TBS EVO

FLANGE HEAD SCREW

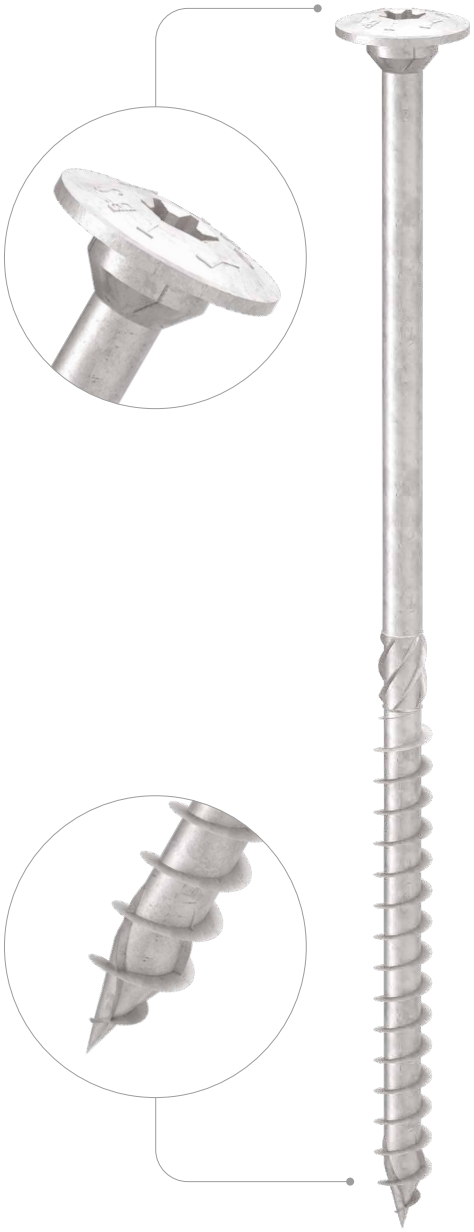
ELC-4645 ESR-4645 UKTA-0836 22/6195 ETA-11/0030

C4 EVO COATING
Multilayer coating with a surface treatment of epoxy resin and aluminium flakes. No rust after 1440 hours of salt spray exposure test, as per ISO 9227. Can be used in exposure condition 3 outdoor applications and under class C4 atmospheric corrosion conditions.

INTEGRATED WASHER
The flange head serves as washer and ensures high head strength and pull-through. Ideal in the presence of wind or variations in timber dimensions.

PRESSURE TREATED LUMBER
The C4 EVO coating has been certified according to US acceptance criteria AC257 for outdoor use in ACQ-treated wood.

T3 TIMBER CORROSIVITY
Coating suitable for use in applications on wood with an acidity level (pH) greater than 4, such as spruce, larch and pine (see page 354).



MY PROJECT SOFTWARE | MANUALS

BIT INCLUDED

DIAMETER [in]	0.24 **0.24 0.40** 0.63
LENGTH [in]	1 9/16 **2 3/8 15 3/4** 39 3/8
EXPOSURE CONDITION	**EC1** **EC3**
ATMOSPHERIC CORROSIVITY	**C1** **C2** **C3** **C4**
WOOD CORROSIVITY	**T1** **T2** **T3**
MATERIAL	C4 EVO COATING carbon steel with C4 EVO coating

FIELDS OF USE

- timber based panels
- solid timber and glulam
- CLT and LVL
- high density woods
- ACQ, CCA treated timber

OUTDOOR WALKWAYS

Ideal for the construction of outdoor structures such as walkways and arcades. Values also certified for screw insertion parallel to the grain.

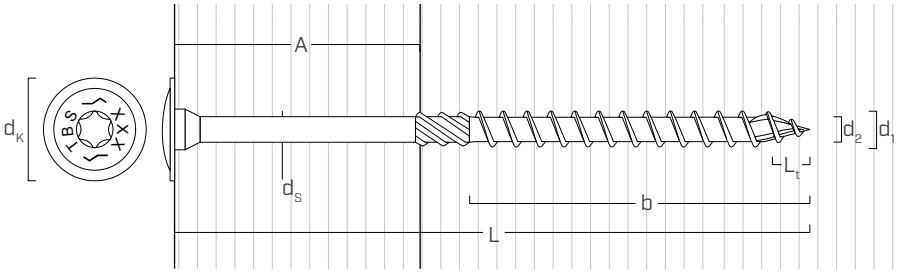
SIP PANELS

Values also tested and certified for CLT and high density woods such as LVL and other laminated veneer products. Suitable for fastening SIP and sandwich panels.

Fastening Wood Trusses outdoors.

Multi-ply beam fastening.

GEOMETRY AND MECHANICAL CHARACTERISTICS



Ø0.24 in - Ø0.32 in

Ø0.40 in

GEOMETRY

Nominal diameter	**d_1**	**[in](1)**	**0.24**	**0.32**	**0.40**
Outer thread diameter	**d_1**	[mm]	6	8	10
		[in]	**0.236**	**0.315**	**0.394**
Head diameter	d_K	[in]	0.610	0.748	0.984
Root diameter	d_2	[in]	0.156	0.213	0.252
Shank diameter	d_S	[in]	0.169	0.228	0.276
Tip Length	L_t	[in]	0.236	0.315	0.394
Pre-drilling hole diameter(2)	$d_{V,G\leq0.55}$	[in]	5/32	13/64	15/64
Pre-drilling hole diameter(3)	$d_{V,G>0.55}$	[in]	5/32	15/64	9/32

(1) The nominal diameter of the screw is converted into imperial units and rounded up to the nearest decimal point.
(2) Pre-drilling applies to timber with G≤0.55 (optional).
(3) Pre-drilling applies to timber with G>0.55 (required).

