TBS

FLANGE HEAD SCREW

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

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.

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.

NEW-GENERATION WOODS

Tested and certified for use on a wide variety of engineered timbers such as CLT, GL, LVL, OSB and beech LVL.
Extremely versatile, the TBS screw guarantees the use of new-generation woods for the creation of increasingly innovative and sustainable structures.

FAST

With the 3 THORNS tip, screw grip becomes more reliable and faster, while maintaining the usual mechanical performance.
More speed, less effort.

MY PROJECT SOFTWARE

BIT INCLUDED

DIAMETER [in]	0.24	**0.24**	**0.48**	0.63
LENGTH [in]	1 9/16	**1 9/16**	**39 3/8**	39 3/8
EXPOSURE CONDITION	**EC1**	**DRY**		
ATMOSPHERIC CORROSIVITY	**C1**	**C2**		
WOOD CORROSIVITY	**T1**	**T2**		
MATERIAL	**Zn** ELECTRO PLATED	electrogalvanized carbon steel		

FIELDS OF USE

- timber based panels
- fibreboard and MDF panels
- solid timber and glulam
- CLT and LVL
- high density woods

SECONDARY BEAMS

Ideal for fastening joists to sill beams to achieve high wind uplift resistance. The flange head guarantees excellent tensile strength which means the use of additional lateral fastening systems can be avoided.

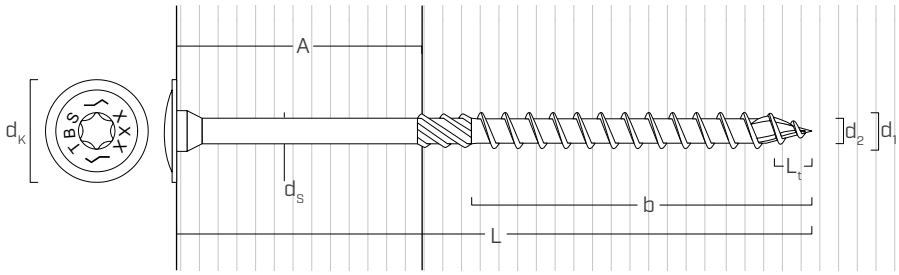
I-JOIST

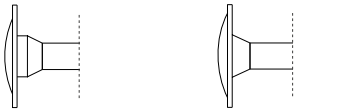
Values also tested and certified for CLT and high density woods such as LVL and other laminated veneer products.

Fastening SIP panels with 0.32 inch (8 mm) diameter TBS screws.

Fastening CLT walls with TBS screws.

GEOMETRY AND MECHANICAL CHARACTERISTICS





Ø0.24 in - Ø0.32 in

Ø0.40 in - Ø0.48 in

GEOMETRY

Nominal diameter	**d_1**	**[in](1)**	**0.24**	**0.32**	**0.40**	**0.48**
Outer thread diameter	**d_1**	[mm]	6	8	10	12
		[in]	**0.236**	**0.315**	**0.394**	**0.472**
Head diameter	d_K	[in]	0.610	0.748	0.984	1.142
Root diameter	d_2	[in]	0.156	0.213	0.252	0.268
Shank diameter	d_S	[in]	0.169	0.228	0.276	0.315
Tip Length	L_t	[in]	0.236	0.315	0.394	0.472
Pre-drilling hole diameter(2)	$d_{V,G\leq0.55}$	[in]	5/32	13/64	15/64	9/32
Pre-drilling hole diameter(3)	$d_{V,G>0.55}$	[in]	5/32	15/64	9/32	5/16

(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	0.48
Tensile strength (allowable)	f_{tens}	[lbf]	1180	2040	2700	3060
Bending yield strength (specified)	$F_{y,b}$	[psi]	200000	180000	185000	190000

