm]	α = 45°	α = 45°
WT-T/S-6,5x90	40	–	–	–	–	–	–
WT-T/S-6,5x130	55	100	h/2 + 6	h/2 - 6	h x 0,707 - 65	3.61	3.89
WT-T-6,5x160	65	120	h/2	h/2	h x 0,707 - 80	4.33	4.67
WT-T-6,5x190	80	140	h/2	h/2	h x 0,707 - 95	5.42	5.85
WT-T-6,5x220	95	160	h/2	h/2	h x 0,707 - 110	6.50	7.02
WT-T-8,2x160	65	120	h/2+7	h/2–7	hx0.707–80	5.34	5.77
WT-T-8,2x190	80	140	h/2+2	h/2–2	hx0.707–95	6.71	7.25
WT-T-8,2x220	95	160	h/2	h/2	hx0.707–110	8.08	8.72
WT-T-8,2x245	107	180	h/2	h/2	hx0.707–123	9.18	9.91
WT-T-8,2x275	122	200	h/2	h/2	hx0.707–138	10.55	11.39
WT-T-8,2x300	135	220	h/2	h/2	hx0.707–150	11.74	12.67
WT-T-8,2x330	135	240	h/2	h/2	hx0.707–165	11.74	12.67

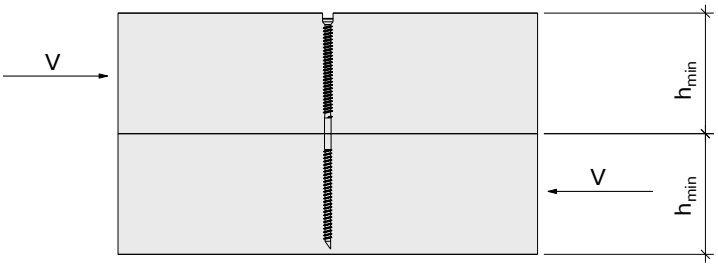
$n_{ef} = n^{0.9}$, where n = total number of fasteners of the connection

α = 45° (screw-in angle)

General remarks see page 6

General WT

Shear connection, thread-free part in shear joint



Shear-connection			**C24**	**GL24h**
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
			$R_{v,d}$ [kN] [1]	$R_{v,d}$ [kN] [1]
Fastener d x L	s [mm]	h_{min} [mm]	α = 45°	α = 45°
WT-T/S-6,5x90	40	65 [2]	1.14	1.21
WT-T/S-6,5x130	55	65	1.30	1.38
WT-T-6,5x90	40	45	1.00	1.06
WT-T-6,5x130	55	65	1.12	1.18
WT-T-6,5x160	65	80	1.12	1.18
WT-T-6,5x190	80	95	1.12	1.18
WT-T-6,5x220	95	110	1.12	1.18
WT-T-8,2x160	65	82 [2]	2.01	2.13
WT-T-8,2x190	80	95	2.22	2.34
WT-T-8,2x220	95	110	2.23	2.34
WT-T-8,2x245	107	123	2.23	2.34
WT-T-8,2x275	122	138	2.23	2.34
WT-T-8,2x300	135	150	2.23	2.34
WT-T-8,2x330	135	165	2.23	2.34

[1] Only up to max. 5 fasteners in a row in grain direction
[2] With pre-drilling, smaller minimum wood thicknesses are also possible

Conversion factors when there are less than 5 screws in a row in the fiber direction:

Number of screws	1	2	3	4	5
Conversion factor	1.38	1.29	1.24	1.21	1.00

General remarks

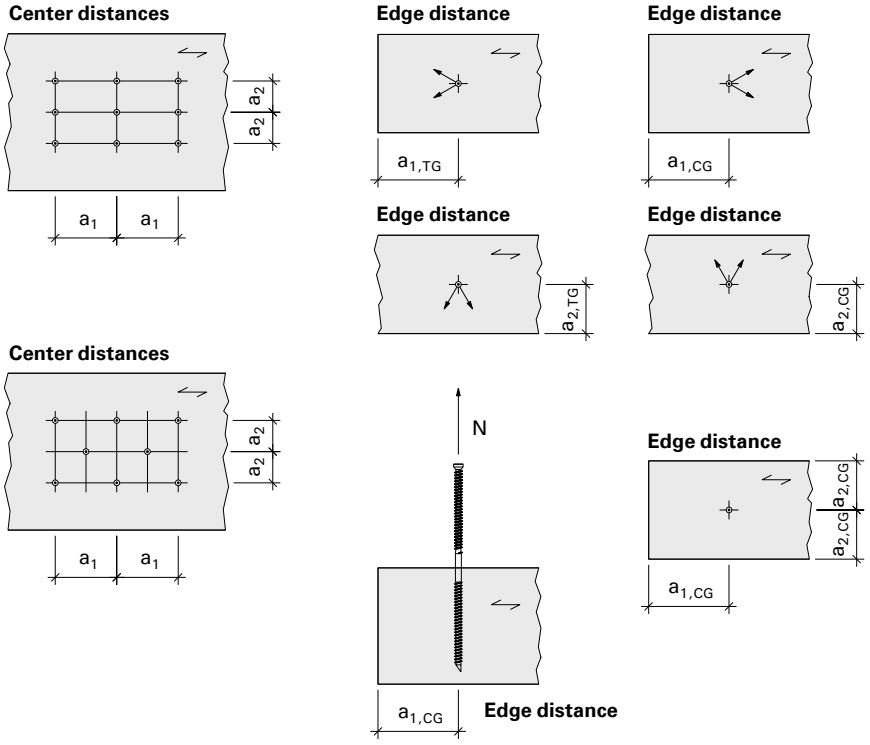
- If several fasteners or pairs of fasteners are used together in a connection, the resistances given must be multiplied by the factor n_{ef}
- Values apply to connections where half of the fasteners are located in each component
- Connection geometries according to drawings must be observed
- Angle between screw and fiber direction is 90°
- Table values for k_{mod} = 0.8 und γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible planner**

General WT

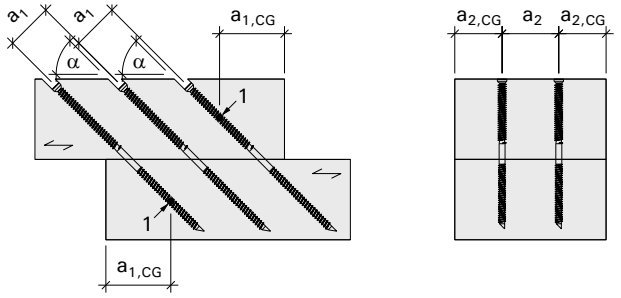
WT Edge and intermediate distances

Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the grain	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the grain	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

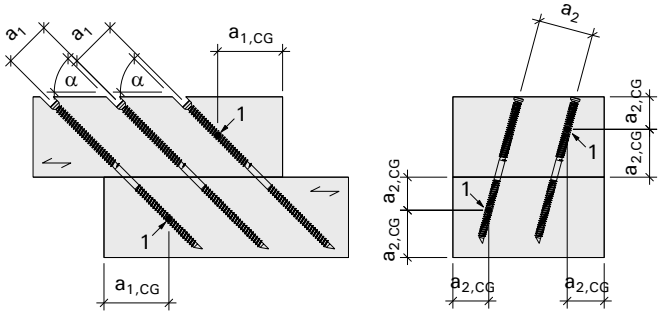
[1] Smaller spacing possible with predrilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without predrilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)



General WT



1 Center of gravity of the screw thread in the component

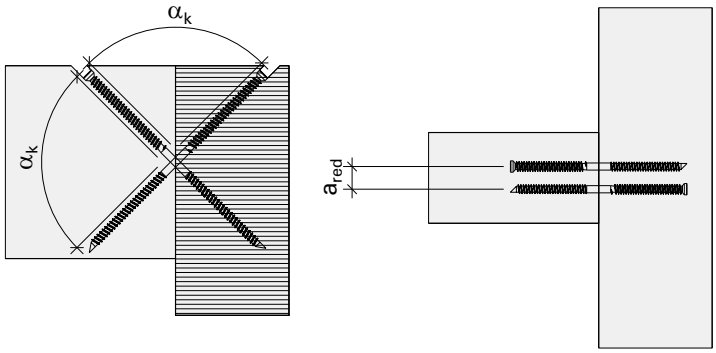


1 Center of gravity of the screw thread in the component

General WT

Minimum distances between crossed screws (axial stress)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25



eneral remarks
Before execution, all calculations must be checked and approved by the responsible planner

Fastening Sytsem WT

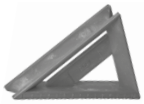
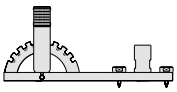
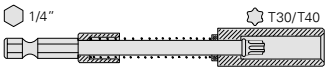
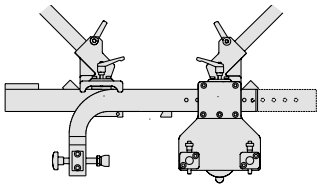
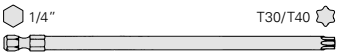
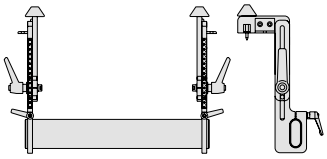
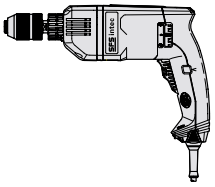
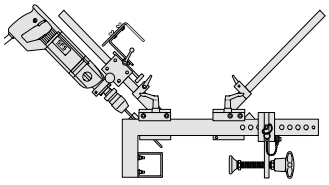
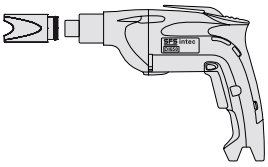
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	3.5 (4)
WT-T-8,2xL	5.0

Typ		Material		Thread diameter Ø		Length	Thread length	Head Ø	Head height	Recess
		S: A2		d		L	s	d_k	l_k	
		T: verzinkt blau [1]		[mm]		[mm]	[mm]	[mm]	[mm]	
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] for use classes: 1 and 2 (not directly weathered)

General WT

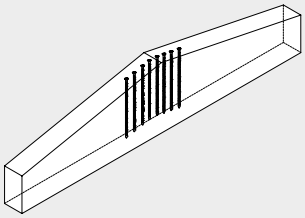
Mounting devices and accessories

Application	Devices/Accessories	Fastener	Devices/Accessories
Main/secondary beam, dowelled beam, element construction, etc.	Screw-in aid for wood construction screws 	WT-T/S-6,5xL WT-T-8,2xL	Bit holder Magic Flip Force ZA 1/4" 
Main/secondary beam, dowelled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Seting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupling purlin	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep-stop-sleeve Z661 

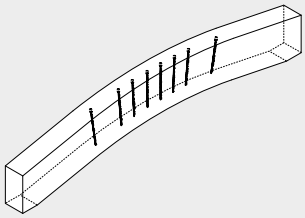
General WR

Design basis system WR

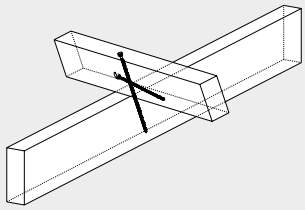
Shear tension reinforcements
gable roofs



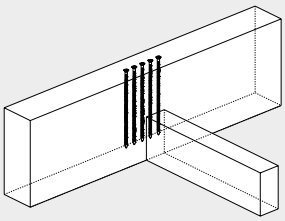
Shear tension reinforcements
curved beams



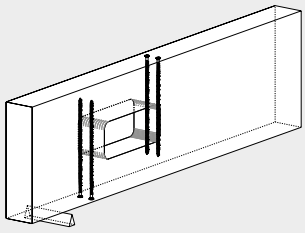
Wood-to-Wood-Connections
Rafter-Purlin. Connection



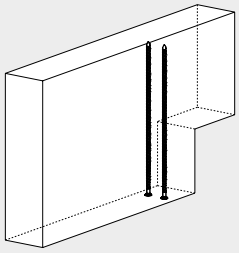
Wood-Reinforcement
Shear-tension by connections



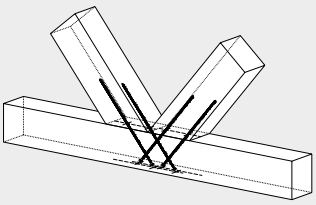
Wood-Reinforcement
Penetrations



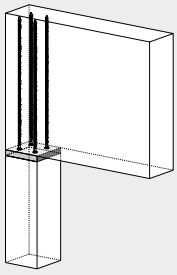
Wood-Reinforcement
Notches



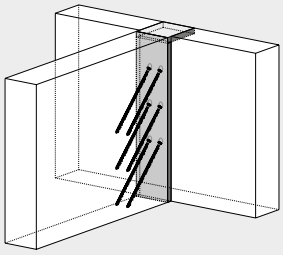
Wood-to-Wood-Connections
Face-Wood-Connections



Shear tension reinforcements
Support reinforcements



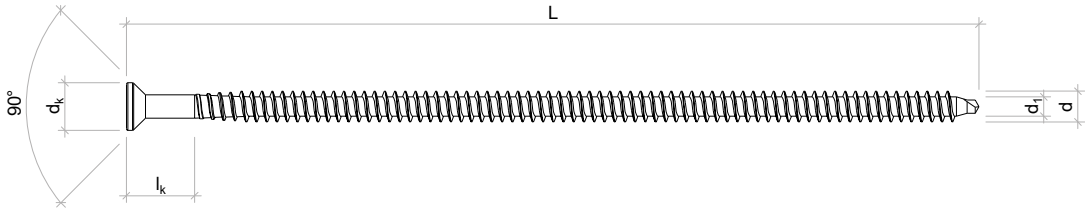
Steel-to-wood-connections
Main-Subbeam-Connections



Advantages that convince

- High load bearing capacity
- Easy processing
- Wood-steel connections
- High fire resistance of the connection
- Quick assembly without pre-drilling
- Transmission of transverse and normal forces
- Connecting means not visible
- ETA-12/0062 (WR)

General WR



Basic information about the fastener WR

	WR-T-9xL	**WR-T-13xL**	Einheit
d	9	13	[mm]
d_1	5.7	8.5	[mm]
d_k	14	22	[mm]
l_k	20	20	[mm]
$M_{y,k}$	30	80	[Nm]
$f_{tens,k}$	25	55	[kN]
$f_{tor,k}$	30	100	[Nm]

$l_{ef} = \min \{4 \cdot d / \sin \alpha ; 20 \cdot d\}$

d Outer thread diameter of the screw [mm]
α Angle between screw axis and grain direction
l_{ef} Embedment depth of the threaded part of the screw in the wood component [mm]

$f_{ax,k}$ = 12.8 [N/mm²] for solid wood (C24) and glulam (GL24h) other wood building materials see ETA-12/0063
k_{ax} = 1 at $45° \le \alpha \le 90°$
k_{ax} = $0.3 + (0.7 \cdot \alpha/45°)$ at $0° \le \alpha < 45°$
α Angle between screw axis and grain direction

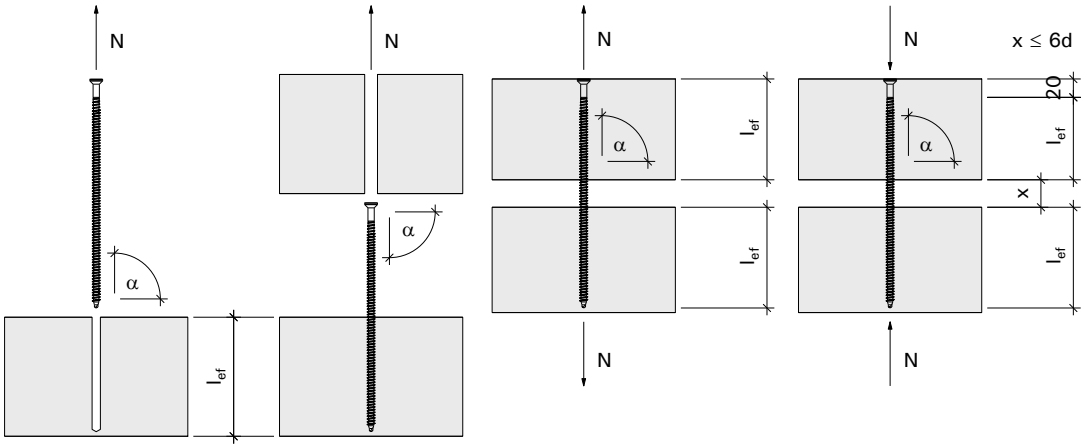
Displacement modulus when loaded in the axial direction:
$K_{ser} = 25 \cdot l_{ef} \cdot d$ (Softwood)
$K_{ser} = 30 \cdot l_{ef} \cdot d$ (Softwood ash,beech,oak)
d Outer thread diameter of the screw [mm]
l_{ef} Embedment depth of the threaded part of the screw in the wood component [mm]

Use in hardwood (ash, oak, beech, BauBuche) possible → see ETA-12/0062

For execution planning, all designs in ETA-12/0062 must be taken into account

General WR

Tension/compression connection



Tensile force connection												**C24**
												ρ_k = 350 [kg/m³]
												$R_{N,d}$ [kN]
Fastener	l_{ef} [mm]	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
WR-T-9xL	50	–	–	–	–	–	–	3.54	3.54	3.54	3.54	3.54
	100	–	–	–	5.44	6.54	7.09	7.09	7.09	7.09	7.09	7.09
	150	–	–	6.50	8.15	9.81	10.63	10.63	10.63	10.63	10.63	10.63
	200	4.25	6.46	8.66	10.87	13.08	14.18	14.18	14.18	14.18	14.18	14.18
	250	5.32	8.07	10.83	13.59	16.34	17.72	17.72	17.72	17.72	17.72	17.72
	300	6.38	9.69	13.00	16.31	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	350	7.44	11.30	15.16	19.02	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	400	8.51	12.92	17.33	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	450	9.57	14.53	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	500	10.63	16.15	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
WR-T-13xL	100	–	–	–	7.85	9.44	10.24	10.24	10.24	10.24	10.24	10.24
	200	6.14	9.33	12.52	15.70	18.89	20.48	20.48	20.48	20.48	20.48	20.48
	300	9.22	13.99	18.77	23.55	28.33	30.72	30.72	30.72	30.72	30.72	30.72
	400	12.29	18.66	25.03	31.40	37.77	40.96	40.96	40.96	40.96	40.96	40.96
	500	15.36	23.32	31.29	39.25	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	600	18.43	27.99	37.55	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	700	21.50	32.65	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	800	24.58	37.32	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	900	27.65	41.98	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	1000	30.72	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31

$n_{ef} = n^{0.9}$, where n = total number of fasteners of the joint
General remarks see page 22

= Steel failure

General WR

Tensile force connection												**C24**
												ρ_k = 350 [kg/m³]
												$R_{N,d}$ [kN]
Fastener	l_{ef} [mm]	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
WR-T-9xL	50	–	–	–	–	–	–	3.54	3.54	3.54	3.54	3.54
	100	–	–	–	5.44	6.54	7.09	7.09	7.09	7.09	7.09	7.09
	150	–	–	6.50	8.15	9.81	10.04	10.11	10.25	10.38	10.50	10.61
	200	4.25	6.46	8.66	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
	250	5.32	8.07	9.61	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
	300	6.38	9.40	9.61	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
	350	7.44	9.40	9.61	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
	400	8.51	9.40	9.61	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
	450	9.17	9.40	9.61	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
	500	9.17	9.40	9.61	9.79	9.96	10.04	10.11	10.25	10.38	10.50	10.61
WR-T-13xL	100	–	–	–	7.85	9.44	10.24	10.24	10.24	10.24	10.24	10.24
	200	6.14	9.33	12.52	15.70	18.89	20.48	20.48	20.48	20.48	20.48	20.48
	300	9.22	13.99	18.77	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	400	12.29	18.66	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	500	15.36	21.62	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	600	18.43	21.62	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	700	21.12	21.62	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	800	21.12	21.62	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	900	21.12	21.62	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22
	1000	21.12	21.62	22.07	22.47	22.83	22.99	23.15	23.45	23.73	23.98	24.22

$n_{ef} = n^{0.9}$, where n = total number of fasteners of the joint

General remarks see page 22

☐ = Steel failure

General WR

Tensile force connection												**GL24h**
												ρ_k = 385 [kg/m3]
												$R_{N,d}$ [kN]
Fastener	l_{ef} [mm]	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
WR-T-9xL	50	–	–	–	–	–	–	3.83	3.83	3.83	3.83	3.83
	100	–	–	–	5.87	7.06	7.65	7.65	7.65	7.65	7.65	7.65
	150	–	–	7.01	8.80	10.58	11.48	11.48	11.48	11.48	11.48	11.48
	200	4.59	6.97	9.35	11.73	14.11	15.30	15.30	15.30	15.30	15.30	15.30
	250	5.74	8.71	11.69	14.66	17.64	19.13	19.13	19.13	19.13	19.13	19.13
	300	6.89	10.46	14.03	17.60	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	350	8.03	12.20	16.36	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	400	9.18	13.94	18.70	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	450	10.33	15.68	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
	500	11.48	17.43	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23	19.23
WR-T-13xL	100	–	–	–	8.47	10.19	11.05	11.05	11.05	11.05	11.05	11.05
	200	6.63	10.07	13.51	16.95	20.38	22.10	22.10	22.10	22.10	22.10	22.10
	300	9.95	15.10	20.26	25.42	30.58	33.15	33.15	33.15	33.15	33.15	33.15
	400	13.26	20.14	27.01	33.89	40.77	42.31	42.31	42.31	42.31	42.31	42.31
	500	16.58	25.17	33.77	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	600	19.89	30.21	40.52	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	700	23.21	35.24	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	800	26.52	40.28	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	900	29.84	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31
	1000	33.15	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31	42.31

$n_{ef} = n^{0.9}$, where n = total number of fasteners of the joint

General remarks see page 22

= Steel failure

General WR

Compression force Connection												**GL24h**
												ρ_k = 385 [kg/m³]
												$R_{N,d}$ [kN]
Fastener	l_{ef} [mm]	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°	90°
WR-T-9xL	50	–	–	–	–	–	–	3.83	3.83	3.83	3.83	3.83
	100	–	–	–	5.87	7.06	7.65	7.65	7.65	7.65	7.65	7.65
	150	–	–	7.01	8.80	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	200	4.59	6.97	9.35	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	250	5.74	8.71	9.81	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	300	6.89	9.61	9.81	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	350	8.03	9.61	9.81	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	400	9.18	9.61	9.81	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	450	9.38	9.61	9.81	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
	500	9.38	9.61	9.81	9.99	10.16	10.23	10.31	10.44	10.57	10.68	10.79
WR-T-13xL	100	–	–	–	8.47	10.19	11.05	11.05	11.05	11.05	11.05	11.05
	200	6.63	10.07	13.51	16.95	20.38	22.10	22.10	22.10	22.10	22.10	22.10
	300	9.95	15.10	20.26	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	400	13.26	20.14	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	500	16.58	22.07	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	600	19.89	22.07	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	700	21.58	22.07	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	800	21.58	22.07	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	900	21.58	22.07	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61
	1000	21.58	22.07	22.50	22.90	23.25	23.41	23.57	23.86	24.13	24.38	24.61

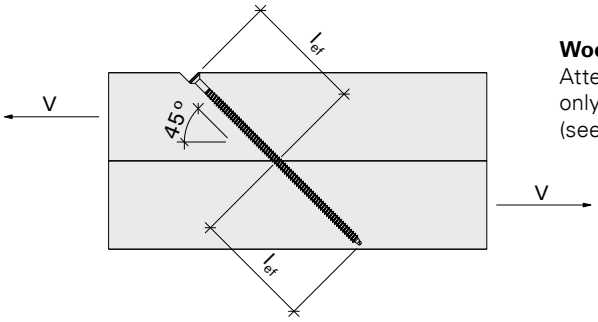
$n_{ef} = n^{0.9}$, where n = total number of fasteners of the joint

General remarks see page 22

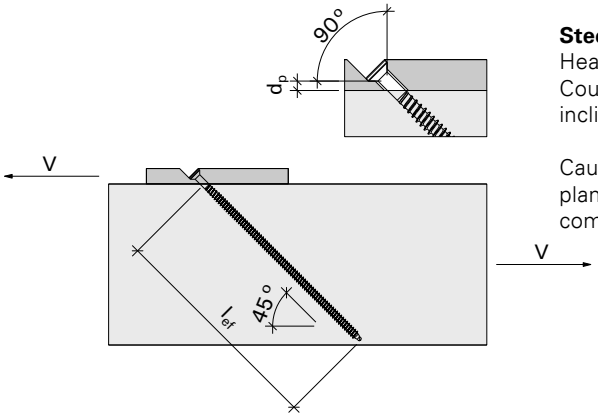
= Steel failure

General WR

Shear load connection

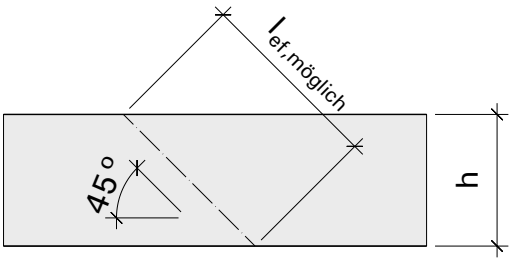


Wood–Wood
Attention: In case of one-sided inclination, only forces from one direction can be absorbed (see fig.)



Steel–Wood
Head must rest fully in the hole in the steel plate. Countersink the hole according to the screw inclination. dp should be at least 5 mm.

Caution: Steel-wood connections should only be planned and executed by experienced specialist companies.



h [mm]	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360
$l_{ef,\,möglich}$ [mm]	56	84	113	141	169	197	226	254	282	311	339	367	395	424	452	480	509

General WR

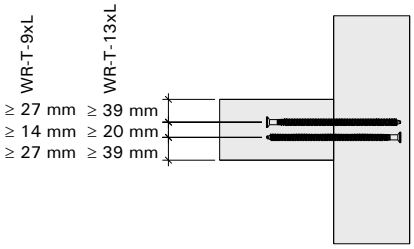
Shear load connection		**C24**	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9xL	50	–	–
	100	5.01	5.41
	150	7.52	8.12
	200	10.03	10.82
	250	12.53	13.53
	300	13.60	13.60
	350	13.60	13.60
	400	13.60	13.60
	450	13.60	13.60
	500	13.60	13.60
WR-T-13xL	100	7.24	7.81
	200	14.48	15.63
	300	21.72	23.44
	400	28.96	29.92
	500	29.92	29.92
	600	29.92	29.92
	700	29.92	29.92
	800	29.92	29.92
	900	29.92	29.92
	1000	29.92	29.92

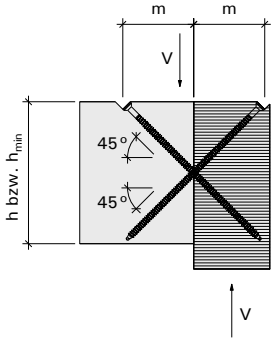
$n_{ef} = n^{0.9}$, where n = total number of fasteners in the connection
Exception: dowelled beam → $n_{ef} = n$
For steel connections, fasteners must be equally stressed.
It is recommended to use torque-controlled tools.
For general remarks see page 22

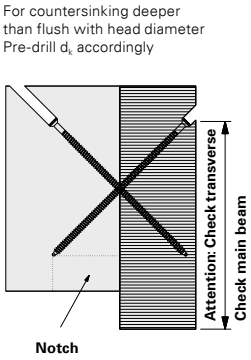
= Steel failure

General WR

Connection main/secondary beam







General WR

Connection main/secondary beam				**C24**	**GL24h**
				ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	h_{min} [mm]	m [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9x250	105	200	98	10.53	11.36
WR-T-9x300	130	240	116	13.03	14.07
WR-T-9x350	155	260	134	14.20	14.47
WR-T-9x400	180	300	151	14.20	14.47
WR-T-9x450	205	340	169	14.20	14.47
WR-T-9x500	230	380	187	14.20	14.47
WR-T-13x400	180	300	157	26.07	28.13
WR-T-13x500	230	380	192	32.52	33.11
WR-T-13x600	280	440	228	32.52	33.11
WR-T-13x700	330	520	263	32.52	33.11
WR-T-13x800	380	580	298	32.52	33.11
WR-T-13x900	430	660	334	32.52	33.11
WR-T-13x1000	480	720	369	32.52	33.11

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws
Values apply to connections where half of the fasteners are in both components
α = 45° (screw-in angle)
General remarks see below

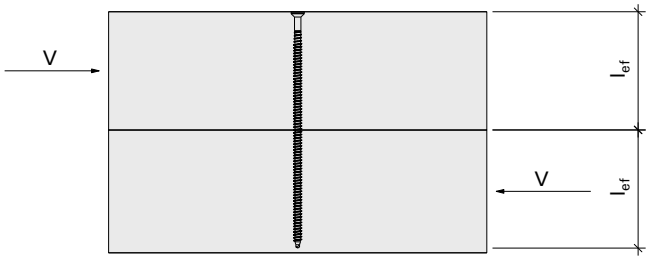
☐ = Steel failure

General remarks

- Transverse tensile stresses must be verified separately
- In case of several fasteners or pairs of fasteners acting together in one connection, the indicated resistances must be multiplied by the factor n_{ef}.
- Values apply to corresponding anchorage lengths l_{ef} of the thread
- For WR-T screws subjected to axial compression, where the screw head is pushed out of the wood and therefore does not carry, the screw head side must be offset by 20 mm
- For steel connections, the fasteners must be equally stressed. It is recommended to work with torque-controlled tools
- Connection geometries according to drawings must be observed
- Table values for k_{mod} = 0.8 und γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible planner**

General WR

Shear connection



Shear connection	C24	GL24h
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	$R_{v,d}$ [kN][1)]	$R_{v,d}$ [kN][1)]
WR-T-9xL	2.48	2.60
WR-T-13xL	4.67	4.90

[1)] only up to max. 5 fasteners in a row in fiber direction

Conversion factors when there are less than 5 screws in a row in fiber direction

Number of screws	1	2	3	4	5
Conversion factors	1.38	1.29	1.24	1.21	1.00

General remarks

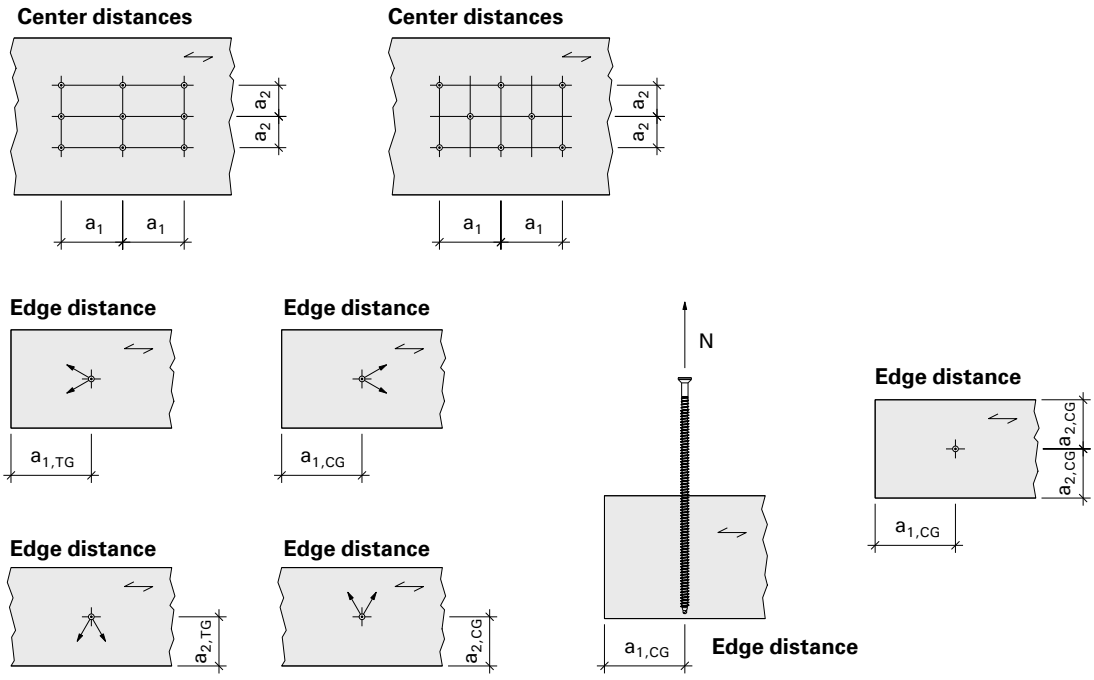
- In the case of several fasteners or pairs of fasteners acting together in one connection, the indicated resistances must be multiplied by the factor nef
- Values apply to connections where the fasteners are located at least l_{ef} = 90 mm (WR-T-9xL) or l_{ef} = 140 mm (WR-T-13xL) in both components
- Table values for k_{mod} = 0.8 and γ_M= 1.3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Before execution, all calculations must be checked and approved by the responsible planner**

General WR

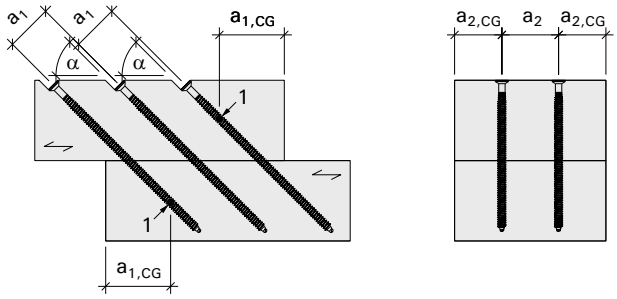
WR Edge and intermediate distances

Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fiber	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fiber	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

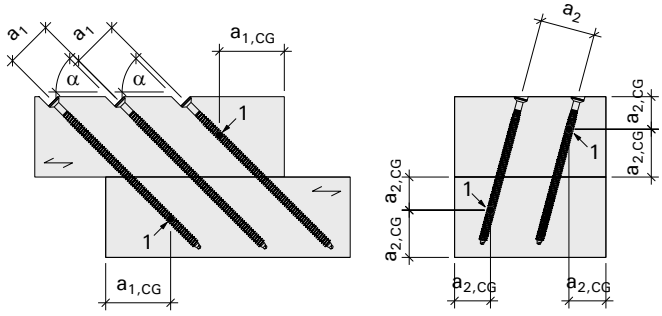
[1] Smaller spacing possible with predrilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without predrilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)



General WR



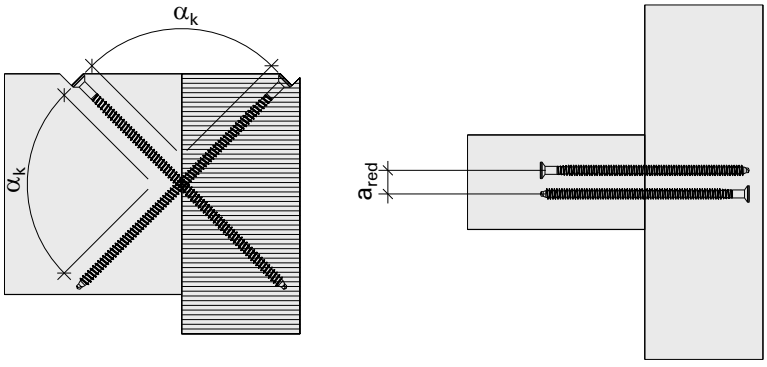
1 Center of gravity of the screw thread in the component



