TBS FRAME

FLAT FLANGE HEAD SCREW

ELC-4645 ESR-4645 ETA-11/0030

FLAT FLANGE HEAD
The flange head ensures excellent tightening capacity of the joint; the flat shape allows a joint without additional thickness on the wooden surface, thus enabling the fixing of plates on the same element without interference.

SHORT THREAD
The short, fixed-length thread at 1 5/16" (34 mm) is optimised for fastening multi-layer elements (Multi-ply) for lightweight frame construction.

BLACK E-COATING
Coated with black E-coating for easy recognition on site and increased corrosion resistance.

3 THORNS TIP
TBSF is easily installed without pre-drilling hole. More screws can be used in less space and larger screws in smaller elements.

BIT INCLUDED

DIAMETER [in]	0.24 — **0.32** — 0.63
LENGTH [in]	1 9/16 — **2 7/8** — **6 7/8** — 39 3/8
EXPOSURE CONDITION	EC1 DRY
ATMOSPHERIC CORROSIVITY	C1 C2
WOOD CORROSIVITY	T1 T2
MATERIAL	Zn E-COATING electrogalvanised carbon steel with black E-Coating

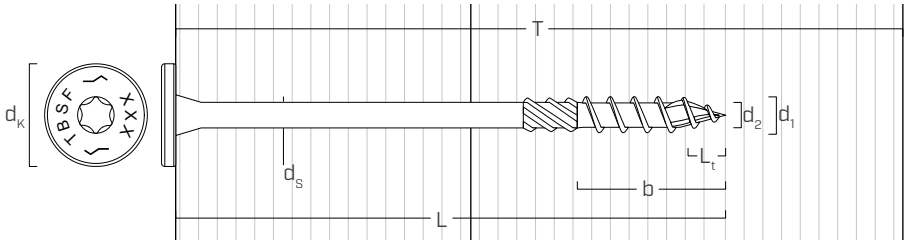
FIELDS OF USE

- timber based panels
- solid timber and glulam
- CLT and LVL
- high density woods
- multi-ply trusses

CODES AND DIMENSIONS

d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	T [in]	pcs
8 **0.32** TX 40	**TBSF873**	73	2 7/8	34	1 5/16	3	100
	TBSF886	86	3 3/8	34	1 5/16	3 1/2	100
	TBSF898	98	3 7/8	34	1 5/16	4	50
	TBSF8111	111	4 3/8	34	1 5/16	4 1/2	50
	TBSF8130	130	5 1/8	34	1 5/16	5 1/4	50
	TBSF8149	149	5 7/8	34	1 5/16	6	50
	TBSF8175	175	6 7/8	34	1 5/16	7	50

GEOMETRY AND MECHANICAL CHARACTERISTICS



Nominal diameter	**d_1**	**[in]**(1)	**0.32**
Outer thread diameter	**d_1**	[mm] **[in]**	8 **0.315**
Head diameter	d_K	[in]	0.748
Root diameter	d_2	[in]	0.213
Shank diameter	d_S	[in]	0.228
Tip Length	L_t	[in]	0.315
Pre-drilling hole diameter(2)	$d_{V,G\leq0.55}$	[in]	13/64
Pre-drilling hole diameter(3)	$d_{V,G>0.55}$	[in]	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).

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

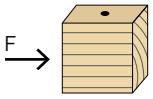
Nominal diameter	**d_1**	[in]		0.32
Withdrawal (design value)	W_{90}	[lbf/in]	G = 0.35	172
			G = 0.42	199
			G = 0.49	225
			G = 0.55	247
minimum embedded length		[in]		1 7/8
Head pull-through (design value)	W_H	[lbf]	G = 0.35	223
			G = 0.42	322
			G = 0.49	438
			G = 0.55	552
minimum side member thickness		[in]		1 1/2

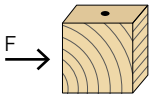
MULTI-PLY TRUSSES

It is available in optimised lengths for fastening 2-, 3- and 4-ply truss elements of the most common solid timber and LVL dimensions.

MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

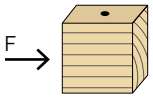
screws inserted **WITHOUT pre-drilled hole** — **G ≤ 0.48**

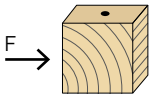




d_1	[in]		0.32		0.32
	[mm]		8		8
a_1	[in]	**15·d**	3 1/8	**10·d**	1 9/16
a_2	[in]	**5·d**	1 9/16	**5·d**	1 9/16
$a_{3,t}$	[in]	**15·d**	4 3/4	**15·d**	4 3/4
$a_{3,c}$	[in]	**10·d**	3 1/8	**10·d**	3 1/8
$a_{4,t}$	[in]	**10·d**	3 1/8	**10·d**	3 1/8
$a_{4,c}$	[in]	**5·d**	1 9/16	**5·d**	1 9/16

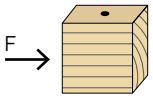
screws inserted **WITHOUT pre-drilled hole** — **0.48 < G ≤ 0.50**

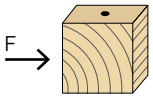




d_1	[in]		0.32		0.32
	[mm]		8		8
a_1	[in]	**15·d**	4 3/4	**10·d**	2 3/16
a_2	[in]	**5·d**	1 9/16	**5·d**	1 9/16
$a_{3,t}$	[in]	**15·d**	4 3/4	**15·d**	4 3/4
$a_{3,c}$	[in]	**10·d**	3 1/8	**10·d**	3 1/8
$a_{4,t}$	[in]	**10·d**	3 1/8	**10·d**	3 1/8
$a_{4,c}$	[in]	**5·d**	1 9/16	**5·d**	1 9/16

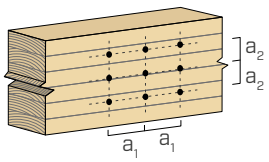
screws inserted **WITHOUT pre-drilled hole** — **G > 0.50**



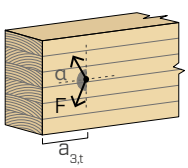


d_1	[in]		0.32		0.32
	[mm]		8		8
a_1	[in]	**15·d**	4 3/4	**10·d**	3 1/8
a_2	[in]	**7·d**	2 3/16	**7·d**	2 3/16
$a_{3,t}$	[in]	**20·d**	6 1/4	**20·d**	6 1/4
$a_{3,c}$	[in]	**15·d**	4 3/4	**15·d**	4 3/4
$a_{4,t}$	[in]	**12·d**	3 3/4	**12·d**	3 3/4
$a_{4,c}$	[in]	**7·d**	2 3/16	**7·d**	2 3/16

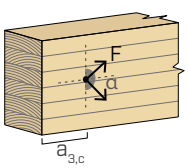
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



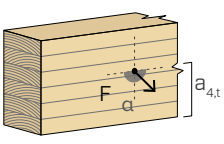
stressed end
-90° < α < 90°



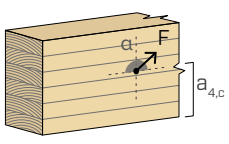
unloaded end
90° < α < 270°



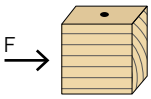
stressed edge
0° < α < 180°

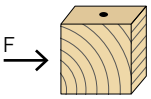


unload edge
180° < α < 360°



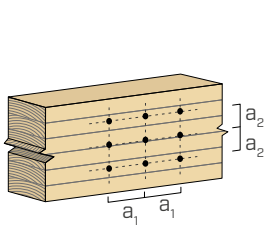
screws inserted **WITH pre-drilled hole**