Nominal diameter	**d_1**	[in]		0.24	0.32	0.40	0.48
Withdrawal (design value)	W_{90}	[lbf/in]	G = 0.35	131	172	206	220
			G = 0.42	151	199	239	255
			G = 0.49	171	225	270	288
			G = 0.55	188	247	296	316
minimum embedded length		[in]		1 7/16	1 7/8	2 3/8	2 13/16
Head pull-through (design value)	W_H	[lbf]	G = 0.35	182	223	314	314
			G = 0.42	263	322	452	452
			G = 0.49	357	438	615	615
			G = 0.55	450	552	774	774
minimum side member thickness		[in]		1 1/2	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	**TBS660**	60	2 3/8	40	1 9/16	3/4	100
	TBS670	70	2 3/4	40	1 9/16	1	100
	TBS680	80	3 1/8	50	1 15/16	1	100
	TBS690	90	3 1/2	50	1 15/16	1 1/2	100
	TBS6100	100	4	60	2 3/8	1 1/2	100
	TBS6120	120	4 3/4	75	2 15/16	1 3/4	100
	TBS6140	140	5 1/2	75	2 15/16	2 1/2	100
	TBS6160	160	6 1/4	75	2 15/16	3 1/4	100
	TBS6180	180	7 1/8	75	2 15/16	4	100
	TBS6200	200	8	75	2 15/16	4 3/4	100
	TBS6220	220	8 5/8	100	4	4 1/2	100
	TBS6240	240	9 1/2	100	4	5 1/2	100
	TBS6260	260	10 1/4	100	4	6 1/4	100
	TBS6280	280	11	100	4	7	100
	TBS6300	300	11 3/4	100	4	7 3/4	100
	TBS6320	320	12 5/8	100	4	8 1/2	100
	TBS6360	360	14 1/4	100	4	10	100
	TBS6400	400	15 3/4	100	4	11 3/4	100
8 **0.32** TX 40	**TBS840**	40	1 9/16	32	1 1/4	1/4	100
	TBS860	60	2 3/8	52	2 1/16	1/4	100
	TBS880	80	3 1/8	52	2 1/16	1	50
	TBS8100	100	4	52	2 1/16	1 3/4	50
	TBS8120	120	4 3/4	80	3 1/8	1 1/2	50
	TBS8140	140	5 1/2	80	3 1/8	2 1/4	50
	TBS8160	160	6 1/4	100	4	2 1/4	50
	TBS8180	180	7 1/8	100	4	3	50
	TBS8200	200	8	100	4	3 3/4	50
	TBS8220	220	8 5/8	100	4	4 1/2	50
	TBS8240	240	9 1/2	100	4	5 1/2	50
	TBS8260	260	10 1/4	100	4	6 1/4	50
	TBS8280	280	11	100	4	7	50
	TBS8300	300	11 3/4	100	4	7 3/4	50
	TBS8320	320	12 5/8	100	4	8 1/2	50
	TBS8340	340	13 3/8	100	4	9 1/4	50
	TBS8360	360	14 1/4	100	4	11 1/2	50
	TBS8380	380	15	100	4	11	50
	TBS8400	400	15 3/4	100	4	11 3/4	50
	TBS8440	440	17 1/4	100	4	13 1/4	50
	TBS8480	480	19	100	4	14 3/4	50
	TBS8520	520	20 1/2	100	4	16 1/2	50
	TBS8560	560	22	100	4	18	50
	TBS8580	580	22 13/16	100	4	18 3/4	50
	TBS8600	600	23 5/8	100	4	19 1/2	50

d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
10 **0.40** TX 50	**TBS10100**	100	4	52	2 1/16	1/2	50
	TBS10120	120	4 3/4	60	2 3/8	1	50
	TBS10140	140	5 1/2	60	2 3/8	2 1/8	50
	TBS10160	160	6 1/4	80	3 1/8	2 3/4	50
	TBS10180	180	7 1/8	80	3 1/8	3 3/4	50
	TBS10200	200	8	100	4	3 3/4	50
	TBS10220	220	8 5/8	100	4	4 1/2	50
	TBS10240	240	9 1/2	100	4	5 1/2	50
	TBS10260	260	10 1/4	100	4	6 1/4	50
	TBS10280	280	11	100	4	7	50
	TBS10300	300	11 3/4	100	4	7 3/4	50
	TBS10320	320	12 5/8	120	4 3/4	7 3/4	50
	TBS10340	340	13 3/8	120	4 3/4	8 1/2	50
	TBS10360	360	14 1/4	120	4 3/4	9 1/4	50
	TBS10380	380	15	120	4 3/4	10	50
	TBS10400	400	15 3/4	120	4 3/4	11	50
	TBS10440	440	17 1/4	120	4 3/4	11 1/2	50
	TBS10480	480	19	120	4 3/4	14	50
	TBS10520	520	20 1/2	120	4 3/4	15 1/2	50
	TBS10560	560	22	120	4 3/4	17 1/4	50
	TBS10600	600	23 5/8	120	4 3/4	18 3/4	50
12 **0.48** TX 50	**TBS12200**	200	8	120	4 3/4	3	25
	TBS12240	240	9 1/2	120	4 3/4	4 1/2	25
	TBS12280	280	11	120	4 3/4	6 1/4	25
	TBS12320	320	12 5/8	120	4 3/4	7 3/4	25
	TBS12360	360	14 1/4	120	4 3/4	9 1/4	25
	TBS12400	400	15 3/4	140	5 1/2	10	25
	TBS12440	440	17 1/4	140	5 1/2	11 3/4	25
	TBS12480	480	19	140	5 1/2	13 1/4	25
	TBS12520	520	20 1/2	140	5 1/2	14 3/4	25
	TBS12560	560	22	140	5 1/2	16 1/2	25
	TBS12600	600	23 5/8	140	5 1/2	18	25
	TBS12800	800	31 1/2	160	6 1/4	17	25
	TBS121000	1000	39 3/8	160	6 1/4	18 1/2	25

