HBS EVO

COUNTERSUNK 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. It can be used for exposure condition 3 outdoor applications and under class C4 atmospheric corrosion conditions tested by the Research Institutes of Sweden - RISE.

3 THORNS TIP

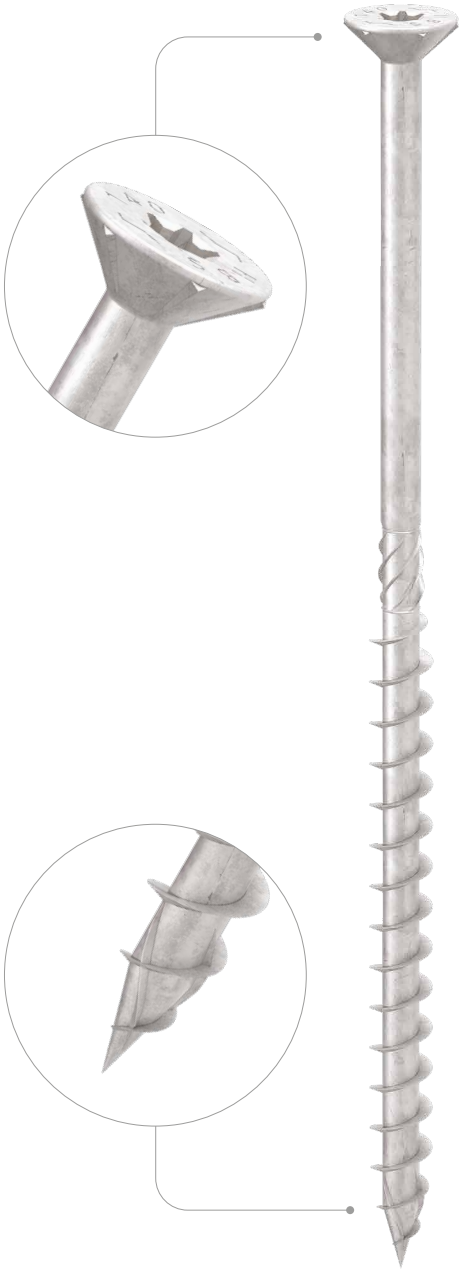
Thanks to the 3 THORNS tip, minimum installation distances are reduced. More screws can be used in less space and larger screws in smaller elements. Costs and time for project implementation are reduced.

PRESSURE TREATED LUMBER

The C4 EVO coating has been certified according to US acceptance criteria AC257 for outdoor use with ACQ-treated timber.

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]	0.12		**0.16**			**0.32**				0.48
LENGTH [in]	1/2				**1 9/16**			**12 5/8**		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

EXPOSURE CONDITION 3

Certified for use in exposure condition 3 outdoor applications and under class C4 atmospheric corrosion conditions. Ideal for fastening timber framed panels and trusses (Rafter, Truss).

PERGOLAS AND DECKS

The smaller sizes are ideal for securing boards and battens of decks set up outdoors.

CODES AND DIMENSIONS

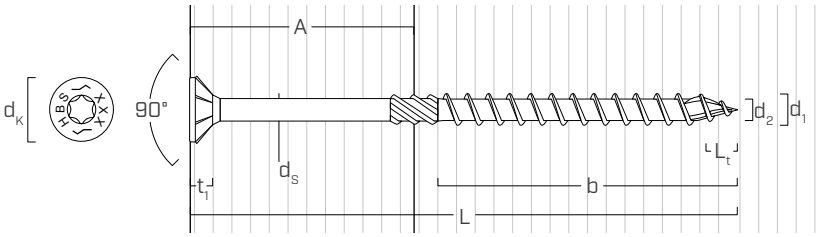
d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
4 **0.16** #7 TX 20	**HBSEVO440**	40	1 9/16	24	15/16	1/2	500
	HBSEVO450	50	1 15/16	30	1 3/16	3/4	500
	HBSEVO460	60	2 3/8	35	1 3/8	3/4	500
4,5 **0.18** #9 TX 20	**HBSEVO4545**	45	1 3/4	30	1 3/16	1/2	400
	HBSEVO4550	50	1 15/16	30	1 3/16	3/4	200
	HBSEVO4560	60	2 3/8	35	1 3/8	3/4	200
	HBSEVO4570	70	2 3/4	40	1 9/16	1	200
	HBSEVO4580	80	3 1/8	40	1 9/16	1 1/2	200
5 **0.20** #11 TX 25	**HBSEVO550**	50	1 15/16	24	15/16	1	200
	HBSEVO560	60	2 3/8	30	1 3/16	1	200
	HBSEVO570	70	2 3/4	35	1 3/8	1 1/4	100
	HBSEVO580	80	3 1/8	40	1 9/16	1 1/2	100
	HBSEVO590	90	3 1/2	45	1 3/4	1 3/4	100
	HBSEVO5100	100	4	50	1 15/16	1 3/4	100
6 **0.24** #14 TX 30	**HBSEVO660**	60	2 3/8	30	1 3/16	1	100
	HBSEVO670	70	2 3/4	40	1 9/16	1	100
	HBSEVO680	80	3 1/8	40	1 9/16	1 1/2	100
	HBSEVO6100	100	4	50	1 15/16	1 3/4	100
	HBSEVO6120	120	4 3/4	60	2 3/8	2 1/4	100
	HBSEVO6140	140	5 1/2	75	2 15/16	2 1/2	100
	HBSEVO6160	160	6 1/4	75	2 15/16	3 1/4	100
	HBSEVO6180	180	7 1/8	75	2 15/16	4	100
	HBSEVO6200	200	8	75	2 15/16	4 3/4	100
8 **0.32** TX 40	**HBSEVO8100**	100	4	52	2 1/16	1 3/4	100
	HBSEVO8120	120	4 3/4	60	2 3/8	2 1/4	100
	HBSEVO8140	140	5 1/2	60	2 3/8	3	100
	HBSEVO8160	160	6 1/4	80	3 1/8	3	100
	HBSEVO8180	180	7 1/8	80	3 1/8	3 3/4	100
	HBSEVO8200	200	8	80	3 1/8	4 1/2	100
	HBSEVO8220	220	8 5/8	80	3 1/8	5 1/2	100
	HBSEVO8240	240	9 1/2	80	3 1/8	6 1/4	100
	HBSEVO8260	260	10 1/4	80	3 1/8	7	100
	HBSEVO8280	280	11	80	3 1/8	7 3/4	100
	HBSEVO8300	300	11 3/4	100	4	7 3/4	100
	HBSEVO8320	320	12 5/8	100	4	8 1/2	100