MECHANICAL PARAMETERS

Nominal diameter	**d_1**	[in]	0.24	0.32	0.40
Tensile strength (allowable)	f_{tens}	[lbf]	1180	2040	2700
Bending yield strength (specified)	$F_{y,b}$	[psi]	200000	180000	185000

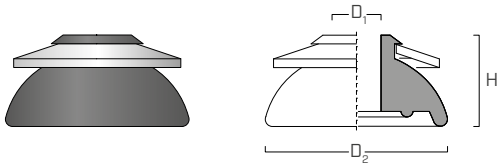
Nominal diameter	**d_1**	[in]		0.24	0.32	0.40
Withdrawal (design value)	W_{90}	[lbf/in]	G = 0.35	131	172	206
			G = 0.42	151	199	239
			G = 0.49	171	225	270
			G = 0.55	188	247	296
minimum embedded length		[in]		1 7/16	1 7/8	2 3/8
Head pull-through (design value)	W_H	[lbf]	G = 0.35	182	223	314
			G = 0.42	263	322	452
			G = 0.49	357	438	615
			G = 0.55	450	552	774
minimum side member thickness		[in]		1 1/2	1 1/2	1 1/2

CODES AND DIMENSIONS

d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
6 **0.24** #14 TX 30	**TBSEVO660**	60	2 3/8	40	1 9/16	3/4	100
	TBSEVO680	80	3 1/8	50	1 15/16	1	100
	TBSEVO6100	100	4	60	2 3/8	1 1/2	100
	TBSEVO6120	120	4 3/4	75	2 15/16	1 3/4	100
	TBSEVO6140	140	5 1/2	75	2 15/16	2 1/2	100
	TBSEVO6160	160	6 1/4	75	2 15/16	3 1/4	100
	TBSEVO6180	180	7 1/8	75	2 15/16	4	100
	TBSEVO6200	200	8	75	2 15/16	4 3/4	100
8 **0.32** TX 40	**TBSEVO8100**	100	4	52	2 1/16	1 3/4	50
	TBSEVO8120	120	4 3/4	80	3 1/8	1 1/2	50
	TBSEVO8140	140	5 1/2	80	3 1/8	2 1/4	50
	TBSEVO8160	160	6 1/4	100	4	2 1/4	50
	TBSEVO8180	180	7 1/8	100	4	3	50
	TBSEVO8200	200	8	100	4	3 3/4	50
	TBSEVO8220	220	8 5/8	100	4	4 1/2	50
	TBSEVO8240	240	9 1/2	100	4	5 1/2	50
	TBSEVO8280	280	11	100	4	7	50
	TBSEVO8320	320	12 5/8	100	4	8 1/2	50
	TBSEVO8360	360	14 1/4	100	4	10	50
	TBSEVO8400	400	15 3/4	100	4	11 3/4	50

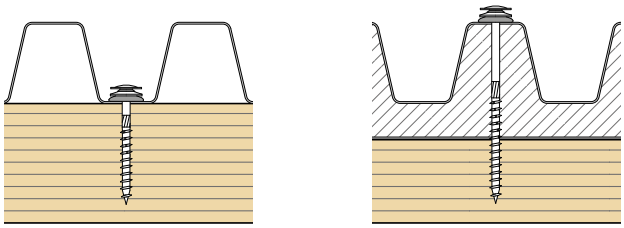
d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
10 **0.40** TX 50	**TBSEVO10120**	120	4 3/4	60	2 3/8	1/2	50
	TBSEVO10140	140	5 1/2	60	2 3/8	1	50
	TBSEVO10160	160	6 1/4	80	3 1/8	2 1/8	50
	TBSEVO10180	180	7 1/8	80	3 1/8	2 3/4	50
	TBSEVO10200	200	8	100	4	3 3/4	50
	TBSEVO10220	220	8 5/8	100	4	4 1/2	50
	TBSEVO10240	240	9 1/2	100	4	5 1/2	50
	TBSEVO10280	280	11	100	4	7	50

WBAZ WASHER



CODE	$Ø_{screw}$ [mm]	$Ø_{screw}$ [in]	D_2 [in]	D_1 [in]	H [in]	pcs
WBAZ25A2	6 - 6,5	0.24 - 0.26	0.98	0.26	0.59	100