RELATED PRODUCTS

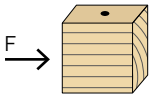
TBS MAX
page 104

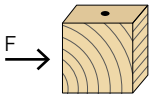
XYLOFON WASHER
page 84

TORQUE LIMITER
page 436

MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

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

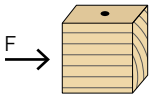


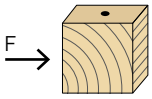


d_1	[in]		0.24	0.32	0.40	0.48
	[mm]		6	8	10	12
a_1	[in]	**15·d**	3 1/2	**3 1/8**	**4**	**4 3/4**
a_2	[in]	**5·d**	1 3/16	1 9/16	1 15/16	2 3/8
$a_{3,t}$	[in]	**15·d**	3 1/2	4 3/4	6	7 1/8
$a_{3,c}$	[in]	**10·d**	2 3/8	3 1/8	4	4 3/4
$a_{4,t}$	[in]	**10·d**	2 3/8	3 1/8	4	4 3/4
$a_{4,c}$	[in]	**5·d**	1 3/16	1 9/16	1 15/16	2 3/8

	0.24	0.32	0.40	0.48
	6	8	10	12
10·d	2 3/8	**1 9/16**	**1 15/16**	**2 3/8**
5·d	1 3/16	1 9/16	1 15/16	2 3/8
15·d	3 1/2	4 3/4	6	7 1/8
10·d	2 3/8	3 1/8	4	4 3/4
10·d	2 3/8	3 1/8	4	4 3/4
5·d	1 3/16	1 9/16	1 15/16	2 3/8

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

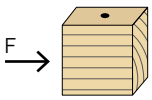


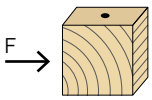


d_1	[in]		0.24	0.32	0.40	0.48
	[mm]		6	8	10	12
a_1	[in]	**15·d**	3 1/2	4 3/4	6	7 1/8
a_2	[in]	**5·d**	1 3/16	1 9/16	1 15/16	2 3/8
$a_{3,t}$	[in]	**15·d**	3 1/2	4 3/4	6	7 1/8
$a_{3,c}$	[in]	**10·d**	2 3/8	3 1/8	4	4 3/4
$a_{4,t}$	[in]	**10·d**	2 3/8	3 1/8	4	4 3/4
$a_{4,c}$	[in]	**5·d**	1 3/16	1 9/16	1 15/16	2 3/8

	0.24	0.32	0.40	0.48
	6	8	10	12
10·d	2 3/8	**2 3/16**	**2 3/4**	**3 5/16**
5·d	1 3/16	1 9/16	1 15/16	2 3/8
15·d	3 1/2	4 3/4	6	7 1/8
10·d	2 3/8	3 1/8	4	4 3/4
10·d	2 3/8	3 1/8	4	4 3/4
5·d	1 3/16	1 9/16	1 15/16	2 3/8

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

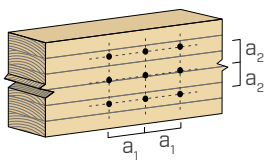




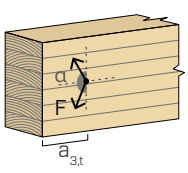
d_1	[in]		0.24	0.32	0.40	0.48
	[mm]		6	8	10	12
a_1	[in]	**15·d**	3 1/2	4 3/4	6	7 1/8
a_2	[in]	**7·d**	1 5/8	2 3/16	2 3/4	3 5/16
$a_{3,t}$	[in]	**20·d**	4 3/4	6 1/4	8	9 1/2
$a_{3,c}$	[in]	**15·d**	3 1/2	4 3/4	6	7 1/8
$a_{4,t}$	[in]	**12·d**	2 13/16	3 3/4	4 3/4	5 11/16
$a_{4,c}$	[in]	**7·d**	1 5/8	2 3/16	2 3/4	3 5/16

	0.24	0.32	0.40	0.48
	6	8	10	12
10·d	2 3/8	3 1/8	4	4 3/4
7·d	1 5/8	2 3/16	2 3/4	3 5/16
20·d	4 3/4	6 1/4	8	9 1/2
15·d	3 1/2	4 3/4	6	7 1/8
12·d	2 13/16	3 3/4	4 3/4	5 11/16
7·d	1 5/8	2 3/16	2 3/4	3 5/16

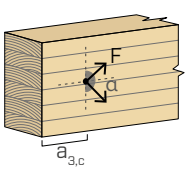
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