RELATED PRODUCTS

HUS EVO
TURNED WASHER

see page 72

GEOMETRY AND MECHANICAL CHARACTERISTICS



GEOMETRY

Nominal diameter	d_1	[in](1)	**0.16**	**0.18**	**0.20**	**0.24**	**0.32**
Outer thread diameter	d_1	[mm]	4	4,5	5	6	8
		[in]	**0.157**	**0.177**	**0.197**	**0.236**	**0.315**
Head diameter	d_K	[in]	0.315	0.354	0.394	0.472	0.571
Root diameter	d_2	[in]	0.100	0.110	0.134	0.156	0.213
Shank diameter	d_S	[in]	0.108	0.124	0.144	0.169	0.228
Head thickness	t_1	[in]	0.110	0.110	0.122	0.177	0.177
Tip Length	L_t	[in]	0.157	0.177	0.197	0.236	0.315
Pre-drilling hole diameter(2)	$d_{V,G\leq0.55}$	[in]	-	-	1/8	5/32	13/64
Pre-drilling hole diameter(3)	$d_{V,G>0.55}$	[in]	-	-	9/64	5/32	15/64

(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).

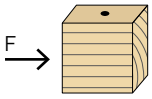
MECHANICAL PARAMETERS

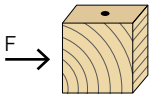
Nominal diameter	d_1	[in]	0.16	0.18	0.20	0.24	0.32
Tensile strength (allowable)	f_{tens}	[lbf]	430	540	680	1180	2040
Bending yield strength (specified)	$F_{y,b}$	[psi]	248000	253500	220000	200000	180000

Nominal diameter	d_1	[in]		0.16	0.18	0.20	0.24	0.32
Withdrawal (design value)	W_{90}	[lbf/in]	G = 0.35	86	86	103	131	172
			G = 0.42	99	99	119	151	199
			G = 0.49	111	111	133	171	225
			G = 0.55	121	121	146	188	247
minimum embedded length		[in]		15/16	1 1/16	1 3/16	1 7/16	1 7/8
Head pull-through (design value)	W_H	[lbf]	G = 0.35	75	95	117	142	220
			G = 0.42	87	110	136	165	264
			G = 0.49	98	124	153	186	298
			G = 0.55	108	136	168	204	327
minimum side member thickness		[in]		1 1/2	1 1/2	1 1/2	1 1/2	1 1/2

MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

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

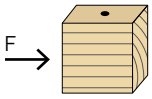


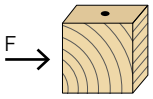


d_1	[in]		0.16	0.18	0.20	0.24	0.32
	[mm]		4	4,5	5	6	8
a_1	[in]	**15·d**	2 3/8	2 11/16	2 15/16	3 1/2	**3 1/8**
a_2	[in]	**5·d**	13/16	7/8	1	1 3/16	1 9/16
$a_{3,t}$	[in]	**15·d**	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
$a_{3,c}$	[in]	**10·d**	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,t}$	[in]	**10·d**	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,c}$	[in]	**5·d**	13/16	7/8	1	1 3/16	1 9/16

	0.16	0.18	0.20	0.24	0.32
	4	4,5	5	6	8
10·d	1 9/16	1 3/4	1 15/16	2 3/8	**1 9/16**
5·d	13/16	7/8	1	1 3/16	1 9/16
15·d	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
10·d	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
10·d	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
5·d	13/16	7/8	1	1 3/16	1 9/16

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

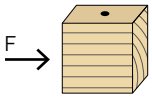


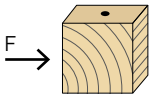


d_1	[in]		0.16	0.18	0.20	0.24	0.32
	[mm]		4	4,5	5	6	8
a_1	[in]	**15·d**	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
a_2	[in]	**5·d**	13/16	7/8	1	1 3/16	1 9/16
$a_{3,t}$	[in]	**15·d**	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
$a_{3,c}$	[in]	**10·d**	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,t}$	[in]	**10·d**	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,c}$	[in]	**5·d**	13/16	7/8	1	1 3/16	1 9/16