1 Center of gravity of the screw thread in the component

Minimum distances between crossed screws (axial stress)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{red} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{red} [mm]	20	38	44	49	55	60	65



General WR

General remarks
Before execution, all calculations must be checked and approved by the responsible planner

Fastening system WR

Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Typ		Material		Thread Ø		Length	Head Ø	Head Height	Bit
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T		9	x	250	14	20	T40
WR	-	T		9	x	300	14	20	T40
WR	-	T		9	x	350	14	20	T40
WR	-	T		9	x	400	14	20	T40
WR	-	T		9	x	450	14	20	T40
WR	-	T		9	x	500	14	20	T40
WR	-	T		13	x	400	22	20	T50
WR	-	T		13	x	500	22	20	T50
WR	-	T		13	x	600	22	20	T50
WR	-	T		13	x	700	22	20	T50
WR	-	T		13	x	800	22	20	T50
WR	-	T		13	x	900	22	20	T50
WR	-	T		13	x	1000	22	20	T50

[1] for use classes: 1 and 2 (not directly weathered)

General WR

Mounting devices and accessories

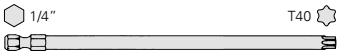
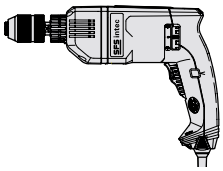
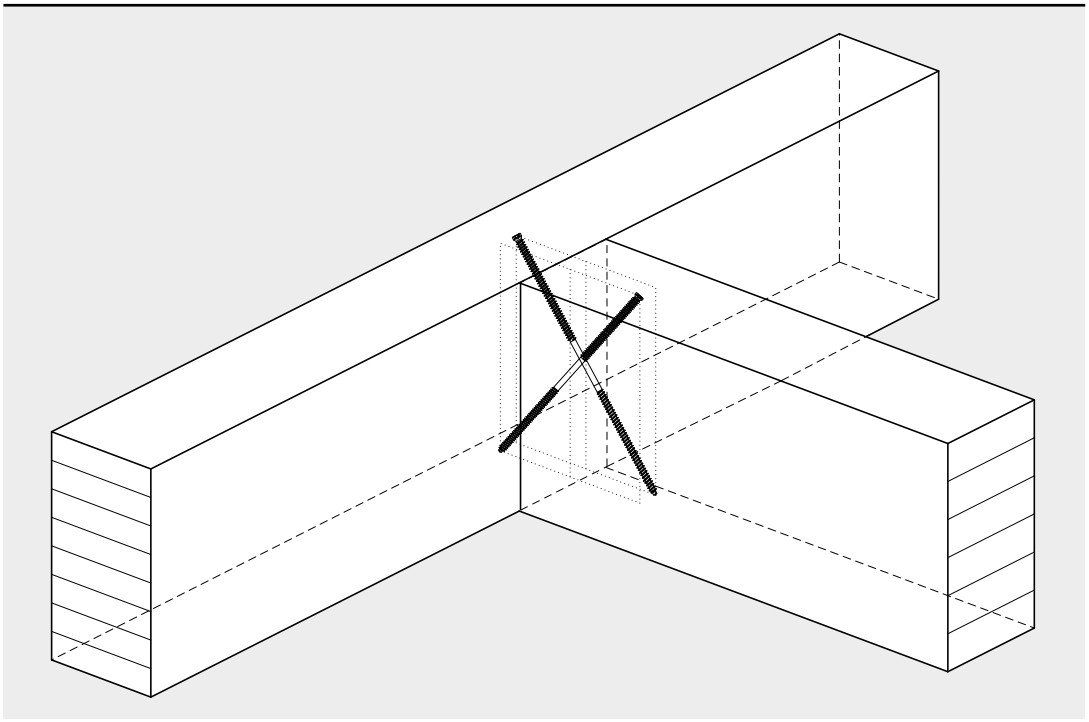
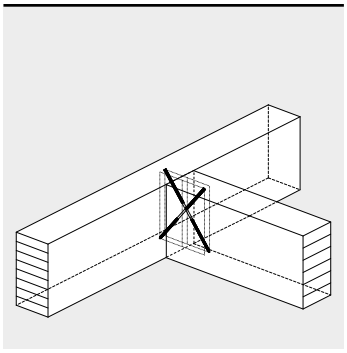
Fastener WR-T-9×L	Fastener WR-T-13×L	
Bit T40: Length 70, 152, 200, 350, 520 [mm] 	Wera Torx-Bit 5/16 Drive: E 3,6 ¼" 	Garant Torx ½" Drive: Square ½" 
Screw-in adapter for WR 	SFS attachment ZA ½" Drive square ½" 	Screw-in adapter for WR 
Power drill BO 1055 	Power drill 32-4 	

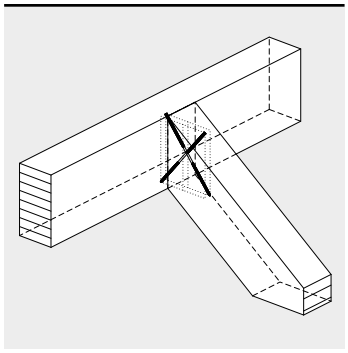

Bild © by Dani Ammann Photography

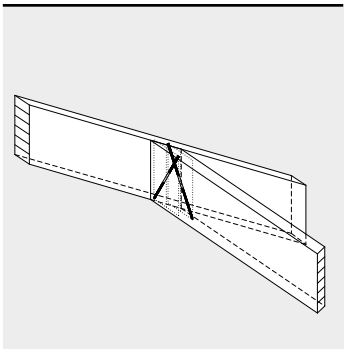
Connection main/secondary beam

Applications



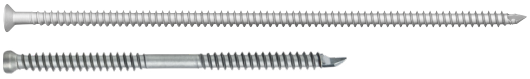






Advantages that convince

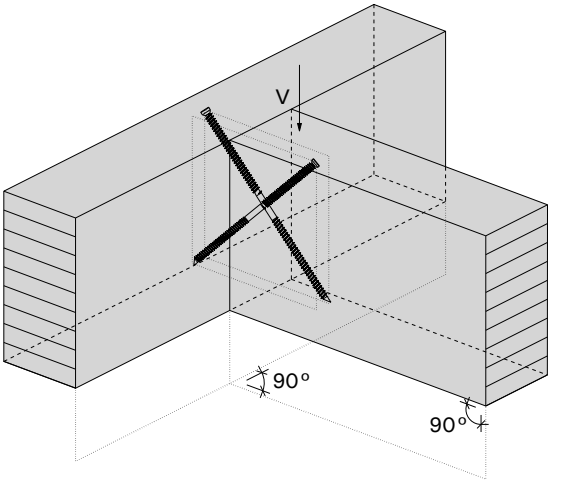
- High load capacity
- Easy processing
- Connecting means not visible
- High fire resistance of the joint
- Fast assembly
- Transmission of transverse and normal forces
- ETA-12/0062 (WT)
- ETA-12/0063 (WR)

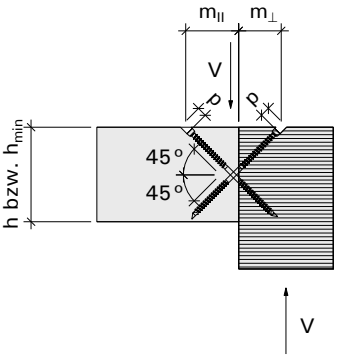


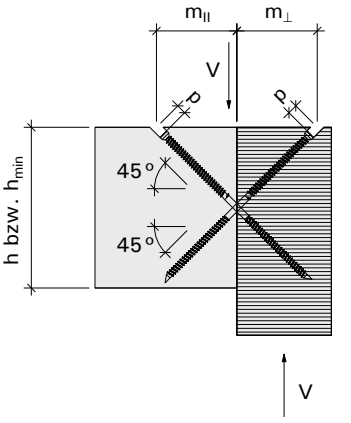
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

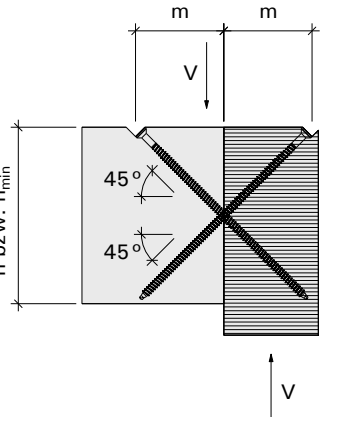
Connection main/secondary beam

Right angle connection

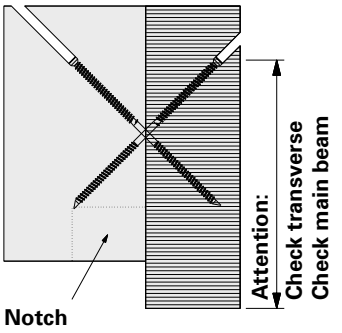




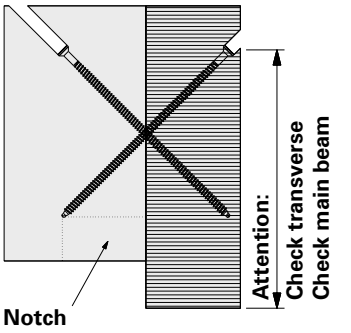




Notch



For countersinking deeper than flush with head diameter d_k pre-drill accordingly



Connection main/secondary beam

Connection main/secondary beam with WT

Fastener-dxL [mm]	s [mm]	h_{min} [mm]	m_{II} [mm]	$m_{\perp}$ [mm]	p [mm]
WT-T/S-6,5x90	40	–	–	–	–
WT-T/S-6,5x130	55	100	h/2 + 6	h/2 – 6	hx0,707 – 65
WT-T-6,5x160	65	120	h/2	h/2	hx0,707 – 80
WT-T-6,5x190	80	140	h/2	h/2	hx0,707 – 95
WT-T-6,5x220	95	160	h/2	h/2	hx0,707 – 110
WT-T-8,2x160	65	120	h/2 + 7	h/2 – 7	hx0,707 – 80
WT-T-8,2x190	80	140	h/2 + 2	h/2 – 2	hx0,707 – 95
WT-T-8,2x220	95	160	h/2	h/2	hx0,707 – 110
WT-T-8,2x245	107	180	h/2	h/2	hx0,707 – 123
WT-T-8,2x275	122	200	h/2	h/2	hx0,707 – 138
WT-T-8,2x300	135	220	h/2	h/2	hx0,707 – 150
WT-T-8,2x330	135	240	h/2	h/2	hx0,707 – 165

	1 Pair		2 Pair		3 Pair	
	C24	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WT-T/S-6,5x90	–	–	–	–	–	–
WT-T/S-6,5x130	3.61	3.89	6.73	7.26	9.69	10.46
WT-T-6,5x160	4.33	4.67	8.08	8.72	11.64	12.56
WT-T-6,5x190	5.42	5.85	10.11	10.91	14.56	15.71
WT-T-6,5x220	6.50	7.02	12.13	13.09	17.48	18.86
WT-T-8,2x160	5.34	5.77	9.97	10.76	14.36	15.50
WT-T-8,2x190	6.71	7.25	12.53	13.52	18.05	19.48
WT-T-8,2x220	8.08	8.72	15.09	16.28	21.73	23.45
WT-T-8,2x245	9.18	9.91	17.13	18.49	24.68	26.63
WT-T-8,2x275	10.55	11.39	19.69	21.25	28.36	30.60
WT-T-8,2x300	11.74	12.67	21.90	23.64	31.55	34.05
WT-T-8,2x330	11.74	12.67	21.90	23.64	31.55	34.05

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws
α = 45° (screw-in angle)
If the edge distances allow it, h_{min} can be undercut
General remarks see page 33

Connection main/secondary beam

Connection main/secondary beam with WR

Fastener-dxL [mm]	l_{ef} [mm]	h_{min} [mm]	m [mm]
WR-T-9x250	105	200	98
WR-T-9x300	130	240	116
WR-T-9x350	155	260	134
WR-T-9x400	180	300	151
WR-T-9x450	205	340	169
WR-T-9x500	230	380	187
WR-T-13x400	180	300	157
WR-T-13x500	230	380	192
WR-T-13x600	280	440	228
WR-T-13x700	330	520	263
WR-T-13x800	380	580	298
WR-T-13x900	430	660	334
WR-T-13x1000	480	720	369

	1 Pair		2 Pair		3 Pair	
	C24	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9x250	10.61	11.45	19.79	21.36	28.51	30.77
WR-T-9x300	13.13	14.17	24.50	26.45	35.29	38.09
WR-T-9x350	14.20	14.47	26.49	27.00	38.16	38.90
WR-T-9x400	14.20	14.47	26.49	27.00	38.16	38.90
WR-T-9x450	14.20	14.47	26.49	27.00	38.16	38.90
WR-T-9x500	14.20	14.47	26.49	27.00	38.16	38.90
WR-T-13x400	26.26	28.34	49.01	52.89	70.59	76.18
WR-T-13x500	32.52	33.11	60.68	61.78	87.41	88.99
WR-T-13x600	32.52	33.11	60.68	61.78	87.41	88.99
WR-T-13x700	32.52	33.11	60.68	61.78	87.41	88.99
WR-T-13x800	32.52	33.11	60.68	61.78	87.41	88.99
WR-T-13x900	32.52	33.11	60.68	61.78	87.41	88.99
WR-T-13x1000	32.52	33.11	60.68	61.78	87.41	88.99

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws
Values apply to connections where the fasteners are located half in each component
α = 45° (screw-in angle)
For countersinking deeper than flush with head diameter d_k, pre-drill accordingly (see end of chapter)
If the edge distances permit, h_{min} may be less than the specified value
If the edge distances allow it, h_{min} can be undercut
General remarks see page 33

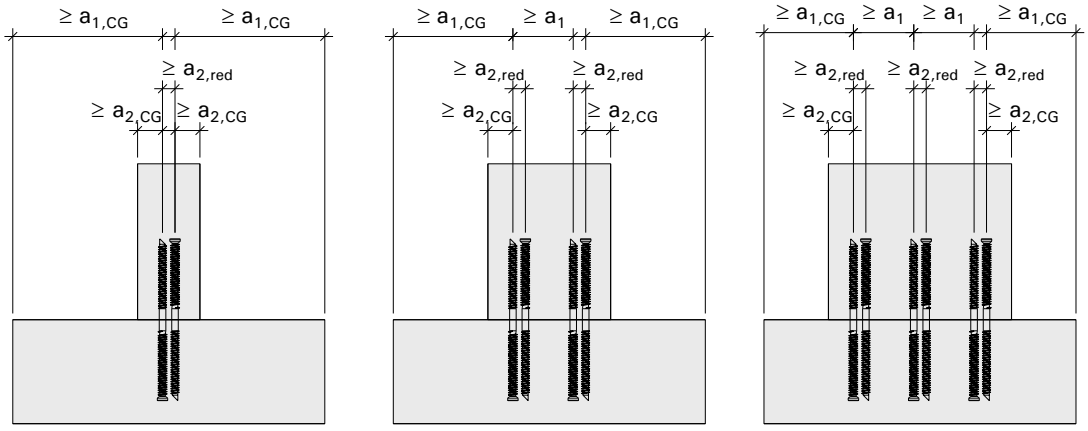
= Steel failure

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

General remarks

- Transverse tensile stresses must be verified separately
- In the case of several fasteners or pairs of fasteners acting together in one connection, the resistances given must be multiplied by the factor n_{ef}
- Values apply to connections where half of the fasteners are located in each component "WT" (for a few exceptions see "Connection of main/secondary beam") or for the indicated anchorage lengths l_{ef} of the thread "WR"
- Connection geometries according to drawings must be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- General information on WT and WR bolts can be found in the subchapters:
  "General information WT" from page 3
  "General information WR" from page 13
- **Prior to execution, all calculations must be checked and approved by the responsible planner**



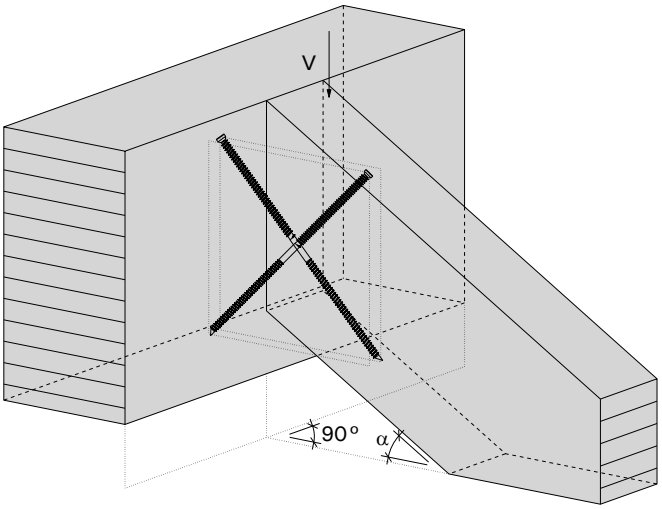
Distance [mm]	**WT-T/S-6,5xL**	**WT-T-8,2xL**	**WR-T-9xL**	**WR-T-13xL**
a_1	78	99	45	65
$a_{1,CG}$	52	66	45	65
$a_{2,CG}$	20	24	27	39
a_{red}	10	12	14	20

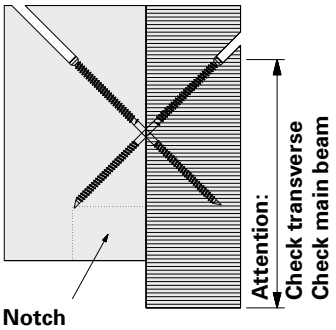
Minimum bar width [mm]	**1 Pair**	**2 Pair**	**3 Pair**
WT-T/S-6,5xL	50	128	206
WT-T-8,2xL	60	138	258
WR-T-9xL	68	113	158
WR-T-13xL	98	163	228

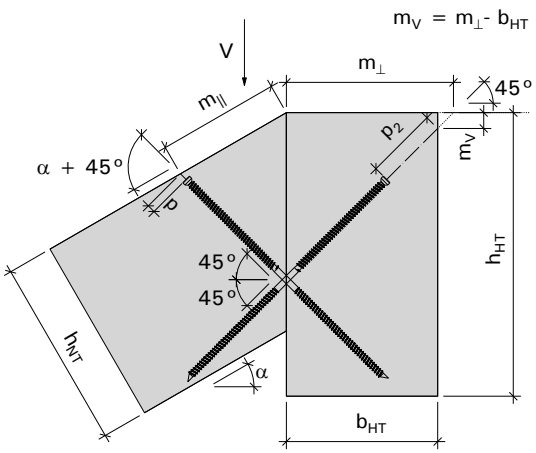
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

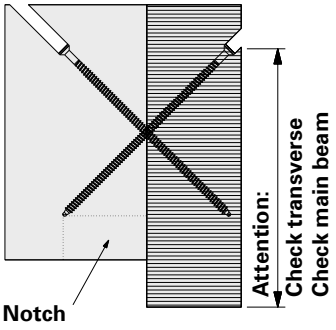
Inclined connection in vertical plane







For countersinking deeper than flush with head diameter d_k pre-drill accordingly



Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

Connection main/secondary beam with WR

Fastener-dxL [mm]	p [mm]	p_2 [mm]	x [mm]	$m_{\parallel}$ [mm]	$m_{\perp}$ [mm]	h_{HT}	b_{HT}	h_{NT}	b_{NT}
WT-T/S-6,5x130	$\frac{-1\cdot(\cos\alpha\cdot L\cdot\sqrt{2}-2\cdot h_{NT})}{4\cdot\sin(\alpha+45°)}$	$\sqrt{2}\cdot\left[\frac{p}{\sqrt{2}}+m_{\parallel}\cdot\sin\alpha-m_V\right]$	6	$\frac{4\cdot x+(L+2\cdot p)\cdot\sqrt{2}}{4\cdot\cos\alpha}$	$m_{\parallel}\cdot\cos\alpha-2\cdot x+m_{\parallel}\cdot\sin\alpha$	$\frac{p}{\sqrt{2}}+m_{\parallel}\cdot\sin\alpha+\frac{L}{\sqrt{2}}$	40	$\left\{\begin{array}{l}\frac{L\cdot\sin(45°-\alpha)}{4}\\0\\\left\{2\cdot\left[3\cdot d-\frac{L\cdot\sin(45°-\alpha)}{4}\right]\right\}\\\frac{L}{\sqrt{2}}\cdot\cos\alpha+max\end{array}\right.$	50
WT-T-6,5x160			0				55		
WT-T-6,5x190			0				65		
WT-T-6,5x220			0				80		
WT-T-8,2x160			7				50		60
WT-T-8,2x190			2				65		
WT-T-8,2x220			0				80		
WT-T-8,2x245			0				85		
WT-T-8,2x275			0				95		
WT-T-8,2x300			0				105		
WT-T-8,2x330			0				115		

	α = 10°α		α = 20°		α = 30°	
	C24	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WT-T/S-6,5x130	3.04	3.29	–	–	–	–
WT-T-6,5x160	3.66	3.95	2.98	3.22	–	–
WT-T-6,5x190	4.57	4.94	3.73	4.03	–	–
WT-T-6,5x220	5.49	5.93	4.48	4.83	–	–
WT-T-8,2x160	4.51	4.87	–	–	–	–
WT-T-8,2x190	5.67	6.12	4.63	4.99	–	–
WT-T-8,2x220	6.83	7.37	5.57	6.01	–	–
WT-T-8,2x245	7.75	8.37	6.32	6.83	–	–
WT-T-8,2x275	8.91	9.62	7.27	7.84	–	–
WT-T-8,2x300	9.91	10.70	8.09	8.73	6.26	6.76
WT-T-8,2x330	9.91	10.70	8.09	8.73	6.26	6.76

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws General
General remarks see page 37

Connection main/secondary beam

Connection main/secondary beam with WR

Fastener-dxL [mm]	p [mm]	p_2 [mm]	$m_{\parallel}$ [mm]	$m_{\perp}$ [mm]	h_{HT}	b_{HT}	h_{NT}	b_{NT}
WR-T-9x250	$\frac{-1 \cdot \left(\cos\alpha \cdot L \cdot \sqrt{2} - 2 \cdot h_{NT}\right)}{4 \cdot \sin(\alpha + 45°)}$	$\sqrt{2} \cdot \left[\frac{p}{\sqrt{2}} + m_{\parallel} \cdot \sin\alpha - m_V\right]$	$\frac{(L + 2 \cdot p) \cdot \sqrt{2}}{4 \cdot \cos\alpha}$	$m_{\parallel} \cdot \cos\alpha + m_{\parallel} \cdot \sin\alpha$	$\frac{p}{\sqrt{2}} + m_{\parallel} \cdot \sin\alpha + \frac{L}{\sqrt{2}}$	90	$\frac{L}{\sqrt{2}} \cdot \cos\alpha + max\left\{2 \cdot \left[3 \cdot d - \frac{L \cdot \sin(45° - \alpha))}{4}\right]\right\}$	68
WR-T-9x300						105		
WR-T-9x350						125		
WR-T-9x400						140		
WR-T-9x450						160		
WR-T-9x500						175		
WR-T-13x400						140		98
WR-T-13x500						175		
WR-T-13x600						210		
WR-T-13x700						245		
WR-T-13x800						285		
WR-T-13x900						320		
WR-T-13x1000						355		

	α = 10°α		α = 20°		α = 30°	
	C24	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9x250	8.89	9.59	7.25	7.83	–	–
WR-T-9x300	11.01	11.88	8.98	9.69	–	–
WR-T-9x350	13.12	14.16	10.71	11.55	8.29	8.94
WR-T-9x400	13.97	14.25	12.43	13.42	9.62	10.39
WR-T-9x450	13.97	14.25	13.72	14.01	10.96	11.83
WR-T-9x500	13.97	14.25	13.72	14.01	12.30	13.27
WR-T-13x400	22.01	23.76	17.96	19.38	–	–
WR-T-13x500	28.13	30.35	22.95	24.76	17.76	19.17
WR-T-13x600	32.03	32.63	27.93	30.15	21.63	23.34
WR-T-13x700	32.03	32.63	31.50	32.11	25.49	27.51
WR-T-13x800	32.03	32.63	31.50	32.11	29.35	31.53
WR-T-13x900	32.03	32.63	31.50	32.11	30.90	31.53
WR-T-13x1000	32.03	32.63	31.50	32.11	30.90	31.53

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

Connection main/secondary beam

	α = 40°α		α = 45°	
	C24	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9x250	–	–	–	–
WR-T-9x300	–	–	–	–
WR-T-9x350	–	–	–	–
WR-T-9x400	6.82	7.36	5.41	5.84
WR-T-9x450	7.76	8.38	6.17	6.65
WR-T-9x500	8.71	9.40	6.92	7.47
WR-T-13x400	–	–	–	–
WR-T-13x500	–	–	–	–
WR-T-13x600	15.32	16.53	12.16	13.13
WR-T-13x700	18.05	19.48	14.34	15.47
WR-T-13x800	20.79	22.44	16.51	17.82
WR-T-13x900	23.52	25.39	18.68	20.16
WR-T-13x1000	26.26	28.34	20.85	22.51

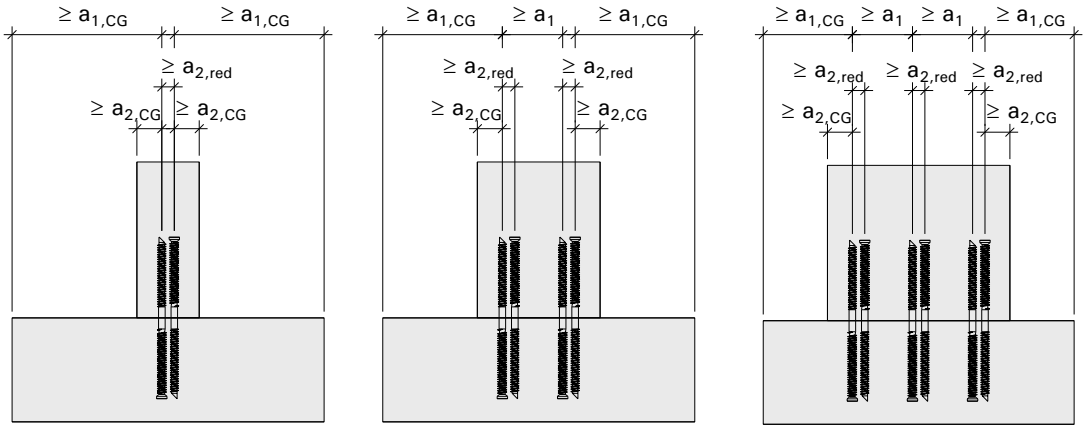
$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws
Values apply to connections where half of the fasteners are in both components
For countersinking deeper than flush with head diameter d_k pre-drill accordingly (see end of chapter)
General remarks see below

= Steel failure

General remarks

- Transverse tensile stresses must be verified separately
- In the case of several fasteners or pairs of fasteners acting together in one connection, the resistances given must be multiplied by the factor n_{ef}
- Values apply to connections where half of the fasteners are located in each component "WT" (for a few exceptions see "Connection of main/secondary beam") or for the indicated anchorage lengths l_{ef} of the thread "WR"
- Connection geometries according to drawings must be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- General information on WT and WR bolts can be found in the subchapters:
  "General information WT" from page 3
  "General information WR" from page 13
- **Prior to execution, all calculations must be checked and approved by the responsible planner**

Connection main/secondary beam



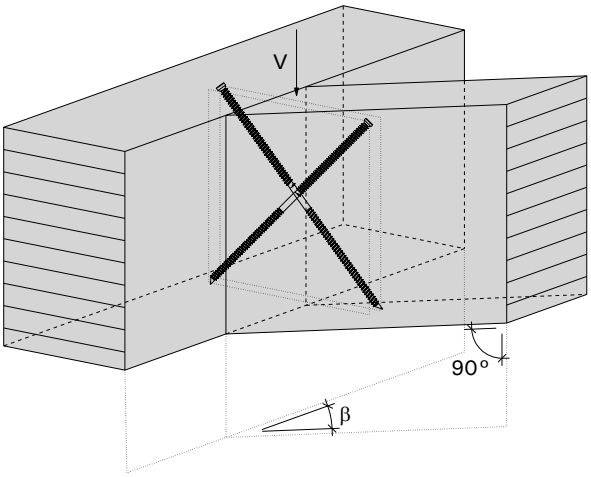
Distance [mm]	**WT-T/S-6,5xL**	**WT-T-8,2xL**	**WR-T-9xL**	**WR-T-13xL**
a_1	78	99	45	65
$a_{1,CG}$	52	66	45	65
$a_{2,CG}$	20	24	27	39
a_{red}	10	12	14	20

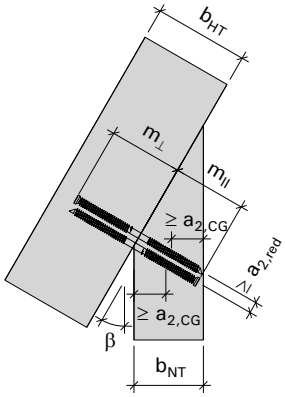
Minimum beam width [mm]	**1 Pair**	**2 Pair**	**3 Pair**
WT-T/S-6,5xL	50	128	206
WT-T-8,2xL	60	138	258
WR-T-9xL	68	113	158
WR-T-13xL	98	163	228

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

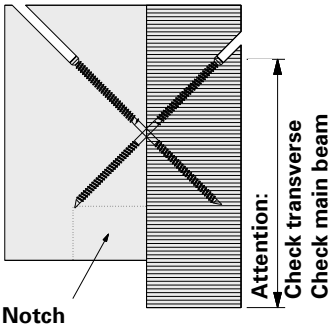
Connection main/secondary beam

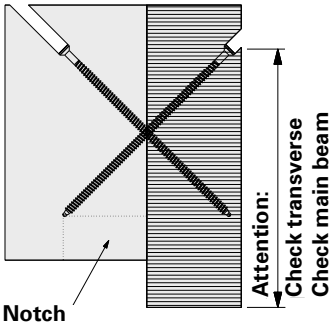
Inclined connection in horizontal plane - Fastener arrangement perpendicular to the main beam





For countersinking deeper than flush with head diameter d_k pre-drill accordingly





Connection main/secondary beam

Connection main/secondary beam

					Minimum dimension [mm]		
Fastener-dxL [mm]	s [mm]	m_{II} [mm]	$m_{\perp}$ [mm]	p [mm] [1)]	$h_{HT} = h_{NT} = h$ [mm]	b_{HT} [mm]	b_{NT} [mm]
WT-T/S-6,5x90	40	–	–	–	–	–	–
WT-T/S-6,5x130	55	h/2 + 6	h/2 – 6	hx0,707 – 65	100	40	$\max\left\{\begin{matrix} a_{2,red} \cdot \sin\beta + \frac{L}{2 \cdot \sqrt{2}} \cdot \sin\beta \\ 2 \cdot a_{2,CG} + a_{2,red} \end{matrix}\right.$
WT-T-6,5x160	65	h/2	h/2	hx0,707 – 80	120	55	
WT-T-6,5x190	80	h/2	h/2	hx0,707 – 95	140	65	
WT-T-6,5x220	95	h/2	h/2	hx0,707 – 110	160	80	
WT-T-8,2x160	65	h/2 + 7	h/2 – 7	hx0,707 – 80	120	50	
WT-T-8,2x190	80	h/2 + 2	h/2 – 2	hx0,707 – 95	140	65	
WT-T-8,2x220	95	h/2	h/2	hx0,707 – 110	160	80	
WT-T-8,2x245	107	h/2	h/2	hx0,707 – 123	180	85	
WT-T-8,2x275	122	h/2	h/2	hx0,707 – 138	200	95	
WT-T-8,2x300	135	h/2	h/2	hx0,707 – 150	220	105	
WT-T-8,2x330	135	h/2	h/2	hx0,707 – 165	240	115	

	C24	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WT-T/S-6,5x90	–	–
WT-T/S-6,5x130	3.61	3.89
WT-T-6,5x160	4.33	4.67
WT-T-6,5x190	5.42	5.85
WT-T-6,5x220	6.50	7.02
WT-T-8,2x160	5.34	5.77
WT-T-8,2x190	6.71	7.25
WT-T-8,2x220	8.08	8.72
WT-T-8,2x245	9.18	9.91
WT-T-8,2x275	10.55	11.39
WT-T-8,2x300	11.74	12.67
WT-T-8,2x330	11.74	12.67
	11.74	

[1)] see "Right-angle connection

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws

α = 45° (screw-in angle)

If the edge distances permit, h can be undershot

General remarks see page 41

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

Connection main/secondary beam

						C24	GL24h
			Minimum dimension [mm]			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	l_{ef} [mm]	m [mm] [1]	$h_{HT} = h_{NT} = h$ [mm]	b_{HT} [mm]	b_{NT} [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9x250	105	98	200	90	$\max\left\{\begin{matrix} a_{2,red}\cdot\sin\beta + \frac{L}{2\cdot\sqrt{2}}\cdot\sin\beta \\ 2\cdot a_{2,CG} + a_{2,red}\end{matrix}\right.$	10.53	11.36
WR-T-9x300	130	116	240	105		13.03	14.07
WR-T-9x350	155	134	260	125		14.20	14.47
WR-T-9x400	180	151	300	140		14.20	14.47
WR-T-9x450	205	169	340	160		14.20	14.47
WR-T-9x500	230	187	380	175		14.20	14.47
WR-T-13x400	180	157	300	140		26.07	28.13
WR-T-13x500	230	192	380	175		32.52	33.11
WR-T-13x600	280	228	440	210		32.52	33.11
WR-T-13x700	330	263	520	245		32.52	33.11
WR-T-13x800	380	298	580	285		32.52	33.11
WR-T-13x900	430	334	660	320		32.52	33.11
WR-T-13x1000	480	369	720	355		32.52	33.11

[1] $m = m_{\parallel} = m_{\perp}$ [mm]

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws

Values apply to connections where the fasteners are half in each component

α = 45° (screw-in angle)

For countersinking deeper than flush with head diameter d_k, pre-drill accordingly (see end of chapter)