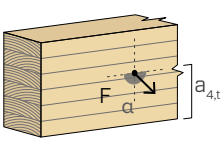
stressed end
-90° < α < 90°



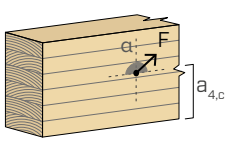
unloaded end
90° < α < 270°



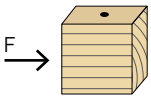
stressed edge
0° < α < 180°

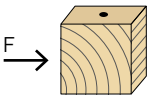


unload edge
180° < α < 360°



screws inserted **WITH pre-drilled hole**





d_1	[in]		0.24	0.32		0.40	0.48		0.24	0.32		0.40	0.48
	[mm]		6	8		10	12		6	8		10	12
a_1	[in]	**10·d**	2 3/8	3 1/8	**5·d**	1 15/16	2 3/8	**5·d**	1 3/16	1 9/16	**5·d**	1 15/16	2 3/8
a_2	[in]	**4·d**	15/16	1 1/4	**5·d**	1 15/16	2 3/8	**4·d**	15/16	1 1/4	**5·d**	1 15/16	2 3/8
$a_{3,t}$	[in]	**12·d**	2 13/16	3 3/4	**7·d**	2 3/4	3 5/16	**12·d**	2 13/16	3 3/4	**7·d**	2 3/4	3 5/16
$a_{3,c}$	[in]	**7·d**	1 5/8	2 3/16	**4·d**	1 9/16	1 7/8	**7·d**	1 5/8	2 3/16	**4·d**	1 9/16	1 7/8
$a_{4,t}$	[in]	**7·d**	1 5/8	2 3/16	**4·d**	1 9/16	1 7/8	**7·d**	1 5/8	2 3/16	**4·d**	1 9/16	1 7/8
$a_{4,c}$	[in]	**3·d**	11/16	15/16	**3·d**	1 3/16	1 7/16	**3·d**	11/16	15/16	**3·d**	1 3/16	1 7/16

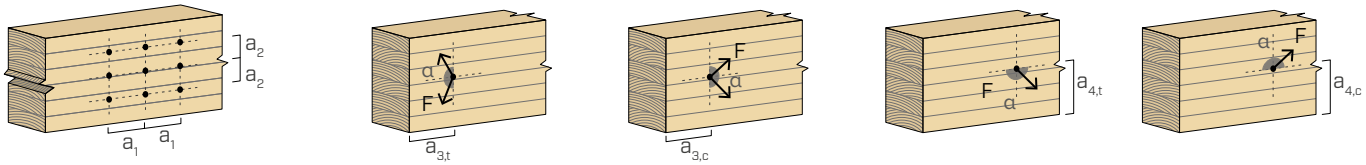
α = load-to-grain angle
d = d_1 = nominal diameter of the screw

stressed end
-90° < α < 90°

unloaded end
90° < α < 270°

stressed edge
0° < α < 180°

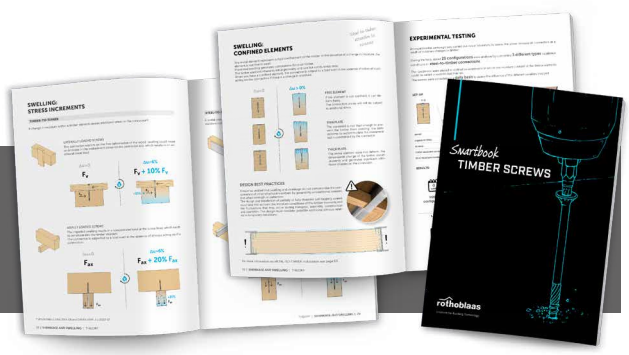
unload edge
180° < α < 360°



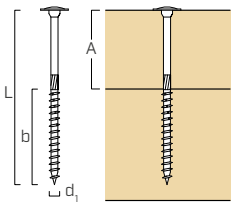
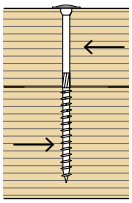
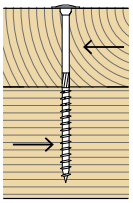
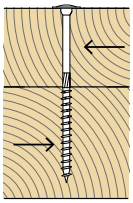
NOTES

- 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.

Theory, practice and experimental campaigns:
our experience is in your hands.
Download the SMARTBOOK TIMBER SCREWS.