	0.16	0.18	0.20	0.24	0.32
	4	4,5	5	6	8
10·d	1 9/16	1 3/4	1 15/16	2 3/8	**2 3/16**
5·d	13/16	7/8	1	1 3/16	1 9/16
15·d	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
10·d	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
10·d	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
5·d	13/16	7/8	1	1 3/16	1 9/16

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

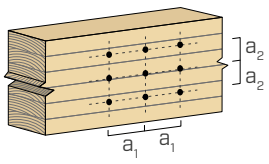




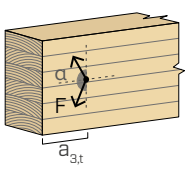
d_1	[in]		0.16	0.18	0.20	0.24	0.32
	[mm]		4	4,5	5	6	8
a_1	[in]	**15·d**	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
a_2	[in]	**7·d**	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16
$a_{3,t}$	[in]	**20·d**	3 1/8	3 1/2	4	4 3/4	6 1/4
$a_{3,c}$	[in]	**15·d**	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
$a_{4,t}$	[in]	**12·d**	1 7/8	2 1/8	2 3/8	2 13/16	3 3/4
$a_{4,c}$	[in]	**7·d**	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16

	0.16	0.18	0.20	0.24	0.32
	4	4,5	5	6	8
10·d	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
7·d	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16
20·d	3 1/8	3 1/2	4	4 3/4	6 1/4
15·d	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4
12·d	1 7/8	2 1/8	2 3/8	2 13/16	3 3/4
7·d	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16

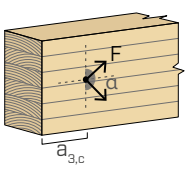
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



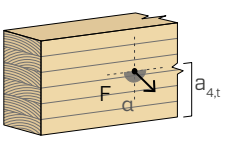
stressed end
-90° < α < 90°



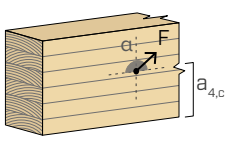
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°

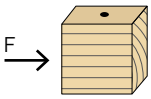


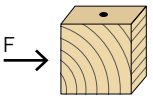
unload edge
180° < α < 360°



MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

screws inserted **WITH pre-drilled hole**

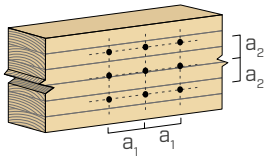




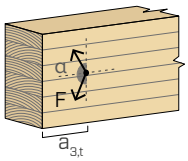
d_1	[in]		0.16	0.18	0.20	0.24	0.32
	[mm]		4	4,5	5	6	8
a_1	[in]	**10·d**	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8
a_2	[in]	**4·d**	5/8	11/16	13/16	15/16	1 1/4
$a_{3,t}$	[in]	**12·d**	1 7/8	2 1/8	2 3/8	2 13/16	3 3/4
$a_{3,c}$	[in]	**7·d**	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16
$a_{4,t}$	[in]	**7·d**	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16
$a_{4,c}$	[in]	**3·d**	1/2	9/16	9/16	11/16	15/16

	0.16	0.18	0.20	0.24	0.32
	4	4,5	5	6	8
5·d	13/16	7/8	1	1 3/16	1 9/16
4·d	5/8	11/16	13/16	15/16	1 1/4
12·d	1 7/8	2 1/8	2 3/8	2 13/16	3 3/4
7·d	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16
7·d	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16
3·d	1/2	9/16	9/16	11/16	15/16

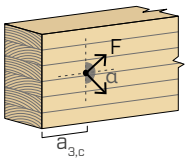
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



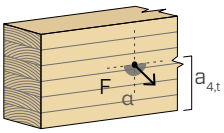
stressed end
-90° < α < 90°



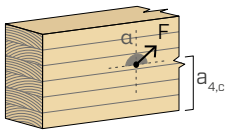
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°



unload edge
180° < α < 360°

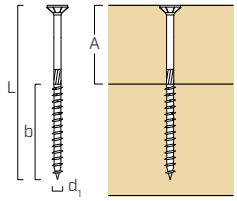
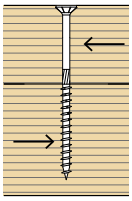
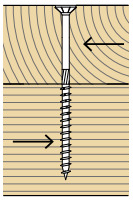
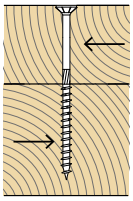


NOTES

- Values in blue are from Table 10 of ESR-4645 (REDUCED CONNECTION GEOMETRY REQUIREMENTS BASED ON TESTING);
- The minimum spacing and distances comply with ESR-4645, where d refers to the nominal diameter of the screw, and are valid for screw installed into sawn lumber, structural glued laminated timber and cross laminated timber;
- 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.

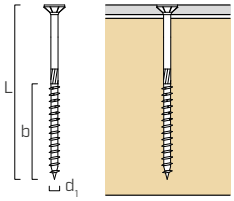
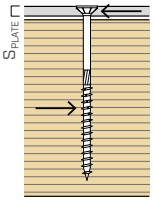
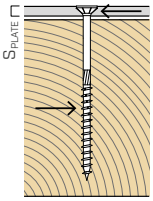
NOTES and **GENERAL PRINCIPLES** on page 67.