If edge distances permit, h can be undercut

General remarks see below

= Steel failure

General remarks

- Transverse tensile stresses must be verified separately
- In the case of several fasteners or pairs of fasteners acting together in one connection, the resistances given must be multiplied by the factor n_{ef}
- Values apply to connections where half of the fasteners are located in each component
  "WT" (for a few exceptions see "Connection of main/secondary beam") or for the indicated anchorage lengths l_{ef} of the thread "WR"
- Connection geometries according to drawings must be observed
- Table values for k_{mod} = 0.8 and γ_M = 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- General information on WT and WR bolts can be found in the subchapters:
  "General information WT" from page 3
  "General information WR" from page 13
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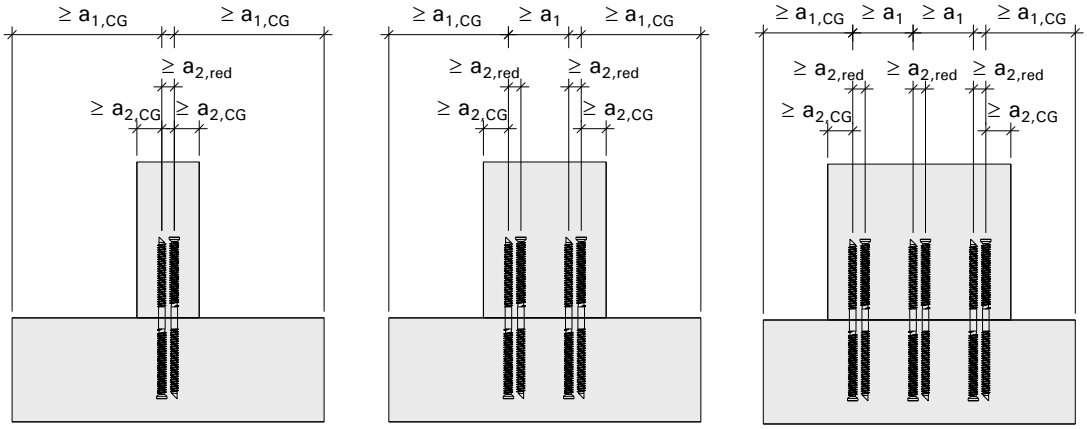
Connection main/secondary beam



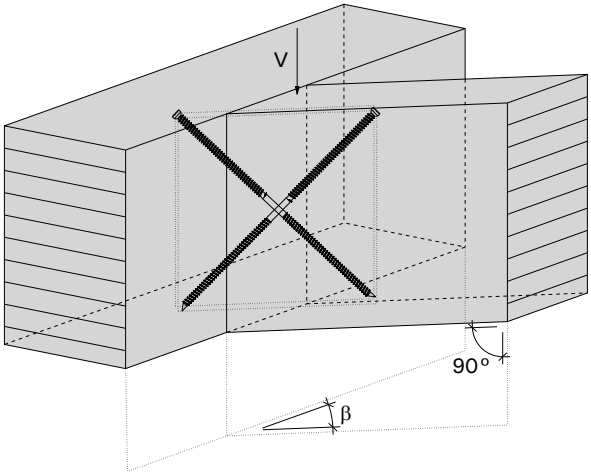
Distance [mm]	**WT-T/S-6,5xL**	**WT-T-8,2xL**	**WR-T-9xL**	**WR-T-13xL**
a_1	78	99	45	65
$a_{1,CG}$	52	66	45	65
$a_{2,CG}$	20	24	27	39
a_{red}	10	12	14	20

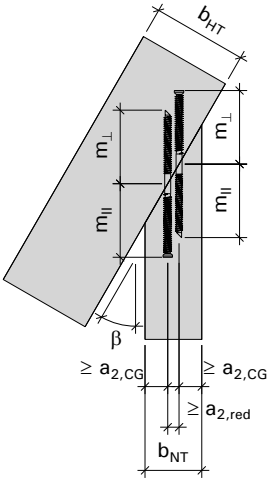
Minimum beam width [mm]	**1 Pair**	**2 Pair**	**3 Pair**
WT-T/S-6,5xL	50	128	206
WT-T-8,2xL	60	138	258
WR-T-9xL	68	113	158
WR-T-13xL	98	163	228

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

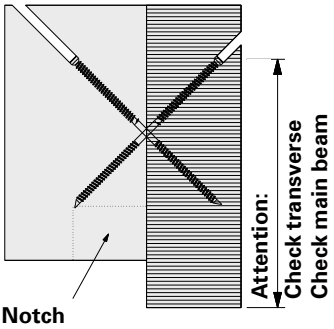
Connection main/secondary beam

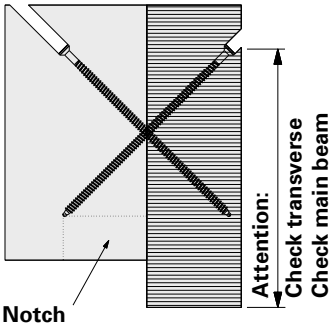
Inclined connection in horizontal plane – Fastener arrangement parallel to secondary beam





For countersinking deeper than flush with head diameter d_k pre-drill accordingly





Connection main/secondary beam

Connection main/secondary beam

					Minimum dimension [mm]		
Fastener-dxL [mm]	s [mm]	m_{II} [mm]	$m_{\perp}$ [mm]	p [mm] [1]	$h_{HT} = h_{NT} = h$ [mm]	b_{HT} [mm]	b_{NT} [mm]
WT-T/S-6,5x90	40	–	–	–	–	–	–
WT-T/S-6,5x130	55	h/2 + 6	h/2 – 6	hx0,707 – 65	100	$\frac{L}{2 \cdot \sqrt{2}} \cdot \sin\beta$	50
WT-T-6,5x160	65	h/2	h/2	hx0,707 – 80	120		
WT-T-6,5x190	80	h/2	h/2	hx0,707 – 95	140		
WT-T-6,5x220	95	h/2	h/2	hx0,707 – 110	160		
WT-T-8,2x160	65	h/2 + 7	h/2 – 7	hx0,707 – 80	120		60
WT-T-8,2x190	80	h/2 + 2	h/2 – 2	hx0,707 – 95	140		
WT-T-8,2x220	95	h/2	h/2	hx0,707 – 110	160		
WT-T-8,2x245	107	h/2	h/2	hx0,707 – 123	180		
WT-T-8,2x275	122	h/2	h/2	hx0,707 – 138	200		
WT-T-8,2x300	135	h/2	h/2	hx0,707 – 150	220		
WT-T-8,2x330	135	h/2	h/2	hx0,707 – 165	240		

				C24	**GL24h**
			Possible angles b	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	30°	45°	60°	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WT-T/S-6,5x90	–	–	–	–	–
WT-T/S-6,5x130	✓	–	–	3.61	3.89
WT-T-6,5x160	✓	✓	–	4.33	4.67
WT-T-6,5x190	✓	✓	–	5.42	5.85
WT-T-6,5x220	✓	✓	–	6.50	7.02
WT-T-8,2x160	✓	–	–	0.00	0.00
WT-T-8,2x190	✓	✓	–	5.34	5.77
WT-T-8,2x220	✓	✓	–	6.71	7.25
WT-T-8,2x245	✓	✓	–	8.08	8.72
WT-T-8,2x275	✓	✓	✓	9.18	9.91
WT-T-8,2x300	✓	✓	✓	10.55	11.39
WT-T-8,2x330	✓	✓	✓	11.74	12.67
				11.74	12.67

[1] see "Right-angle connection

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws

α = 45° (screw-in angle)

If the edge distances permit, h can be undershot

General remarks see page 46

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

Connection main/secondary beam

			Minimum dimension [mm]			Possible angles b			
Fastener-dxL [mm]	l_{ef} [mm]	m [mm] [1]	$h_{HT} = h_{NT} = h$ [mm]	b_{HT} [mm]	b_{NT} [mm]	30°	45°	60°	75°
WR-T-9x250	105	98	200	$\frac{L}{2 \cdot \sqrt{2}} \cdot \sin\beta$	68	✓	✓	–	–
WR-T-9x300	130	116	240			✓	✓	–	–
WR-T-9x350	155	134	260			✓	✓	✓	–
WR-T-9x400	180	151	300			✓	✓	✓	–
WR-T-9x450	205	169	340			✓	✓	✓	–
WR-T-9x500	230	187	380			✓	✓	✓	–
WR-T-13x400	180	157	300		98	✓	✓	–	–
WR-T-13x500	230	192	380			✓	✓	✓	–
WR-T-13x600	280	228	440			✓	✓	✓	–
WR-T-13x700	330	263	520			✓	✓	✓	–
WR-T-13x800	380	298	580			✓	✓	✓	–
WR-T-13x900	430	334	660			✓	✓	✓	✓
WR-T-13x1000	480	369	720			✓	✓	✓	✓

	C24	GL24h
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9x250	10.53	11.36
WR-T-9x300	13.03	14.07
WR-T-9x350	14.20	14.47
WR-T-9x400	14.20	14.47
WR-T-9x450	14.20	14.47
WR-T-9x500	14.20	14.47
WR-T-13x400	26.07	28.13
WR-T-13x500	32.52	33.11
WR-T-13x600	32.52	33.11
WR-T-13x700	32.52	33.11
WR-T-13x800	32.52	33.11
WR-T-13x900	32.52	33.11
WR-T-13x1000	32.52	33.11

[1] $m = m_{\parallel} = m_{\perp}$ [mm]

$n_{ef} = n^{0.9}$, where n = number of screw crosses consisting of 2 screws

values apply to connections where the fasteners are half in each component

α = 45° (screw-in angle)

For countersinking deeper than flush with head diameter d_k, pre-drill accordingly (see end of chapter)

If the edge distances permit, h may be less than the specified value

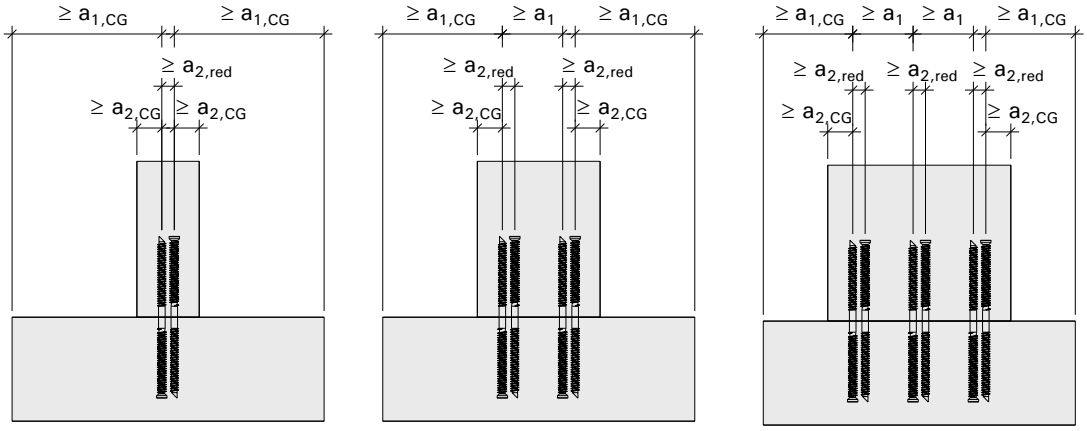
General remarks see page 46

= Steel failure

Connection main/secondary beam

General remarks

- Transverse tensile stresses must be verified separately
- In the case of several fasteners or pairs of fasteners acting together in one connection, the resistances given must be multiplied by the factor n_{ef}
- Values apply to connections where half of the fasteners are located in each component "WT" (for a few exceptions see "Connection of main/secondary beam") or for the indicated anchorage lengths l_{ef} of the thread "WR"
- Connection geometries according to drawings must be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- General information on WT and WR bolts can be found in the subchapters:
  "General information WT" from page 3
  "General information WR" from page 13
- **Prior to execution, all calculations must be checked and approved by the responsible planner**



Distance [mm]	**WT-T/S-6,5xL**	**WT-T-8,2xL**	**WR-T-9xL**	**WR-T-13xL**
a_1	78	99	45	65
$a_{1,CG}$	52	66	45	65
$a_{2,CG}$	20	24	27	39
a_{red}	10	12	14	20

Minimum bar width [mm]	**1 Pair**	**2 Pair**	**3 Pair**
WT-T/S-6,5xL	50	128	206
WT-T-8,2xL	60	138	258
WR-T-9xL	68	113	158
WR-T-13xL	98	163	228

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection main/secondary beam

Fastening system WR

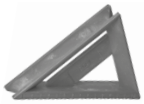
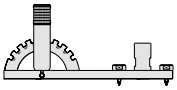
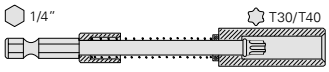
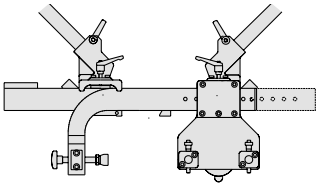
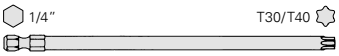
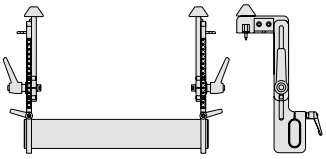
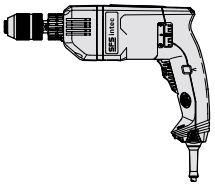
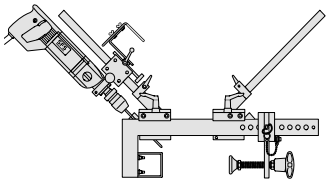
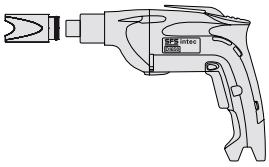
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	3.5 (4)
WT-T-8,2xL	5.0

Type		Material		Thread Ø		Length	Thread length	Head Ø	Head height	Recess
		S: A2		d		L	s	d_k	l_k	
		T: blue zinc [1]		[mm]		[mm]	[mm]	[mm]	[mm]	
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] for use classes: 1 and 2 (not directly weathered)

Connection main/secondary beam

Mounting devices and accessories

Application	Devices/Accessories	Fasteners	Devices/Accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in-aid for wood-screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Gauge ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Gauge ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupling purlin	Gauge ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep-stop-sleeve Z661 

Connection main/secondary beam

Fastening system WR

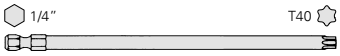
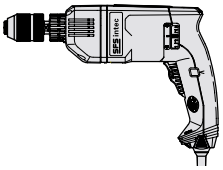
Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T		9	x	250	14	20	T40
WR	-	T		9	x	300	14	20	T40
WR	-	T		9	x	350	14	20	T40
WR	-	T		9	x	400	14	20	T40
WR	-	T		9	x	450	14	20	T40
WR	-	T		9	x	500	14	20	T40
WR	-	T		13	x	400	22	20	T50
WR	-	T		13	x	500	22	20	T50
WR	-	T		13	x	600	22	20	T50
WR	-	T		13	x	700	22	20	T50
WR	-	T		13	x	800	22	20	T50
WR	-	T		13	x	900	22	20	T50
WR	-	T		13	x	1000	22	20	T50

[1] for use classes: 1 and 2 (not directly weathered)

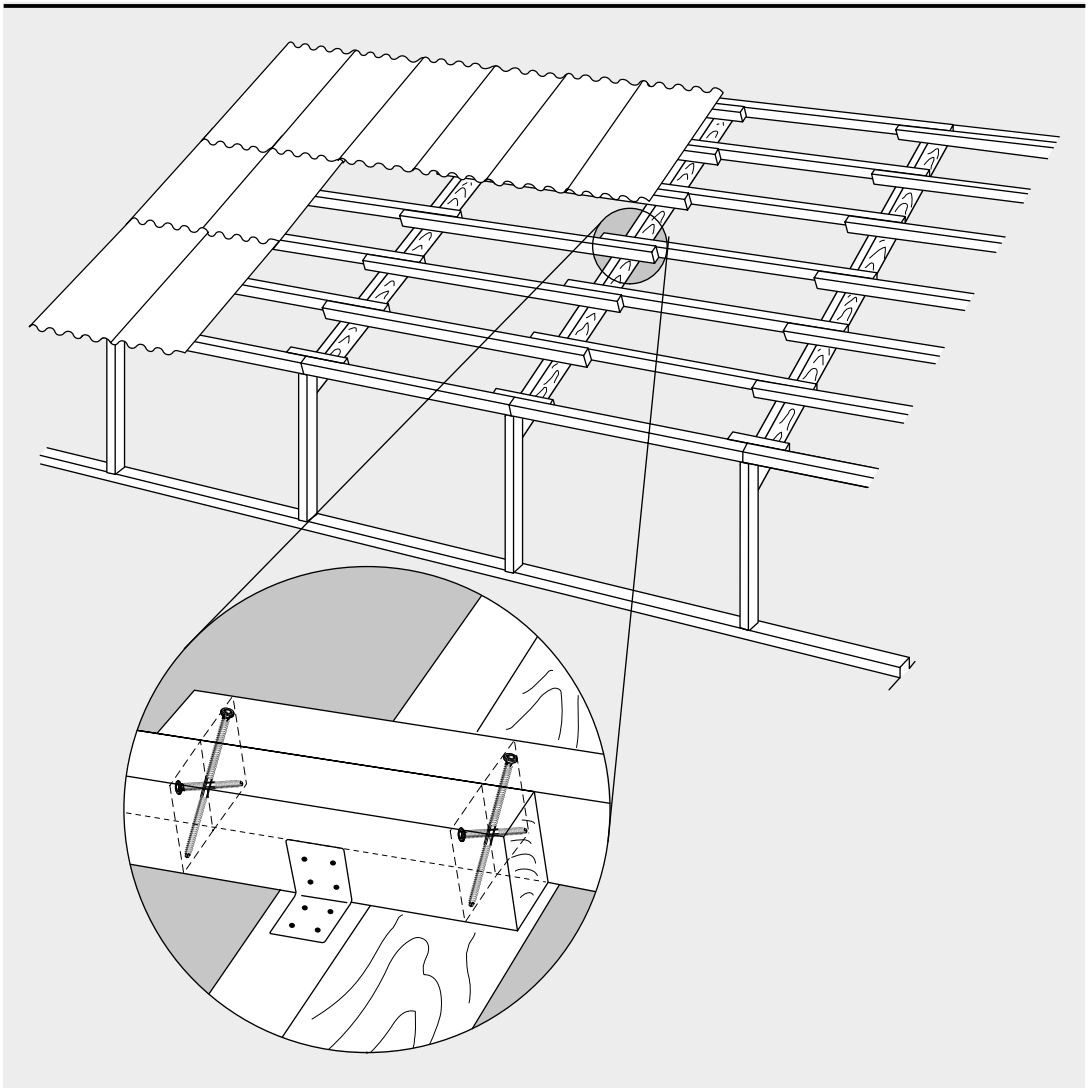
Connection main/secondary beam

Mounting devices and accessories

Fastener WR-T-9xL	Fastener WR-T-13xL	
Bit T40: Length 70, 152, 200, 350, 520 [mm] 	Wera Torx-Bit 5/16 Drive: E 3,6 ¼" 	Garant Torx ½" Drive: Vierkant ½" 
Screw-in adapter for WR 	SFS attachment ZA ½" Drive square ½" 	Screw-in adapter for WR 
Power drill BO 1055 	Power drill 32-4 	

Connection of coupling purlins

Application



Advantages that convince

- Simple calculation
- High performance
- Fasteners not visible
- Quick assembly
- No pre-drilling
- No retightening
- ETA-12/0063 (WT)

Connection of coupling purlins

General remarks

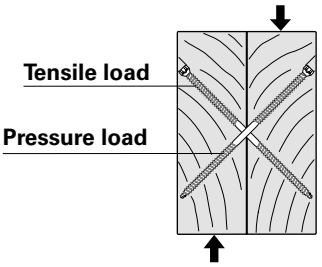
Function
The connection system WT from SFS enables the safe, statically ideal and convenient connection of coupling purlins. New standards set for the permanent and dimensionally stable connection of wooden components.

Functional principle
The special geometry of the fastener WT-T-6,5/8,2xL makes it possible to take the truss model into account. Due to the inclination at e.g. 45°, the forces are diverted into a "tension" and a "compression bar". Thus, only the axial tensile and compressive forces are assigned to the connectors. A further advantage of the cross-like arrangement of the fasteners is the stabilisation of the cross-section of the connected purlins in case of shrinkage and swelling deformations.

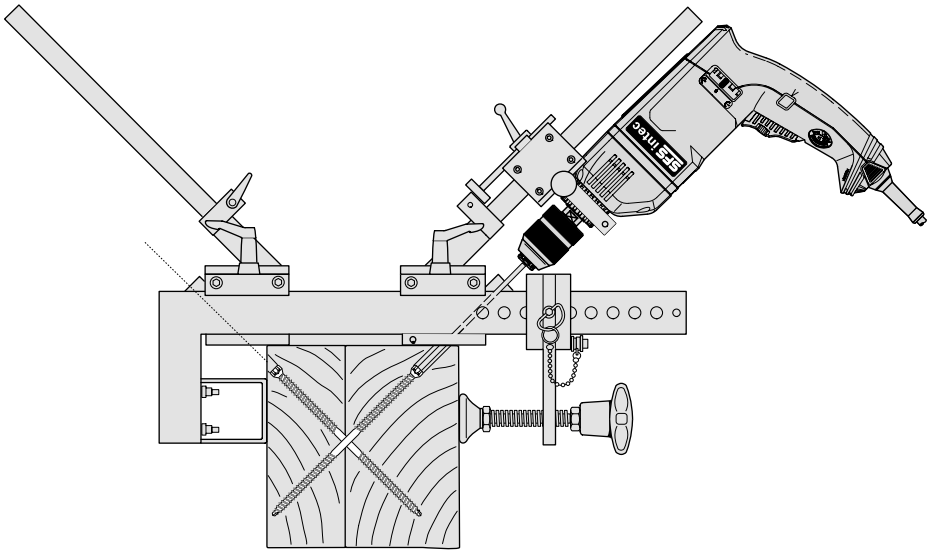
This is also referred to as a blocking effect, as the cross-section reinforced by the fasteners cannot shrink and deform at will.

In order to ensure the optimum fit of the connectors, a setting device, the ZL WT, was of course also developed for this system solution.

This guarantees:
- Accurate fastener placement at 45° to the surface
- Adherence to the correct mounting position
- Safe and convenient processing thanks to stable lightweight construction
- The choice of fasteners depends on the cross-sections of the purlins to be connected
- The number of fasteners is determined by the coupling forces
- The maximum clamping range of the setting device is 320 mm
- Larger clamping ranges for special cross-sections on request



Framework principle



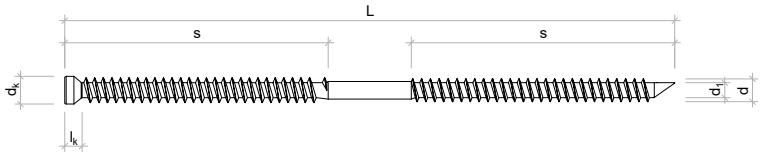
Connection of coupling purlins

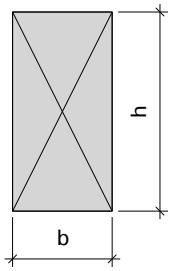
Dimensioning proposal

Determination of the fastener

The fastener length L (in mm) depends on the width b (7-16 cm) and the height h (14-24 cm) of the smaller purlin cross-section.

The table below shows the corresponding fastener lengths L depending on the purlin dimension.





h (cm)							**b** (cm)
	7	**8**	**9**	**10**	**12**	**14**	**16**
14	160	160	160	160	160	160	160
16	160	190	190	190	190	190	190
18	160	190	220	220	220	220	220
20	160	190	220	245	245	245	245
22	160	190	220	245	275	275	275
24	160	190	220	245	300	300	300
26	160	190	220	245	300	330	330
28	160	190	220	245	300	330	330

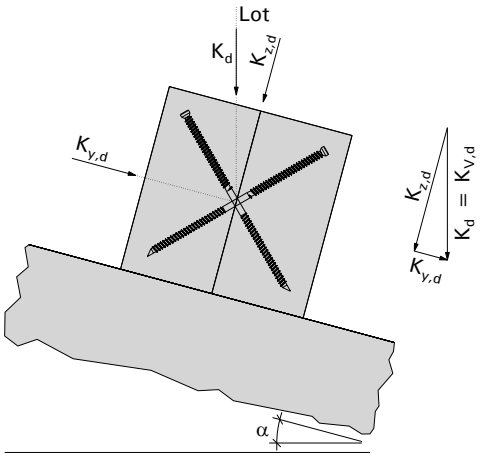
Dimensioning

For exclusively perpendicular external loads, e.g. dead load, snow load, i.e. the coupling force acts vertically ($K = K_v$) One of the following verifications must be carried out in each case.

$$\frac{K_d}{R_{K,d}} \leq 1 \quad \text{or}$$

$$\frac{K_{z,d}}{\cos(\alpha) \cdot R_{K,d}} \leq 1 \quad \text{or}$$

$$\frac{K_{y,d}}{\sin(\alpha) \cdot R_{K,d}} \leq 1$$

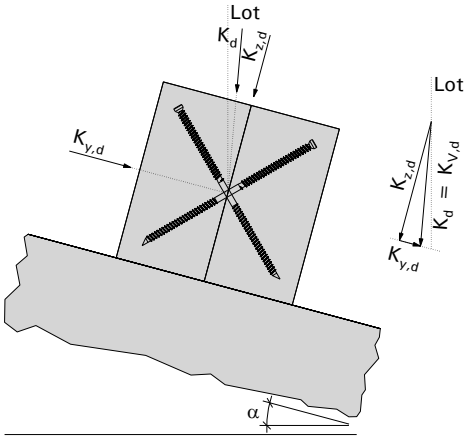


Connection of coupling purlins

For non-vertical external loads, i.e. also combinations with wind loads, i.e. the coupling force does not act vertically. The components K_z and K_y must be determined and the following verification must be carried out.

$$\frac{K_{z,d} + K_{y,d}}{(\cos(\alpha) + \sin(\alpha)) \cdot R_{K,d}} \leq 1$$

K_d	Rated value of the coupling force
$K_{z,d}$	Rated value of the coupling force perpendicular to the roof surface
$K_{y,d}$	Rated value of the coupling force parallel to the roof surface
$R_{K,d}$	Rated value of the coupling force resistance
α	Roof pitch angle



Connection of coupling purlins

Resistance of couplin purlins $R_{K,d}$ [kN]		0°		10°		15°		20°	
Fastener	Number of pairs per couplin purlins	**C24**	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
		ρ_k = [kg/m³]		ρ_k = [kg/m³]		ρ_k = [kg/m³]		ρ_k = [kg/m³]	
		350	385	350	385	350	385	350	385
WT-T-6,5x160	1	4.33	4.67	3.74	4.03	3.54	3.82	3.38	3.65
	2	8.08	8.72	6.97	7.53	6.60	7.12	6.30	6.80
	3	11.64	12.56	10.05	10.84	9.50	10.26	9.08	9.80
WT-T-6,5x190	1	5.42	5.85	4.68	5.05	4.42	4.77	4.23	4.56
	2	10.11	10.91	8.72	9.42	8.25	8.91	7.89	8.51
	3	14.56	15.71	12.57	13.56	11.89	12.83	11.36	12.26
WT-T-6,5x220	1	6.50	7.02	5.61	6.06	5.31	5.73	5.07	5.48
	2	12.13	13.09	10.47	11.30	9.91	10.69	9.47	10.22
	3	17.48	18.86	15.09	16.28	14.27	15.40	13.64	14.72
WT-T-8,2x160	1	5.34	5.77	4.61	4.98	4.36	4.71	4.17	4.50
	2	9.97	10.76	8.61	9.29	8.14	8.79	7.78	8.40
	3	14.36	15.50	12.40	13.38	11.73	12.66	11.21	12.09
WT-T-8,2x190	1	6.71	7.25	5.80	6.25	5.48	5.92	5.24	5.65
	2	12.53	13.52	10.81	11.67	10.23	11.04	9.77	10.55
	3	18.05	19.48	15.58	16.81	14.73	15.90	14.08	15.20
WT-T-8,2x220	1	8.08	8.72	6.98	7.53	6.60	7.12	6.31	6.81
	2	15.09	16.28	13.02	14.05	12.32	13.29	11.77	12.70
	3	21.73	23.45	18.76	20.24	17.74	19.15	16.95	18.30
WT-T-8,2x245	1	9.18	9.91	7.92	8.55	7.50	8.09	7.16	7.73
	2	17.13	18.49	14.79	15.96	13.99	15.10	13.37	14.42
	3	24.68	26.63	21.30	22.99	20.15	21.74	19.25	20.78
WT-T-8,2x275	1	10.55	11.39	9.11	9.83	8.61	9.30	8.23	8.88
	2	19.69	21.25	16.99	18.34	16.07	17.35	15.36	16.58
	3	28.36	30.60	24.48	26.42	23.15	24.99	22.13	23.88
WT-T-8,2x300	1	11.74	12.67	10.13	10.94	9.58	10.34	9.16	9.88
	2	21.90	23.64	18.91	20.41	17.88	19.30	17.09	18.44
	3	31.55	34.05	27.23	29.39	25.76	27.80	24.62	26.57
WT-T-8,2x330	1	11.74	12.67	10.13	10.94	9.58	10.34	9.16	9.88
	2	21.90	23.64	18.91	20.41	17.88	19.30	17.09	18.44
	3	31.55	34.05	27.23	29.39	25.76	27.80	24.62	26.57

Connection of coupling purlins

Resistance of couplin purlins $R_{K,d}$ [kN]		25°		30°		90°	
Fastener	Number of pairs per couplin purlins	**C24**	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
			ρ_k = [kg/m³]		ρ_k = [kg/m³]		ρ_k = [kg/m³]
		350	385	350	385	350	385
WT-T-6,5x160	1	3.26	3.52	3.17	3.42	4.33	4.67
	2	6.08	6.56	5.91	6.38	8.08	8.72
	3	8.76	9.45	8.52	9.19	11.64	12.56
WT-T-6,5x190	1	4.08	4.40	3.96	4.28	5.42	5.85
	2	7.61	8.21	7.40	7.98	10.11	10.91
	3	10.95	11.82	10.66	11.50	14.56	15.71
WT-T-6,5x220	1	4.89	5.28	4.76	5.14	6.50	7.02
	2	9.13	9.85	8.88	9.59	12.13	13.09
	3	13.15	14.19	12.79	13.81	17.48	18.86
WT-T-8,2x160	1	4.02	4.34	3.91	4.22	5.34	5.77
	2	7.50	8.10	7.30	7.88	9.97	10.76
	3	10.81	11.66	10.51	11.35	14.36	15.50
WT-T-8,2x190	1	5.05	5.45	4.91	5.30	6.71	7.25
	2	9.43	10.17	9.17	9.90	12.53	13.52
	3	13.58	14.66	13.21	14.26	18.05	19.48
WT-T-8,2x220	1	6.08	6.57	5.92	6.39	8.08	8.72
	2	11.35	12.25	11.04	11.92	15.09	16.28
	3	16.35	17.65	15.91	17.17	21.73	23.45
WT-T-8,2x245	1	6.91	7.46	6.72	7.25	9.18	9.91
	2	12.89	13.91	12.54	13.53	17.13	18.49
	3	18.57	20.04	18.06	19.49	24.68	26.63
WT-T-8,2x275	1	7.94	8.57	7.72	8.34	10.55	11.39
	2	14.81	15.99	14.41	15.55	19.69	21.25
	3	21.34	23.03	20.76	22.40	28.36	30.60
WT-T-8,2x300	1	8.83	9.53	8.59	9.27	11.74	12.67
	2	16.48	17.79	16.03	17.30	21.90	23.64
	3	23.74	25.62	23.10	24.93	31.55	34.05
WT-T-8,2x330	1	8.83	9.53	8.59	9.27	11.74	12.67
	2	16.48	17.79	16.03	17.30	21.90	23.64
	3	23.74	25.62	23.10	24.93	31.55	34.05

General remarks

- Values apply to connections where half of the fasteners are located in each component
- Connection geometries according to drawings are to be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- General information on WT bolts can be found in the subchapter "General information on WT bolts" from page 3 onwards
- **Before execution, all calculations must be checked and approved by the responsible planner**

Connection of coupling purlins

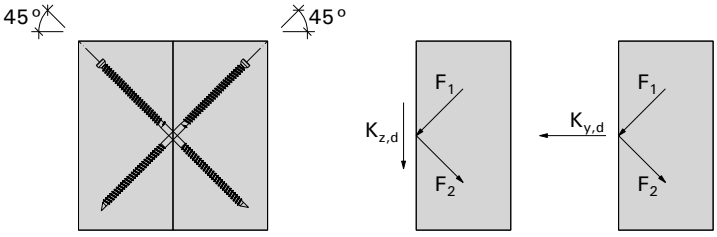
Basic information on the design aid

Bolt forces
In the following, the calculation principles of the previous design aid are explained. In addition, this information can also be used to calculate coupling points with other roof pitch angles.

$K_{y,d}$; $K_{z,d}$: Coupling force in y- and z-direction
F_1 ; F_2 : Resulting forces in the bolts

The bolt forces result from:

$$F_1 = \frac{K_{z,d} + K_{y,d}}{\sqrt{2}}$$ (Positive tension, negative pressure) $$F_2 = \frac{K_{z,d} - K_{y,d}}{\sqrt{2}}$$



Screw 1 is always decisive, i.e. the maximum load on the coupling point is reached when the tensile force in screw 1 is equal to its load-bearing capacity.