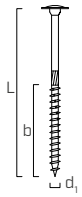
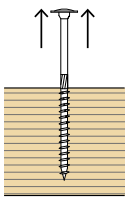
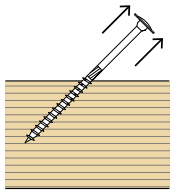
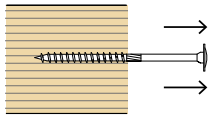


REFERENCE LATERAL DESIGN VALUES (Z) | WOOD-TO-WOOD

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
	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 15/16	1	104	129	156	182	104	129	156	182	104	129	156	182
	90	3 1/2	1 15/16	1 1/2	120	154	190	211	120	154	190	211	120	154	190	211
	100	4	2 3/8	1 1/2	120	154	190	211	120	154	190	211	120	154	190	211
	120-200	4 3/4-8	2 15/16	≥ 1 3/4	129	165	190	211	129	165	190	211	129	165	190	211
	220-400	8 5/8-15 3/4	4	≥ 4 1/2	139	165	190	211	139	165	190	211	139	165	190	211
8 **0.32**	40	1 9/16	1 1/4	1/4	49	68	90	112	39	54	72	89	39	54	72	89
	60-100	2 /8-4	2 1/16	≥ 1/4	49	68	90	112	39	54	72	89	39	54	72	89
	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
	160-600	6 1/4-23 5/8	4	≥ 2 1/4	191	245	282	313	153	196	225	251	153	196	225	251
10 **0.40**	100	4	2 1/16	1/2	217	261	304	341	149	184	220	253	118	153	192	226
	120	4 3/4	2 3/8	1	259	311	362	387	173	215	259	295	140	182	228	270
	140	5 1/2	2 3/8	2 1/8	300	338	365	387	195	245	274	295	165	216	259	282
	160	6 1/4	3 1/8	2 3/4	308	338	365	387	220	249	274	295	186	232	259	282
	180	7 1/8	3 1/8	3 3/4	308	338	365	387	222	249	274	295	203	232	259	282
	200-300	8-11 3/4	4	≥ 3 3/4	308	338	365	387	222	249	274	295	203	232	259	282
	320-600	12 5/8-23 5/8	4 3/4	≥ 7 3/4	308	338	365	387	222	249	274	295	203	232	259	282
12 **0.48**	200-360	8-14 1/4	4 3/4	≥ 3	353	387	418	442	235	282	311	334	220	261	292	317
	400-1000	15 3/4-39 3/8	5 1/2	≥ 10	353	387	418	442	251	282	311	334	229	261	292	317

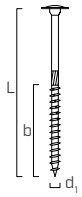
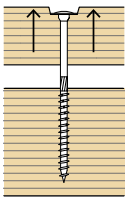
NOTES and **GENERAL PRINCIPLES** on page 100.

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**	60-70	2 3/8-2 3/4(1)	1 9/16	175	202	229	252	160	184	208	229	53	61	69	75
	80-90	3 1/8-3 1/2(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
	220-400	8 5/8-15 3/4	4	485	559	633	696	441	509	576	633	145	168	190	209
8 **0.32**	40	1 9/16(1)	1 1/4	163	188	213	233	148	171	193	212	49	56	64	70
	60-100	2 3/8-4(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
	160-600	6 1/4-23 5/8	4	623	721	815	895	567	656	742	814	187	216	244	268
10 **0.40**	100	4(1)	2 1/16	341	395	446	489	310	360	406	445	102	119	134	147
	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
	200-300	8-11 3/4	4	730	847	957	1049	664	771	871	954	219	254	287	315
	320-600	12 5/8-23 5/8	4 3/4	892	1035	1169	1282	812	942	1064	1167	268	311	351	385
12 **0.48**	200-360	8-14 1/4	4 3/4	935	1084	1225	1344	851	987	1114	1223	281	325	367	403
	400-600	15 3/4-23 5/8	5 1/2	1109	1285	1451	1592	1009	1169	1321	1449	333	386	435	478
	800-1000	31 1/2-39 3/8	6 1/4	1282	1486	1678	1841	1167	1352	1527	1676	385	446	503	552

(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).

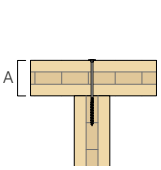
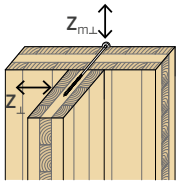
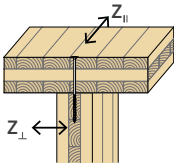
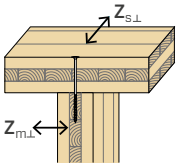
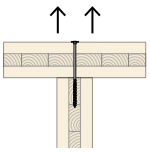
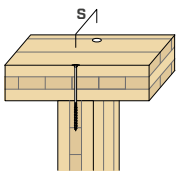
HEAD PULL-THROUGH (W_H) | WOOD

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
12(*)	0.48	1.14	314	452	615	774

(*)Head pull-through values for TBS Ø12 (0.48 in) are not adressed in ESR-4645. The same head pull-through values of TBS Ø10 (0.40 in) can be considered.

NOTES and GENERAL PRINCIPLES on page 100.