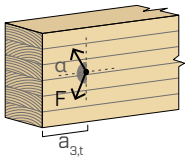


d_1	[in]		0.32		0.32
	[mm]		8		8
a_1	[in]	**10·d**	3 1/8	**5·d**	1 9/16
a_2	[in]	**4·d**	1 1/4	**4·d**	1 1/4
$a_{3,t}$	[in]	**12·d**	3 3/4	**12·d**	3 3/4
$a_{3,c}$	[in]	**7·d**	2 3/16	**7·d**	2 3/16
$a_{4,t}$	[in]	**7·d**	2 3/16	**7·d**	2 3/16
$a_{4,c}$	[in]	**3·d**	15/16	**3·d**	15/16

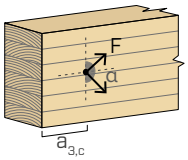
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



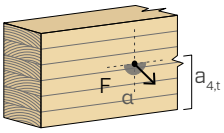
stressed end
-90° < α < 90°



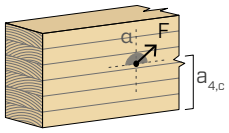
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°



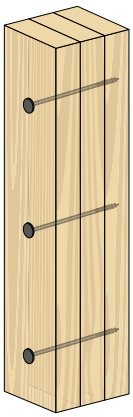
unload edge
180° < α < 360°

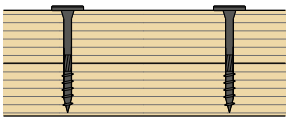


NOTES

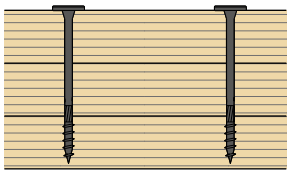
- Values in blue are from Table 10 of ESR-4645 (REDUCED CONNECTION GEOMETRY REQUIREMENTS BASED ON TESTING);
- The minimum spacing and distances comply with Table 8 of ESR-4645, where d refers to the nominal diameter of the screw;
- Wood member stresses must be checked in accordance with the corresponding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

APPLICATION EXAMPLES: MULTI-PLY FASTENINGS

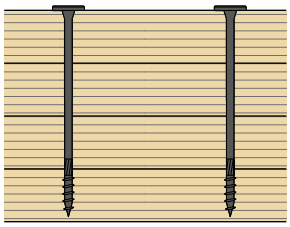




screw: TBSF873
timber element:
2 x 1 1/2" (38 mm)
total thickness:
3" (76 mm)



screw: TBSF8111
timber element:
3 x 1 1/2" (38 mm)
total thickness:
4 1/2" (114 mm)



screw: TBSF8149
timber element:
4 x 1 1/2" (38 mm)
total thickness:
6" (152 mm)

NOTES and **GENERAL PRINCIPLES** on page 121.

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

geometry						$Z_{\parallel}$				$Z_{\perp/\parallel}$				$Z_{\perp}$			
d_1	L		b	T	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]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
8 **0.32**	73	2 7/8	1 5/16	3	1 1/2	110	154	205	253	88	123	164	203	19	27	36	45
	86	3 3/8	1 5/16	3 1/2	1 3/4	131	183	243	288	104	146	194	231	58	82	109	134
	98	3 7/8	1 5/16	4	2	151	211	267	313	121	169	213	251	70	98	130	160
	111	4 3/8	1 5/16	4 1/2	2 1/4	170	233	282	313	136	186	225	251	72	101	134	166
	130	5 1/8	1 5/16	5 1/4	2 5/8	200	245	282	313	160	196	225	251	80	111	148	183
	149	5 7/8	1 5/16	6	3	207	245	282	313	165	196	225	251	92	129	171	211
	175	6 7/8	1 5/16	7	3 1/2	207	245	282	313	165	196	225	251	111	155	188	220

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]
8 **0.32**	73	2 7/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76
	86	3 3/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76
	98	3 7/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76
	111	4 3/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76
	130	5 1/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76
	149	5 7/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76
	175	6 7/8[1]	1 5/16	176	204	230	253	160	185	210	230	53	61	69	76