Verification:

$$\frac{F_{1,d}}{n_{ef} \cdot R_{ax,d}} = \frac{K_{z,d} + K_{y,d}}{\sqrt{2} \cdot n_{ef} \cdot R_{N,d}} \leq 1$$

Connection of coupling purlins

In the case that a load combination of only vertically acting loads is decisive, i.e. K_d acts vertically, the following applies:
$K_{z,d} = K \cdot \cos(\alpha)$
$K_{y,d} = K \cdot \sin(\alpha)$

The proofs for this case can therefore also be written as follows.

$$K_d \cdot \frac{\cos\alpha + \sin\alpha}{\sqrt{2} \cdot n_{ef} \cdot R_{ax,d}} \leq 1$$

The following values are listed in the design table (due to the pressure screw, $l_{ef} = s - l_k$ was taken into account when determining $R_{ax,d}$):

$$R_{K,d} = \frac{\sqrt{2} \cdot n_{ef} \cdot R_{ax,d}}{\cos\alpha \cdot \sin\alpha}$$

Thus, with perpendicular loading, the verification equation is as follows

$$\frac{K_d}{R_{K,d}} \leq 1$$

n	Number of screws
n_{ef}	$n^{0.9}$
l_{ef}	Effective considered thread length
s	Thread length per screw side (incl. screw head)
l_k	Length of screw head
$R_{K,d}$	See previous table
$R_{ax,d}$	See following table

Connection of coupling purlins

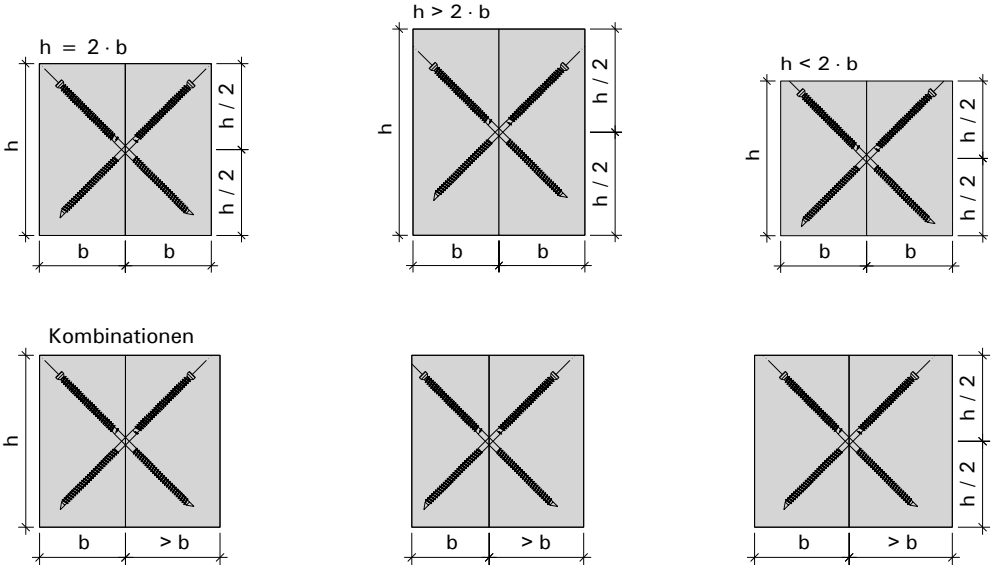
		C24	GL24h
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener-dxL [mm]	h_{min} [mm]	$R_{ax,d}$ [kN]	$R_{ax,d}$ [kN]
WT-T-6,5x160	120	3.06	3.30
WT-T-6,5x190	140	3.83	4.13
WT-T-6,5x220	160	4.60	4.96
WT-T-8,2x160	120	3.78	4.08
WT-T-8,2x190	140	4.75	5.12
WT-T-8,2x220	160	5.72	6.17
WT-T-8,2x245	180	6.49	7.01
WT-T-8,2x275	200	7.46	8.05
WT-T-8,2x300	220	8.30	8.96
WT-T-8,2x330	240	8.30	8.96

General remarks

- Longitudinal forces in coupling purlins (e.g. from roof trusses) cannot be transmitted with this design of the coupling point
- Suitable measures must be taken to ensure that the screw-in angles are observed
- Values apply to connections where half of the fasteners are in both components
- Connection geometries according to drawings are to be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- General information on WT bolts can be found in the subchapter: "General information WT" → on page 3
- **Before execution, all calculations must be checked and approved by the responsible planner**

Arrangement

The screws are always arranged in such a way that they cross at half purlin height in the shear plane between the two purlins.



Connection of coupling purlins

Fastening system WT

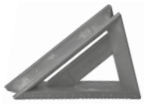
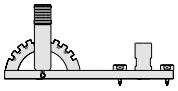
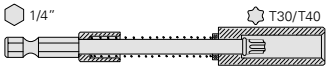
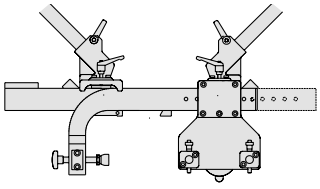
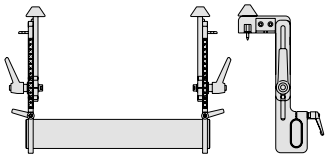
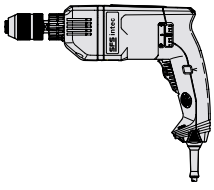
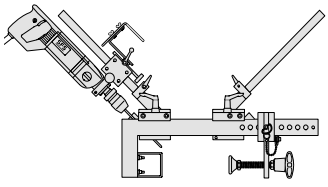
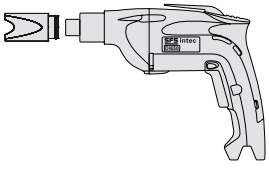
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	3.5 (4)
WT-T-8,2xL	5.0

Type		Material		Thread Ø		Length	Thread length	Head Ø	Head height	Recess
		S: A2		d		L	s	d_k	l_k	
		T: blue zinc [1]		[mm]		[mm]	[mm]	[mm]	[mm]	
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] for use classes: 1 and 2 (not directly weathered)

Connection of coupling purlins

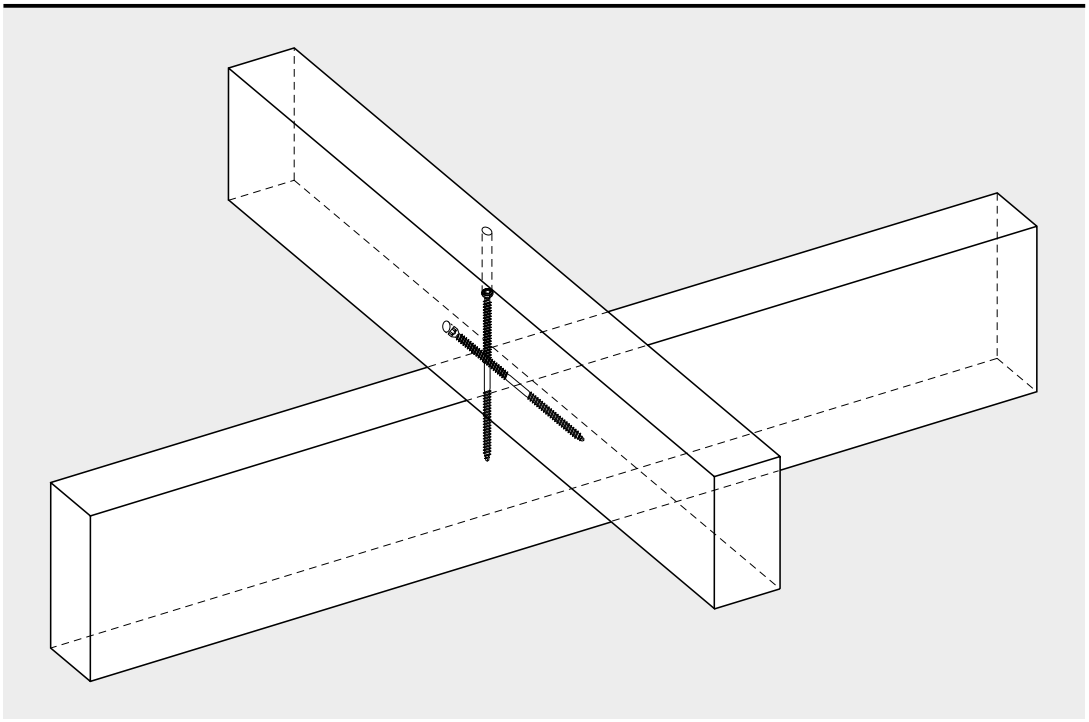
Mounting devices and accessories

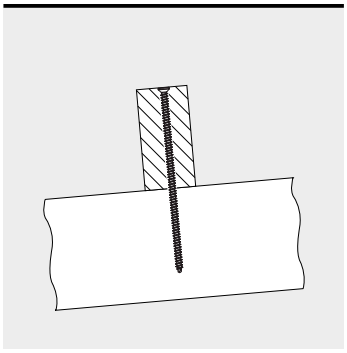
Application	Devices/accessories	Fastener	Devices/accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Couplin purlins	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

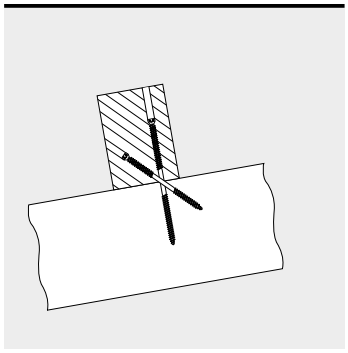
Swatch HQ © by Plumier-Lehmann AG

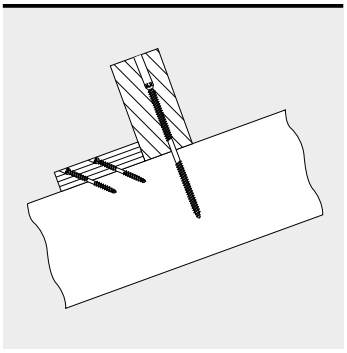
Connection rafter purlins/main trusses

Applications



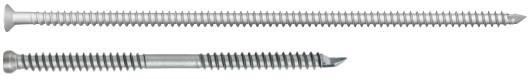






Advantages that convince

- High performance
- Lanyards not visible
- Quick assembly
- High fire resistance of the joint
- ETA-12/0063 (WT)
- ETA-12/0062 (WR)

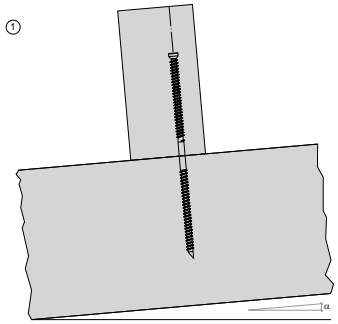


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses

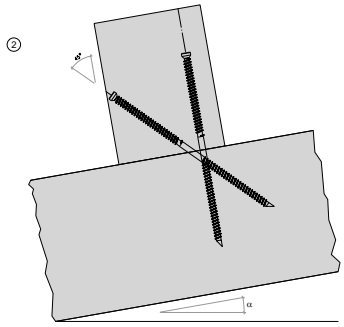
Dimensioning proposal; Arrangement types

Fastener arrangement 1



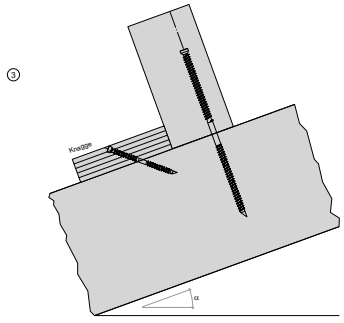
Suitable for small roof pitches $\alpha \approx 0°$ to 5° depending on the load. If no lifting loads are acting, the WT/WR fastener can also be set eccentrically to improve the load-bearing capacity against tilting.

Fastener arrangement 2



Suitable for medium roof pitches $\alpha \approx 5°$ to 15° depending on the load. If no lifting loads are acting, the WT/WR fastener can also be set eccentrically to improve the load-bearing capacity against tilting.

Fastener arrangement 3



Suitable for large roof pitches from $\alpha \approx 10°$ depending on the load. If no lifting loads are acting, the WT/WR fastener can also be set eccentrically to improve the load-bearing capacity against tilting.

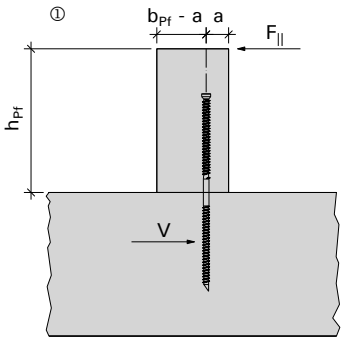
Connection rafter purlins/main trusses

Dimensioning

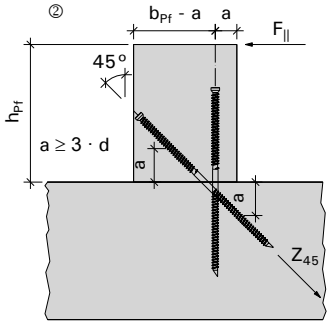
For the purlin design, the loads must first be converted into the components $F_{||}$ and $F_{\perp}$, which are parallel and perpendicular to the roof surface. The purlin design is divided into two parts.

1) Loading parallel to the roof surface ($F_{||}$)

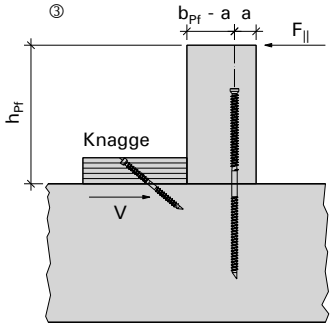
In the first part, the verification of shearing is carried out depending on the arrangement of the WT/ WR fastener.



$V = F_{||}$



$Z_{45} = F_{||} \cdot \sqrt{2}$



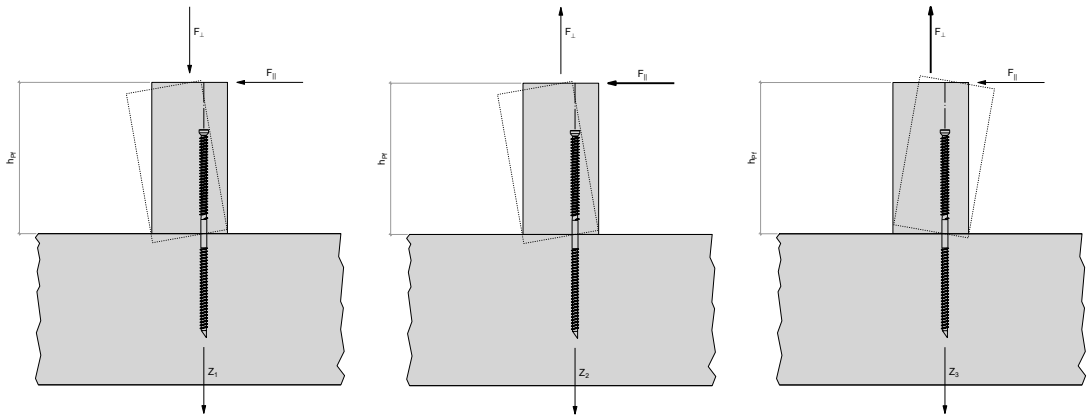
$V = F_{||}$

Design of the clevis attachment for the shear force V according to the chapters "General WT" and "General WR".

Connection rafter purlins/main trusses

2) Load perpendicular to the roof surface ($F_\perp$)

In the second part, the most unfavourable load on the WT/WR fastener that has just been screwed in must be determined, irrespective of the fastener arrangement 1 to 3.



Tension load 1 $$Z_1 = \frac{3}{2 \cdot (b_{Pf} - a)} \cdot \left[F_{||} \cdot h_{Pf} - F_\perp \cdot \left(\frac{b_{Pf}}{6} + \frac{a}{3} \right) \right]$$

Tension load 2 $$Z_2 = \frac{3}{2 \cdot (b_{Pf} - a)} \cdot \left[F_{||} \cdot h_{Pf} - F_\perp \cdot \left(\frac{b_{Pf}}{2} - a \right) \right] + F_\perp$$

Tension load 3 $$Z_3 = \frac{3}{2 \cdot a} \cdot \left[-F_{||} \cdot h_{Pf} + F_\perp \cdot \left(\frac{b_{Pf}}{2} - a \right) \right] + F_\perp$$

The maximum of these 3 tensile forces is decisive for the load on the WT/ WR connector: Maximum tensile force: Z = max {Z_1 ; Z_2 ; Z_3}

Required number of cfasteners

① $$n = \left[\left(\frac{Z_d}{R_{Z,d}} \right)^2 + \left(\frac{V_d}{R_{V,d}} \right)^2 \right]^{0.57}$$

② $$n_{45} = \left[\frac{Z_{45,d}}{R_{Z,45,d}} \right]^{1.11}$$

③ $$n = \left[\frac{Z_d}{R_{Z,d}} \right]^{1.11}$$

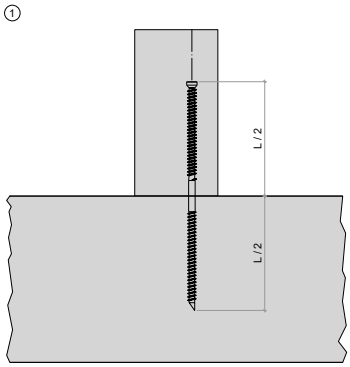
$$n = \left[\frac{Z_d}{R_{Z,d}} \right]^{1.11}$$

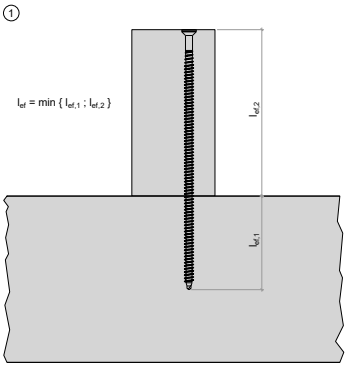
Group effects are taken into account in the calculation.

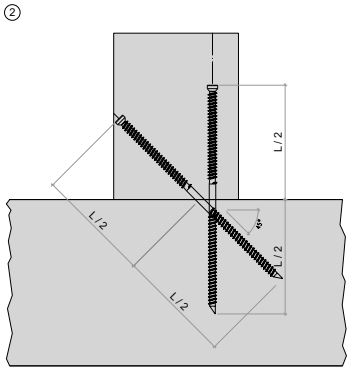
Connection rafter purlins/main trusses

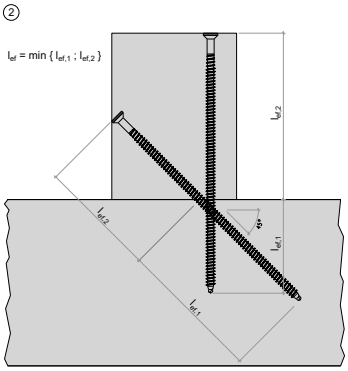
Arrangement

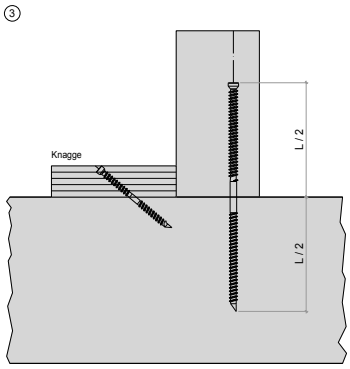
- When arranging the fasteners, the centre distances and edge distances must be observed as shown in the sketches
- The angled fastener must be placed at 45° to the truss
- WT fasteners must be arranged so that one threaded part is in each component
- For WR fasteners, the effective thread length per component must be calculated

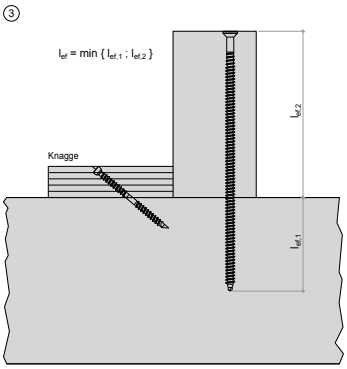












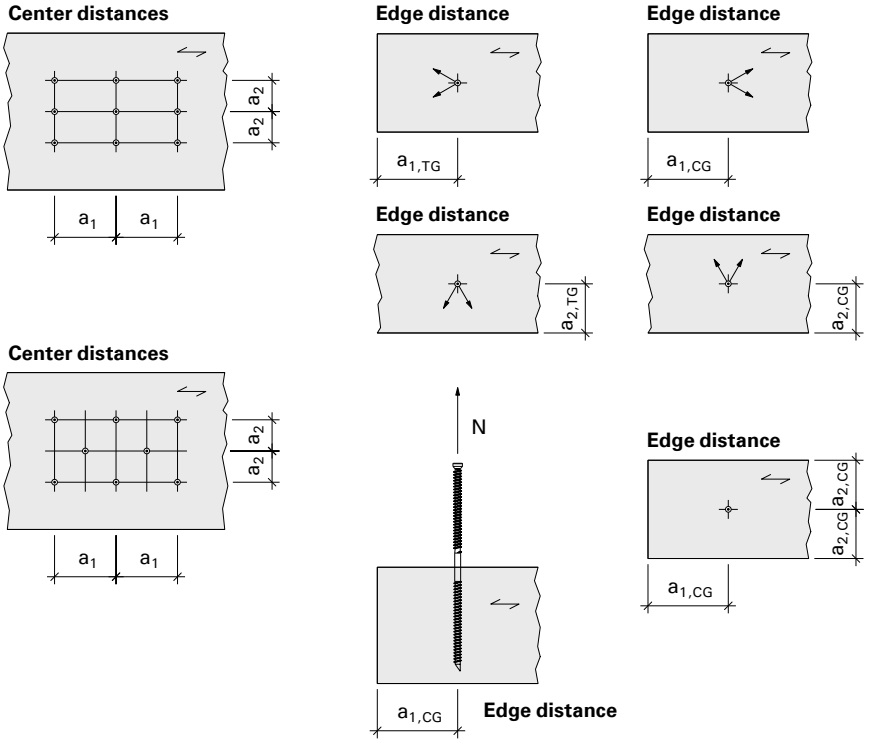
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses

WT Edge and intermediate distances

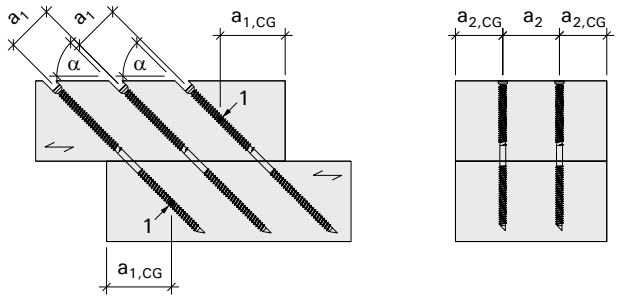
Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the fibre	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the fibre	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)

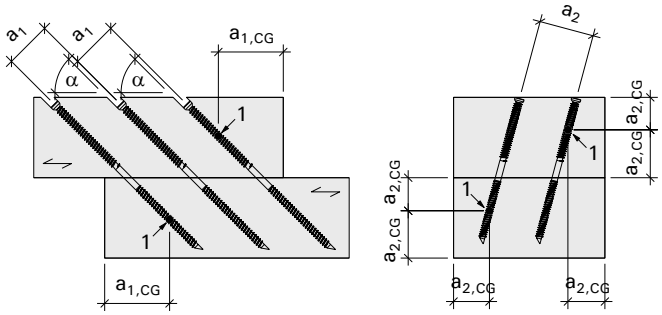


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses



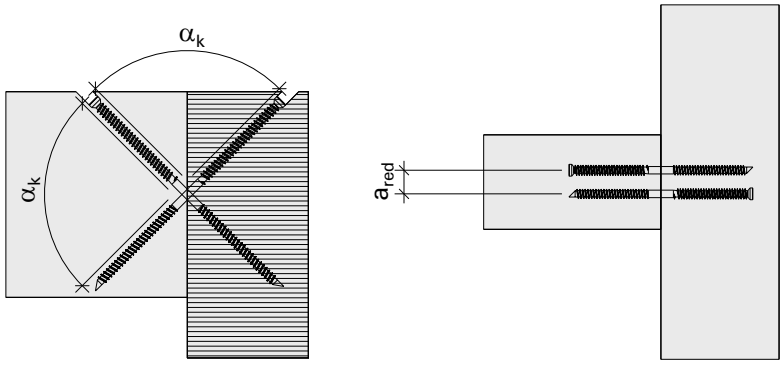
1 Centre of gravity of the screw thread in the component



1 Centre of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25



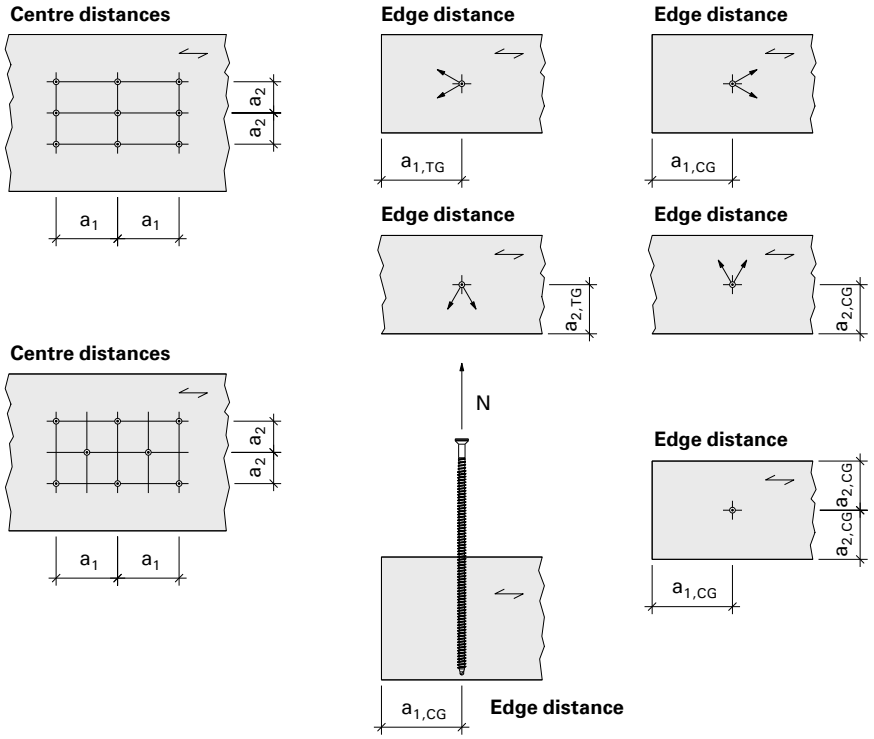
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses

WR Edge and intermediate distances

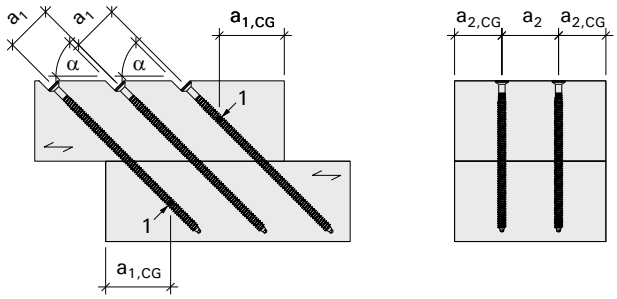
Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fibre	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fibre	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)

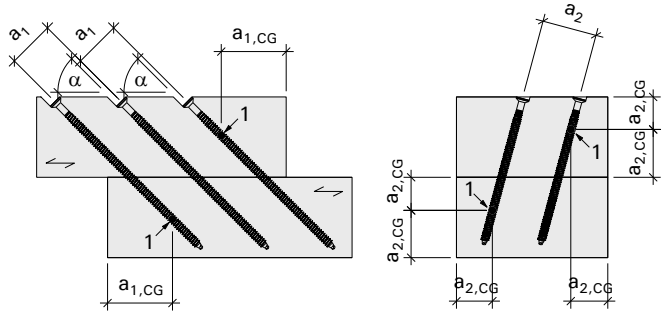


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses



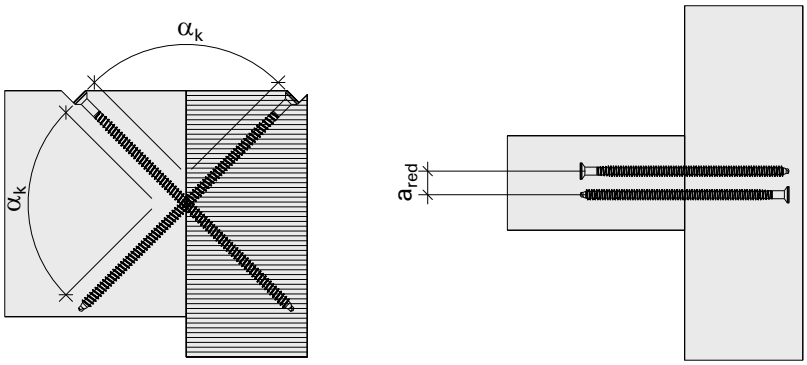
1 Centre of gravity of the screw thread in the component



1 Centre of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial loading)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{cross} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{cross} [mm]	20	38	44	49	55	60	65



Connection rafter purlins/main trusses

Allgemeine Bemerkungen

$F_{\perp,d}$ Design value of the load perpendicular to the roof surface
$F_{II,d}$ Design value of the load parallel to the roof surface
V_d Design value of shear force in fastener
$Z_{45,d}$ Design value of the tensile force in the fastener located at 45°
Z_d Design value of the tensile force in the fastener arranged perpendicular to the roof surface
$R_{Z,d}$ Design value of pull-out resistance of a fastener (see following tables)
$R_{V,d}$ Design value of shear resistance of a fastener (see following tables)
$R_{Z,45,d}$ Design value of pull-out resistance of a fastener placed at 45° (see following tables)
b_{Pf} Width of rafter purlin
h_{Pf} Height of rafter purlin
a Selected edge distance of fastener
n Required number of fasteners
n_{45} n required number of fasteners

Prior to execution, all calculations must be checked and approved by the responsible designer

			C24	**GL24h**
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	s [mm]	h_{min} [mm]	$R_{z,d}$ [kN]	$R_{z,d}$ [kN]
WT-T/S-6,5x90	40	50	2.05	2.21
WT-T/S-6,5x130	55	70	2.82	3.04
WT-T-6,5x160	65	85	3.33	3.59
WT-T-6,5x190	80	100	4.10	4.42
WT-T-6,5x220	95	115	4.86	5.25
WT-T-8,2x160	65	85	4.20	4.53
WT-T-8,2x190	80	100	5.17	5.58
WT-T-8,2x220	95	115	6.14	6.62
WT-T-8,2x245	107	125	6.91	7.46
WT-T-8,2x275	122	140	7.88	8.50
WT-T-8,2x300	135	155	8.72	9.41
WT-T-8,2x330	135	170	8.72	9.41

General remarks see above and page 74

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses

	C24	GL24h	C24	GL24h
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	$R_{z,45,d}$ [kN]	$R_{z,45,d}$ [kN]	$R_{V,d}$ [kN] [1)]	$R_{V,d}$ [kN] [1)]
WT-T/S-6,5x90	2.05	2.21	1.58	1.67
WT-T/S-6,5x130	2.82	3.04	1.80	1.92
WT-T-6,5x160	3.33	3.59	1.38	1.47
WT-T-6,5x190	4.10	4.42	1.56	1.63
WT-T-6,5x220	4.86	5.25	1.56	1.63
WT-T-8,2x160	4.20	4.53	1.56	1.63
WT-T-8,2x190	5.17	5.58	1.38	1.38
WT-T-8,2x220	6.14	6.62	2.78	2.95
WT-T-8,2x245	6.91	7.46	3.07	3.24
WT-T-8,2x275	7.88	8.50	3.09	3.24
WT-T-8,2x300	8.72	9.41	3.09	3.24
WT-T-8,2x330	8.72	9.41	3.09	3.24

[1)] up to a maximum of 1 screw in succession in the fibre direction of the binder General remarks see page 72 and 74

			C24	GL24h
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	h_{min} [mm]	$R_{Z,d}$ [kN]	$R_{Z,d}$ [kN]
WR-T-9xL	50	L/2	3.54	3.83
	100		7.09	7.65
	150		10.63	11.48
	200		14.18	15.30
	250		17.72	19.13
	300		19.23	19.23
	350		19.23	19.23
	400		19.23	19.23
	450		19.23	19.23
	500		19.23	19.23
WR-T-13xL	100		10.24	11.05
	200		20.48	22.10
	300		30.72	33.15
	400		40.96	42.31
	500		42.31	42.31
	600		42.31	42.31
	700		42.31	42.31
	800		42.31	42.31
	900		42.31	42.31
	1000		42.31	42.31

☐ = Steel failure

General remarks see page 72 und 74

Connection rafter purlins/main trusses

			C24	GL24h	C24	GL24h
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	h_{min} [mm]	$R_{z,45,d}$ [kN]	$R_{z,45,d}$ [kN]	$R_{V,d}$ [kN] [1)]	$R_{V,d}$ [kN] [1)]
WR-T-9xL	50	L/2	–	–	3.43	3.60
	100		7.09	7.65	3.43	3.60
	150		10.63	11.48	3.43	3.60
	200		14.18	15.30	3.43	3.60
	250		17.72	19.13	3.43	3.60
	300		19.23	19.23	3.43	3.60
	350		19.23	19.23	3.43	3.60
	400		19.23	19.23	3.43	3.60
	450		19.23	19.23	3.43	3.60
	500		19.23	19.23	3.43	3.60
WR-T-13xL	100		10.24	11.05	6.47	6.78
	200		20.48	22.10	6.47	6.78
	300		30.72	33.15	6.47	6.78
	400		40.96	42.31	6.47	6.78
	500		42.31	42.31	6.47	6.78
	600		42.31	42.31	6.47	6.78
	700		42.31	42.31	6.47	6.78
	800		42.31	42.31	6.47	6.78
	900		42.31	42.31	6.47	6.78
	1000		42.31	42.31	6.47	6.78

[1)] to a maximum of 1 screw in grain direction of the beam.
General remarks see page 72 and below

= Steel failure

General remarks

- In the case of several fasteners or pairs of fasteners acting together in one connection, the resistances given must be multiplied by the factor $n_{ef} = n^{0.9}$
- Connection geometries according to drawings must be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Before execution, all calculations must be checked and approved by the responsible planner**

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Connection rafter purlins/main trusses

Fastening system WT

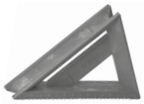
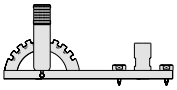
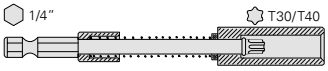
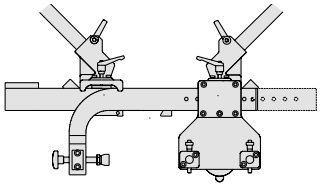
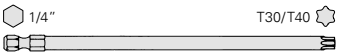
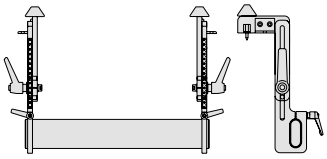
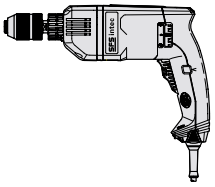
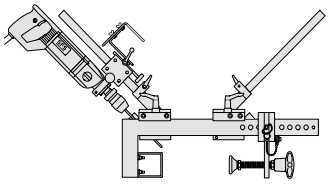
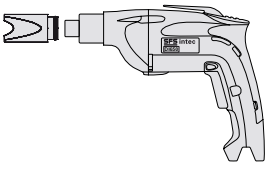
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	3.5 (4)
WT-T-8,2xL	5.0

Type		Material S: A2 T: blue zinc [1)]		Thread Ø d [mm]		Length L [mm]	Thread length s [mm]	Head Ø d_k [mm]	Head height l_k [mm]	Bit
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1)] for use classes: 1 and 2 (not directly weathered)

Connection rafter purlins/main trusses

Mounting devices and accessories

Application	Devices/accessories	Fastener	Devices/accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Couplin purlins	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

Connection rafter purlins/main trusses

Fastening system WR

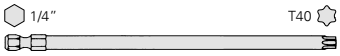
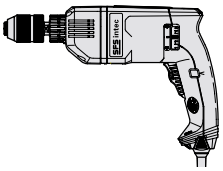
Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T		9	x	250	14	20	T40
WR	-	S		9	x	300	14	20	T40
WR	-	S		9	x	350	14	20	T40
WR	-	T		9	x	400	14	20	T40
WR	-	T		9	x	450	14	20	T40
WR	-	T		9	x	500	14	20	T40
WR	-	T		13	x	400	22	20	T50
WR	-	T		13	x	500	22	20	T50
WR	-	T		13	x	600	22	20	T50
WR	-	T		13	x	700	22	20	T50
WR	-	T		13	x	800	22	20	T50
WR	-	T		13	x	900	22	20	T50
WR	-	T		13	x	1000	22	20	T50

[1] for use classes: 1 and 2 (not directly weathered)

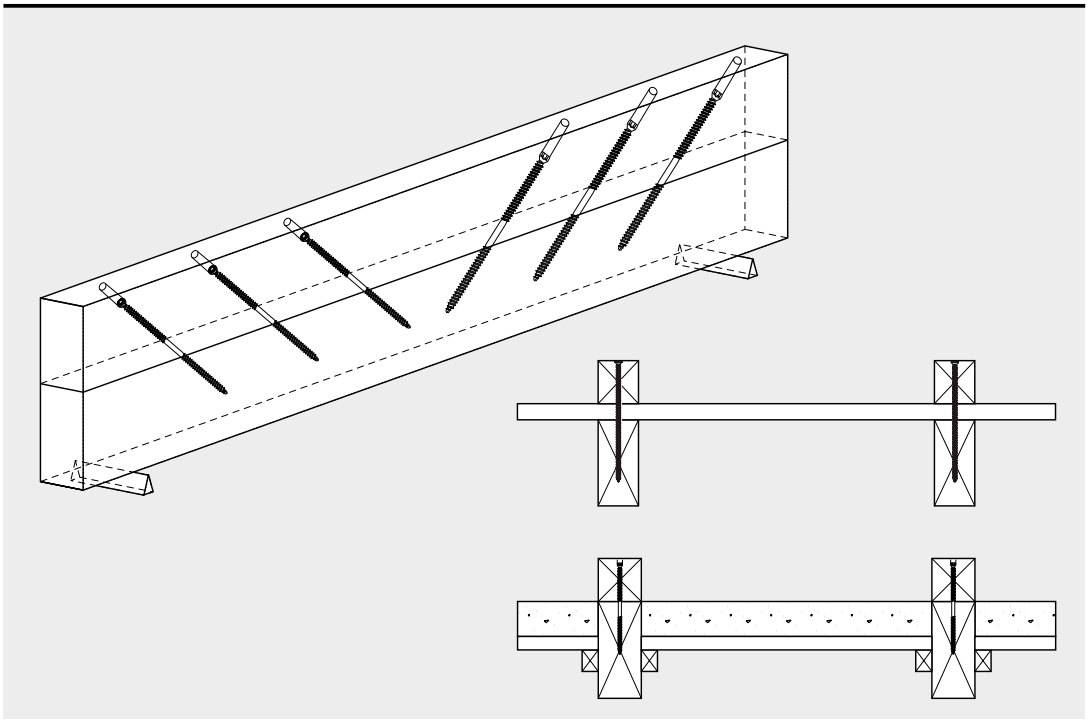
Connection rafter purlins/main trusses

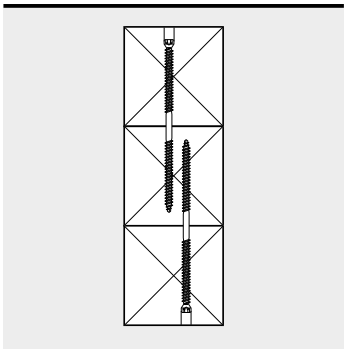
Mounting devices and accessories

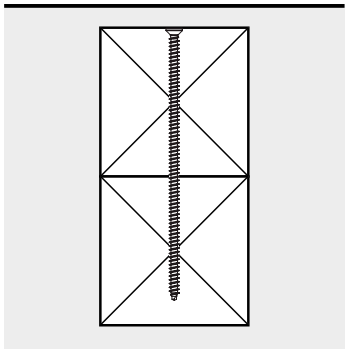
Fastener WR-T-9xL	Fastener WR-T-13xL	
Bit T40: Length 70, 152, 200, 350, 520 [mm] 	Wera Torx-Bit 5/16 Drive: E 3,6 ¼" 	Garant Torx ½" Drive: Square ½" 
Screw-in adapter for WR 	SFS attachment ZA ½" Drive: Square ½" 	Screw-in adapter for WR 
Power drill BO 1055 	Drill Power drill 32-4 	

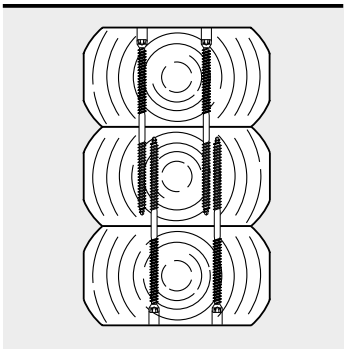
Dowelled beam

Application



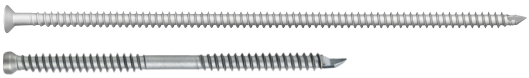






Advantages that convince

- Easy processing
- High performance
- Fasteners not visible
- Quick assembly
- High fire resistance of the joint
- ETA-12/0063 (WT)
- ETA-12/0062 (WR)



Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Dowelled beam

For unequal cross-sections, a design method suitable for this purpose must be used (e.g. the γ-method)

Design proposal for equal cross-sections according to SIA 265:2012 (2019)

Cross-section values

The following calculation method is an approximate calculation according to SIA 265:2012 (2019). 5.3.3 for doweled beams of two to three equal cross-sections.