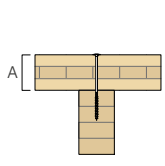
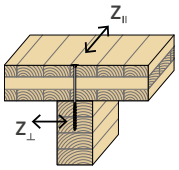
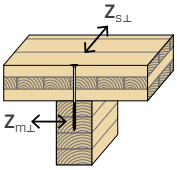
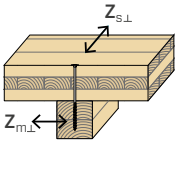
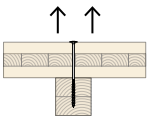
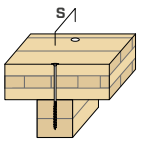
CLT | WALL-TO-WALL | FLOOR-TO-WALL

					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_{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	TBS6140	or longer	110	110	110	110	110	110	263	3 1/2	6
			TBS8140		131	131	131	164	131	131	322	3 1/8	6
			TBS10140		144	164	144	226	164	155	452	4	8
			TBS12200		158	189	158	258	189	168	452	4 3/4	10
	79	3 1/8	TBS6160		110	110	110	110	110	110	263	3 1/2	6
			TBS8180		131	131	131	164	131	131	322	3 1/8	6
			TBS10180		155	167	155	226	167	167	452	4	8
			TBS12200		175	189	175	259	189	189	452	4 3/4	10
	105	4 1/8	TBS6180		110	110	110	110	110	110	263	3 1/2	6
			TBS8220		131	131	131	164	131	131	322	3 1/8	6
			TBS10220		155	167	155	226	167	167	452	4	8
			TBS12240		175	189	175	259	189	189	452	4 3/4	10
	120	4 3/4	TBS6200		110	110	110	110	110	110	263	3 1/2	6
			TBS8220		131	131	131	164	131	131	322	3 1/8	6
			TBS10220		155	167	155	226	167	167	452	4	8
			TBS12240		175	189	175	259	189	189	452	4 3/4	10
5 PLY	100	3 15/16	TBS6180	or longer	110	110	110	110	110	110	263	3 1/2	6
			TBS8200		131	131	131	164	131	131	322	3 1/8	6
			TBS10200		155	167	155	226	167	167	452	4	8
			TBS12240		175	189	175	259	189	189	452	4 3/4	10
	140	5 1/2	TBS6240		110	110	110	110	110	110	263	3 1/2	6
			TBS8240		131	131	131	164	131	131	322	3 1/8	6
			TBS10240		155	167	155	226	167	167	452	4	8
			TBS12280		175	189	175	259	189	189	452	4 3/4	10
	175	6 7/8	TBS6280		110	110	110	110	110	110	263	3 1/2	6
			TBS8280		131	131	131	164	131	131	322	3 1/8	6
			TBS10280		155	167	155	226	167	167	452	4	8
			TBS12320		175	189	175	259	189	189	452	4 3/4	10
	200	7 7/8	TBS6300		110	110	110	110	110	110	263	3 1/2	6
			TBS8300		131	131	131	164	131	131	322	3 1/8	6
			TBS10300		155	167	155	226	167	167	452	4	8
			TBS12320		175	189	175	259	189	189	452	4 3/4	10
7 PLY	140	5 1/2	TBS6240	or longer	110	110	110	110	110	110	263	3 1/2	6
			TBS8240		131	131	131	164	131	131	322	3 1/8	6
			TBS10240		155	167	155	226	167	167	452	4	8
			TBS12280		175	189	175	259	189	189	452	4 3/4	10
	191	7 1/2	TBS6300		110	110	110	110	110	110	263	3 1/2	6
			TBS8300		131	131	131	164	131	131	322	3 1/8	6
			TBS10300		155	167	155	226	167	167	452	4	8
			TBS12320		175	189	175	259	189	189	452	4 3/4	10
	244	9 5/8	TBS6360		110	110	110	110	110	110	263	3 1/2	6
			TBS8360		131	131	131	164	131	131	322	3 1/8	6
			TBS10380		155	167	155	226	167	167	452	4	8
			TBS12400		175	189	175	259	189	189	452	4 3/4	10
	280	11	TBS6400		110	110	110	110	110	110	263	3 1/2	6
			TBS8400		131	131	131	164	131	131	322	3 1/8	6
			TBS10400		155	167	155	226	167	167	452	4	8
			TBS12440		175	189	175	259	189	189	452	4 3/4	10

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

NOTES and GENERAL PRINCIPLES on page 100.