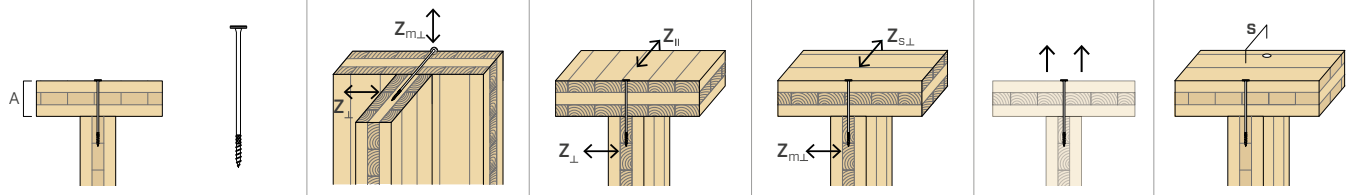
[1] The embedded thread length does not comply with the minimum requirement of ESR-4645 (6 times the outer thread diameter for screws installed at 90° to the grain and 8 times the outer thread diameter for screws installed at an angle 0°≤ α <90° to the grain).

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]
8	0.32	0.75	223	322	438	552

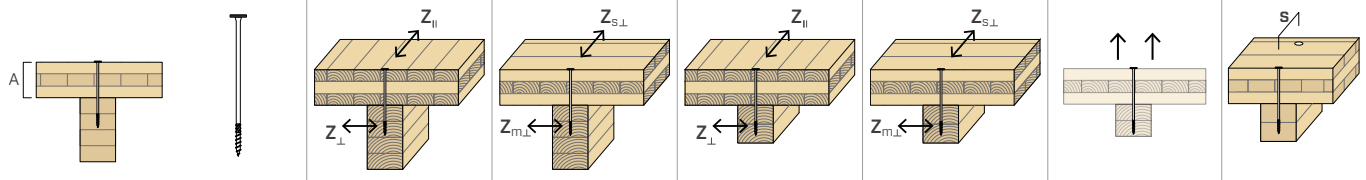
NOTES and GENERAL PRINCIPLES on page 121.

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	$Z_{\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{m\perp}$	$Z_{s\perp}$	W(*)	minimum	typical
[mm]		[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	60	2 3/8	TBSF898	104	104	104	130	104	104	322	3 1/8	6
3 PLY	79	3 1/8	TBSF8130	119	119	119	149	119	119	322	3 1/8	6
3 PLY	105	4 1/8	TBSF8149	111	111	111	139	111	111	322	3 1/8	6
3 PLY	120	4 3/4	TBSF8175	125	125	125	156	125	125	322	3 1/8	6
5 PLY	100	3 15/16	TBSF8149	117	117	117	146	117	117	322	3 1/8	6
5 PLY	140	5 1/2	TBSF8175	100	100	100	126	100	100	322	3 1/8	6
7 PLY	140	5 1/2	TBSF8175	100	100	100	125	100	100	322	3 1/8	6

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

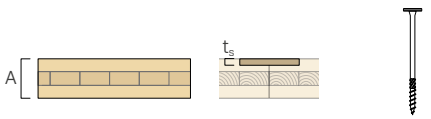
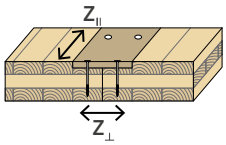
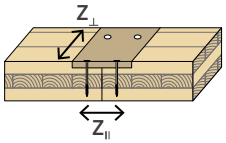
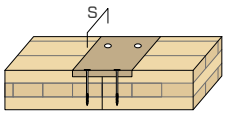
CLT | FLOOR-TO-BEAM