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]
4 **0.16**	40	1 9/16	15/16	1/2	37	52	65	74	37	52	65	74	37	52	65	74
	50	1 15/16	1 3/16	3/4	45	61	74	86	45	61	74	86	45	61	74	86
	60	2 3/8	1 3/8	3/4	49	61	74	86	49	61	74	86	49	61	74	86
4,5 **0.18**	45	1 3/4	1 3/16	1/2	48	66	78	88	48	66	78	88	48	66	78	88
	50	1 15/16	1 3/16	3/4	49	68	86	100	49	68	86	100	49	68	86	100
	60	2 3/8	1 3/8	3/4	58	71	86	100	58	71	86	100	58	71	86	100
	70	2 3/4	1 9/16	1	63	80	98	116	63	80	98	116	63	80	98	116
	80	3 1/8	1 9/16	1 1/2	76	93	107	119	76	93	107	119	76	93	107	119
5 **0.20**	50	1 15/16	15/16	1	57	80	106	131	57	80	106	131	57	80	106	131
	60	2 3/8	1 3/16	1	69	97	127	149	69	97	127	149	69	97	127	149
	70	2 3/4	1 3/8	1 1/4	81	113	143	164	81	113	143	164	81	113	143	164
	80	3 1/8	1 9/16	1 1/2	93	127	147	164	93	127	147	164	93	127	147	164
	90	3 1/2	1 3/4	1 3/4	104	128	147	164	104	128	147	164	104	128	147	164
	100	4	1 15/16	1 3/4	107	128	147	164	107	128	147	164	107	128	147	164
6 **0.24**	60	2 3/8	1 3/16	1	80	112	148	182	80	112	148	182	80	112	148	182
	70	2 3/4	1 9/16	1	97	129	156	182	97	129	156	182	97	129	156	182
	80	3 1/8	1 9/16	1 1/2	107	149	190	211	107	149	190	211	107	149	190	211
	100	4	1 15/16	1 3/4	129	165	190	211	129	165	190	211	129	165	190	211
	120	4 3/4	2 3/8	2 1/4	139	165	190	211	139	165	190	211	139	165	190	211
	140	5 1/2	2 15/16	2 1/2	139	165	190	211	139	165	190	211	139	165	190	211
	160	6 1/4	2 15/16	3 1/4	139	165	190	211	139	165	190	211	139	165	190	211
	180	7 1/8	2 15/16	4	139	165	190	211	139	165	190	211	139	165	190	211
	200	8	2 15/16	4 3/4	139	165	190	211	139	165	190	211	139	165	190	211
8 **0.32**	100	4	2 1/16	1 3/4	153	214	270	313	123	171	216	251	123	171	216	251
	120	4 3/4	2 3/8	2 1/4	184	245	282	313	147	196	225	251	147	196	225	251
	140	5 1/2	2 3/8	3	196	245	282	313	157	196	225	251	157	196	225	251
	160	6 1/4	3 1/8	3	207	245	282	313	165	196	225	251	165	196	225	251
	180	7 1/8	3 1/8	3 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	200	8	3 1/8	4 1/2	207	245	282	313	165	196	225	251	165	196	225	251
	220	8 5/8	3 1/8	5 1/2	207	245	282	313	165	196	225	251	165	196	225	251
	240	9 1/2	3 1/8	6 1/4	207	245	282	313	165	196	225	251	165	196	225	251
	260	10 1/4	3 1/8	7	207	245	282	313	165	196	225	251	165	196	225	251
	280	11	3 1/8	7 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	300	11 3/4	4	7 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	320	12 5/8	4	8 1/2	207	245	282	313	165	196	225	251	165	196	225	251

NOTES and **GENERAL PRINCIPLES** on page 67.

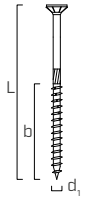
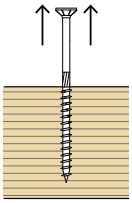
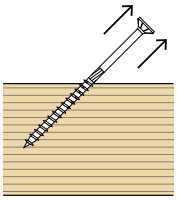
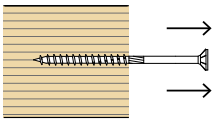
REFERENCE LATERAL DESIGN VALUES (Z) | STEEL-TO-WOOD

geometry				$Z_{\parallel}$ [1]				$Z_{\perp}$ [2]				
												