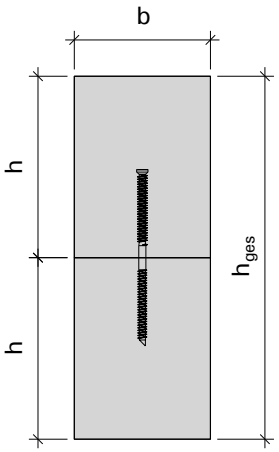
Reduction factors

Structure of the beam	Resistance torque β	Moment of inertia η
2-part	0.85	0.65
3-part	0.60	0.33

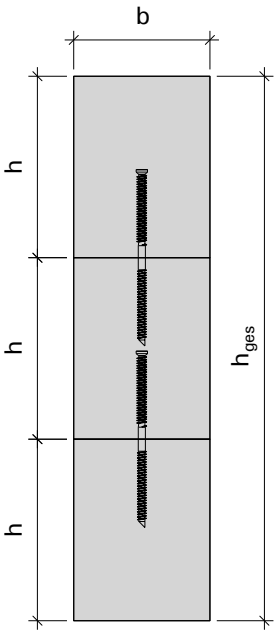
The reduction factors take into account the compliance of the lanyards in the shear joint.

2-part: n = 2
3-part: n = 3
$h_{ges} = n \cdot h$
$W_{y,ef} = \beta \cdot W_{y,starr} = ß \cdot h_{ges}^2 \cdot b / 6$
$I_{y,ef} = \eta \cdot I_{y,starr} = h \cdot h_{ges}^3 \cdot b / 12$

2-part



3-part



Dowelled beam

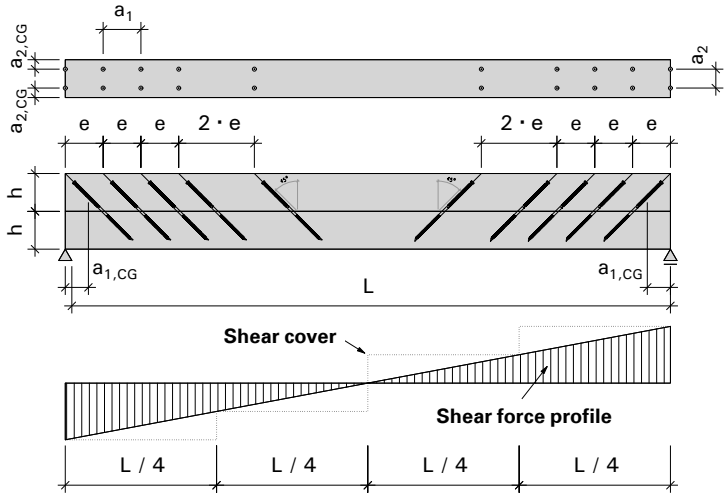
Dimensioning

The dowelling is dimensioned assuming a rigid connection.

2-part cross-section: $$e \leq e_{erf} = \frac{2 \cdot h_{ges} \cdot R_{V,d} \cdot m^{0.9}}{3 \cdot V_d}$$

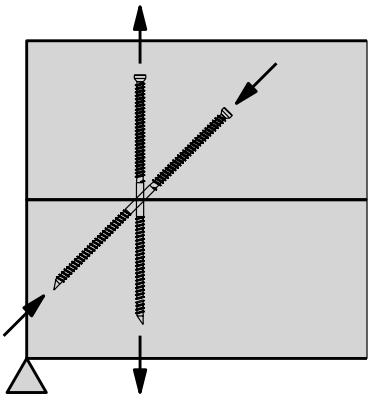
3-part cross-section: $$e \leq e_{erf} = \frac{3 \cdot h_{ges} \cdot R_{V,d} \cdot m^{0.9}}{4 \cdot V_d}$$

e	Selected spacing between fasteners in the longitudinal direction of the beam
e_{erf}	Maximum required spacing between fasteners in the longitudinal direction of the beam
h	Height of a section
h_{ges}	Height of total section
V_d	Design value of maximum shear force
R_d	Design shear capacity of one fastener
m	Number of rows of fasteners side by side



Dowelled beam

The screws can be processed from above and from below.If it is not possible to place the fasteners in the support area at an inclination of 45°, the arrangement shown below is possible. In this case, the vertical screw must be dimensioned for the corresponding tensile force.



General remarks

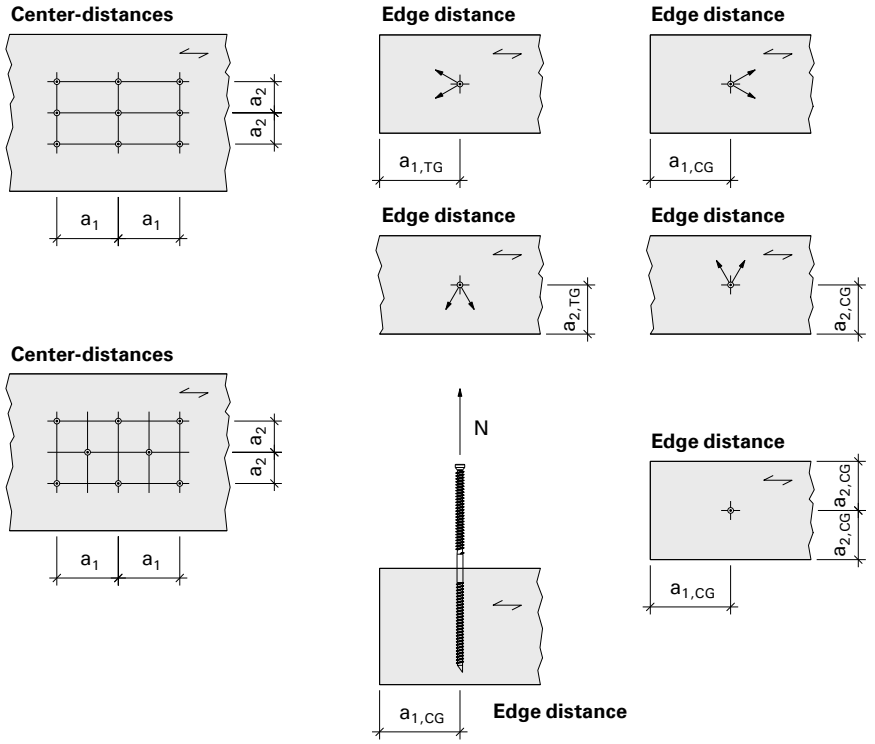
- The fasteners must be arranged in such a way that they are located half in each component
- The spacing e can be adjusted according to the shear force distribution
- If there is a layer of boards between the beams, this can be regarded as statically ineffective. However, it must be ensured that there is no distance between the board layer and the beam so that the pressure component can be absorbed without deformation
- Connection geometries according to drawings must be observed
- **Before execution, all calculations must be checked and approved by the responsible planner**

Dowelled beam

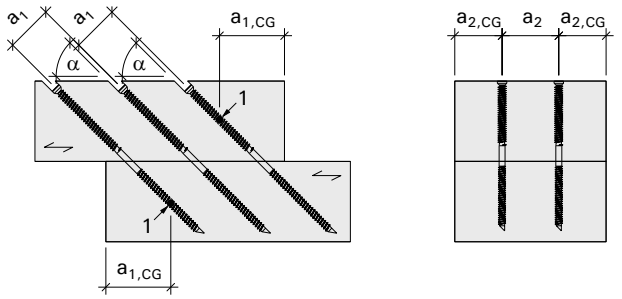
WT Edge and intermediate distances

Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the fibre	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the fibre	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

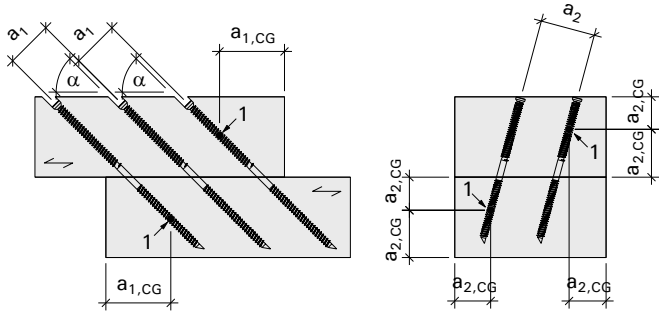
[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components.
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)



Dowelled beam



1 Center of gravity of the screw thread in the component

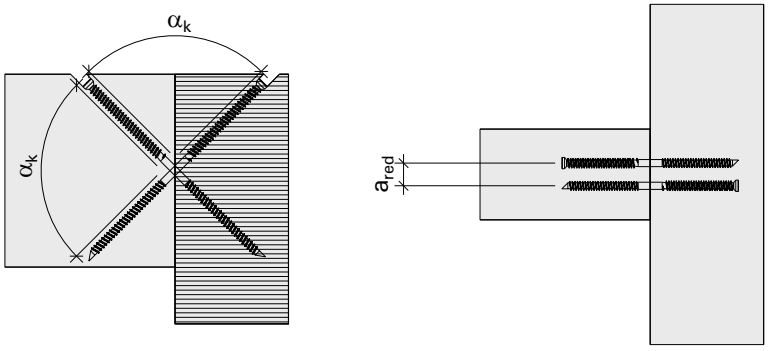


1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		0° <_ α_k <_ 90°						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25

Dowelled beam

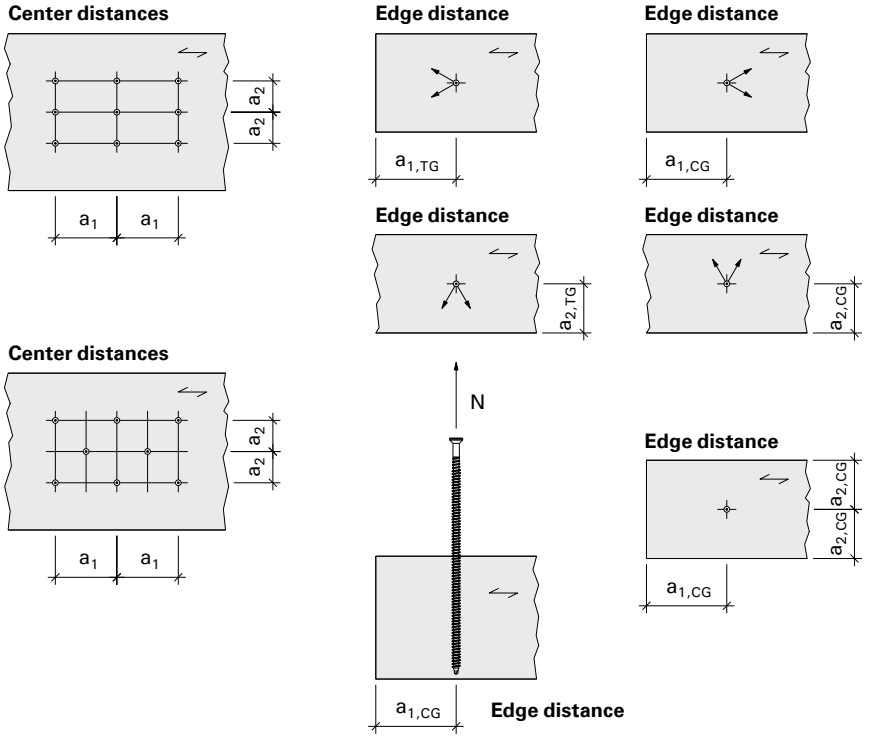


WR Edge and intermediate distances

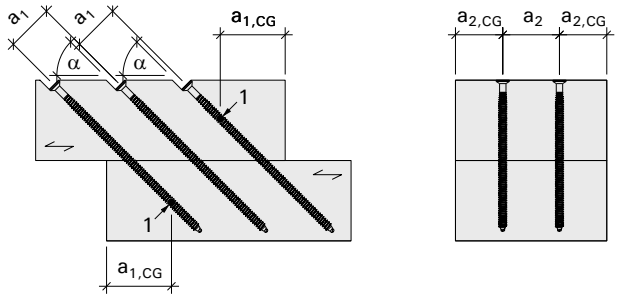
Without pre-drilling			**Axial**	**Shear** [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fibre	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fibre	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)

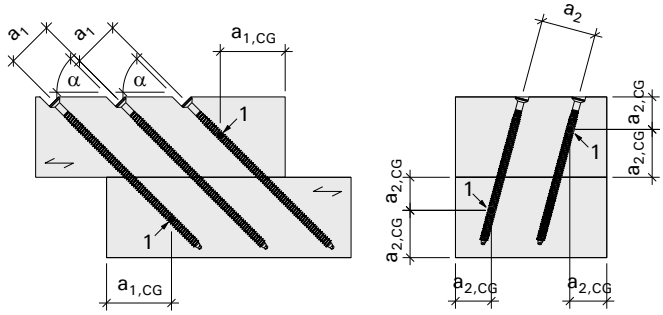
Dowelled beam



Dowelled beam



1 Center of gravity of the screw thread in the component

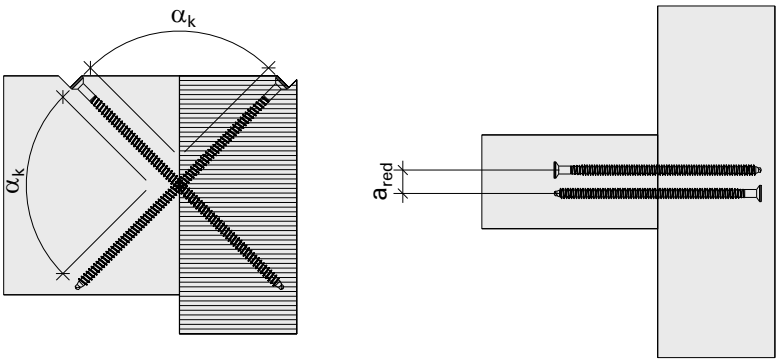


1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \leq \alpha_k \leq 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{red} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{red} [mm]	20	38	44	49	55	60	65

Dowelled beam



Example

System
Support width L = 5.00 m
Cross-section 2-part ; C24 ; b = 100 mm ; h = 160 mm

Loads
Dead load g_k = 1.25 kN/m'
Payload q_k = 1.60 kN/m'

Load combinations
Load-bearing safety $q'_d = \gamma_G \cdot g'_k + \gamma_Q \cdot q'_k = 1.35 \cdot 1.25 + 1.5 \cdot 1.60 = 4.09$ kN/m'
Serviceability $q'_{d,ser} = (1 + \varphi) \cdot g'_k + (\psi_0 + \varphi \cdot \psi_2) \cdot q'_k = (1 + 0.6) \cdot 1.25 + (0.7 + 0.6 \cdot 0.3) \cdot 1.60 = 3.41$ kN/m'

Cut sizes

Max. shear force $$V_d = \frac{q'_d \cdot L}{2} = \frac{4.09 \cdot 5.00}{2} = 10.22\ kN$$

max. torque $$M_d = \frac{q'_d \cdot L^2}{8} = \frac{4.09 \cdot 5.00^2}{8} = 12.77\ kNm$$

Cross-section

Resistance torque $$W_{y,ef} = \beta \cdot \frac{b \cdot {h_{ges}}^2}{6} = 0.85 \cdot \frac{100 \cdot (2 \cdot 160)^2}{6} = 1.45 \cdot 10^6 mm^3$$

Moment of inertia $$I_{y,ef} = \eta \cdot \frac{b \cdot {h_{ges}}^3}{12} = 0.65 \cdot \frac{100 \cdot (2 \cdot 160)^3}{12} = 177.49 \cdot 10^6 mm^4$$

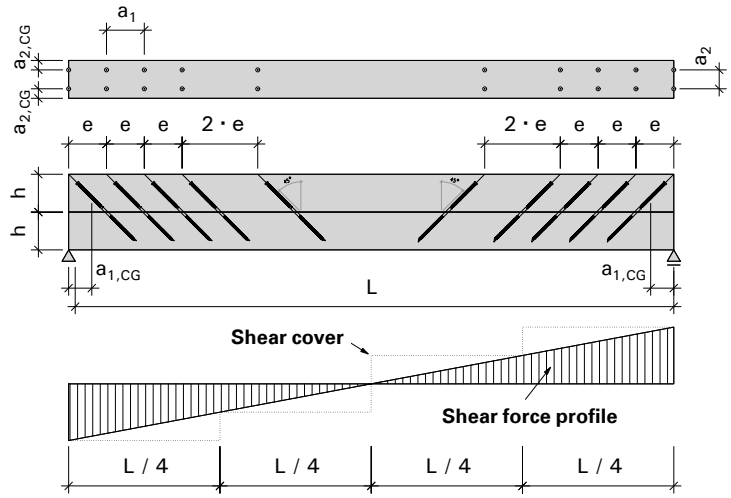
Dowelled beam

$$\sigma_{m,ef,d} = \frac{M_d}{W_{y,ef}} = \frac{12.77 \cdot 10^6}{1.45 \cdot 10^6} = 8.81 \frac{N}{mm^2} < f_{m,d} = 14.0\ N/mm^2$$

$$w = \frac{5 \cdot q'_{d,ser} \cdot L^4}{384 \cdot E \cdot I_{y,ef}} = \frac{5 \cdot 3.41 \cdot 5'000^4}{384 \cdot 11'000 \cdot 177.49 \cdot 10^6} = 14.2\ mm\ < \frac{L}{350} = \frac{5'000}{350} = 14.3\ mm$$

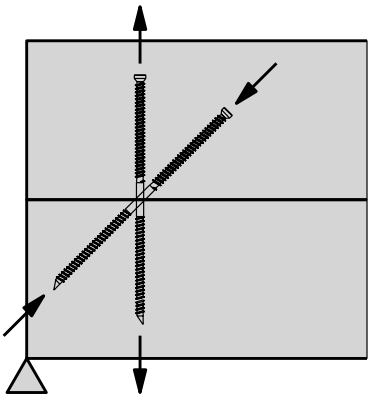
$$e\ \leq e_{erf} = \frac{2 \cdot h_{ges} \cdot R_{V,d} \cdot m^{0.9}}{3 \cdot V_d} = \frac{2 \cdot (2 \cdot 160) \cdot 6.21 \cdot 1^{0.9}}{3 \cdot 10.22} = 129.6\ mm$$

	selected
Outer quarters	e= 120 mm
Inner quarters	e = 240 mm



Dowelled beam

The screws can be processed from above and from below.
If it is not possible to place the fasteners in the support area at an inclination of 45°, the arrangement shown below is possible. In this case, the vertical screw must be dimensioned for the corresponding tensile force.



Shear connection			**C24**	**GL24h**
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
			$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
Fastener	s [mm]	h_{min} [mm]	α = 45°	α = 45°
WT-T/S-6,5x90	40	65 [1)]	1.45	1.56
WT-T/S-6,5x130	55	65 [1)]	1.99	2.15
WT-T-6,5x160	65	65 [1)]	2.35	2.54
WT-T-6,5x190	80	70	2.90	3.13
WT-T-6,5x220	95	80	3.44	3.71
WT-T-8,2x160	65	82 [1)]	2.97	3.20
WT-T-8,2x190	80	82 [1)]	3.65	3.94
WT-T-8,2x220	95	82 [1)]	4.34	4.68
WT-T-8,2x245	107	90	4.89	5.27
WT-T-8,2x275	122	100	5.57	6.01
WT-T-8,2x300	135	110	6.17	6.65
WT-T-8,2x330	135	120	6.17	6.65

1) With pre-drilling, smaller minimum timber thicknesses are also possible

General remarks see page 91

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Dowelled beam

Shear connection		**C24**	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	$R_{V,d}$ [kN]	$R_{V,d}$ [kN]
WR-T-9xL	50	–	–
	100	5.01	5.41
	150	7.52	8.12
	200	10.03	10.82
	250	12.53	13.53
	300	13.60	13.60
	350	13.60	13.60
	400	13.60	13.60
	450	13.60	13.60
	500	13.60	13.60
WR-T-13xL	100	7.24	7.81
	200	14.48	15.63
	300	21.72	23.44
	400	28.96	29.92
	500	29.92	29.92
	600	29.92	29.92
	700	29.92	29.92
	800	29.92	29.92
	900	29.92	29.92
	1000	29.92	29.92

General remarks see below

= Steel failure

General remarks

- Values apply to corresponding anchoring lengths s or l_{ef} of the thread
- For WT screws subjected to axial compression, where the screw head is pressed out of the wood and therefore does not carry, 5.2 mm (d = 6.5 mm) and 6.5 mm (d = 8.2 mm) on the screw head side
- For WR-T screws subjected to axial compression, where the screw head is pressed out of the wood and therefore does not carry, 20 mm must be deducted on the screw head side
- Connection geometries according to drawings are to be observed
- k_α = 0.62 (according to SIA 265:2012 (2019))
- **Before execution, all calculations must be checked and approved by the responsible planner**

Dowelled beam

Fastening system WT

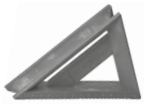
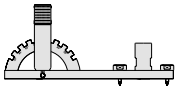
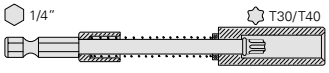
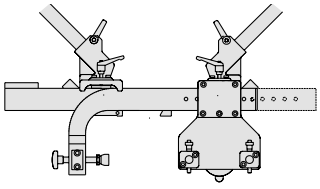
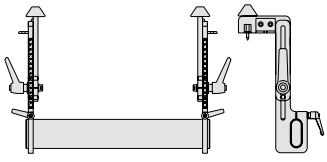
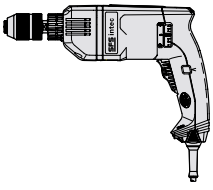
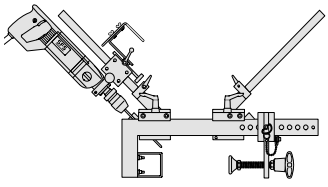
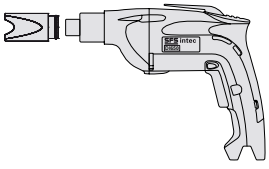
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	4.0
WT-T-8,2xL	5.0

Type		Material S: A2 T: blue zinc [1]		Thread Ø d [mm]		Length L [mm]	Thread length s [mm]	Head Ø d_k [mm]	Head height l_k [mm]	Recess
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] For moisture classes: 1 and 2 (not directly weathered)

Dowelled beam

Mounting devices and accessories

Application	Tools/Accessories	Fastener	Tools/Accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bit holder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupling purlin	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

Dowelled beam

Fastening system WR

Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T	-	9	x	250	14	20	T40
WR	-	T	-	9	x	300	14	20	T40
WR	-	T	-	9	x	350	14	20	T40
WR	-	T	-	9	x	400	14	20	T40
WR	-	T	-	9	x	450	14	20	T40
WR	-	T	-	9	x	500	14	20	T40
WR	-	T	-	13	x	400	22	20	T50
WR	-	T	-	13	x	500	22	20	T50
WR	-	T	-	13	x	600	22	20	T50
WR	-	T	-	13	x	700	22	20	T50
WR	-	T	-	13	x	800	22	20	T50
WR	-	T	-	13	x	900	22	20	T50
WR	-	T	-	13	x	1000	22	20	T50

[1] for moisture classes: 1 and 2 (not directly weathered)

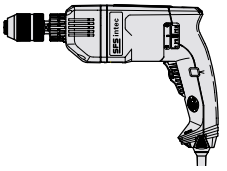
Mounting devices and accessories

Fastener WR-T-9xL

Bit T40: Length 70, 152, 200, 350, 520 [mm]

Screw-in adapter for WR

Power drill BO 1055



Fastener WR-T-13xL

Wera Torx-Bit 5/16
Drive: E 3,6 ¼"

SFS Tool holder ZA ½"
Drive: Square ½"

Garant Torx ½"
Drive: Square ½"

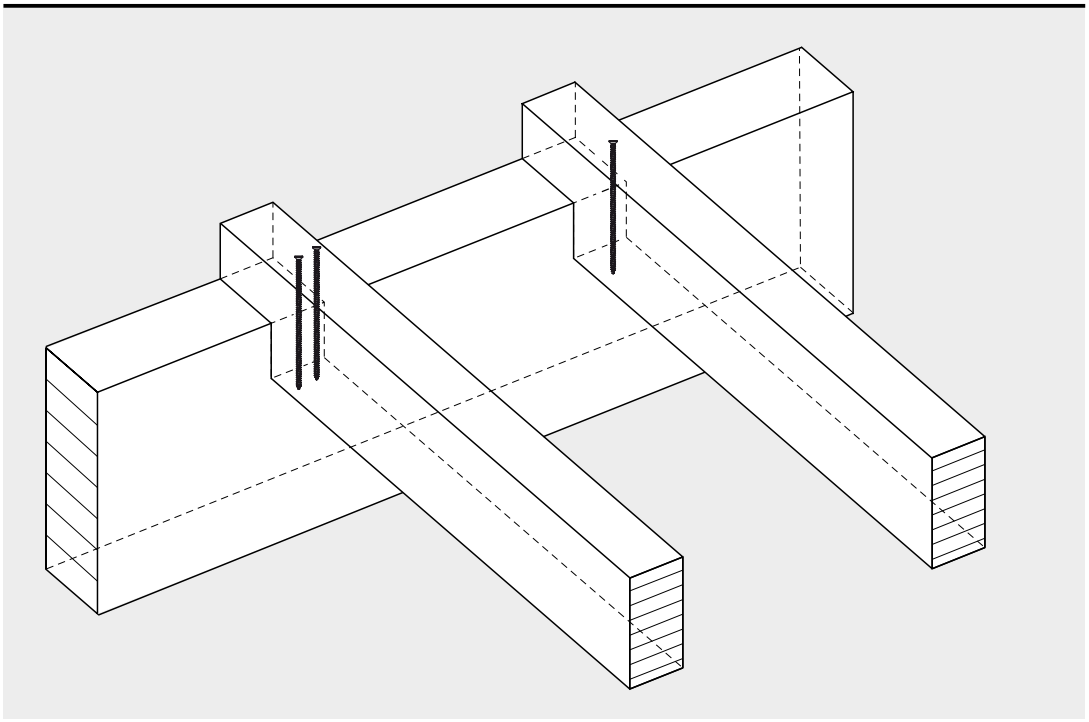
Screw-in adaptor for WR

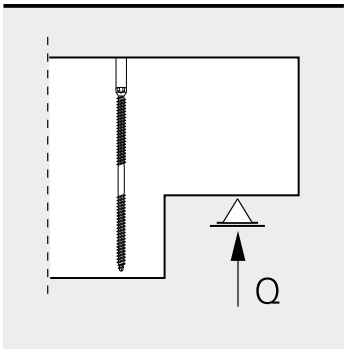
Power drill 32-4

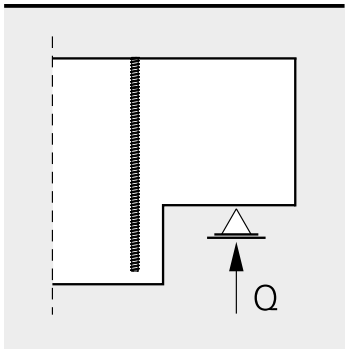
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement notched beams

Appication



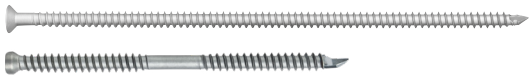




For large cross-sections, reinforcement is also possible with WB fasteners (see separate chapter for WB)

Advantages that convince

- Easy processing
- High performance
- Fasteners not visible
- Quick assembly
- High fire resistance of the joint
- ETA-12/0063 (WT)
- ETA-12/0062 (WR)



Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

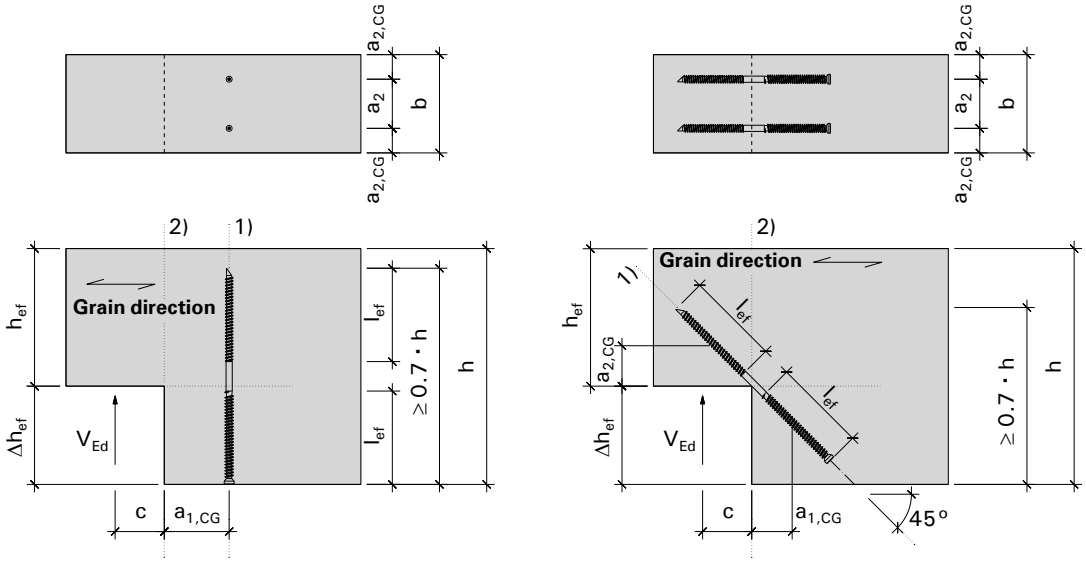
Reinforcement notched beams

Design proposal according to SIA 265:2012 Annex D3 (2019 Annex E3)

The reinforcements and the stresses in the remaining cross-section (h – Δh_{ef}) must be verified. Only 1 fastener may be placed in the longitudinal direction of the beam. The reinforcement of a right-angled notch on the transversely tensile side of a beam support shall be checked for the following design value of the tensile force $F_{t,90,Ed}$:

$$F_{t,90,Ed} = 1.3\left[3 \cdot \left(\frac{\Delta h_{ef}}{h}\right)^2 - 2 \cdot \left(\frac{\Delta h_{ef}}{h}\right)^3\right] \cdot V_{Ed}$$

$F_{t,90,Ed}$ Design value of the tensile force acting on the reinforcement. The tensile force $F_{t,90,Ed}$ is to be assumed to act at the height of the notch corner subject to transverse tensile stress and to be introduced via the anchorage length l_{ef}
h Beam height
Δh_{ef} Height of the notch
V_{Ed} Design value of the shear force



Evidence

$$\frac{F_{t,90,d}}{n^{0.9} \cdot R_d} \leq 1.0$$

n Number of fasteners (side by side ; only one fastener may be placed in the longitudinal direction of the beam)
R_d Rated capacity of a fastener (see table)
l_{ef} Length of effective threaded part
s Thread length WT fastener per side (head or tip)

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ; ETA-12/0062 ; ETA-12/0063

Reinforcement notched beams

Half of the total thread length must be in the upper and half in the lower (notched) section, otherwise the fastener load capacity must be reduced from R_d auf $R_{d,ef}$.