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]
3 PLY	60	2 3/8	TBSF898	155	194	104	155	155	194	104	155	322	3 1/8	6
3 PLY	79	3 1/8	TBSF8130	178	222	119	178	178	222	119	178	322	3 1/8	6
3 PLY	105	4 1/8	TBSF8149	165	207	111	165	165	207	111	165	322	3 1/8	6
3 PLY	120	4 3/4	TBSF8175	186	232	125	186	186	232	125	186	322	3 1/8	6
5 PLY	100	3 15/16	TBSF8149	175	218	117	175	175	218	117	175	322	3 1/8	6
5 PLY	140	5 1/2	TBSF8175	150	187	100	150	150	187	100	150	322	3 1/8	6
7 PLY	140	5 1/2	TBSF8175	149	187	100	149	149	187	100	149	322	3 1/8	6

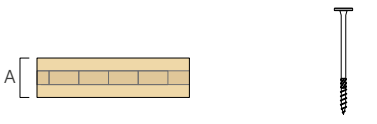
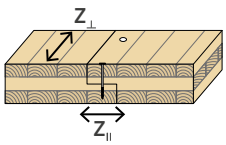
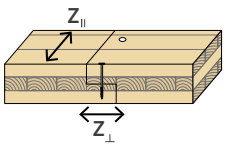
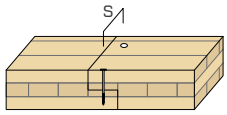
(*) Minumum between head pull-through and withdrawal resistance

NOTES and GENERAL PRINCIPLES on page 121.

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	$Z_{\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp}$	minimum	typical
[mm]	[in]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	79	3 1/8	1/2	TBSF873	136	108	136	108	3 1/8	4
			3/4	TBSF873	173	139	173	139	3 1/8	4
			1	TBSF886	179	143	179	143	3 1/8	4
	86	3 3/8	1/2	TBSF873	136	108	136	108	3 1/8	4
			3/4	TBSF886	173	139	173	139	3 1/8	4
			1	TBSF8111	179	143	179	143	3 1/8	4
	105	4 1/8	1/2	TBSF886	136	108	136	108	3 1/8	4
			3/4	TBSF898	173	139	173	139	3 1/8	4
			1	TBSF8111	179	143	179	143	3 1/8	4
5 PLY	130	5 1/8	3/4	TBSF886	173	139	173	139	3 1/8	4
			1	TBSF898	179	143	179	143	3 1/8	4
	140	5 1/2	3/4	TBSF8111	173	139	173	139	3 1/8	4
			1	TBSF8130	179	143	179	143	3 1/8	4
	175	6 7/8	3/4	TBSF8130	173	139	173	139	3 1/8	4
			1	TBSF8149	179	143	179	143	3 1/8	4
7 PLY	191	7 1/2	3/4	TBSF898	173	139	173	139	3 1/8	4
			1	TBSF8111	179	143	179	143	3 1/8	4
	220	8 5/8	3/4	TBSF8111	173	139	173	139	3 1/8	4
			1	TBSF8149	179	143	179	143	3 1/8	4
	244	9 5/8	3/4	TBSF8149	173	139	173	139	3 1/8	4
			1	TBSF8175	192	154	192	154	3 1/8	4

CLT | HALF LAP

geometry			SHEAR				SPACING	
			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	TBSF873	125	156	125	156	3 1/8	6
	105	4 1/8	TBSF886	148	185	148	185	3 1/8	6
	120	4 3/4	TBSF898	155	194	155	194	3 1/8	6
5 PLY	100	3 15/16	TBSF886	151	189	151	189	3 1/8	6
	140	5 1/2	TBSF8130	196	245	196	245	3 1/8	6
	175	6 7/8	TBSF8149	196	245	196	245	3 1/8	6
	200	7 7/8	TBSF8175	196	245	196	245	3 1/8	6
7 PLY	140	5 1/2	TBSF8130	196	245	196	245	3 1/8	6
	191	7 1/2	TBSF8175	196	245	196	245	3 1/8	6
9 PLY	180	7 1/16	TBSF8175	196	245	196	245	3 1/8	6

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, 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 FRAME 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 118 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.
- $Z_{||}$: 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.