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]
5 PLY													
100	3 15/16	TBS6180	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS8200	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS10180	232	338	167	249	232	338	167	249	452	4	8
		TBS12200	261	387	189	282	261	387	189	282	452	4 3/4	10
140	5 1/2	TBS6240	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS8240	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS10240	232	338	167	249	232	338	167	249	452	4	8
		TBS12240	261	387	189	282	261	387	189	282	452	4 3/4	10
175	6 7/8	TBS6260	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS6280	165	165	110	165	-	-	-	-	263	3 1/2	6
		TBS8260	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS8280	196	245	131	196	-	-	-	-	322	3 1/8	6
		TBS10260	232	338	167	249	232	338	167	249	452	4	8
		TBS10280	232	338	167	249	-	-	-	-	452	4	8
		TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10
200	7 7/8	TBS6300	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS8300	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS10300	232	338	167	249	232	338	167	249	452	4	8
		TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10
7 PLY													
140	5 1/2	TBS6240	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS8240	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS10240	232	338	167	249	232	338	167	249	452	4	8
		TBS12280	261	387	189	282	-	-	-	-	452	4 3/4	10
191	7 1/2	TBS6280	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS6300	165	165	110	165	-	-	-	-	263	3 1/2	6
		TBS8280	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS8300	196	245	131	196	-	-	-	-	322	3 1/8	6
		TBS10280	232	338	167	249	232	338	167	249	452	4	8
		TBS10300	232	338	167	249	-	-	-	-	452	4	8
		TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10
244	9 5/8	TBS6320	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS6360	165	165	110	165	-	-	-	-	263	3 1/2	6
		TBS8360	196	245	131	196	-	-	-	-	322	3 1/8	6
		TBS10380	232	338	167	249	-	-	-	-	452	4	8
		TBS12400	261	387	189	282	-	-	-	-	452	4 3/4	10
280	11	TBS6360	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS6400	165	165	110	165	-	-	-	-	263	3 1/2	6
		TBS8380	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS10400	232	338	167	249	-	-	-	-	452	4	8
		TBS12440	261	387	189	282	-	-	-	-	452	4 3/4	10
9 PLY													
180	7 1/16	TBS6280	165	165	110	165	165	165	110	165	263	3 1/2	6
		TBS8280	196	245	131	196	196	245	131	196	322	3 1/8	6
		TBS10280	232	338	167	249	232	338	167	249	452	4	8
		TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10
267	10 1/2	TBS6400	165	165	110	165	-	-	-	-	263	3 1/2	6
		TBS8380	196	245	131	196	-	-	-	-	322	3 1/8	6
		TBS10400	232	338	167	249	-	-	-	-	452	4	8
		TBS12440	261	387	189	282	-	-	-	-	452	4 3/4	10

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

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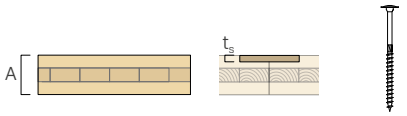
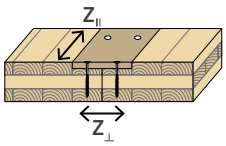
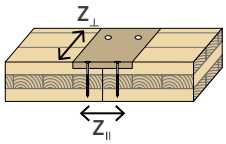
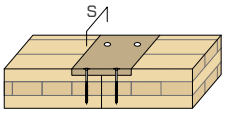
CLT | SPLINE JOINT

				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	TBS660	116	116	116	116	3 1/2	4
				TBS840	86	69	86	69	3 1/8	4
			3/4	TBS660	120	120	120	120	3 1/2	4
				TBS860	135	108	135	108	3 1/8	4
			1	TBS670	128	128	128	128	3 1/2	4
				TBS880	179	143	179	143	3 1/8	4
	86	3 3/8	1/2	TBS660	116	116	116	116	3 1/2	4
				TBS860	136	108	136	108	3 1/8	4
			3/4	TBS670	120	120	120	120	3 1/2	4
				TBS880	173	139	173	139	3 1/8	4
			1	TBS680	128	128	128	128	3 1/2	4
				TBS880	179	143	179	143	3 1/8	4
	105	4 1/8	1/2	TBS670	116	116	116	116	3 1/2	4
				TBS880	136	108	136	108	3 1/8	4
			3/4	TBS680	120	120	120	120	3 1/2	4
				TBS880	173	139	173	139	3 1/8	4
			1	TBS690	128	128	128	128	3 1/2	4
				TBS8100	179	143	179	143	3 1/8	4
5 PLY	130	5 1/8	3/4	TBS680	120	120	120	120	3 1/2	4
				TBS880	173	139	173	139	3 1/8	4
			1	TBS690	128	128	128	128	3 1/2	4
				TBS880	179	143	179	143	3 1/8	4
				TBS10100	211	164	211	164	4	6
	140	5 1/2	3/4	TBS690	120	120	120	120	3 1/2	4
				TBS8100	173	139	173	139	3 1/8	4
			1	TBS6100	128	128	128	128	3 1/2	4
				TBS8100	179	143	179	143	3 1/8	4
				TBS10120	211	164	211	164	4	6
	175	6 7/8	3/4	TBS6100	120	120	120	120	3 1/2	4
				TBS8100	173	139	173	139	3 1/8	4
			1	TBS6120	128	128	128	128	3 1/2	4
				TBS8120	179	143	179	143	3 1/8	4
				TBS10140	211	164	211	164	4	6
7 PLY	191	7 1/2	3/4	TBS690	120	120	120	120	3 1/2	4
				TBS8100	173	139	173	139	3 1/8	4
			1	TBS6100	128	128	128	128	3 1/2	4
				TBS8100	179	143	179	143	3 1/8	4
				TBS10160	211	164	211	164	4	6
	220	8 5/8	3/4	TBS6100	120	120	120	120	3 1/2	4
				TBS8100	173	139	173	139	3 1/8	4
			1	TBS6120	128	128	128	128	3 1/2	4
				TBS8120	179	143	179	143	3 1/8	4
				TBS10160	211	164	211	164	4	6
	244	9 5/8	3/4	TBS6120	120	120	120	120	3 1/2	4
				TBS8120	173	139	173	139	3 1/8	4
			1	TBS6140	128	128	128	128	3 1/2	4
				TBS8140	179	143	179	143	3 1/8	4
				TBS10160	211	164	211	164	4	6