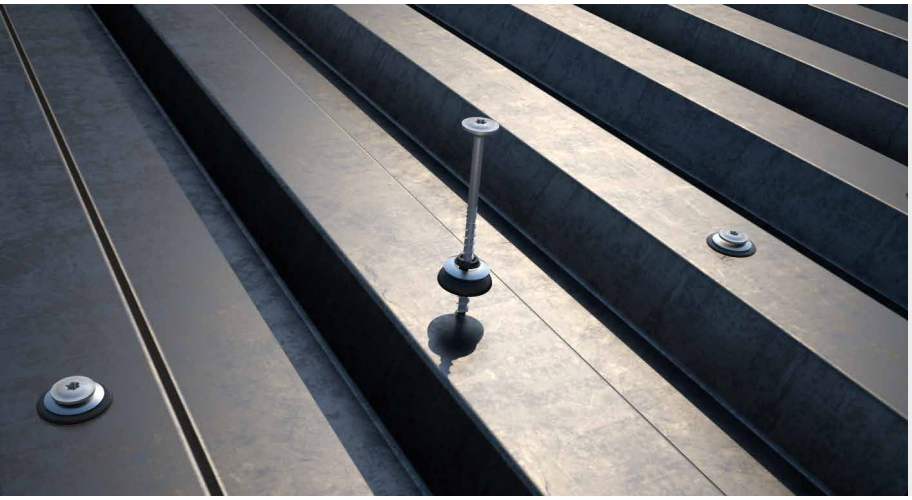
INSTALLATION



TBS EVO + WBAZ Ø x L [mm] x [mm]	TBS EVO + WBAZ Ø x L [in] x [in]	fastening thickness [min to max] [mm]	fastening thickness [min to max] [in]
6 x 60	0.24 x 2 3/8	0 - 30	0 - 1.18
6 x 80	0.24 x 3 1/8	10 - 50	0.39 - 1.97
6 x 100	0.24 x 4	30 - 70	1.18 - 2.76
6 x 120	0.24 x 4 3/4	50 - 90	1.97 - 3.54
6 x 140	0.24 x 5 1/2	70 - 110	2.76 - 4.33
6 x 160	0.24 x 6 1/4	90 - 130	3.54 - 5.12
6 x 180	0.24 x 7 1/8	110 - 150	4.33 - 5.91
6 x 200	0.24 x 8	130 - 170	5.12 - 6.69

Correct tightening | Excessive tightening | Insufficient tightening | Tightening off axis

NOTE: The thickness of the washer after installation is approximately 0.31-0.35 inch.
The maximum thickness of the fastening package was calculated by ensuring a minimum penetration length into the wood of 4·d.

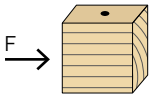


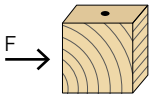
FASTENING METAL SHEET

Can be installed on sheets up to 0.027 inch (0,7 mm) thick without pre-drilling. TBS EVO Ø0.24 inch (6 mm) is ideal when used in combination with washer WBAZ.
For outdoor use in exposure conditions 1 and 3 according to AC257 and wet use according to NDS.

MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

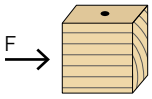
screws inserted **WITHOUT pre-drilled hole** — **G ≤ 0.48**

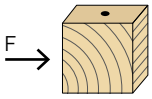




d_1	[in]		0.24	0.32	0.40		0.24	0.32	0.40
	[mm]		6	8	10		6	8	10
a_1	[in]	**15·d**	3 1/2	**3 1/8**	**4**	**10·d**	2 3/8	**1 9/16**	**1 15/16**
a_2	[in]	**5·d**	1 3/16	1 9/16	1 15/16	**5·d**	1 3/16	1 9/16	1 15/16
$a_{3,t}$	[in]	**15·d**	3 1/2	4 3/4	6	**15·d**	3 1/2	4 3/4	6
$a_{3,c}$	[in]	**10·d**	2 3/8	3 1/8	4	**10·d**	2 3/8	3 1/8	4
$a_{4,t}$	[in]	**10·d**	2 3/8	3 1/8	4	**10·d**	2 3/8	3 1/8	4
$a_{4,c}$	[in]	**5·d**	1 3/16	1 9/16	1 15/16	**5·d**	1 3/16	1 9/16	1 15/16

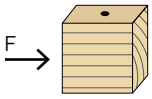
screws inserted **WITHOUT pre-drilled hole** — **0.48 < G ≤ 0.50**

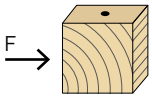




d_1	[in]		0.24	0.32	0.40		0.24	0.32	0.40
	[mm]		6	8	10		6	8	10
a_1	[in]	**15·d**	3 1/2	4 3/4	6	**10·d**	2 3/8	**2 3/16**	**2 3/4**
a_2	[in]	**5·d**	1 3/16	1 9/16	1 15/16	**5·d**	1 3/16	1 9/16	1 15/16
$a_{3,t}$	[in]	**15·d**	3 1/2	4 3/4	6	**15·d**	3 1/2	4 3/4	6
$a_{3,c}$	[in]	**10·d**	2 3/8	3 1/8	4	**10·d**	2 3/8	3 1/8	4
$a_{4,t}$	[in]	**10·d**	2 3/8	3 1/8	4	**10·d**	2 3/8	3 1/8	4
$a_{4,c}$	[in]	**5·d**	1 3/16	1 9/16	1 15/16	**5·d**	1 3/16	1 9/16	1 15/16

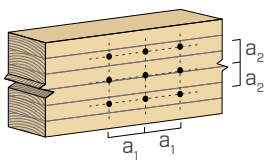
screws inserted **WITHOUT pre-drilled hole** — **G > 0.50**



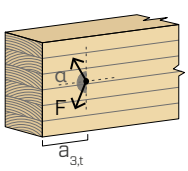


d_1	[in]		0.24	0.32	0.40		0.24	0.32	0.40
	[mm]		6	8	10		6	8	10
a_1	[in]	**15·d**	3 1/2	4 3/4	6	**10·d**	2 3/8	3 1/8	4
a_2	[in]	**7·d**	1 5/8	2 3/16	2 3/4	**7·d**	1 5/8	2 3/16	2 3/4
$a_{3,t}$	[in]	**20·d**	4 3/4	6 1/4	8	**20·d**	4 3/4	6 1/4	8
$a_{3,c}$	[in]	**15·d**	3 1/2	4 3/4	6	**15·d**	3 1/2	4 3/4	6
$a_{4,t}$	[in]	**12·d**	2 13/16	3 3/4	4 3/4	**12·d**	2 13/16	3 3/4	4 3/4
$a_{4,c}$	[in]	**7·d**	1 5/8	2 3/16	2 3/4	**7·d**	1 5/8	2 3/16	2 3/4