WT: $R_{d,ef} = R_d \cdot l_{ef} / s$

		Fastener 90°		Fastener 45°	
		C24	**GL24h**	**C24**	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	s [mm]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]
WT-T/S-6,5x90	40	2.05	2.21	1.45	1.56
WT-T/S-6,5x130	55	2.82	3.04	1.99	2.15
WT-T-6,5x160	65	3.33	3.59	2.35	2.54
WT-T-6,5x190	80	4.10	4.42	2.90	3.13
WT-T-6,5x220	95	4.86	5.25	3.44	3.71
WT-T-8,2x160	65	4.20	4.53	2.97	3.20
WT-T-8,2x190	80	5.17	5.58	3.65	3.94
WT-T-8,2x220	95	6.14	6.62	4.34	4.68
WT-T-8,2x245	107	6.91	7.46	4.89	5.27
WT-T-8,2x275	122	7.88	8.50	5.57	6.01
WT-T-8,2x300	135	8.72	9.41	6.17	6.65
WT-T-8,2x330	135	8.72	9.41	6.17	6.65

General remarks see page 98

Reinforcement notched beams

		Fastener 90°		Fastener 45°	
		C24	**GL24h**	**C24**	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]
WR-T-9xL	50	3.54	3.83	–	–
	100	7.09	7.65	5.01	5.41
	150	10.63	11.48	7.52	8.12
	200	14.18	15.30	10.03	10.82
	250	17.72	19.13	12.53	13.53
	300	19.23	19.23	13.60	13.60
	350	19.23	19.23	13.60	13.60
	400	19.23	19.23	13.60	13.60
	450	19.23	19.23	13.60	13.60
	500	19.23	19.23	13.60	13.60
WR-T-13xL	100	10.24	11.05	7.24	7.81
	200	20.48	22.10	14.48	15.63
	300	30.72	33.15	21.72	23.44
	400	40.96	42.31	28.96	29.92
	500	42.31	42.31	29.92	29.92
	600	42.31	42.31	29.92	29.92
	700	42.31	42.31	29.92	29.92
	800	42.31	42.31	29.92	29.92
	900	42.31	42.31	29.92	29.92
	1000	42.31	42.31	29.92	29.92

General remarks see below

= Steel failure

General remarks

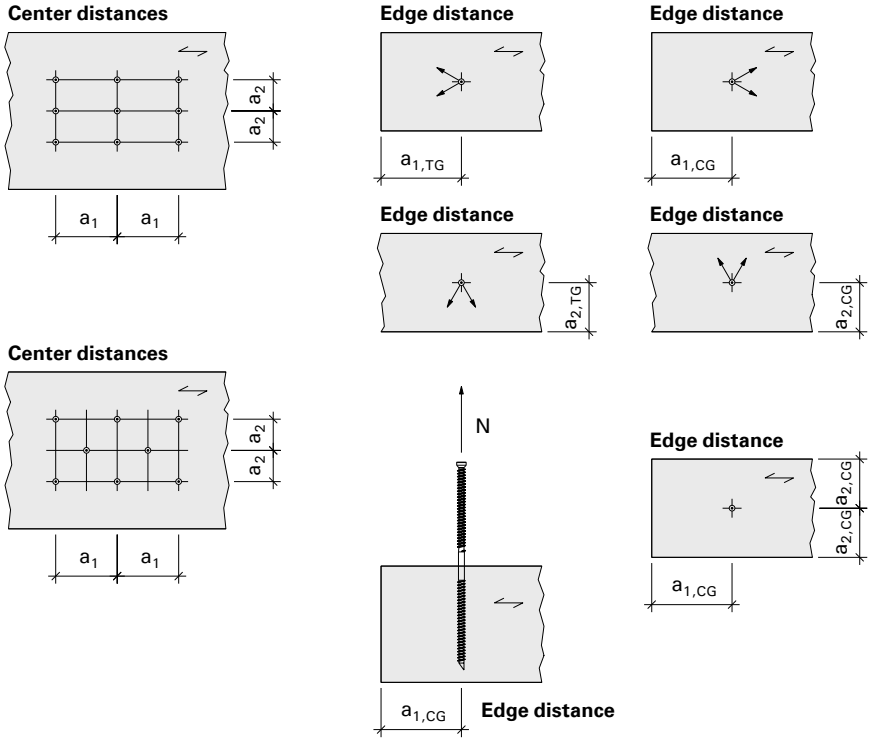
- Values apply to the corresponding anchorage lengt-hn s or. l_{ef} of the thread
- Connection geometries according to drawings are to be observed
- Table values for k_{mod} = 0.8 and γ_M = 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible planner.**

Reinforcement notched beams

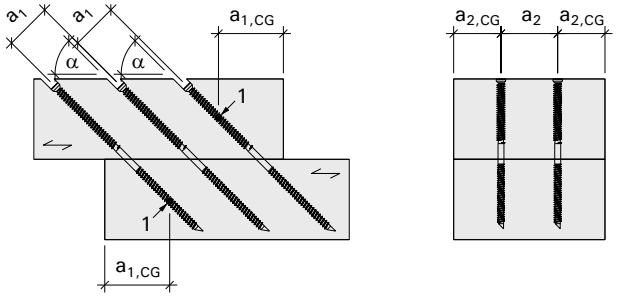
WT edge and intermediate distances

Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the fibre	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the fibre	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

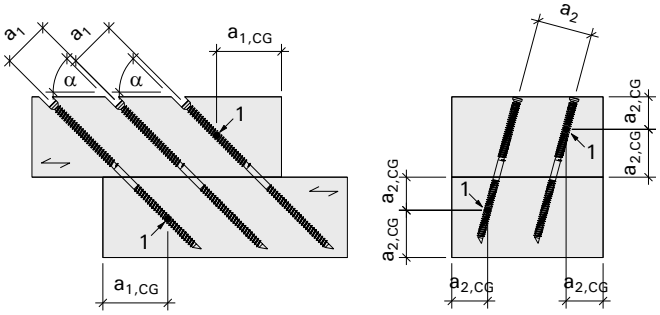
[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)



Reinforcement notched beams



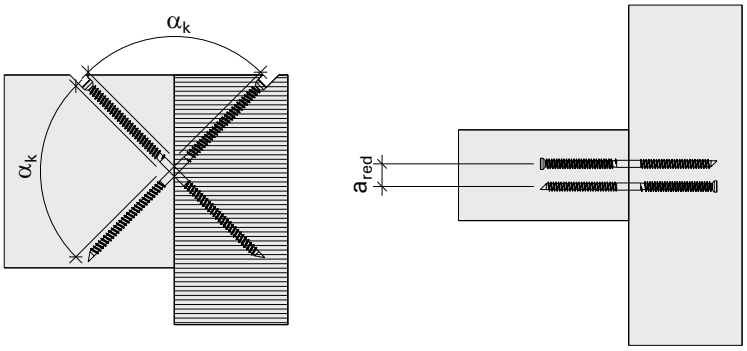
1 Center of gravity of the screw thread in the component



1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25



General remarks
Prior to execution, all calculations must be checked and approved by the responsible planner.

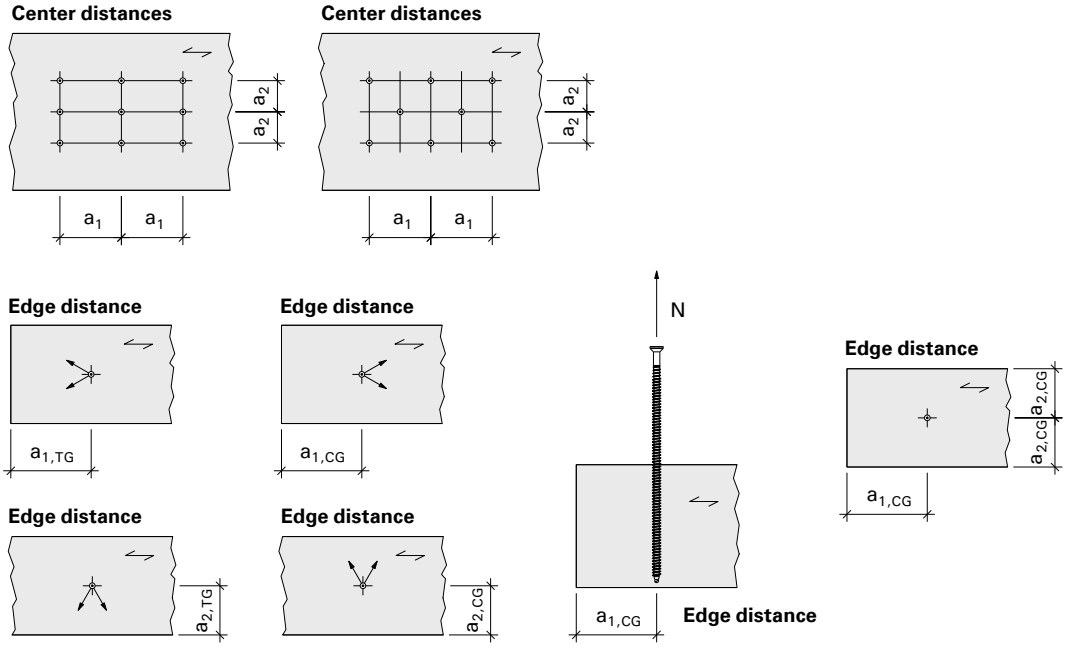
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement notched beams

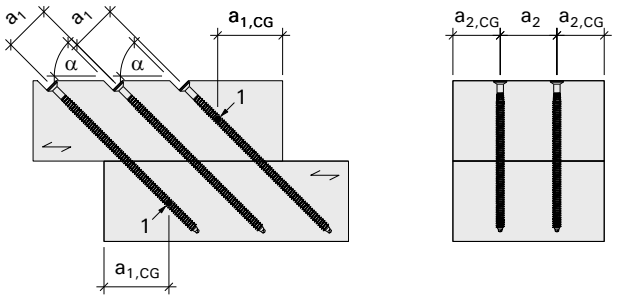
WR Edge and intermediate distances

Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fibre	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fibre	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

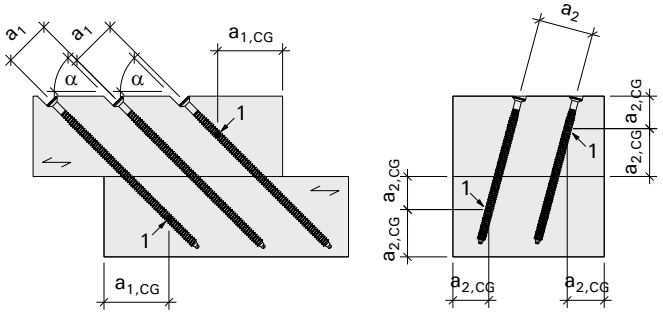
[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)



Reinforcement notched beams



1 Center of gravity of the screw thread in the component

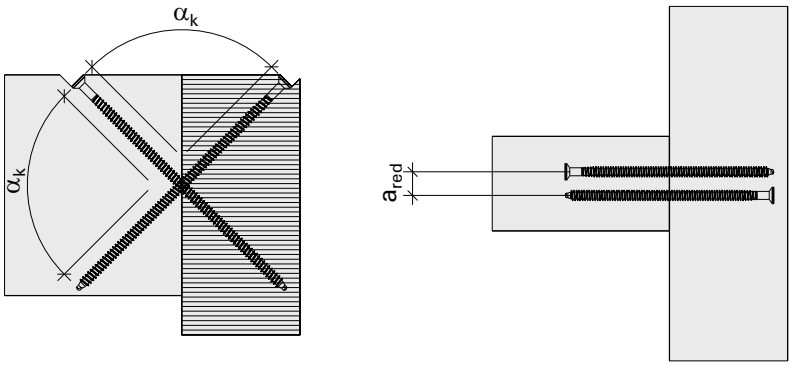


1 Center of gravity of the screw thread in the component

Reinforcement notched beams

Minimum distances between crossed bolts (axial loading)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{red} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{red} [mm]	20	38	44	49	55	60	65

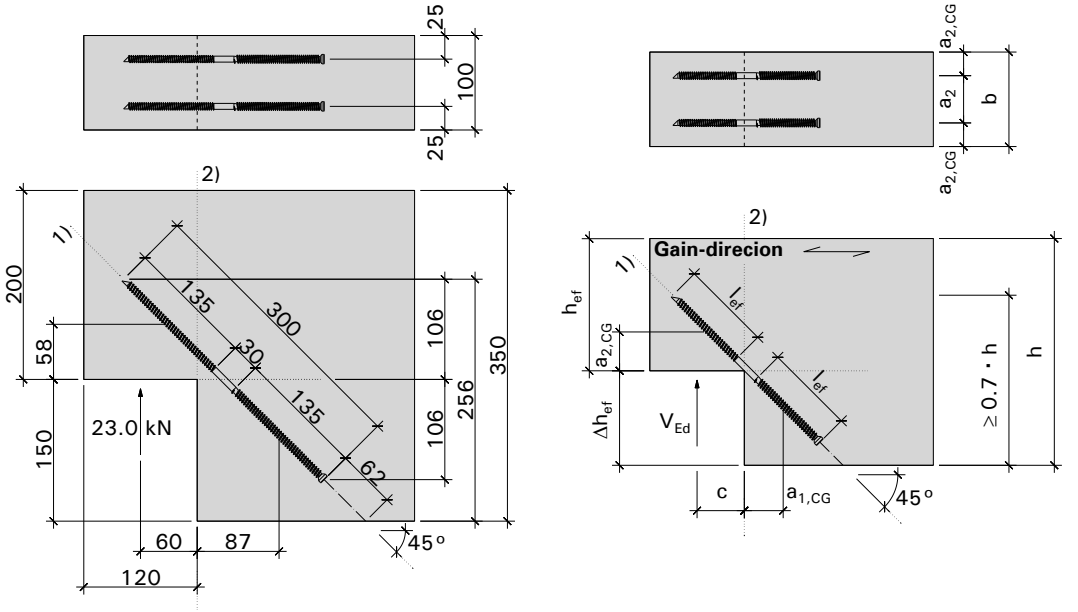


Reinforcement notched beams

Example

Glued laminated timber GL24h; Humidity class 1

Reinforcement 2 x WT-T-8,2x300



without pre-drilling (see EN 1995-1-1:2010-12 chapter 6.5.2)
h_{ef} = 350 – 150 = 200 mm
GL24h → k_n = 6,5

$$kv = \min \left\{ \frac{k_n \left[1 + \frac{1{,}1 i^{1{,}5}}{\sqrt{h}}\right]}{\sqrt{h}\left[\sqrt{\propto (1-\propto)} + 0{,}8\frac{x}{h}\sqrt{\frac{1}{\propto} - \propto^2}\right]} \right.$$

$$\tau_d = 1.5 \cdot \frac{V_{Ed}}{b \cdot h_{ef}} = \frac{23.0 \cdot 10^3}{100 \cdot 200} = 1.15 \frac{N}{mm^2} > k_v \cdot f_{v,d} = 0.54 \cdot 1.8 = 0.97 \frac{N}{mm^2} \rightarrow nicht\ i.O.$$

→ Reinforcement required!

Reinforcement notched beams

With reinforcement

$a_{1,CG}$ = 86.6 mm > 66 mm → i.O.
$a_{2,CG}$ = 58.3 mm > 25 mm → i.O.
$a_{2,CG}$ = 25.0 mm = 25 mm → i.O.
256.1 mm > 0.7 · 350 mm = 245 mm → i.O.

Evidence in place 1)

$$F_{t,90,Ed} = 1.3\left[3 \cdot \left(\frac{\Delta h_{ef}}{h}\right)^2 - 2 \cdot \left(\frac{\Delta h_{ef}}{h}\right)^3\right] \cdot V_{Ed} = 1.3\left[3 \cdot \left(\frac{150}{350}\right)^2 - 2 \cdot \left(\frac{150}{350}\right)^3\right] \cdot 23.0 = 11.77\ kN$$

$$\frac{F_{t,90,d}}{n^{0.9} \cdot R_d} = \frac{11.77}{2^{0.9} \cdot 6.70} = 0.94 < 1.0 \rightarrow i.O.$$

Evidence in place 2)

$$\frac{\tau_d}{f_{v,d}} = \frac{1.5 \cdot V_{Ed}}{b \cdot h_{ef} \cdot f_{v,d}} = \frac{1.5 \cdot 23.0 \cdot 10^3}{100 \cdot 200 \cdot 1.8} = 0.96 < 1.0 \rightarrow i.O.$$

If the distance c is large, a bending stress check may also be required at point 2).

Fastening system WT

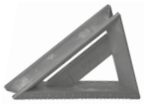
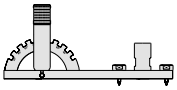
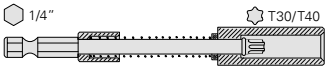
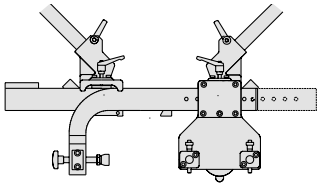
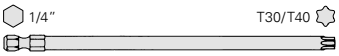
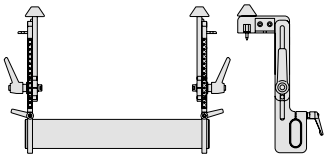
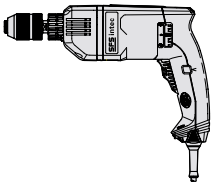
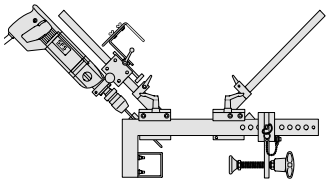
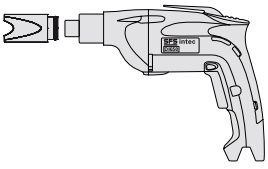
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	4.0
WT-T-8,2xL	5.0

Type		Material S: A2 T: blue zinc [1)]		Thread Ø d [mm]		Length L [mm]	Thread length s [mm]	Head Ø d_k [mm]	Head height l_k [mm]	Bit
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1)] for moisture classes: 1 and 2 (not directly weathered)

Reinforcement notched beams

Mounting devices and accessories

Application	Tools/Accessories	Fastener	Tools/Accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupled purllin	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

Reinforcement notched beams

Fastening system WR

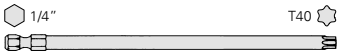
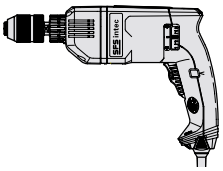
Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T	-	9	x	250	14	20	T40
WR	-	T	-	9	x	300	14	20	T40
WR	-	T	-	9	x	350	14	20	T40
WR	-	T	-	9	x	400	14	20	T40
WR	-	T	-	9	x	450	14	20	T40
WR	-	T	-	9	x	500	14	20	T40
WR	-	T	-	13	x	400	22	20	T50
WR	-	T	-	13	x	500	22	20	T50
WR	-	T	-	13	x	600	22	20	T50
WR	-	T	-	13	x	700	22	20	T50
WR	-	T	-	13	x	800	22	20	T50
WR	-	T	-	13	x	900	22	20	T50
WR	-	T	-	13	x	1000	22	20	T50

[1] for use classes: 1 and 2 (not directly weathered)

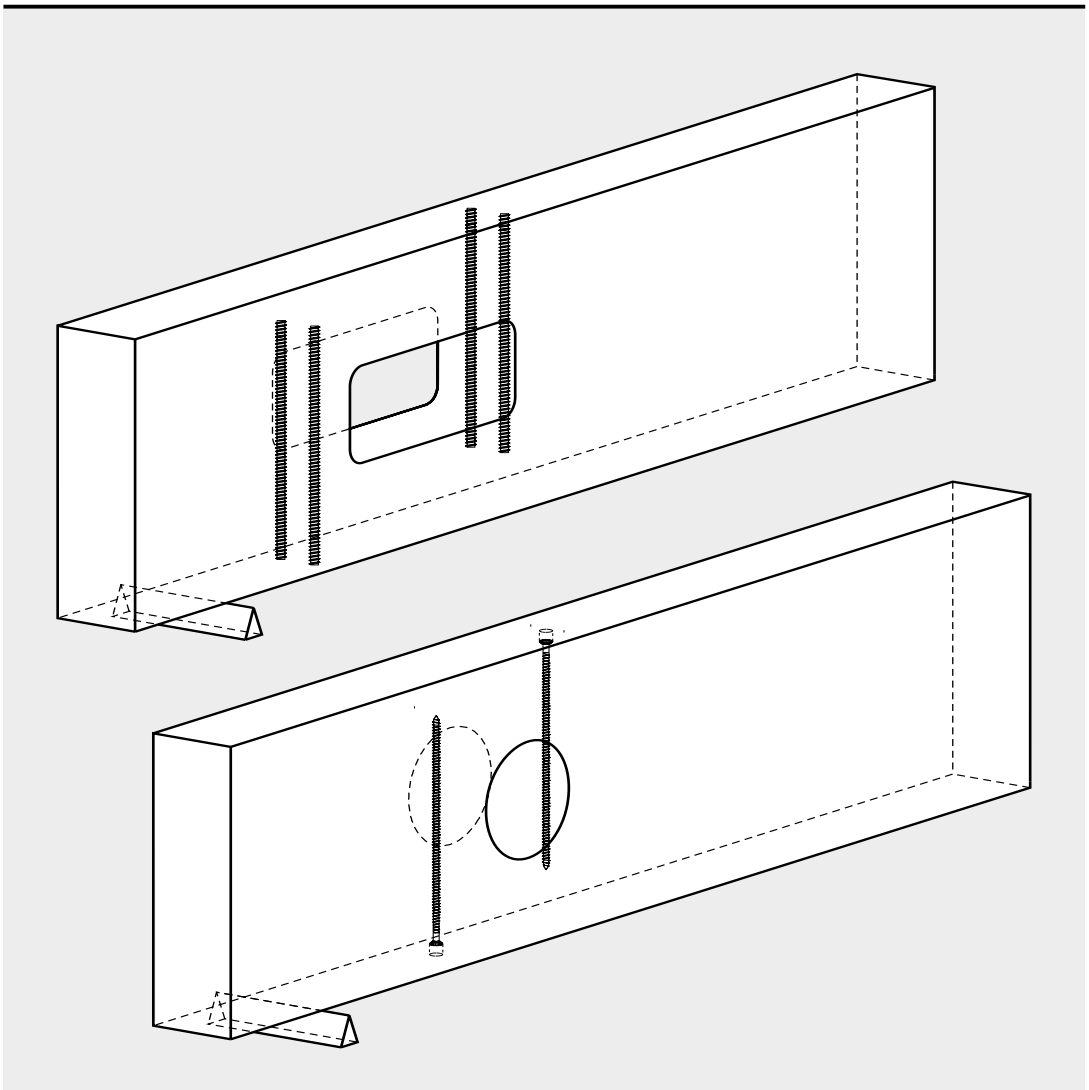
Reinforcement notched beams

Mounting devices and accessories

Fastener WR-T-9xL	Fastener WR-T-13xL	
Bit T40: Length 70, 152, 200, 350, 520 [mm] 	Wera Torx-Bit 5/16 Drive: E 3,6 ¼" 	Garant Torx ½" Drive: Square ½" 
Screw-in adapter for WR 	SFS tool holder ZA ½" Drive: Square ½" 	Screw-in adapter for WR 
Power drill BO 1055 	Power drill 32-4 	

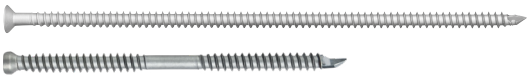
Reinforcement of beam penetrations

Application



Advantages that convince

- High load-bearing capacity
- Simple calculation and processing
- Reinforcement not visible
- High fire resistance of the joint
- No glue approval necessary
- Fastener can be used from above and below
- ETA-12/0063 (WT)
- ETA-12/0062 (WR)

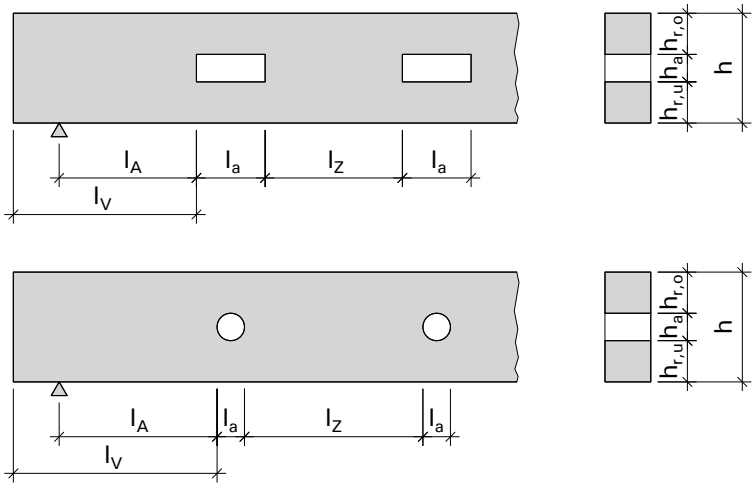


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement of beam penetrations

Design proposal according to SIA 265:2012 Annex D.4 (2019 Annex E4)

The following boundary conditions must be observed:
$l_V \geq h$
$l_A \geq h / 2$
$l_Z \geq \max \{h ; 300\ mm\}$
$l_a \leq h$
$l_a / h_a \leq 2.5$
$h_r \geq 0.25 \cdot h$
$h_a \leq 0.3 \cdot h$



$$F_{t,90,Ed} = \frac{h_a}{4 \cdot h} \cdot \left[3 - \left(\frac{h_a}{h}\right)^2\right] \cdot V_{Ed} + \frac{1}{125 \cdot h_r} \cdot M_{Ed}$$

$F_{t,90,Ed}$	Design value of the tensile force at right angles to the wood fibre as a result of V_d and M_d
h	Beam height
h_a	Height of the penetration

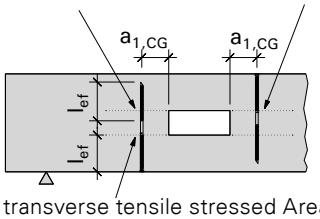
Rectangular openings $h_r = \min\{h_{r,o} ; h_{r,u}\}$
Round openings $h_r = \min \{h_{r,o} + 0.15 \cdot h_a ; h_{r,u} + 0.15 \cdot h_a\}$

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

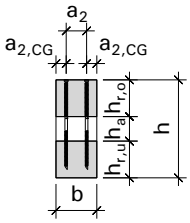
Reinforcement of beam penetrations

Fastener at 90°

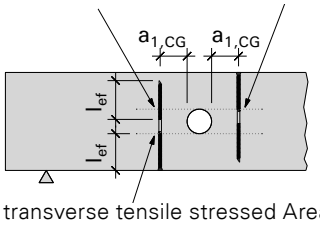
Additional transverse tensile stress Area if $F_{t,M,d} \geq F_{t,V,d}$



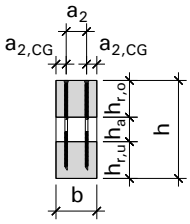
transverse tensile stressed Area



Additional transverse tensile stress Area if $F_{t,M,d} \geq F_{t,V,d}$

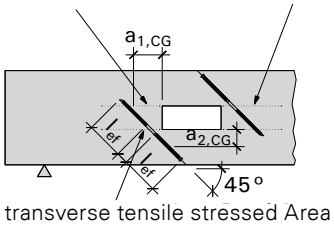


transverse tensile stressed Area

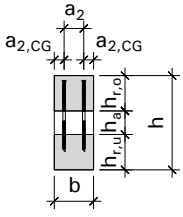


Fastener at 45°

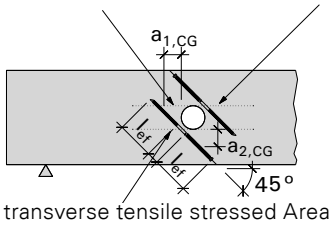
Additional transverse tensile stress Area if $F_{t,M,d} \geq F_{t,V,d}$



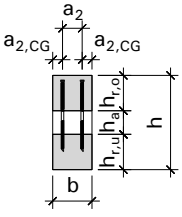
transverse tensile stressed Area



Additional transverse tensile stress Area if $F_{t,M,d} \geq F_{t,V,d}$



transverse tensile stressed Area



Reinforcement of beam penetrations

Evidence

$$\frac{F_{t,90,d}}{n^{0.9} \cdot R_d} \leq 1.0$$

3

n Number of fasteners (side by side ; only one fastener may be placed in the longitudinal direction of the beam)
R_d Rated capacity of a fastener (see table)
l_{ef} Length of the effective threaded part
s Thread length WT fastener per side (head or tip)

Half of the total thread length must be in the top and half in the bottom (notched) section, otherwise the fastener load capacity must be reduced from R_d to $R_{d,ef}$.

WT $R_{d,ef} = R_d \cdot l_{ef} / s$

			Fastener 90°		Fastener 45°	
			C24	**GL24h**	**C24**	**GL24h**
			ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	s [mm]	h_{min} [mm]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]
WT-T/S-6,5x90	40	50	2.05	2.21	1.45	1.56
WT-T/S-6,5x130	55	70	2.82	3.04	1.99	2.15
WT-T-6,5x160	65	85	3.33	3.59	2.35	2.54
WT-T-6,5x190	80	100	4.10	4.42	2.90	3.13
WT-T-6,5x220	95	115	4.86	5.25	3.44	3.71
WT-T-8,2x160	65	85	4.20	4.53	2.97	3.20
WT-T-8,2x190	80	100	5.17	5.58	3.65	3.94
WT-T-8,2x220	95	115	6.14	6.62	4.34	4.68
WT-T-8,2x245	107	125	6.91	7.46	4.89	5.27
WT-T-8,2x275	122	140	7.88	8.50	5.57	6.01
WT-T-8,2x300	135	155	8.72	9.41	6.17	6.65
WT-T-8,2x330	135	170	8.72	9.41	6.17	6.65

General remarks see page 179

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement of beam penetrations

		Fastener 90°		Fastener 45°	
		C24	**GL24h**	**C24**	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]
WR-T-9xL	50	3.54	3.83	–	–
	100	7.09	7.65	5.01	5.41
	150	10.63	11.48	7.52	8.12
	200	14.18	15.30	10.03	10.82
	250	17.72	19.13	12.53	13.53
	300	19.23	19.23	13.60	13.60
	350	19.23	19.23	13.60	13.60
	400	19.23	19.23	13.60	13.60
	450	19.23	19.23	13.60	13.60
	500	19.23	19.23	13.60	13.60
WR-T-13xL	100	10.24	11.05	7.24	7.81
	200	20.48	22.10	14.48	15.63
	300	30.72	33.15	21.72	23.44
	400	40.96	42.31	28.96	29.92
	500	42.31	42.31	29.92	29.92
	600	42.31	42.31	29.92	29.92
	700	42.31	42.31	29.92	29.92
	800	42.31	42.31	29.92	29.92
	900	42.31	42.31	29.92	29.92
	1000	42.31	42.31	29.92	29.92

General remarks see below

= Steel failure

General remarks

- The checks on the net transverse section must be carried out additionally. In the case of rectangular breakthroughs, the additional bending moment from the transverse force and the increased shear stresses in the area of the breakthrough corners must be taken into account
- The design of the reinforcement is to be carried out for both sides of the breakthrough
- Values apply to the corresponding anchorage length s or l_{ef} of the thread
- Connection geometries according to drawings are to be observed
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible planner**

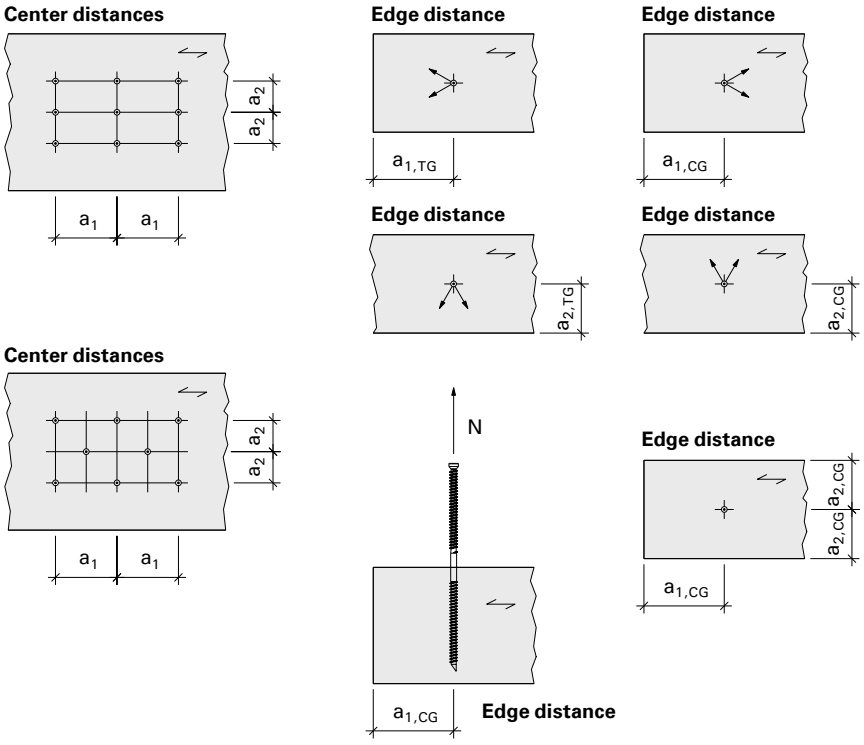
Reinforcement of beam penetrations

WT Edge and intermediate distances

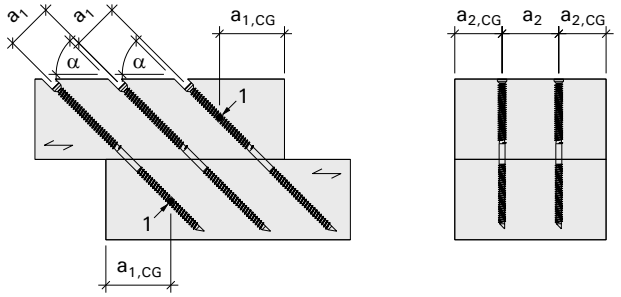
Without pre-drilling			**Axial**	**Shear** [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the fibre	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the fibre	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)