d_1	L		b	S_{PLATE}	G				S_{PLATE}	G		
					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]	[in]	[lbf]	[lbf]	[lbf]	[lbf]
4 **0.16**	40	1 9/16	15/16	1/16	67	78	89	98	1/16	67	78	89	98
	50	1 15/16	1 3/16		67	78	89	98		67	78	89	98
	60	2 3/8	1 3/8		67	78	89	98		67	78	89	98
4,5 **0.18**	45	1 3/4	1 3/16	1/16	81	95	108	119	1/16	81	95	108	119
	50	1 15/16	1 3/16		81	95	108	119		81	95	108	119
	60	2 3/8	1 3/8		81	95	108	119		81	95	108	119
	70	2 3/4	1 9/16		81	95	108	119		81	95	108	119
	80	3 1/8	1 9/16		81	95	108	119		81	95	108	119
5 **0.20**	50	1 15/16	15/16	1/16	110	129	147	162	1/16	110	129	147	162
	60	2 3/8	1 3/16		110	129	147	162		110	129	147	162
	70	2 3/4	1 3/8		110	129	147	162		110	129	147	162
	80	3 1/8	1 9/16		110	129	147	162		110	129	147	162
	90	3 1/2	1 3/4		110	129	147	162		110	129	147	162
	100	4	1 15/16		110	129	147	162		110	129	147	162
6 **0.24**	60	2 3/8	1 3/16	1/8	155	180	205	225	1/8	155	180	205	225
	70	2 3/4	1 9/16		155	180	205	225		155	180	205	225
	80	3 1/8	1 9/16		155	180	205	225		155	180	205	225
	100	4	1 15/16		155	180	205	225		155	180	205	225
	120	4 3/4	2 3/8		155	180	205	225		155	180	205	225
	140	5 1/2	2 15/16		155	180	205	225		155	180	205	225
	160	6 1/4	2 15/16		155	180	205	225		155	180	205	225
	180	7 1/8	2 15/16		155	180	205	225		155	180	205	225
	200	8	2 15/16		155	180	205	225		155	180	205	225
8 **0.32**	100	4	2 1/16	1/8	218	255	290	319	1/8	174	204	232	255
	120	4 3/4	2 3/8		218	255	290	319		174	204	232	255
	140	5 1/2	2 3/8		218	255	290	319		174	204	232	255
	160	6 1/4	3 1/8		218	255	290	319		174	204	232	255
	180	7 1/8	3 1/8		218	255	290	319		174	204	232	255
	200	8	3 1/8		218	255	290	319		174	204	232	255
	220	8 5/8	3 1/8		218	255	290	319		174	204	232	255
	240	9 1/2	3 1/8		218	255	290	319		174	204	232	255
	260	10 1/4	3 1/8		218	255	290	319		174	204	232	255
	280	11	3 1/8		218	255	290	319		174	204	232	255
	300	11 3/4	4		218	255	290	319		174	204	232	255
	320	12 5/8	4		218	255	290	319		174	204	232	255

[1] Main member loaded parallel to the grain.
[2] Main member loaded perpendicular to the grain.

NOTES and **GENERAL PRINCIPLES** on page 67.

THREAD WITHDRAWAL (W) | WOOD

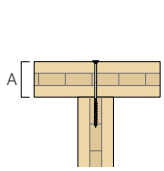
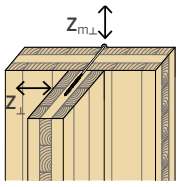
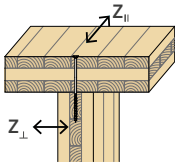
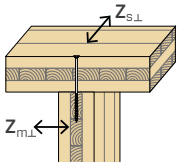
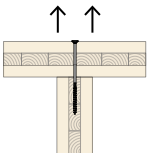
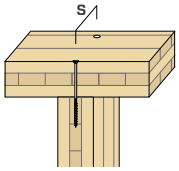
geometry				thread withdrawal α = 90°				thread withdrawal α = 45°				thread withdrawal α = 0°			
															
d_1	L		b	G				G				G			
				0.35	0.42	0.49	0.55	0.35	0.42	0.49	0.55	0.35	0.42	0.49	0.55
[mm] [in]	[mm]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
4 **0.16**	40	1 9/16[1]	15/16	68	78	87	95	62	71	80	87	20	23	26	29
	50	1 15/16[2]	1 3/16	88	101	114	124	80	92	103	113	26	30	34	37
	60	2 3/8[2]	1 3/8	105	121	135	148	96	110	123	134	31	36	41	44
4,5 **0.18**	45	1 3/4[1]	1 3/16	86	99	111	121	79	90	101	111	26	30	33	36
	50	1 15/16[1]	1 3/16	86	99	111	121	79	90	101	111	26	30	33	36
	60	2 3/8[2]	1 3/8	103	119	133	145	94	108	121	132	31	36	40	44
	70	2 3/4[2]	1 9/16	120	138	155	169	109	126	141	154	36	42	47	51
	80	3 1/8	1 9/16	120	138	155	169	120	138	155	169	120	138	155	169
5 **0.20**	50	1 15/16[1]	15/16	77	89	99	109	70	81	91	99	23	27	30	33
	60	2 3/8[1]	1 3/16	101	117	131	144	92	107	119	131	30	35	39	43
	70	2 3/4[1]	1 3/8	122	141	157	172	111	128	143	157	36	42	47	52
	80	3 1/8[2]	1 9/16	142	164	183	201	129	149	167	183	43	49	55	60
	90	3 1/2[2]	1 3/4	162	187	209	230	148	171	191	209	49	56	63	69
	100	4	1 15/16	182	211	236	259	166	192	214	235	55	63	71	78
6 **0.24**	60	2 3/8[1]	1 3/16	124	143	162	178	113	130	147	162	37	43	48	53
	70	2 3/4[1]	1 9/16	175	202	229	252	160	184	208	229	53	61	69	75
	80	3 1/8[1]	1 9/16	175	202	229	252	160	184	208	229	53	61	69	75
	100	4[2]	1 15/16	227	262	296	326	207	238	270	296	68	78	89	98
	120	4 3/4	2 3/8	279	321	364	400	253	292	331	364	84	96	109	120
	140	5 1/2	2 15/16	356	410	465	511	324	373	423	465	107	123	139	153
	160	6 1/4	2 15/16	356	410	465	511	324	373	423	465	107	123	139	153
	180	7 1/8	2 15/16	356	410	465	511	324	373	423	465	107	123	139	153
	200	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	4 3/4[2]	2 3/8	352	407	461	506	320	371	419	460	106	122	138	152
	140	5 1/2[2]	2 3/8	352	407	461	506	320	371	419	460	106	122	138	152
	160	6 1/4	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	180	7 1/8	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	200	8	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	220	8 5/8	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	240	9 1/2	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	260	10 1/4	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	280	11	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210
	300	11 3/4	4	623	721	815	895	567	656	742	814	187	216	244	268
	320	12 5/8	4	623	721	815	895	567	656	742	814	187	216	244	268