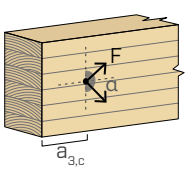
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



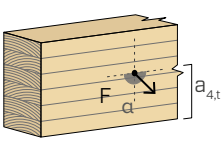
stressed end
-90° < α < 90°



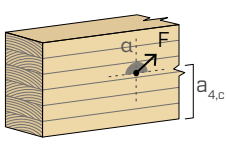
unloaded end
90° < α < 270°



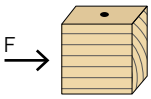
stressed edge
0° < α < 180°

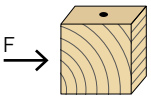


unload edge
180° < α < 360°



screws inserted **WITH pre-drilled hole**

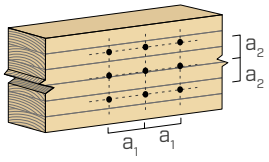




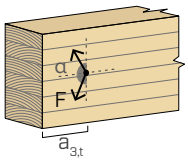
d_1	[in]		0.24	0.32		0.40
	[mm]		6	8		10
a_1	[in]	**10·d**	2 3/8	3 1/8	**5·d**	1 15/16
a_2	[in]	**4·d**	15/16	1 1/4	**5·d**	1 15/16
$a_{3,t}$	[in]	**12·d**	2 13/16	3 3/4	**7·d**	2 3/4
$a_{3,c}$	[in]	**7·d**	1 5/8	2 3/16	**4·d**	1 9/16
$a_{4,t}$	[in]	**7·d**	1 5/8	2 3/16	**4·d**	1 9/16
$a_{4,c}$	[in]	**3·d**	11/16	15/16	**3·d**	1 3/16

	0.24	0.32		0.40
	6	8		10
5·d	1 3/16	1 9/16	**5·d**	1 15/16
4·d	15/16	1 1/4	**5·d**	1 15/16
12·d	2 13/16	3 3/4	**7·d**	2 3/4
7·d	1 5/8	2 3/16	**4·d**	1 9/16
7·d	1 5/8	2 3/16	**4·d**	1 9/16
3·d	11/16	15/16	**3·d**	1 3/16

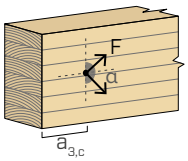
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



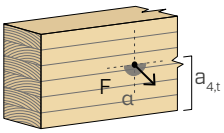
stressed end
-90° < α < 90°



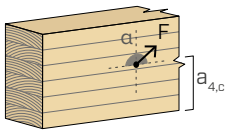
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°



unload edge
180° < α < 360°

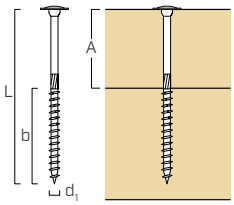
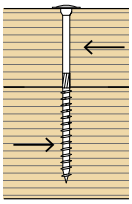
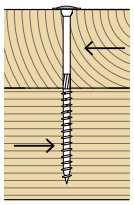
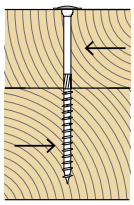


NOTES

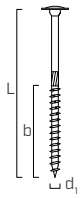
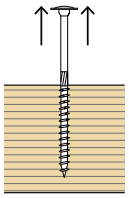
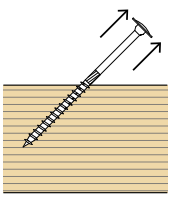
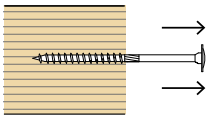
- Values in blue are from Table 10 of ESR-4645 (REDUCED CONNECTION GEOMETRY REQUIREMENTS BASED ON TESTING);
- The minimum spacing and distances comply with Table 8 of ESR-4645, where d refers to the nominal diameter of the screw;
- Wood member stresses must be checked in accordance with the corresponding Sections of the NDS; end distances, edge distances and fastener spacing may need to be increased accordingly.

NOTES and **GENERAL PRINCIPLES** on page 133.

REFERENCE LATERAL DESIGN VALUES (Z) | WOOD-TO-WOOD

geometry				$Z_{\parallel}$				$Z_{\perp/\parallel}$				$Z_{\perp}$			
															
d_1	L		b	A	G				G				G			
					0.35	0.42	0.49	0.55	0.35	0.42	0.49	0.55	0.35	0.42	0.49	0.55
[mm] [in]	[mm]	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
6 **0.24**	60	2 3/8	1 9/16	3/4	87	120	142	163	87	120	142	163	87	120	142	163
	80	3 1/8	1 15/16	1	104	129	156	182	104	129	156	182	104	129	156	182
	100	4	2 3/8	1 1/2	120	154	190	211	120	154	190	211	120	154	190	211
	120	4 3/4	2 15/16	1 3/4	129	165	190	211	129	165	190	211	129	165	190	211
	140-200	5 1/2-8	2 15/16	≥ 2 1/2	139	165	190	211	139	165	190	211	139	165	190	211
8 **0.32**	100	4	2 1/16	1 3/4	156	216	270	313	125	173	216	251	125	173	216	251
	120	4 3/4	3 1/8	1 1/2	160	202	248	292	128	161	198	233	128	161	198	233
	140	5 1/2	3 1/8	2 1/4	191	245	282	313	153	196	225	251	153	196	225	251
	160	6 1/4	4	2 1/4	191	245	282	313	153	196	225	251	153	196	225	251
	180-400	7 1/8-15 3/4	4	≥ 3	207	245	282	313	165	196	225	251	165	196	225	251
10 **0.40**	120	4 3/4	2 3/8	1/2	259	311	362	387	173	215	259	295	140	182	228	270
	140	5 1/2	2 3/8	1	300	338	365	387	195	245	274	295	165	216	259	282
	160	6 1/4	3 1/8	2 1/8	308	338	365	387	220	249	274	295	186	232	259	282
	180	7 1/8	3 1/8	2 3/4	308	338	365	387	222	249	274	295	203	232	259	282
	200-280	8-11	4	≥ 3 3/4	308	338	365	387	222	249	274	295	203	232	259	282