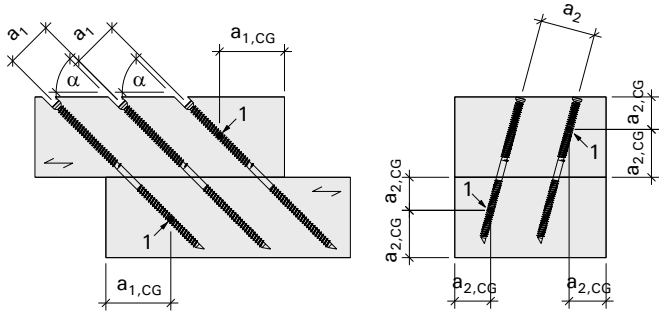
Reinforcement of beam penetrations



Reinforcement of beam penetrations



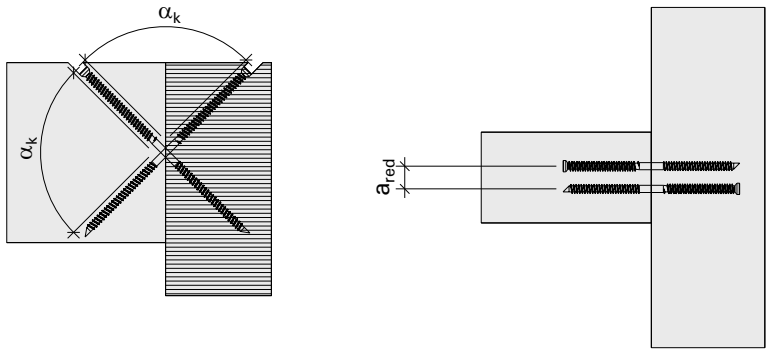
1 Center of gravity of the screw thread in the component



1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial loading)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25



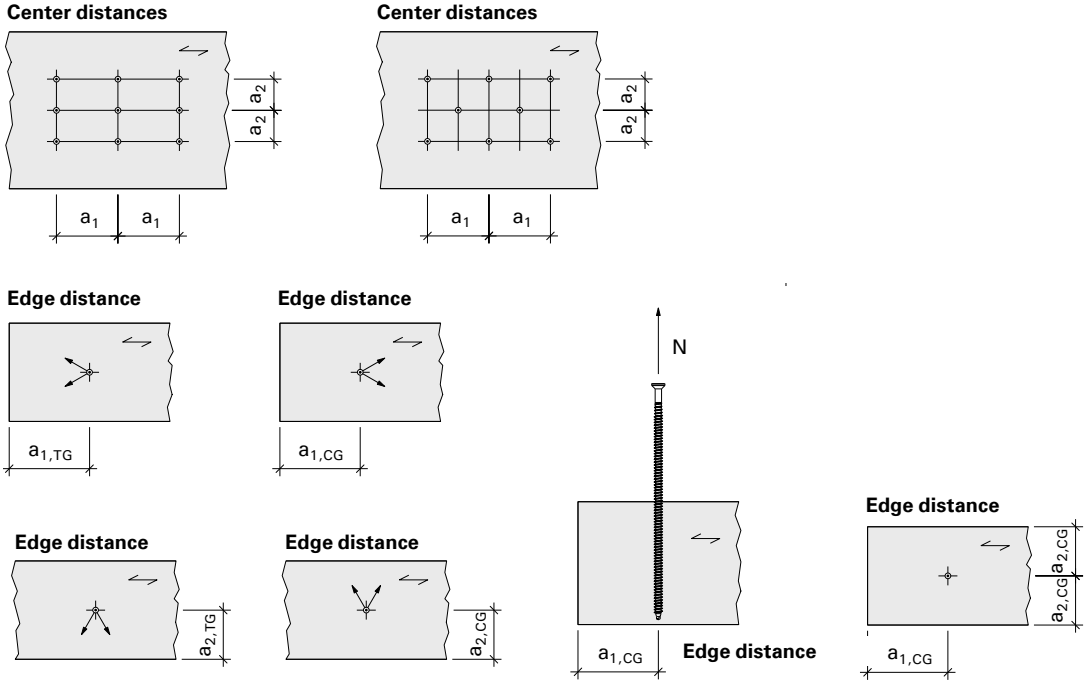
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement of beam penetrations

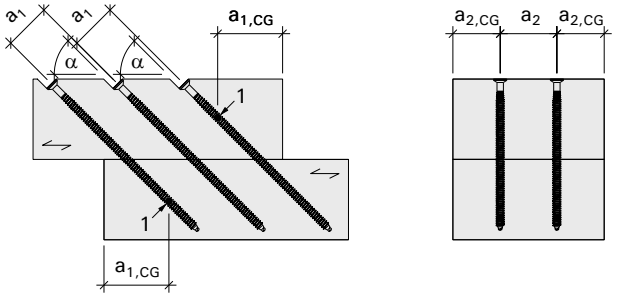
WR Edge and intermediate distances

Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fibre	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fibre	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

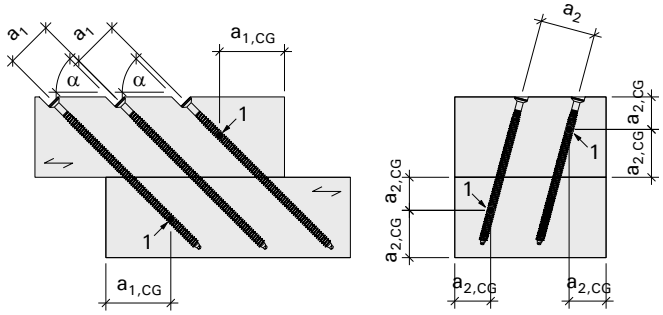
[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)



Reinforcement of beam penetrations



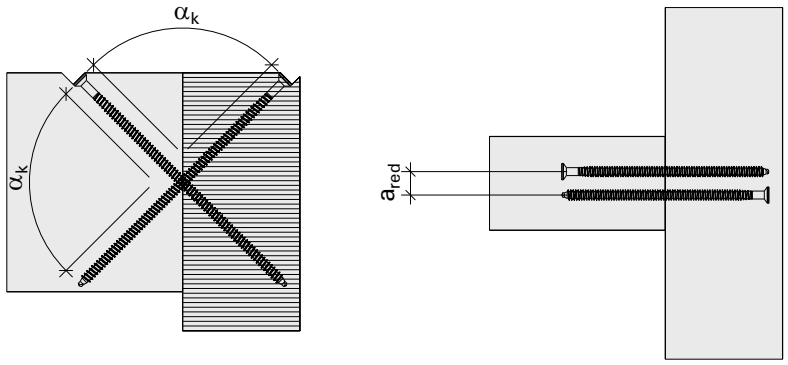
1 Center of gravity of the screw thread in the component



1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial loading)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{red} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{red} [mm]	20	38	44	49	55	60	65

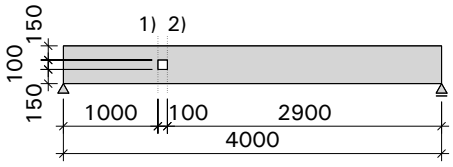


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement of beam penetrations

Example

Glued laminated timber GL24h ; moisture class 1



Cut 1

Cut-sizes
V_d = 45.0 kN
M_d = 67.5 kNm

Transverse tensile force

$$F_{t,90,Ed} = \frac{h_a}{4 \cdot h} \cdot \left[3 - \left(\frac{h_a}{h}\right)^2\right] \cdot V_{Ed} + \frac{1}{125 \cdot h_r} \cdot M_{Ed} = \left[\frac{100}{4 \cdot 400} \cdot \left[3 - \left(\frac{100}{400}\right)^2\right] \cdot 45.0 \cdot 10^3 + \frac{1}{125 \cdot 150} \cdot 67.5 \cdot 10^6\right] \cdot 10^{-3} = 11.86\ kN$$

Choice of fastener
selected: 2 WT-T-8,2x300 with R_d = 9.48 kN

Evidence

$$\frac{F_{t,90,d}}{n^{0.9} \cdot R_d} = \frac{11.86}{2^{0.9} \cdot 9.48} = 0.67 < 1.0 \rightarrow i.O.$$

Cut 2

Cut-size
V_d = 40.5 kN
M_d = 71.8 kNm

Transverse tensile force

$$F_{t,90,Ed} = \frac{h_a}{4 \cdot h} \cdot \left[3 - \left(\frac{h_a}{h}\right)^2\right] \cdot V_{Ed} + \frac{1}{125 \cdot h_r} \cdot M_{Ed} = \left[\frac{100}{4 \cdot 400} \cdot \left[3 - \left(\frac{100}{400}\right)^2\right] \cdot 40.5 \cdot 10^3 + \frac{1}{125 \cdot 150} \cdot 71.8 \cdot 10^6\right] \cdot 10^{-3} = 11.26\ kN$$

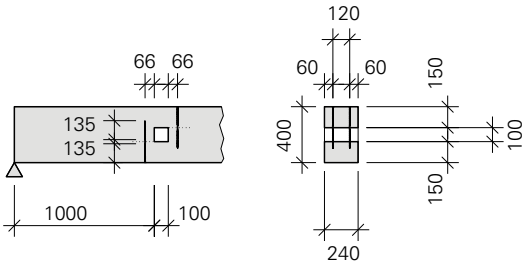
Choice of fastener
selected: 2 WT-T-8,2x300 with R_d = 9.48 kN

Nachweis

$$\frac{F_{t,90,d}}{n^{0.9} \cdot R_d} = \frac{11.26}{2^{0.9} \cdot 9.48} = 0.64 < 1.0 \rightarrow i.O.$$

Reinforcement of beam penetrations

Arrangement



General remarks

- The checks on the net cross-section must also be carried out. In the case of rectangular openings, the additional bending moment from shear force and the increased shear stresses in the area of the opening corners must be taken into account
- The design of the reinforcement must be carried out for both sides of the opening
- **Before execution, all calculations must be checked and approved by the responsible planner**

Fastening system WT

Pre-drilling diameter	[mm]
WT-T/S-6,5xL	4.0
WT-T-8,2xL	5.0

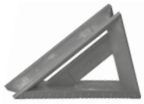
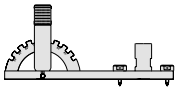
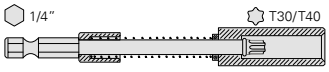
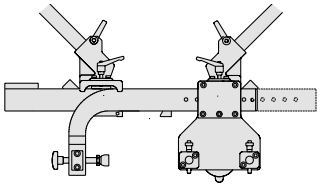
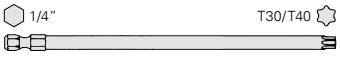
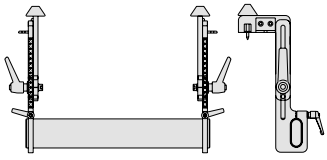
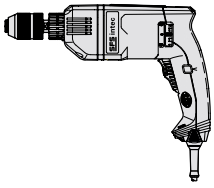
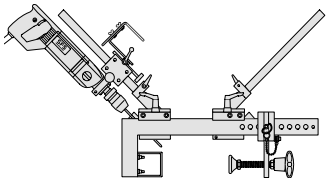
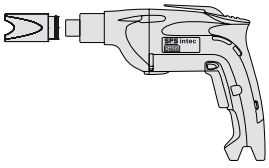
Type		Material S: A2 T: blue zinc [1]		Thread Ø d [mm]		Length L [mm]	Thread length s [mm]	Head Ø d_k [mm]	Head height l_k [mm]	Recess
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] For moisture classes: 1 and 2 (not directly weathered)

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Reinforcement of beam penetrations

Mounting devices and accessories

Application	Tools/Accessories	Fastener	Tools/Accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupled purllin	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

Reinforcement of beam penetrations

Fastening system WR

Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T	-	9	x	250	14	20	T40
WR	-	T	-	9	x	300	14	20	T40
WR	-	T	-	9	x	350	14	20	T40
WR	-	T	-	9	x	400	14	20	T40
WR	-	T	-	9	x	450	14	20	T40
WR	-	T	-	9	x	500	14	20	T40
WR	-	T	-	13	x	400	22	20	T50
WR	-	T	-	13	x	500	22	20	T50
WR	-	T	-	13	x	600	22	20	T50
WR	-	T	-	13	x	700	22	20	T50
WR	-	T	-	13	x	800	22	20	T50
WR	-	T	-	13	x	900	22	20	T50
WR	-	T	-	13	x	1000	22	20	T50

[1] For moisture classes: 1 and 2 (not directly weathered)

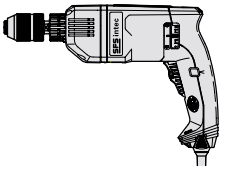
Mounting devices and accessories

Fastener WR-T-9xL

Bit T40: Length 70, 152, 200, 350, 520 [mm]

Screw-in adapter for WR

Power drill BO 1055



Fastener WR-T-13xL

Wera Torx-Bit 5/16
Drive: E 3,6 ¼"

SFS Tool-holder ZA ½"
Drive: Square ½"

Garant Torx ½"
Drive: Square ½"

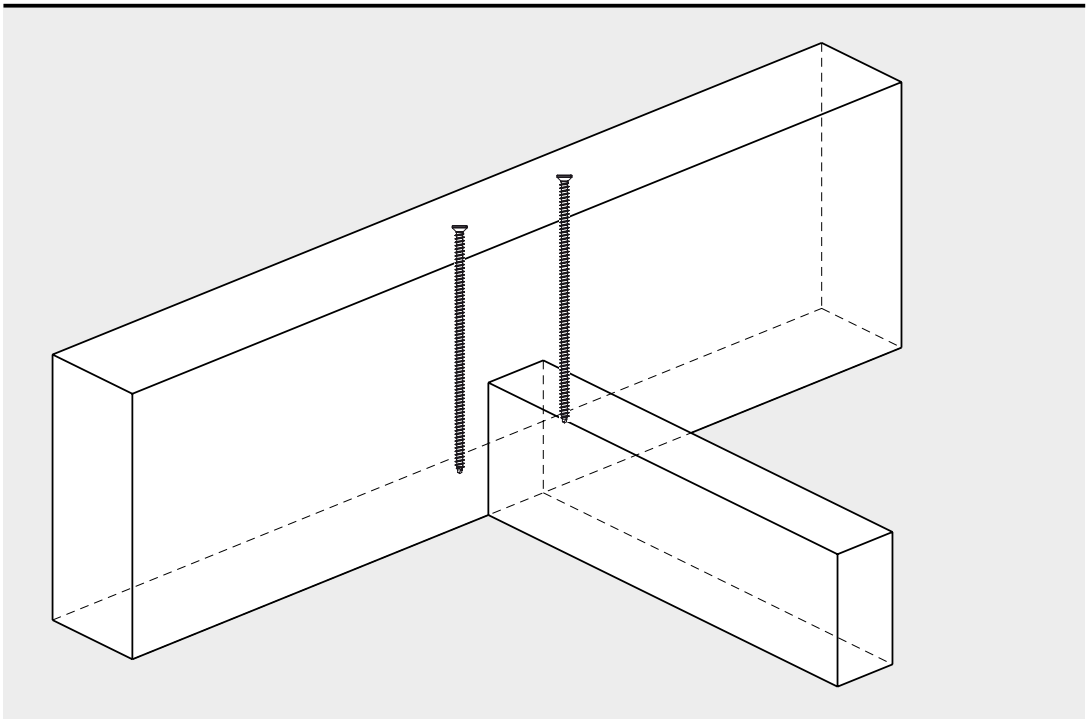
Screw-in adapter for WR

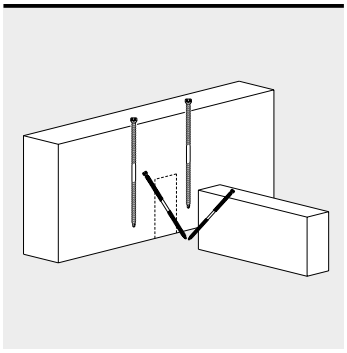
Power drill 32-4

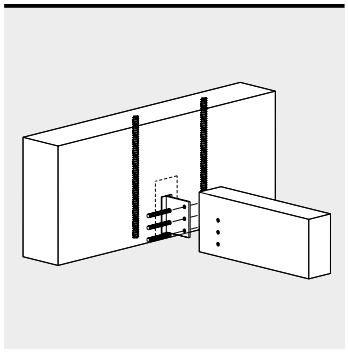
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

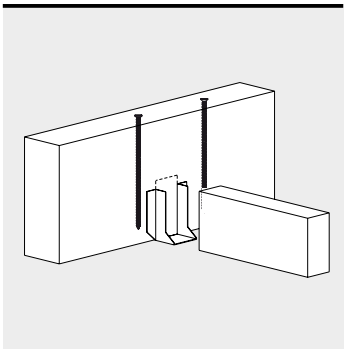
Shear-tension reinforcement

Application



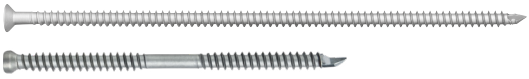






Convincing advantages

- No reduction in the load-bearing capacity of the main beam
- Material saving: main beam dimensions can be chosen smaller
- Simple calculation & processing
- Reinforcement not visible
- High fire resistance of the connection
- Fastener can be used from above and below
- ETA-12/0063 (WT)
- ETA-12/0062 (WR)



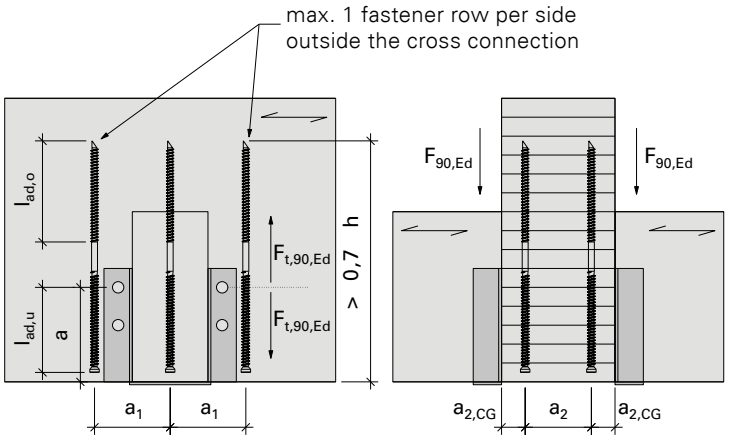
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Shear-tension reinforcement

Design proposal according to DIN EN 1995-1-1/NA:2013-08, 6.8.2

A Connection geometry

Structural members that are subjected to loads perpendicular to the direction of the wood grain below 0.7 times the beam height can be reinforced with WT, WR or WB fasteners so that the load-bearing capacity of the connection does not have to be reduced.



Shear-tension force

The bracing of a transverse connection with the ratio a / h < 0.7 shall be designed for the following design value of the tensile force $F_{t,90,Ed}$:

$$F_{t,90,Ed} = \left[1 - 3 \cdot \left(\frac{a}{h}\right)^2 + 2 \cdot \left(\frac{a}{h}\right)^3\right] \cdot F_{90,Ed}$$

$F_{t,90,Ed}$	Design value of the tensile force acting on the reinforcement. The tensile force $F_{t,90,Ed}$ is to be assumed to act at the height of the distance a from the stressed edge and to be introduced via the thread lengthsn below ($l_{ad,u}$) and above ($l_{ad,o}$) the line at the height a
a	maximum distance of the connecting means of the transverse connection from the stressed edge of the beam
$F_{90,Ed}$	Design value of the connection force to be applied perpendicular to the grain direction of the timber
$l_{ad,u}$	Effective thread length below the line at height a
$l_{ad,o}$	Effective thread length above the line at height a
h	Height of the main beam
a_1	See screw centre distances
a_2	See screw centre distances
$a_{2,CG}$	See screw Edge distances

Shear-tension reinforcement

Evidence

$$\frac{F_{t,90,d}}{n^{0.9} \cdot R_d} \leq 1$$

R_d Rated value of the pull-out resistance of a fastener (for l_{ef} shown the resistance may be interpolated linearly)
n Number of fasteners
$F_{t,90,Ed}$ Design value of the tensile force acting on the reinforcement

Example

Main beam GL24h b/h = 160/400 [mm]
Secondary beam C24 b/h = 80/160 [mm]
Connector „beam-shoe“ 80/120 [mm]
Design value of the shear load $F_{90,Ed}$ = 9.0 kN

Shear-tension force Querzugkraft

$$F_{t,90,Ed} = \left[1 - 3 \cdot \left(\frac{112}{400}\right)^2 + 2 \cdot \left(\frac{112}{400}\right)^3\right] \cdot 9.0 = 7.28\ kN$$

Fastener

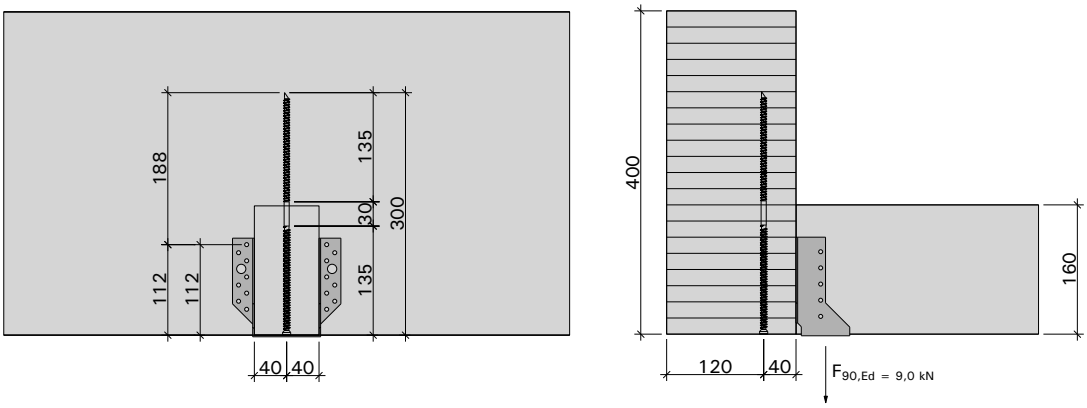
1 piece WT-T-8,2×300
l_{ef} = 112 mm
R_d = 112 / 135 · 9.48 = 7.86 kN

Evidence

$$\frac{7.28}{1^{0.9} \cdot 7.86} = 0.93 \leq 1 \rightarrow i.O.$$

L_{WT} = 300 mm > 0.7 · 400 = 280 mm → i.O.

Shear-tension reinforcement



		Fastener 90°	
		C24	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	s [mm]	R_d [kN]	R_d [kN]
WT-T/S-6,5x90	40	2.06	2.23
WT-T/S-6,5x130	55	2.84	3.06
WT-T-6,5x160	65	3.35	3.62
WT-T-6,5x190	80	4.13	4.45
WT-T-6,5x220	95	4.90	5.29
WT-T-8,2x160	65	4.23	4.57
WT-T-8,2x190	80	5.21	5.62
WT-T-8,2x220	95	6.18	6.67
WT-T-8,2x245	107	6.96	7.51
WT-T-8,2x275	122	7.94	8.57
WT-T-8,2x300	135	8.79	9.48
WT-T-8,2x330	135	8.79	9.48

General remarks see page 127

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Shear-tension reinforcement

			Fastener 90°
		C24	**GL24h**
		ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	l_{ef} [mm]	R_d [kN]	R_d [kN]
WR-T-9xL	50	3.57	3.85
	100	7.14	7.71
	150	10.71	11.56
	200	14.28	15.42
	250	17.86	19.23
	300	19.23	19.23
	350	19.23	19.23
	400	19.23	19.23
	450	19.23	19.23
	500	19.23	19.23
WR-T-13xL	100	10.32	11.13
	200	20.63	22.27
	300	30.95	33.40
	400	41.27	42.31
	500	42.31	42.31
	600	42.31	42.31
	700	42.31	42.31
	800	42.31	42.31
	900	42.31	42.31
	1000	42.31	42.31

General remarks see below

= steel failure

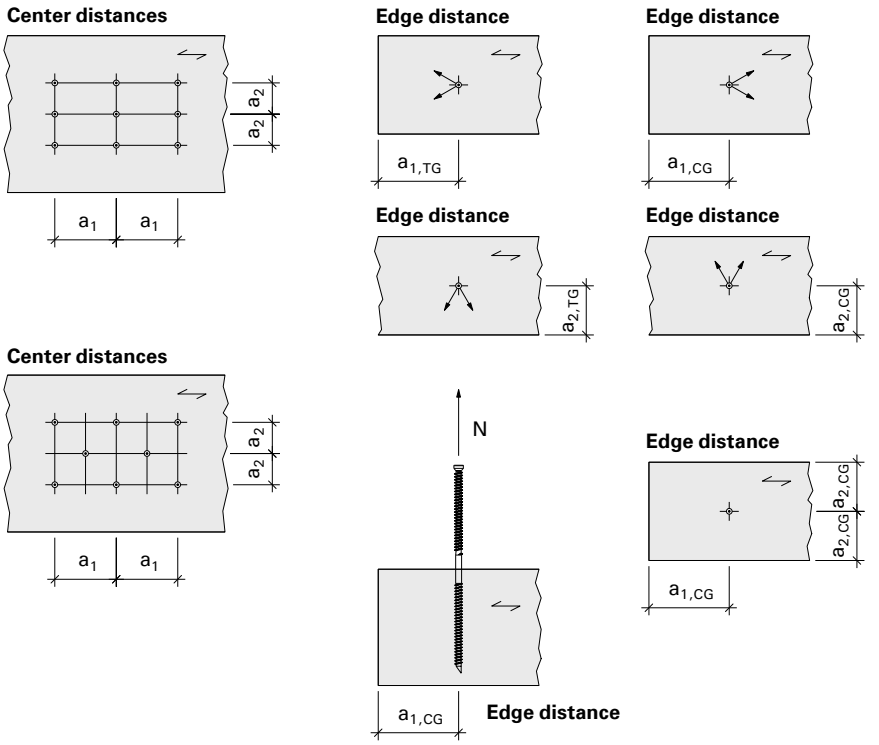
- **General remarks**
- Values apply to corresponding anchorage lengthn s or lef of the thread
- Values for other l_{ef} may be determined by linear interpolation
- Fasteners should be evenly spaced at 90° to the grain, symmetrically adjacent to the cross-connection
- Outside the transverse connection in the longitudinal direction of the beam, only one fastener per side may be taken into account as load-bearing
- The fasteners must be installed over at least 0.7 times the beam height
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible designer**

Shear-tension reinforcement

WT Edge and intermediate distances

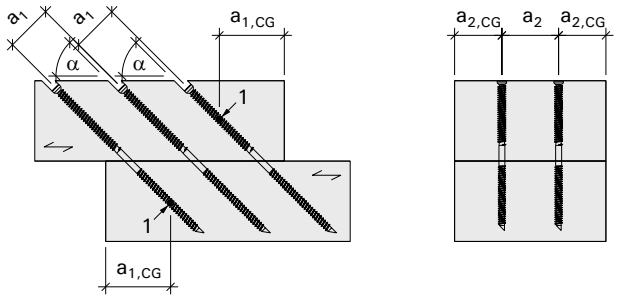
Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the fibre	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the fibre	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)

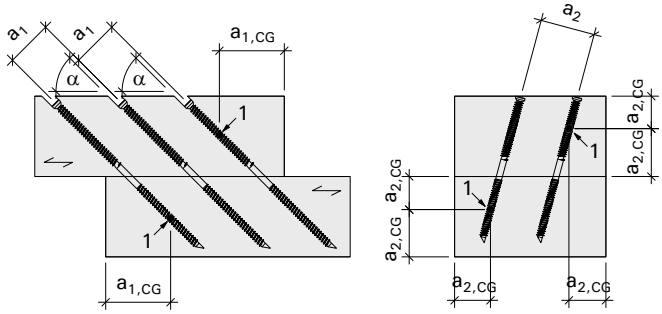


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Shear-tension reinforcement



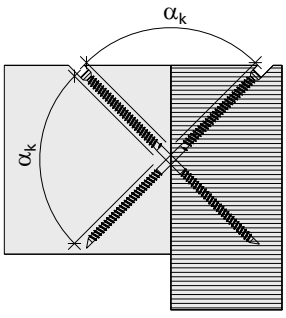
1 Center of gravity of the screw thread in the component

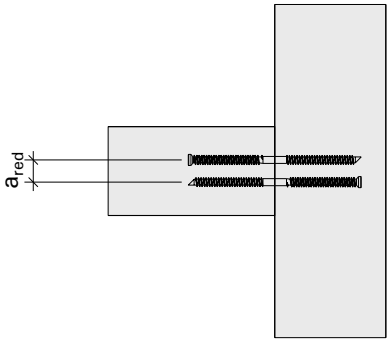


1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25



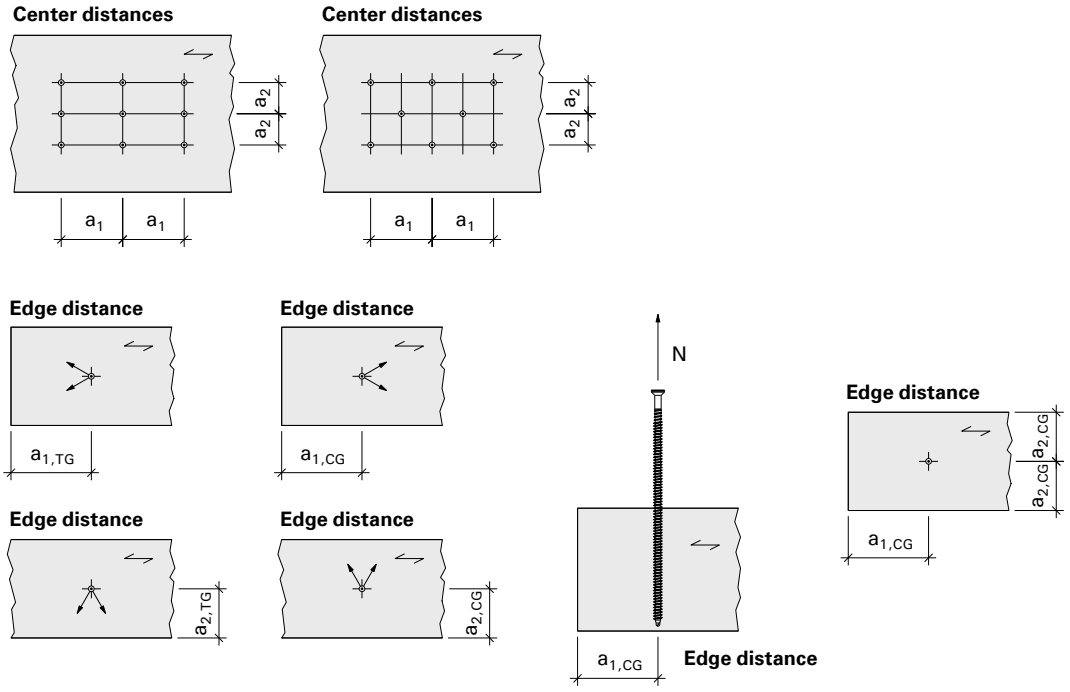


Shear-tension reinforcement

WR Edge and intermediate distances

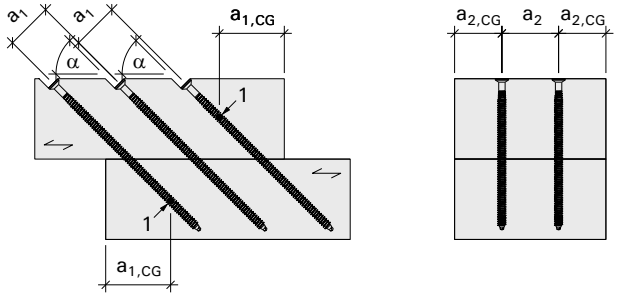
Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fibre	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fibre	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)

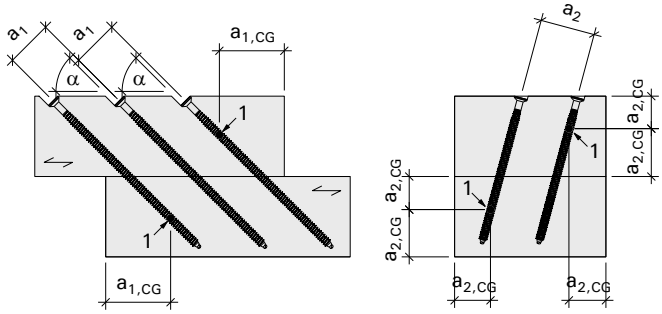


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Shear-tension reinforcement



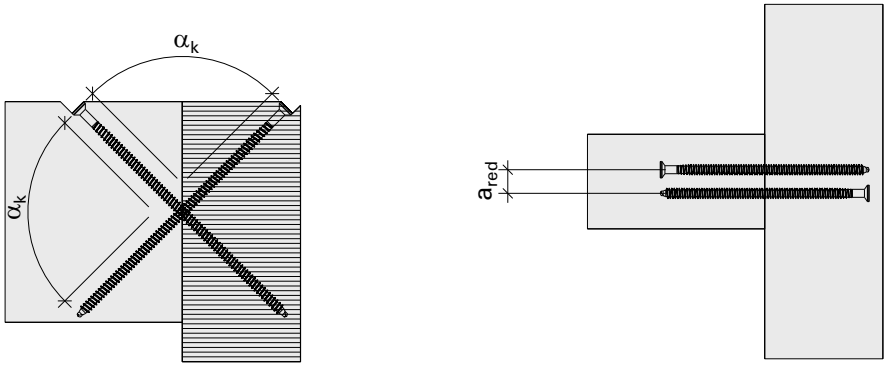
1 Center of gravity of the screw thread in the component



1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{red} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{red} [mm]	20	38	44	49	55	60	65



Shear-tension reinforcement

Fastening system WT

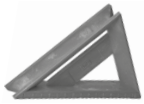
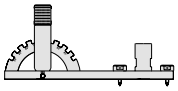
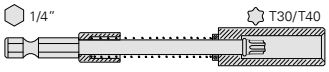
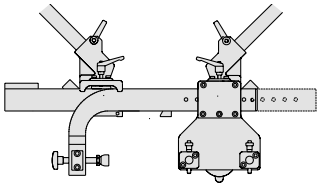
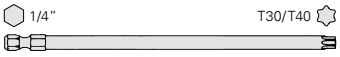
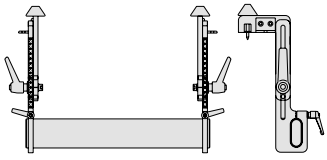
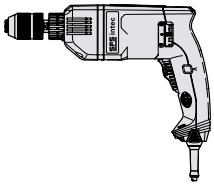
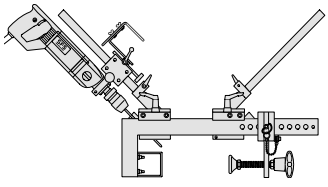
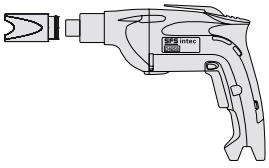
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	4.0
WT-T-8,2xL	5.0