[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]
4	0.16	0.31	75	87	98	108
4,5	0.18	0.35	95	110	124	136
5	0.20	0.39	117	136	153	168
6	0.24	0.47	142	165	186	204
8	0.32	0.57	220	264	298	327

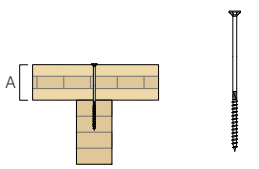
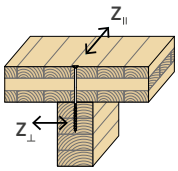
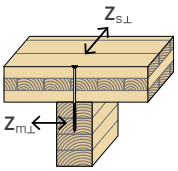
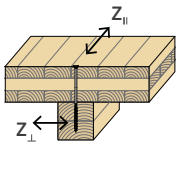
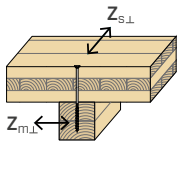
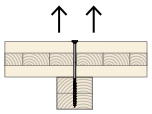
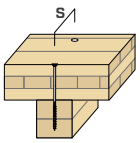
CLT | WALL-TO-WALL | FLOOR-TO-WALL

					SHEAR						TENSION	SPACING	
geometry					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			$Z_{\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{m\perp}$	$Z_{s\perp}$	W(*)	minimum	typical
[mm]	[in]	CODE			[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	60	2 3/8	HBSEVO6120	or longer	110	110	110	110	110	110	165	3 1/2	6
			HBSEVO8120		131	131	131	164	131	131	264	3 1/8	6
	79	3 1/8	HBSEVO6160		110	110	110	110	110	110	165	3 1/2	6
			HBSEVO8160		131	131	131	164	131	131	264	3 1/8	6
	105	4 1/8	HBSEVO6180		110	110	110	110	110	110	165	3 1/2	6
			HBSEVO8200		131	131	131	164	131	131	264	3 1/8	6
	120	4 3/4	HBSEVO6200		110	110	110	110	110	110	165	3 1/2	6
			HBSEVO8200		131	131	131	164	131	131	264	3 1/8	6
5 PLY	100	3 15/16	HBSEVO6180	or longer	110	110	110	110	110	110	165	3 1/2	6
			HBSEVO8180		131	131	131	164	131	131	264	3 1/8	6
	140	5 1/2	HBSEVO8220		131	131	131	164	131	131	264	3 1/8	6
	175	6 7/8	HBSEVO8260		131	131	131	164	131	131	264	3 1/8	6
	200	7 7/8	HBSEVO8280		131	131	131	164	131	131	264	3 1/8	6
7 PLY	140	5 1/2	HBSEVO8220	or longer	131	131	131	164	131	131	264	3 1/8	6
	191	7 1/2	HBSEVO8280		131	131	131	164	131	131	264	3 1/8	6

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

NOTES and GENERAL PRINCIPLES on page 67.

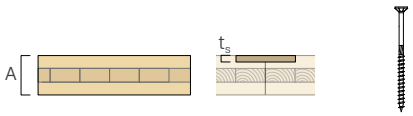
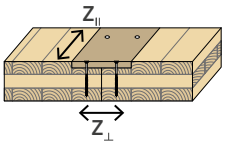
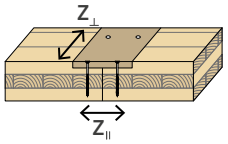
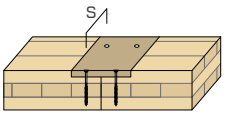
CLT | FLOOR-TO-BEAM

				SHEAR								TENSION	SPACING	
geometry				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]
3 PLY	60	2 3/8	HBSEVO6120	165	165	110	165	165	165	110	165	165	3 1/2	6
			HBSEVO8120	196	245	131	196	196	245	131	196	264	3 1/8	6
	79	3 1/8	HBSEVO6160	165	165	110	165	165	165	110	165	165	3 1/2	6
			HBSEVO8160	196	245	131	196	196	245	131	196	264	3 1/8	6
	105	4 1/8	HBSEVO6180	165	165	110	165	165	165	110	165	165	3 1/2	6
			HBSEVO8200	196	245	131	196	196	245	131	196	264	3 1/8	6
	120	4 3/4	HBSEVO6200	165	165	110	165	165	165	110	165	165	3 1/2	6
			HBSEVO8200	196	245	131	196	196	245	131	196	264	3 1/8	6
5 PLY	100	3 15/16	HBSEVO6180	165	165	165	165	165	165	165	165	165	3 1/2	6
			HBSEVO8180	196	245	196	196	196	245	196	196	264	3 1/8	6
	140	5 1/2	HBSEVO8220	196	245	196	196	196	245	196	196	264	3 1/8	6
	175	6 7/8	HBSEVO8260	196	245	196	196	196	245	196	196	264	3 1/8	6
	200	7 7/8	HBSEVO8280	196	245	196	196	196	245	196	196	264	3 1/8	6
7 PLY	140	5 1/2	HBSEVO8220	196	245	196	196	196	245	196	196	264	3 1/8	6
	191	7 1/2	HBSEVO8280	196	245	196	196	196	245	196	196	264	3 1/8	6
9 PLY	180	7 1/16	HBSEVO8280	196	245	196	196	196	245	196	196	264	3 1/8	6