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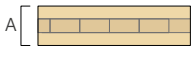
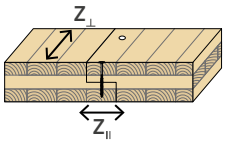
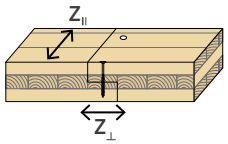
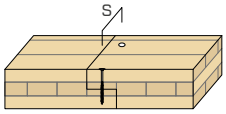
CLT | HALF LAP

				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	**TBS840**	49	61	49	61	3 1/8	6
	79	3 1/8	**TBS860**	114	143	114	143	3 1/8	6
	105	4 1/8	**TBS690**	144	144	144	144	3 1/2	6
			TBS8100	174	218	174	218	3 1/8	6
			TBS10100	153	261	153	261	4	8
	120	4 3/4	**TBS6100**	155	155	155	155	3 1/2	6
			TBS8100	160	200	160	200	3 1/8	6
			TBS10100	160	272	160	272	4	8
5 PLY	100	3 15/16	**TBS680**	130	130	130	130	3 1/2	6
			TBS880	143	179	143	179	3 1/8	6
	140	5 1/2	**TBS6120**	165	165	165	165	3 1/2	6
			TBS8120	178	222	178	222	3 1/8	6
			TBS10120	189	301	189	301	4	8
	175	6 7/8	**TBS6160**	165	165	165	165	3 1/2	6
			TBS8160	196	245	196	245	3 1/8	6
			TBS10160	232	338	232	338	4	8
	200	7 7/8	**TBS6180**	165	165	165	165	3 1/2	6
			TBS8180	196	245	196	245	3 1/8	6
			TBS10180	232	338	232	338	4	8
7 PLY	140	5 1/2	**TBS6120**	165	165	165	165	3 1/2	6
			TBS8120	178	222	178	222	3 1/8	6
			TBS10120	189	301	189	301	4	8
	191	7 1/2	**TBS6180**	165	165	165	165	3 1/2	6
			TBS8180	196	245	196	245	3 1/8	6
			TBS10180	232	338	232	338	4	8
	244	9 5/8	**TBS6220**	165	165	165	165	3 1/2	6
			TBS8220	196	245	196	245	3 1/8	6
			TBS10220	232	338	232	338	4	8
			TBS12200	261	387	261	387	4 3/4	10
	280	11	**TBS6260**	165	165	165	165	3 1/2	6
			TBS8260	196	245	196	245	3 1/8	6
			TBS10260	232	338	232	338	4	8
			TBS12240	261	387	261	387	4 3/4	10
9 PLY	180	7 1/16	**TBS6160**	165	165	165	165	3 1/2	6
			TBS8160	196	245	196	245	3 1/8	6
			TBS10160	228	338	228	338	4	8
	267	10 1/2	**TBS6240**	165	165	165	165	3 1/2	6
			TBS8240	196	245	196	245	3 1/8	6
			TBS10240	232	338	232	338	4	8
			TBS12240	261	387	261	387	4 3/4	10
	314	12 3/8	**TBS6280**	165	165	165	165	3 1/2	6
			TBS8280	196	245	196	245	3 1/8	6
			TBS10280	232	338	232	338	4	8
			TBS12280	261	387	261	387	4 3/4	10
	360	14 3/16	**TBS6300**	165	165	165	165	3 1/2	6
			TBS8300	196	245	196	245	3 1/8	6
			TBS10300	232	338	232	338	4	8
			TBS12320	261	387	261	387	4 3/4	10

NOTES and GENERAL PRINCIPLES on page 100.

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 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 95 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 $0° \leq \alpha < 90°$ 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 $\alpha \leq 15°$.
- 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.