THREAD WITHDRAWAL (W) | WOOD

geometry				thread withdrawal α = 90°				thread withdrawal α = 45°				thread withdrawal α = 0°			
															
d_1	L		b	G				G				G			
				0.35	0.42	0.49	0.55	0.35	0.42	0.49	0.55	0.35	0.42	0.49	0.55
[mm] [in]	[mm]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
6 **0.24**	60	2 3/8[1]	1 9/16	175	202	229	252	160	184	208	229	53	61	69	75
	80	3 1/8[2]	1 15/16	227	262	296	326	207	238	270	296	68	78	89	98
	100	4	2 3/8	279	321	364	400	253	292	331	364	84	96	109	120
	120-200	4 3/4-8	2 15/16	356	410	465	511	324	373	423	465	107	123	139	153
8 **0.32**	100	4[1]	2 1/16	298	345	390	428	271	314	355	389	89	103	117	128
	120-140	4 3/4-5 1/2	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	160-400	6 1/4-15 3/4	4	623	721	815	895	567	656	742	814	187	216	244	268
	120-140	4 3/4-5 1/2[1]	2 3/8	406	470	531	583	369	428	484	530	122	141	159	175
	160-180	6 1/4-7 1/8[2]	3 1/8	568	659	744	816	517	599	677	742	170	198	223	245
	200-280	8-11	4	730	847	957	1049	664	771	871	954	219	254	287	315

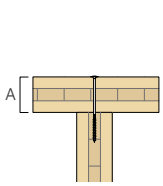
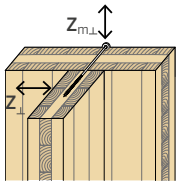
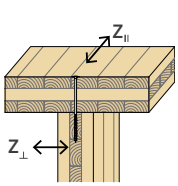
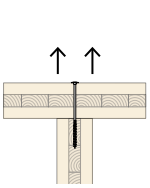
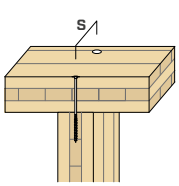
[1] The embedded thread length does not comply with the minimum requirement of ESR-4645 (6 times the outer thread diameter for screws installed at 90° to the grain and 8 times the outer thread diameter for screws installed at an angle 0°≤ α <90° to the grain).

[2] The embedded thread length does not comply with the minimum requirement of ESR-4645 (8 times the outer thread diameter for screws installed at an angle 0°≤ α <90° to the grain).

HEAD PULL-THROUGH (W_H) | WOOD

geometry			head pull through 90° ≤ α ≤ 30°			
d_1		d_k	G			
			0.35	0.42	0.49	0.55
[mm]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]
6	0.24	0.61	182	263	357	450
8	0.32	0.75	223	322	438	552
10	0.40	0.98	314	452	615	774

CLT | WALL-TO-WALL | FLOOR-TO-WALL

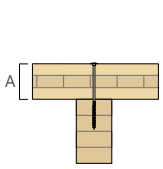
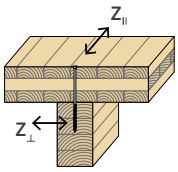
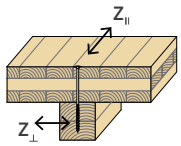
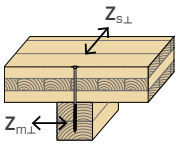
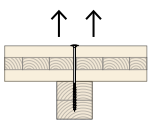
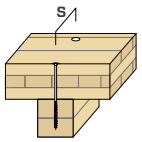
geometry				SHEAR						TENSION	SPACING	
				wall-to-wall		floor-to-wall orientation 1		floor-to-wall orientation 2		withdrawal / head pull-through	fastener in a row	
												
side member thickness (wall/floor) = A		suggested screw		$Z_{\perp}$	$Z_{m\perp}$	$Z_{\perp}$	Z_{II}	$Z_{m\perp}$	$Z_{s\perp}$	W(*)	minimum	typical
[mm]	[in]	CODE		[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	60	2 3/8	TBSEVO6140	110	110	110	110	110	110	263	3 1/2	6
			TBSEVO8140	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10140	144	164	144	226	164	155	452	4	8
	79	3 1/8	TBSEVO6160	110	110	110	110	110	110	263	3 1/2	6
			TBSEVO8180	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10180	155	167	155	226	167	167	452	4	8
	105	4 1/8	TBSEVO6180	110	110	110	110	110	110	263	3 1/2	6
			TBSEVO8220	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10220	155	167	155	226	167	167	452	4	8
	120	4 3/4	TBSEVO6200	110	110	110	110	110	110	263	3 1/2	6
			TBSEVO8220	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10220	155	167	155	226	167	167	452	4	8
5 PLY	100	3 15/16	TBSEVO6180	110	110	110	110	110	110	263	3 1/2	6
			TBSEVO8200	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10200	155	167	155	226	167	167	452	4	8
	140	5 1/2	TBSEVO8240	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10240	155	167	155	226	167	167	452	4	8
	175	6 7/8	TBSEVO8280	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10280	155	167	155	226	167	167	452	4	8
	200	7 7/8	TBSEVO8320	131	131	131	164	131	131	322	3 1/8	6
7 PLY	140	5 1/2	TBSEVO8240	131	131	131	164	131	131	322	3 1/8	6
			TBSEVO10240	155	167	155	226	167	167	452	4	8
	191	7 1/2	TBSEVO8320	131	131	131	164	131	131	322	3 1/8	6
	244	9 5/8	TBSEVO8360	131	131	131	164	131	131	322	3 1/8	6
	280	11	TBSEVO8400	131	131	131	164	131	131	322	3 1/8	6