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

NOTES and GENERAL PRINCIPLES on page 67.

CLT | SPLINE JOINT

				SHEAR				SPACING	
geometry				spline joint orientation 1		spline joint orientation 2		fastener in a row	
									
panel thickness (wall/floor) = A		spline thickness = t_s	suggested screw	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	minimum	typical
[mm]	[in]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	79	3 1/8	1/2	HBSEVO550	91	91	91	91	2 15/16	3
				HBSEVO660	116	116	116	116	3 1/2	4
			3/4	HBSEVO560	95	95	95	95	2 15/16	3
				HBSEVO660	120	120	120	120	3 1/2	4
			1	HBSEVO570	103	103	103	103	2 15/16	3
				HBSEVO670	128	128	128	128	3 1/2	4
	86	3 3/8	1/2	HBSEVO560	91	91	91	91	2 15/16	3
				HBSEVO660	116	116	116	116	3 1/2	4
			3/4	HBSEVO570	95	95	95	95	2 15/16	3
				HBSEVO670	120	120	120	120	3 1/2	4
			1	HBSEVO680	128	128	128	128	3 1/2	4
				HBSEVO8100	179	143	179	143	3 1/8	4
	105	4 1/8	1/2	HBSEVO570	91	91	91	91	2 15/16	3
				HBSEVO670	116	116	116	116	3 1/2	4
			3/4	HBSEVO680	120	120	120	120	3 1/2	4
				HBSEVO8100	173	139	173	139	3 1/8	4
			1	HBSEVO6100	128	128	128	128	3 1/2	4
				HBSEVO8100	179	143	179	143	3 1/8	4
5 PLY	130	5 1/8	3/4	HBSEVO680	120	120	120	120	3 1/2	4
				HBSEVO8100	173	139	173	139	3 1/8	4
			1	HBSEVO680	128	128	128	128	3 1/2	4
				HBSEVO8100	179	143	179	143	3 1/8	4
	140	5 1/2	3/4	HBSEVO6100	120	120	120	120	3 1/2	4
				HBSEVO8100	173	139	173	139	3 1/8	4
			1	HBSEVO6120	128	128	128	128	3 1/2	4
				HBSEVO8100	179	143	179	143	3 1/8	4
				HBSEVO8120	179	143	179	143	3 1/8	4
	175	6 7/8	3/4	HBSEVO6100	120	120	120	120	3 1/2	4
				HBSEVO8100	173	139	173	139	3 1/8	4
			1	HBSEVO6120	128	128	128	128	3 1/2	4
				HBSEVO8120	179	143	179	143	3 1/8	4
				HBSEVO8140	179	143	179	143	3 1/8	4
7 PLY	191	7 1/2	3/4	HBSEVO6120	120	120	120	120	3 1/2	4
				HBSEVO8120	173	139	173	139	3 1/8	4
			1	HBSEVO6140	128	128	128	128	3 1/2	4
				HBSEVO8140	179	143	179	143	3 1/8	4
				HBSEVO8160	179	143	179	143	3 1/8	4
	220	8 5/8	3/4	HBSEVO6120	120	120	120	120	3 1/2	4
				HBSEVO8120	173	139	173	139	3 1/8	4
			1	HBSEVO6140	128	128	128	128	3 1/2	4
				HBSEVO8140	179	143	179	143	3 1/8	4
				HBSEVO8160	179	143	179	143	3 1/8	4
	244	9 5/8	3/4	HBSEVO6120	120	120	120	120	3 1/2	4
				HBSEVO8120	173	139	173	139	3 1/8	4
			1	HBSEVO6140	128	128	128	128	3 1/2	4
				HBSEVO8140	179	143	179	143	3 1/8	4
				HBSEVO8160	179	143	179	143	3 1/8	4

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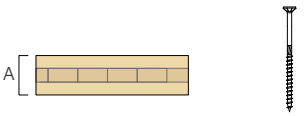
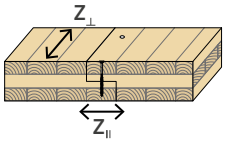
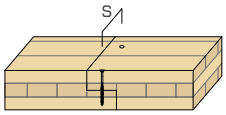
CLT | HALF LAP