Type		Material		Thread Ø		Length	Thread length	Head Ø	Head height	Recess
		S: A2		d		L	s	d_k	l_k	
		T: blue zinc [1]		[mm]		[mm]	[mm]	[mm]	[mm]	
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] for moisture classes: 1 and 2 (not directly weathered)

Shear-tension reinforcement

Mounting devices and accessories

Application	Tools/Accessories	Fastener	Tools/Accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupled purllin	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

Shear-tension reinforcement

Befestigungssystem WR

Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T		9	x	250	14	20	T40
WR	-	T		9	x	300	14	20	T40
WR	-	T		9	x	350	14	20	T40
WR	-	T		9	x	400	14	20	T40
WR	-	T		9	x	450	14	20	T40
WR	-	T		9	x	500	14	20	T40
WR	-	T		13	x	400	22	20	T50
WR	-	T		13	x	500	22	20	T50
WR	-	T		13	x	600	22	20	T50
WR	-	T		13	x	700	22	20	T50
WR	-	T		13	x	800	22	20	T50
WR	-	T		13	x	900	22	20	T50
WR	-	T		13	x	1000	22	20	T50

[1] for moisture classes: 1 and 2 (not directly weathered)

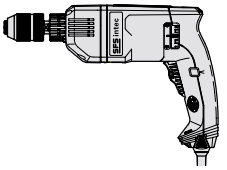
Mounting devices and accessories

Fastener WR-T-9xL

Bit T40: Length 70, 152, 200, 350, 520 [mm]

Screw-in adapter for WR

Power drill BO 1055



Fastener WR-T-13xL

Wera Torx-Bit 5/16
Drive: E 3,6 ¼"

SFS Tool-holder ZA ½"
Drive: Square ½"

Garant Torx ½"
Drive: Square ½"

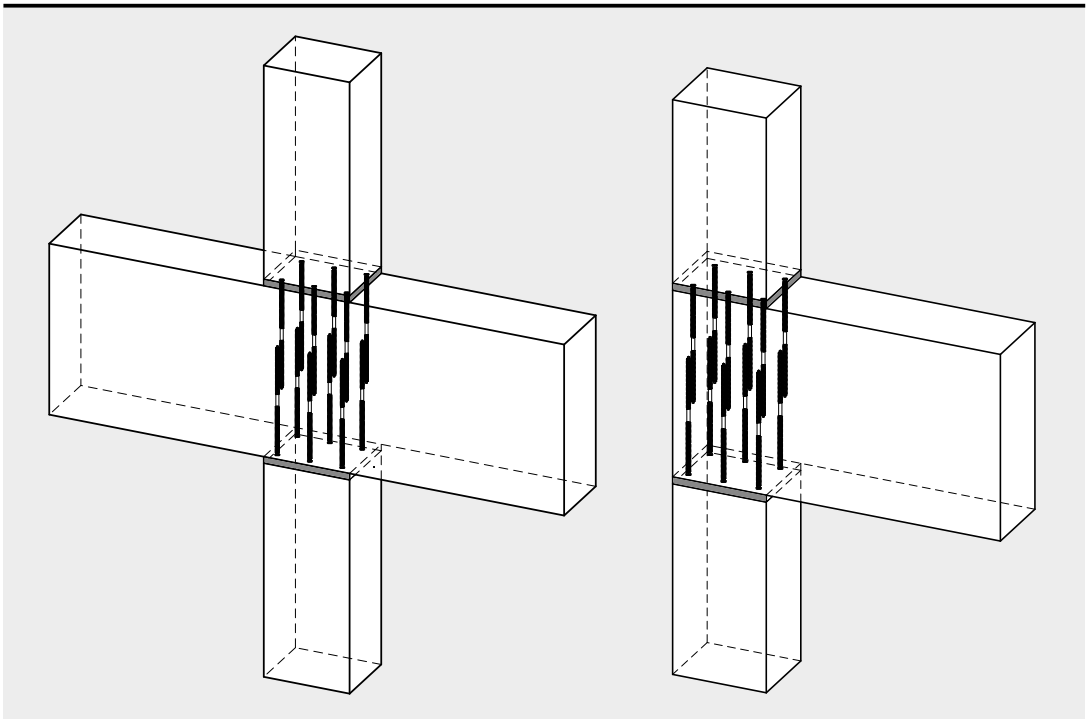
Screw-in adapter for WR

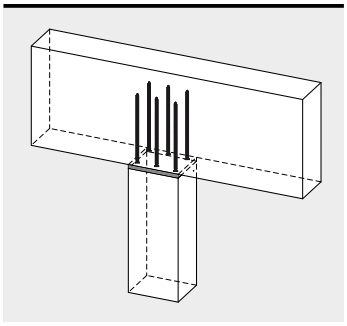
Power drill 32-4

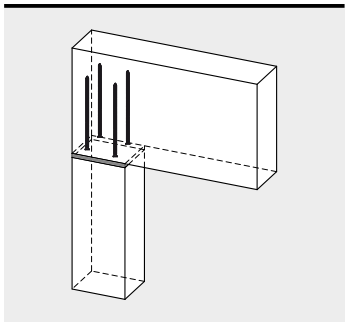
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement

Application

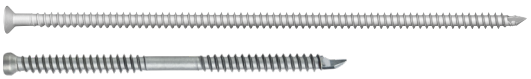






Advantages that convince

- Substantial increase in the absorbable
- transverse pressure
- Material savings: beam dimensions do not have to be increased
- Simple calculation and processing
- Reinforcement not visible
- High fire resistance of the connection
- Fastener can be used from above and below
- ETA-12/0063 (WT)
- ETA-12/0062 (WR)



Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement

	Fastener 45° to the grain		Fastener 70° to the grain		Fastener 90° to the grain	
	C24	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]
WT-T/S-6,5x90[1)]	4.13	4.45	4.13	4.45	4.13	4.45
WT-T/S-6,5x130	4.51	4.57	4.62	4.68	4.70	4.76
WT-T-6,5x160	5.99	6.12	6.22	6.34	6.37	6.49
WT-T-6,5x190						
WT-T-6,5x220						
WT-T-8,2x160	8.46	9.13	8.46	9.13	8.46	9.13
WT-T-8,2x190	10.41	11.24	10.41	11.25	10.41	11.24
WT-T-8,2x220	11.09	11.33	11.51	11.73	11.78	12.00
WT-T-8,2x245						
WT-T-8,2x275						
WT-T-8,2x300						
WT-T-8,2x330						

[1)] Fastener only possible 50° to the grain

General remarks see page 139

	Fastener 45° to the grain		Fastener 70° to the grain		Fastener 90° to the grain	
	C24	**GL24h**	**C24**	**GL24h**	**C24**	**GL24h**
	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]	ρ_k = 350 [kg/m³]	ρ_k = 385 [kg/m³]
Fastener	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN]	R_d [kN
WR-T-9x250	10.04	10.23	10.38	10.57	10.61	10.79
WR-T-9x300						
WR-T-9x350						
WR-T-9x400						
WR-T-9x450						
WR-T-9x500						
WR-T-13x400	22.99	23.41	23.73	24.13	24.22	24.61
WR-T-13x500						
WR-T-13x600						
WR-T-13x700						
WR-T-13x800						
WR-T-13x900						
WR-T-13x1000						

General remarks see page 139

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement

Design proposal according to ETA-12/0063 Annex 3

Required number of fasteners

$$n = \frac{V_d - R_{c,90,d}}{R_d}$$

n Required number of fasteners
V_d Rated value of compressive force
R_d Resistance of fasteners according to table

$R_{c,90,d} = k_{c,90} \cdot B \cdot l \cdot f_{c,90,d}$

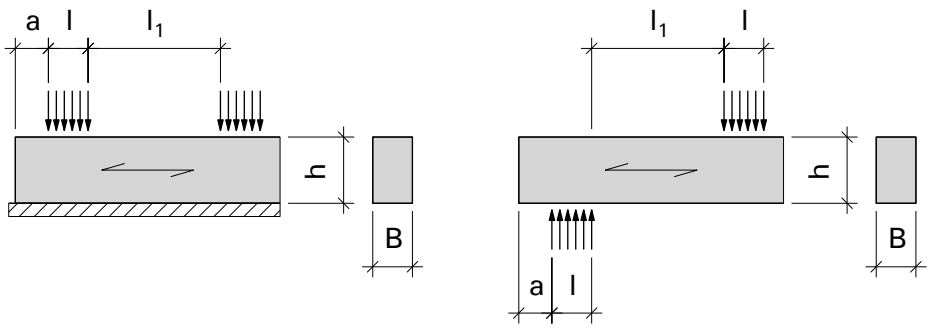
$k_{c,90}$ coefficient

As a rule	$k_{c,90} = 1.00$		
Continuous support and $l_1 \geq 2 \cdot h$	$k_{c,90} = 1.25$	C24	
	$k_{c,90} = 1.50$	GL24h	
Single supports and $l_1 \geq 2 \cdot h$	$k_{c,90} = 1.50$	C24	
	$k_{c,90} = 1.75$	GL24h	provided $l \leq 400$mm

B Support width
l Actual contact length
(l may be increased by 30 mm on each side, but not more than a, l oder l_1 / 2)

$f_{c,90,d}$ Design value of compressive strength perpendicular to grain direction

$f_{c,90,d}$	1.5 N/mm² C24	1.7 N/mm² GL24h



Cross-pressure reinforcement

Verification in the plane of the screw tip

$$\frac{V_d}{B \cdot l_{ef,2} \cdot f_{c,90,d}} \leq 1$$

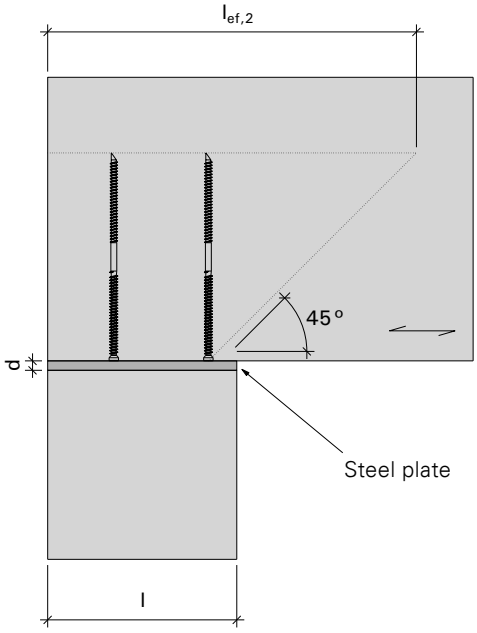
V_d Rated value of the compressive force
B Support width
$l_{ef,2}$ Actual contact length in the plane of the screw tip (see drawing)
$f_{c,90,d}$ Design value of compressive strength perpendicular to the grain direction (see above)

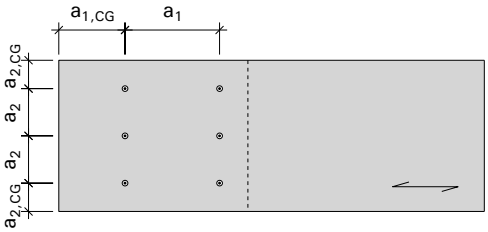
Generally	1.8 N/mm²	C24	1.9 N/mm²	GL24h
With prewood	2.3 N/mm²	C24	2.5 N/mm²	GL24h
End support	1.8 N/mm²	C24	2.5 N/mm²	GL24h

Proposal for dimensioning the steel plate (S235 or better)

$$d[mm] \geq 2.7 \cdot \sqrt{R_d[kN]}$$

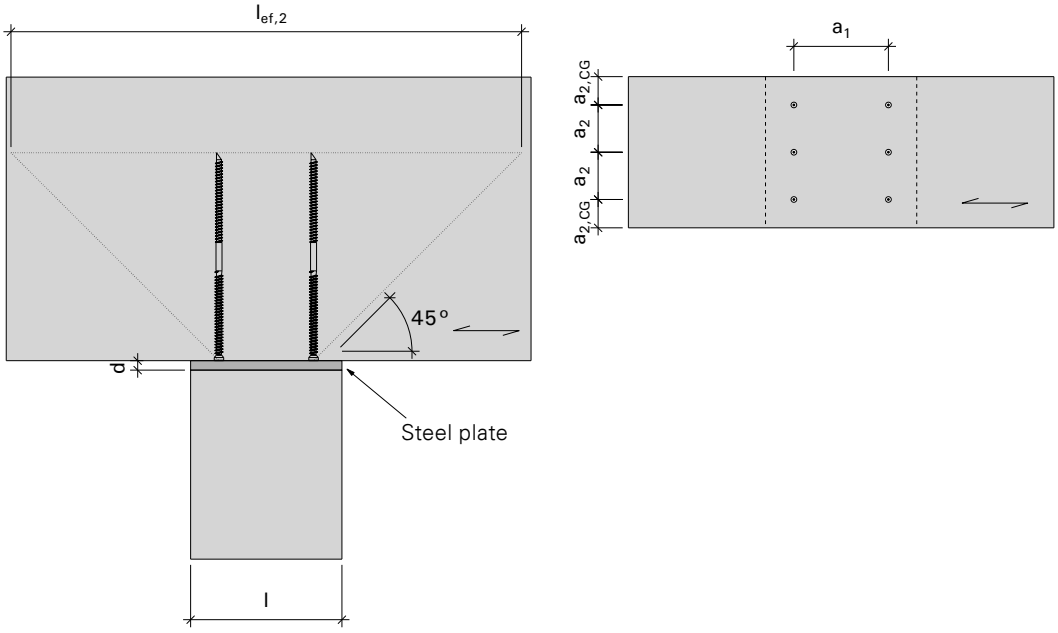
d Thickness of steel-plate
R_d Resistance fastener according to table





Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement



General remarks

- Connection geometries according to drawings must be adhered to
- The fastener heads must all be exactly flush with the wood surface.
- No interlayer is allowed between the fastener head and the steel plate
- The load-bearing capacity of the connection is the sum of the fastener load-bearing capacity and the compressive force that can be taken up by the bearing surface
- The verification of the transverse compressive stress in the plane of the fastener tip must in any case be carried out with $l_{ef,2}$ according to the drawing
- Table values for k_{mod} = 0.8 and γ_M= 1,3 according to EN1995-1-1:2004+AC:2006+A1:2008
- **Prior to execution, all calculations must be checked and approved by the responsible designer**

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement

Example

Beam GL24h ; b/h = 140/400 [mm]
Support b/h = 140/160 [mm]
Steel plate over full cross-sectional area of support
Moisture class 1

Support force V_d = 110 kN

$k_{c,90}$ = 1.5 (due to line load on top of beam and point load on bottom due to support)
B = 140 mm
l = 160 + 1 · 30 = 190 mm
$f_{c,90,d}$ = 1.7 N/mm²

$R_{c,90,d} = 1.5 \cdot 140 \cdot 190 \cdot 1.7 \cdot 10^{-3} = 67.83$ kN

Fastener: WT-T-8,2x275

R_d = 12.00 kN

Required number of fasteners

$$n = \frac{110 - 67.83}{12.00} = 3.51$$

selected: 4 pieces WT-T-8,2x275

Verification in the plane of the bolt tip

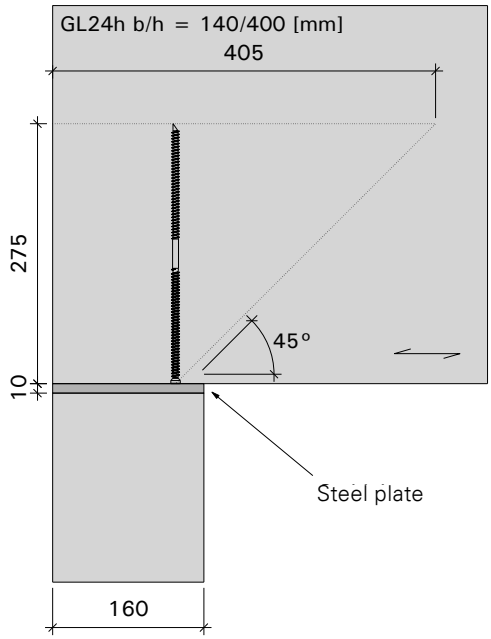
$$\frac{110 \cdot 10^3}{140 \cdot 405 \cdot 2.5} = 0.78 < 1 \rightarrow i.O.$$

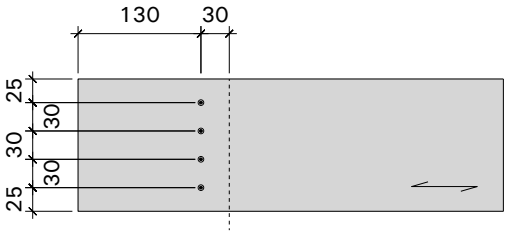
Proposal for dimensioning the steel plate (S235 or better)

$$d = 2.7 \cdot \sqrt{12.00} = 9.4\ mm$$

selected: d = 10 mm

Cross-pressure reinforcement



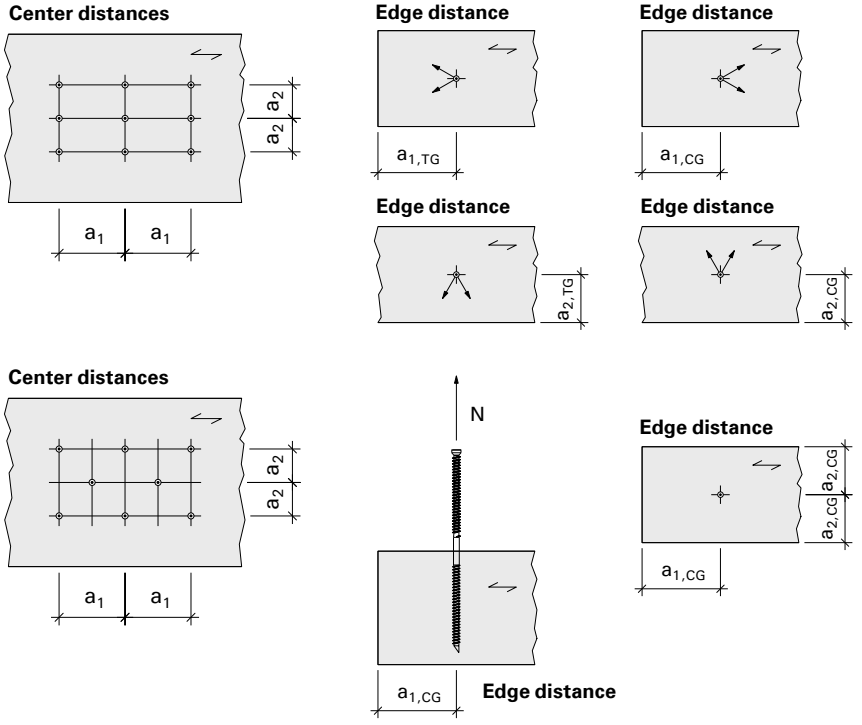


Cross-pressure reinforcement

WT Edge and intermediate distances

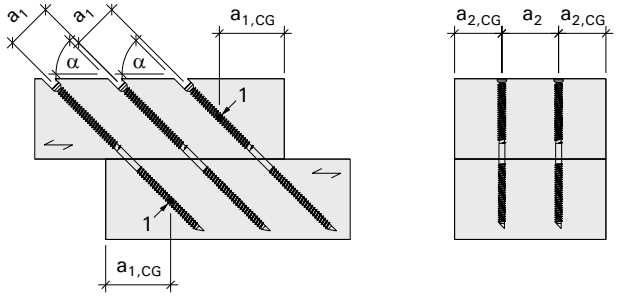
Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WT-T/S-6,5xL	Parallel to the fibre	a_1	78	78
	Perpendicular to the grain	a_2	20	33
	Stressed end grain	$a_{3,t}$	–	98
	Unstressed end grain	$a_{3,c}$	52	65
	Stressed edge	$a_{4,t}$	–	65
	Unstressed edge	$a_{4,c}$	20	33
WT-T-8,2xL	Parallel to the fibre	a_1	99	99
	Perpendicular to the grain	a_2	25	41
	Stressed end grain	$a_{3,t}$	–	123
	Unstressed end grain	$a_{3,c}$	66	82
	Stressed edge	$a_{4,t}$	–	82
	Unstressed edge	$a_{4,c}$	25	41

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0063 A.2.4.2)

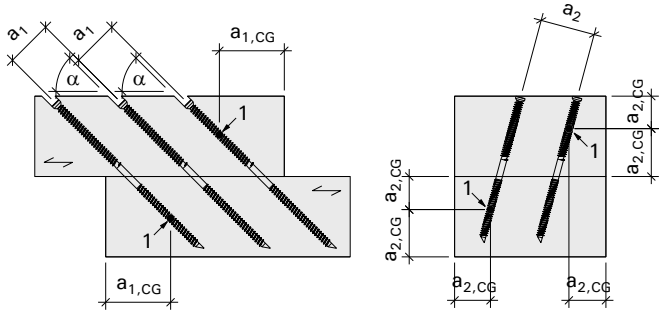


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement



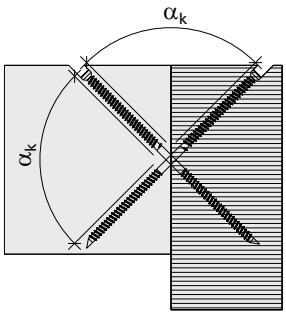
1 Center of gravity of the screw thread in the component

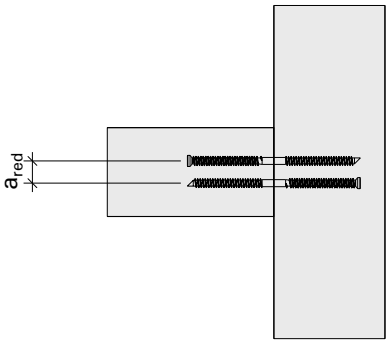


1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \le \alpha_k \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WT-T/S-6,5xL	a_{red} [mm]	10	12	14	15	17	19	20
WT-T-8,2xL	a_{red} [mm]	12	15	17	19	21	23	25





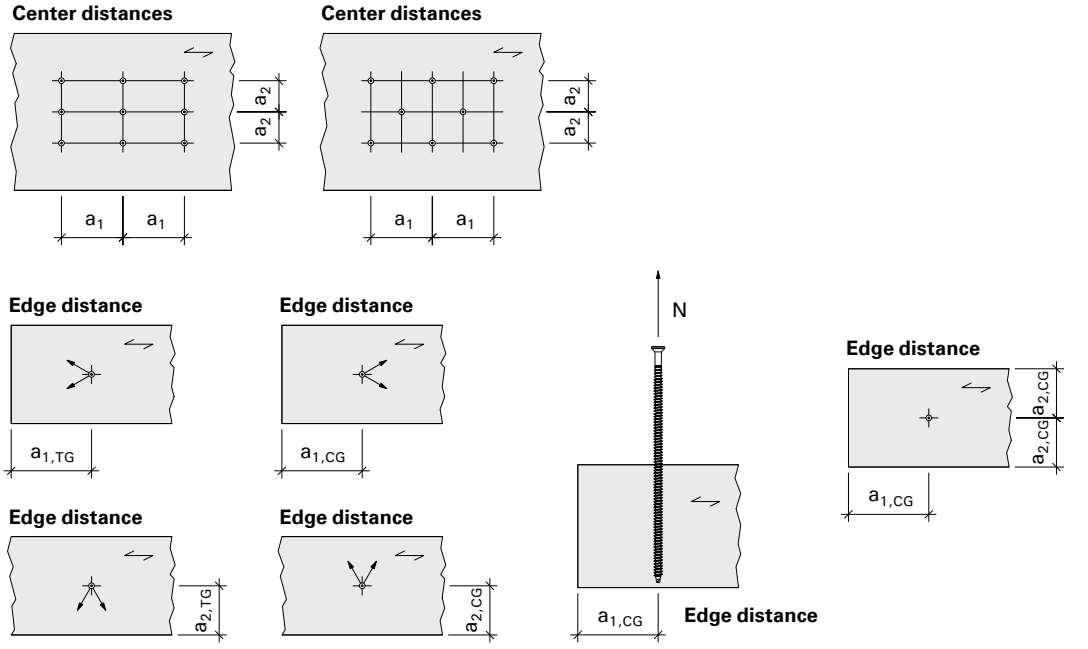
Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement

WR Edge and intermediate distances

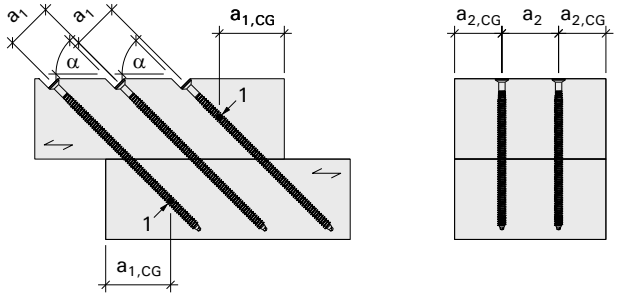
Without pre-drilling			Axial	Shear [1]
			[mm]	[mm]
WR-T-9xL	Parallel to the fibre	a_1	45	108
	Perpendicular to the grain	a_2	45	45
	Stressed end grain	$a_{1,TG}$	–	135
	Unstressed end grain	$a_{1,CG}$	45	90
	Stressed edge	$a_{2,TG}$	–	90
	Unstressed edge	$a_{2,CG}$	27	45
WR-T-13xL	Parallel to the fibre	a_1	65	156
	Perpendicular to the grain	a_2	65	65
	Stressed end grain	$a_{1,TG}$	–	195
	Unstressed end grain	$a_{1,CG}$	65	130
	Stressed edge	$a_{2,TG}$	–	130
	Unstressed edge	$a_{2,CG}$	39	65

[1] Smaller spacing possible with pre-drilling EN1995-1-1:2004+AC:2006+A1:2008, Table 8.2
Without pre-drilling, a minimum timber thickness of 10 · d is required for the timber components
Failure along the circumference of a screw group shall be considered (see ETA-12/0062 A.2.4.2)

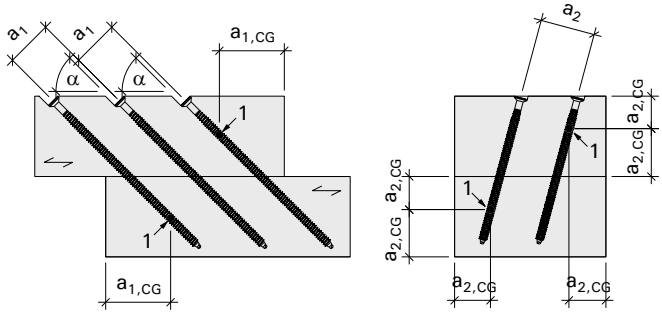


Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement



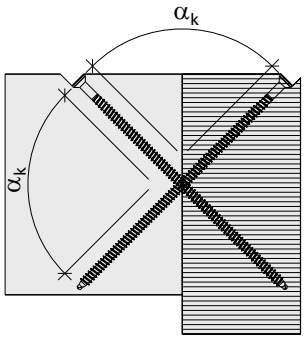
1 Center of gravity of the screw thread in the component

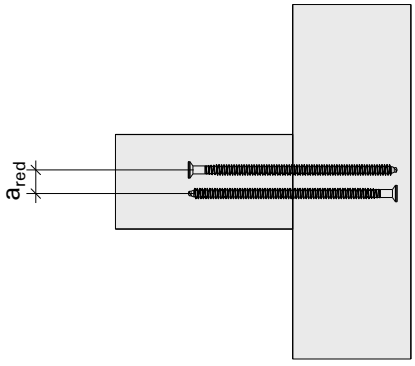


1 Center of gravity of the screw thread in the component

Minimum distances between crossed bolts (axial load)

		α_k						
		$0° \le \alpha_\kappa \le 90°$						
		90°	75°	60°	45°	30°	15°	0°
WR-T-9xL	a_{red} [mm]	14	27	30	34	38	42	45
WR-T-13xL	a_{red} [mm]	20	38	44	49	55	60	65





Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

Cross-pressure reinforcement

Fastening system WT

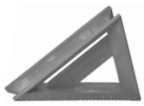
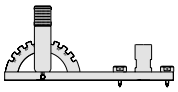
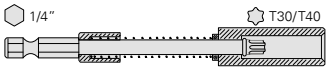
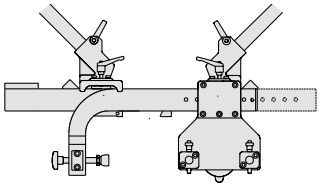
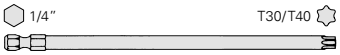
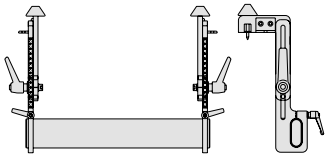
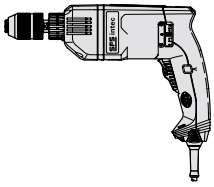
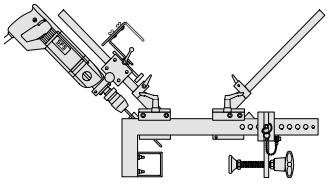
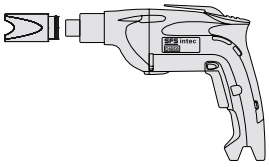
Pre-drilling diameter	[mm]
WT-T/S-6,5xL	4.0
WT-T-8,2xL	5.0

Type		Material S: A2 T: blue zinc [1]		Thread Ø d [mm]		Length L [mm]	Thread length s [mm]	Head Ø d_k [mm]	Head height l_k [mm]	Recess
WT	-	S	-	6.5	x	65	28	8	5.2	T30
WT	-	S	-	6.5	x	90	40	8	5.2	T30
WT	-	S	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	65	28	8	5.2	T30
WT	-	T	-	6.5	x	90	40	8	5.2	T30
WT	-	T	-	6.5	x	130	55	8	5.2	T30
WT	-	T	-	6.5	x	160	65	8	5.2	T30
WT	-	T	-	6.5	x	190	80	8	5.2	T30
WT	-	T	-	6.5	x	220	95	8	5.2	T30
WT	-	T	-	8.2	x	160	65	10	6.5	T40
WT	-	T	-	8.2	x	190	80	10	6.5	T40
WT	-	T	-	8.2	x	220	95	10	6.5	T40
WT	-	T	-	8.2	x	245	107	10	6.5	T40
WT	-	T	-	8.2	x	275	122	10	6.5	T40
WT	-	T	-	8.2	x	300	135	10	6.5	T40
WT	-	T	-	8.2	x	330	135	10	6.5	T40

[1] for moisture classes: 1 and 2 (not directly weathered)

Cross-pressure reinforcement

Mounting devices and accessories

Application	Tools/Accessories	Fastener	Tools/Accessories
Main/secondary beam, doweled beam, element construction, etc.	Screw-in aid for wood screws 	WT-T/S-6,5xL WT-T-8,2xL	Bitholder Magic Flip Force ZA 1/4" 
Main/secondary beam, doweled beam, element construction, etc.	Universal gauge ZL WT/U 	WT-T/S-6,5xL WT-T-8,2xL	Attachment WT-T30 Attachment WT-T40/D10 
Main/secondary beam	Setting tool ZL WT/MS 	WT-T/S-6,5xL WT-T-8,2xL	Bit T30, Length: 70, 200, 350 [mm] Bit T40, Length: 70, 152, 200, 350, 520 [mm] 
Main/secondary beam	Setting tool ZL WT/S 	WT-T/S-6,5xL WT-T-8,2xL	Power drill BO 1055 
Coupled purllin	Setting tool ZL WT 	WT-T/S-6,5xL L max.: 130 mm	Power drill DI 650 Deep stop sleeve Z661 

Cross-pressure reinforcement

Fastening system WR

Pre-drilling diameter	[mm]
WR-T-9xL	5.0
WR-Tx13xL	8.0

Type		Material		Thread Ø		Length	Head Ø	Head height	Recess
		T: Durocoat [1]		d		L	d_k	l_k	
				[mm]		[mm]	[mm]	[mm]	
WR	-	T	-	9	x	250	14	20	T40
WR	-	T	-	9	x	300	14	20	T40
WR	-	T	-	9	x	350	14	20	T40
WR	-	T	-	9	x	400	14	20	T40
WR	-	T	-	9	x	450	14	20	T40
WR	-	T	-	9	x	500	14	20	T40
WR	-	T	-	13	x	400	22	20	T50
WR	-	T	-	13	x	500	22	20	T50
WR	-	T	-	13	x	600	22	20	T50
WR	-	T	-	13	x	700	22	20	T50
WR	-	T	-	13	x	800	22	20	T50
WR	-	T	-	13	x	900	22	20	T50
WR	-	T	-	13	x	1000	22	20	T50

[1] for moisture classes: 1 and 2 (not directly weathered)

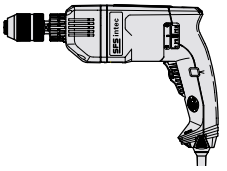
Mounting devices and accessories

Fastener WR-T-9xL

Bit T40: Length 70, 152, 200, 350, 520 [mm]

Screw-in adapter for WR

Power drill BO 1055



Fastener WR-T-13xL

Wera Torx-Bit 5/16
Drive: E 3,6 ¼"

SFS Tool-holder ZA ½"
Drive: Square ½"

Garant Torx ½"
Drive: Square ½"

Screw-in adapter for WR

Power drill 32-4

Basis: EN1995-1-1:2004+AC:2006+A1:2008 ;
ETA-12/0062 ; ETA-12/0063

High level of consulting expertise

Productivity and competitiveness decide tomorrow's success. SFS offers a unique service package in fastening technology. With us as your partner, you can count on a successful future.

High level of consulting expertise
SFS is known for a broad range of products and services in the field of fastening technology – whether it is for use in mechanical- and steel-engineering, steel- or structural timber constructions, concrete and masonry or applications for building-envelope are concerned. You benefit from a high level of consulting expertise and efficient processes. Process control through the entire value chain is ensured by the high availability of goods, the professional procurement market research and continuous quality control.

Proven system provider
As a leading system provider for fastening technology we are not only a dealer, but also have a pronounced manufacturer and development competence for for drawing parts. Our own toolmaking, state-of-the-art production technologies and comprehensive post-processing guarantee a smooth production process. Engineers, materials specialists, application technicians and production managers work with you to develop the ideal solution for you.

Services for timber construction planners
- Project-related calculations
- Elaboration of economical fastening solutions for individual problems in timber construction
- Design proposals for reinforcements in timber construction, e.g. transverse tension and pressure, etc.
- Design proposals for the flexible connection of connection of timber components, e.g. dowelled beams, etc.
- Design proposals for timber-concrete composite floors
- Elaboration of equivalent alternatives for tendered fastening solutions
- Tailor-made training courses
- Application tests

Services for woodworkers
- Oral and written advice
- Site supervision
- Demonstration and introduction of setting tools
- Extensive product range of fastening technology, tools and machines
- Tailor-made training courses

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