or longer

(*) Minimum between head pull-through and withdrawal resistance

NOTES and GENERAL PRINCIPLES on page 133.

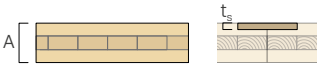
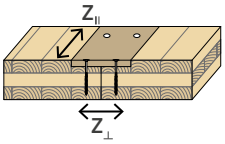
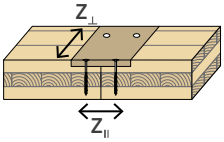
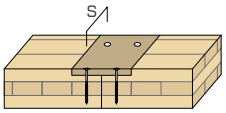
CLT | FLOOR-TO-BEAM

geometry				SHEAR								TENSION	SPACING	
				floor-to-beam orientation 1		floor-to-beam orientation 2		floor-to-double lumber 2" orientation 1		floor-to-double lumber 2" orientation 2		withdrawal / head pull-through	fastener in a row	
														
side member thickness (wall/floor) = A		suggested screw	$Z_{\perp}$	$Z_{\parallel}$	$Z_{m\perp}$	$Z_{s\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{m\perp}$	$Z_{s\perp}$	W(*)	minimum	typical
[mm]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
5 PLY	100	3 15/16	TBSEVO6180	165	165	110	165	165	165	110	165	263	3 1/2	6
			TBSEVO8200	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO10180	232	338	167	249	232	338	167	249	452	4	8
	140	5 1/2	TBSEVO8240	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO10240	232	338	167	249	232	338	167	249	452	4	8
	175	6 7/8	TBSEVO8240	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO8280	196	245	131	196	-	-	-	-	322	3 1/8	6
			TBSEVO10240	224	338	158	249	224	338	158	249	452	4	8
			TBSEVO10280	232	338	167	249	-	-	-	-	452	4	8
	200	7 7/8	TBSEVO8280	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO8320	196	245	131	196	-	-	-	-	322	3 1/8	6
7 PLY	140	5 1/2	TBSEVO8240	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO10240	232	338	167	249	232	338	167	249	452	4	8
	191	7 1/2	TBSEVO8280	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO8320	196	245	131	196	-	-	-	-	322	3 1/8	6
	244	9 5/8	TBSEVO8320	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO8360	196	245	131	196	-	-	-	-	322	3 1/8	6
	280	11	TBSEVO8360	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO8400	196	245	131	196	-	-	-	-	322	3 1/8	6
9 PLY	180	7 1/16	TBSEVO8280	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO10280	232	338	167	249	232	338	167	249	452	4	8
	267	10 1/2	TBSEVO8360	196	245	131	196	196	245	131	196	322	3 1/8	6
			TBSEVO8400	196	245	131	196	-	-	-	-	322	3 1/8	6

(*)Minumum between head pull-through and withdrawal resistance

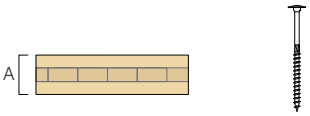
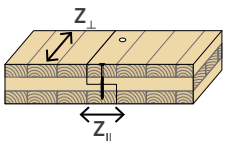
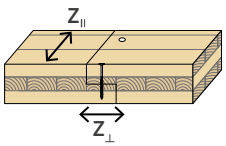
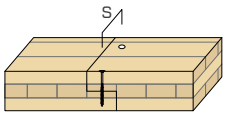
NOTES and GENERAL PRINCIPLES on page 133.

CLT | SPLINE JOINT

geometry				SHEAR				SPACING	
				spline joint orientation 1		spline joint orientation 2		fastener in a row	
									