				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	60	2 3/8	HBSEVO550	83	83	83	83	2 15/16	4
	79	3 1/8	HBSEVO570	107	107	107	107	2 15/16	4
			HBSEVO670	132	132	132	132	3 1/2	6
	105	4 1/8	HBSEVO680	126	126	126	126	3 1/2	6
			HBSEVO8100	174	218	174	218	3 1/8	6
	120	4 3/4	HBSEVO6100	155	155	155	155	3 1/2	6
			HBSEVO8100	160	200	160	200	3 1/8	6
5 PLY	100	3 15/16	HBSEVO580	106	106	106	106	2 15/16	4
			HBSEVO680	130	130	130	130	3 1/2	6
	140	5 1/2	HBSEVO6120	165	165	165	165	3 1/2	6
			HBSEVO8120	178	222	178	222	3 1/8	6
	175	6 7/8	HBSEVO6160	165	165	165	165	3 1/2	6
			HBSEVO8160	196	245	196	245	3 1/8	6
	200	7 7/8	HBSEVO6180	165	165	165	165	3 1/2	6
			HBSEVO8180	196	245	196	245	3 1/8	6
7 PLY	140	5 1/2	HBSEVO6120	165	165	165	165	3 1/2	6
			HBSEVO8120	178	222	178	222	3 1/8	6
	191	7 1/2	HBSEVO6180	165	165	165	165	3 1/2	6
			HBSEVO8180	196	245	196	245	3 1/8	6
	244	9 5/8	HBSEVO6200	165	165	165	165	3 1/2	6
			HBSEVO8200	196	245	196	245	3 1/8	6
	280	11	HBSEVO6200	165	165	165	165	3 1/2	6
			HBSEVO8220	196	245	196	245	3 1/8	6
9 PLY	180	7 1/16	HBSEVO6160	165	165	165	165	3 1/2	6
			HBSEVO8160	196	245	196	245	3 1/8	6
	267	10 1/2	HBSEVO6200	165	165	165	165	3 1/2	6
			HBSEVO8220	196	245	196	245	3 1/8	6
	314	12 3/8	HBSEVO8240	196	245	196	245	3 1/8	6
	360	14 3/16	HBSEVO8280	196	245	196	245	3 1/8	6

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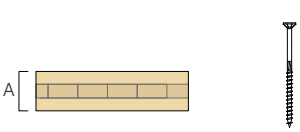
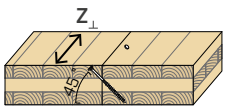
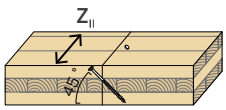
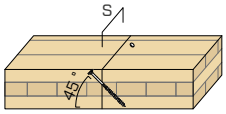
CLT | BUTT JOINT

geometry				SHEAR		SPACING	
				butt joint orientation 1	butt joint orientation 2	fastener in a row	
							
	panel thickness (wall/floor) = A		suggested screw	$Z_{\perp}$	$Z_{\parallel}$	minimum	typical
	[mm]	[in]	CODE	[lbf]	[lbf]	[in]	[in]
3 PLY	60	2 3/8	HBSEVO570	75	75	2 15/16	4
			HBSEVO670	86	86	3 1/2	6
	79	3 1/8	HBSEVO590	86	86	2 15/16	4
			HBSEVO6100	110	110	3 1/2	6
			HBSEVO8100	116	145	3 1/8	6
	105	4 1/8	HBSEVO6120	110	110	3 1/2	6
			HBSEVO8120	131	164	3 1/8	6
	120	4 3/4	HBSEVO6140	110	110	3 1/2	6
			HBSEVO8140	131	164	3 1/8	6
5 PLY	100	3 15/16	HBSEVO6120	110	110	3 1/2	6
			HBSEVO8120	131	164	3 1/8	6
	140	5 1/2	HBSEVO6180	110	110	3 1/2	6
			HBSEVO8180	131	164	3 1/8	6
	175	6 7/8	HBSEVO6200	110	110	3 1/2	6
			HBSEVO8220	131	164	3 1/8	6
	200	7 7/8	HBSEVO8240	131	164	3 1/8	6
7 PLY	140	5 1/2	HBSEVO6180	110	110	3 1/2	6
			HBSEVO8180	131	164	3 1/8	6
	191	7 1/2	HBSEVO8240	131	164	3 1/8	6
	244	9 5/8	HBSEVO8280	131	164	3 1/8	6
	280	11	HBSEVO8300	131	164	3 1/8	6
9 PLY	180	7 1/16	HBSEVO8240	131	164	3 1/8	6
	267	10 1/2	HBSEVO8300	131	164	3 1/8	6
	314	12 3/8	HBSEVO8320	131	164	3 1/8	6

NOTES and GENERAL PRINCIPLES on page 67.

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.
- HBS 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.

STEEL-TO-WOOD

- The steel side member must have a minimum tensile strength equal to 58 ksi (400 MPa) and comply with the minimum requirements of ASTM A36.
- The wood main member thickness must be greater than the screw length minus the thickness of the steel side member.
- In case of steel-to-wood connection with a thick plate, it is necessary to assess the effects of wood deformations and install the connectors according to the assembly instructions.

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 61 are valid for L_{eff} equal to the screw thread length b minus the tip length L_t and k_α = 1 for α=90°, k_α = 0.91 for α= 45°, k_α = 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.
- $Z_{||}$: 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.

BUTT JOINT

- The screw is considered inserted with an angle of 45° between the screw's axis and CLT plane face.
- 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.
- The axis of the connector on the shear plane is considered to run through the central layer of the panel.