panel thickness (wall/floor) = A		spline thickness = t_s	suggested screw	Z_{II}	$Z_{\perp}$	Z_{II}	$Z_{\perp}$	minimum	typical
[mm]	[in]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	79	3 1/8	1/2	TBSEVO660	116	116	116	116	3 1/2	4
			3/4	TBSEVO660	120	120	120	120	3 1/2	4
			1	TBSEVO660	111	111	111	111	3 1/2	4
	86	3 3/8	1/2	TBSEVO660	116	116	116	116	3 1/2	4
			3/4	TBSEVO680	120	120	120	120	3 1/2	4
			1	TBSEVO680	128	128	128	128	3 1/2	4
	105	4 1/8	1/2	TBSEVO680	116	116	116	116	3 1/2	4
				TBSEVO8100	136	108	136	108	3 1/8	4
			3/4	TBSEVO680	120	120	120	120	3 1/2	4
				TBSEVO8100	173	139	173	139	3 1/8	4
			1	TBSEVO6100	128	128	128	128	3 1/2	4
				TBSEVO8100	179	143	179	143	3 1/8	4
5 PLY	130	5 1/8	3/4	TBSEVO660	120	120	120	120	3 1/2	4
				TBSEVO8100	173	139	173	139	3 1/8	4
			1	TBSEVO680	128	128	128	128	3 1/2	4
				TBSEVO8100	179	143	179	143	3 1/8	4
				TBSEVO10120	211	164	211	164	4	6
	140	5 1/2	3/4	TBSEVO680	120	120	120	120	3 1/2	4
				TBSEVO8100	173	139	173	139	3 1/8	4
			1	TBSEVO6100	128	128	128	128	3 1/2	4
				TBSEVO8100	179	143	179	143	3 1/8	4
				TBSEVO10120	211	164	211	164	4	6
	175	6 7/8	3/4	TBSEVO6100	120	120	120	120	3 1/2	4
				TBSEVO8100	173	139	173	139	3 1/8	4
			1	TBSEVO6120	128	128	128	128	3 1/2	4
				TBSEVO8120	179	143	179	143	3 1/8	4
				TBSEVO10140	211	164	211	164	4	6
7 PLY	191	7 1/2	3/4	TBSEVO680	120	120	120	120	3 1/2	4
				TBSEVO8100	173	139	173	139	3 1/8	4
			1	TBSEVO6100	128	128	128	128	3 1/2	4
				TBSEVO8100	179	143	179	143	3 1/8	4
				TBSEVO10160	211	164	211	164	4	6
	220	8 5/8	3/4	TBSEVO6100	120	120	120	120	3 1/2	4
				TBSEVO8100	173	139	173	139	3 1/8	4
			1	TBSEVO6120	128	128	128	128	3 1/2	4
				TBSEVO8140	179	143	179	143	3 1/8	4
				TBSEVO10160	211	164	211	164	4	6
	244	9 5/8	3/4	TBSEVO6120	120	120	120	120	3 1/2	4
				TBSEVO8120	173	139	173	139	3 1/8	4
			1	TBSEVO6140	128	128	128	128	3 1/2	4
				TBSEVO8140	179	143	179	143	3 1/8	4
				TBSEVO10160	211	164	211	164	4	6

NOTES and GENERAL PRINCIPLES on page 133.

CLT | HALF LAP

				SHEAR				SPACING	
geometry				half lap orientation 1		half lap orientation 2		fastener in a row	
									
	panel thickness (wall/floor) = A		suggested screw	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	minimum	typical
	[mm]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	79	3 1/8	TBSEVO660	119	119	119	119	3 1/2	6
	105	4 1/8	TBSEVO6100	165	165	165	165	3 1/2	6
			TBSEVO8100	174	218	174	218	3 1/8	6
	120	4 3/4	TBSEVO6100	155	155	155	155	3 1/2	6
			TBSEVO8100	160	200	160	200	3 1/8	6
5 PLY	100	3 15/16	TBSEVO680	130	130	130	130	3 1/2	6
	140	5 1/2	TBSEVO6120	165	165	165	165	3 1/2	6
			TBSEVO8120	178	222	178	222	3 1/8	6
			TBSEVO10120	189	301	189	301	4	8
	175	6 7/8	TBSEVO6160	165	165	165	165	3 1/2	6
			TBSEVO8160	196	245	196	245	3 1/8	6
			TBSEVO10160	232	338	232	338	4	8
	200	7 7/8	TBSEVO6180	165	165	165	165	3 1/2	6
			TBSEVO8180	196	245	196	245	3 1/8	6
			TBSEVO10180	232	338	232	338	4	8
7 PLY	140	5 1/2	TBSEVO6120	165	165	165	165	3 1/2	6
			TBSEVO8120	178	222	178	222	3 1/8	6
			TBSEVO10120	189	301	189	301	4	8
	191	7 1/2	TBSEVO6180	165	165	165	165	3 1/2	6
			TBSEVO8180	196	245	196	245	3 1/8	6
			TBSEVO10180	232	338	232	338	4	8
	244	9 5/8	TBSEVO8220	196	245	196	245	3 1/8	6
			TBSEVO10220	232	338	232	338	4	8
	280	11	TBSEVO8240	196	245	196	245	3 1/8	6
			TBSEVO10240	232	338	232	338	4	8
9 PLY	180	7 1/16	TBSEVO6160	165	165	165	165	3 1/2	6
			TBSEVO8160	196	245	196	245	3 1/8	6
			TBSEVO10160	228	338	228	338	4	8
	267	10 1/2	TBSEVO8240	196	245	196	245	3 1/8	6
			TBSEVO10240	232	338	232	338	4	8
	314	12 3/8	TBSEVO8280	196	245	196	245	3 1/8	6
			TBSEVO10280	232	338	232	338	4	8
	360	14 3/16	TBSEVO8320	196	245	196	245	3 1/8	6

NOTES and GENERAL PRINCIPLES on page 133.

GENERAL PRINCIPLES

- Tabulated values comply with NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION in accordance with ESR-4645.
- To determine allowable loads for use with ASD, design loads for use with LRFD or both, tabulated values must be multiplied by all adjustment factors included in the NDS for dowel-type fasteners.
- As part of the connection design, the structural wood members, the steel plates must be sized and verified in accordance with the corresponding Section of the NDS and must be done separately by the designer.
- Connections with multiple screws must be designed in accordance with the corresponding Sections of the NDS and ESR-4645.
- TBS EVO screws must be positioned in accordance with the minimum distances.
- In case of combined axial and shear forces, the designer shall refer to the Hankinson formula, as specified in section 12.4.1 of the NDS, to evaluate the load-bearing capacity.

REFERENCE LATERAL DESIGN VALUES

- Tabulated values are determined from the yield model equations in the corresponding Section of the NDS.
- Unless otherwise noted, the threaded part of the screw is fully inserted in the main member.
- The screw penetration into the main member is minimum 6 times the outer thread diameter unless otherwise noted.
- The reference lateral design values may be determined for other connection configurations in accordance with the corresponding Section of NDS and ESR-4645.
- The reference lateral design values are calculated for screws inserted without pre-drilling hole. In the case of screws inserted with pre-drilling hole, greater resistance values can be obtained.

WOOD-TO-WOOD

- The wood main member thickness must be greater than the screw length minus the thickness of the wood side member.
- The tabulated lateral design values are based on both wood members having the same specific gravity G.

REFERENCE WITHDRAWAL DESIGN VALUES

- The reference withdrawal design values (W_{ref}) expressed in pounds-force per inch of thread penetration into the main member for screws installed at an angle of 90° to the grain can be found in the ESR-4645.
- The values for screws installed at an angle α to the grain are determined by multiplying the reference withdrawal design values with the effective thread penetration L_{eff} of the screw in the wood member and with the factor k_α:

  $W_\alpha = W_{ref} \cdot k_\alpha \cdot L_{eff}$

  Where:

  - W_{ref} is the reference withdrawal design value for screws installed at an angle of 90° to the grain, as shown in the table on the left;
  - k_α factor is calculated as:

$$k_\alpha = \begin{cases} 35^\circ < \alpha \leq 90^\circ & \dfrac{1}{1.2 \cdot \cos^2(\alpha) + \sin^2(\alpha)} \\ 0^\circ \leq \alpha \leq 35^\circ & 0.3 + 0.7 \dfrac{\alpha}{45} \end{cases}$$

  - α is the angle between the grain direction and screw axis.

  Tabulated values at page 128 are valid for L_{eff} equal to the screw thread length b minus the tip length L_t and $k_\alpha = 1$ for α=90°, $k_\alpha = 0.91$ for α= 45°, $k_\alpha = 0.3$ for α = 0°.
- The minimum embedded thread length is 6 times the outer thread diameter for screws installed at 90° to the grain, unless otherwise noted.
- The minimum embedded thread length for screws installed at an angle 0° ≤ α < 90° to the grain is 8 times the outer thread diameter, unless otherwise noted.
- At least four screws must be used in a connection with screws installed in the wood member with an angle between the grain direction and screw axis α ≤ 15°.
- The reference withdrawal design values must be inferior to f_{tens} of the screw.

REFERENCE HEAD PULL-THROUGH DESIGN VALUES

While designing a connection the head pull-through values must be compared with the tensile resistance of the screw and, if necessary, thread withdrawal. The lower value is the governing one.

CONNECTIONS

GENERAL NOTES

- Designed connections must respect all requirements on general principles and minimum distances.
- Calculations comply with the NDS in accordance with ESR 4645.
- Tabulated values, that are referred to a single fastener, are valid for Allowable Stress Design (ASD) considering a standard loading ($C_D = 1.0$).
- Timber element specific gravity is considered as G = 0.42.
- Z_{II}: Force-to-grain angle in the shear plane is considered as 0°.
- $Z_\perp$: Force-to-grain angle in the shear plane is considered as 90°.
- $Z_{m\perp}$: Force-to-grain angle in the shear plane is considered as 0° for side member and as 90° for main member.
- $Z_{s\perp}$: Force-to-grain angle in the shear plane is considered as 90° for side member and as 0° for main member.
- For the connectors inserted in the panel's face, it has been considered the same grain direction as the layer in the shear plane. For the connectors inserted in the panel's narrow edge, it has been considered the same grain direction as the layer in which the connector is installed.
- For lateral design values the force-to-fastener angle is always considered 90°.
- Typical fastener spacings are declared considering a generic load condition; spacings should be verified and defined according to the real load conditions.

CLT | WALL-TO-WALL | FLOOR-TO-WALL

- The main grain direction of the CLT wall panel is always considered as vertical.
- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the wall plane.
- The threaded part of the screw has been always considered inserted in the central layer of the CLT panel.
- The withdrawal capacity has been considered as the minimum between thread withdrawal, head-pull through and tensile strength of the screw.
- According to NDS, an end grain coefficient C_{eg}=0.67 is considered for the lateral resistance calculation due to fastener in narrow edge of CLT.

CLT | FLOOR-TO-WOOD BEAM

- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the beam's axis.
- The threaded part of the screw has been always considered inserted in the central layer of the CLT panel.
- The withdrawal capacity has been considered as the minimum between thread withdrawal, head-pull through and tensile strength of the screw.
- According to NDS, an end grain coefficient C_{eg}=0.67 is considered for the lateral resistance calculation due to fastener in narrow edge of CLT.
- Beam element can be considered both solid wood or glulam.
- Double lumber is considered as two coupled element of 2 inches thick.
- The width of the beams must comply with the minimum distance requirements.
- The proposed screw's length does not exceed the total thickness of the connection. In configurations with no declared value (-) the fastener exceeds the main member depth.

SPLINE JOINT

- Spline thickness is considered to be thinner than the top CLT layer.
- For Root Diameter d_2>0.25 inch, the bearing strength of the spline is conservatively considered as 3350 psi according to NDS.
- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the spline's direction.
- The width of the spline and consequent machining on CLT panel must comply with the minimum distance requirements.

HALF LAP

- The main grain direction of the CLT floor panel is considered both parallel and perpendicular to the machining's direction.
- The width of half-lap machining on CLT panel must comply with the minimum distance requirements.
- The proposed screw's length does not exceed the total thickness of the connection.