SHS AISI410

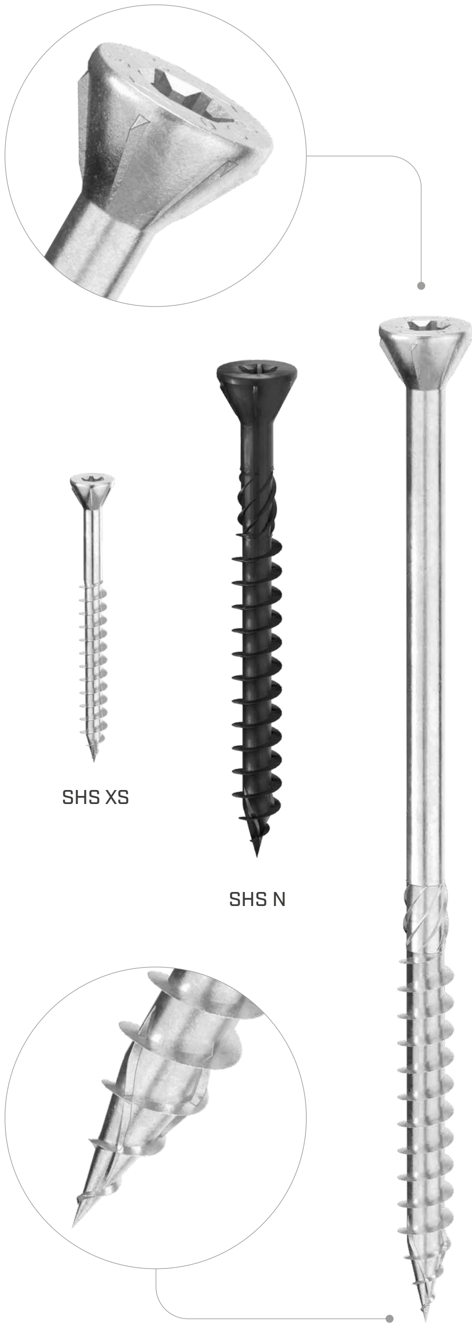
60° COUNTERSUNK SCREW

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

SMALL HEAD AND 3 THORNS TIP
The concealed 60° head and 3 THORNS tip allow easy insertion of the screw into small thickness without creating openings in the timber.

OUTDOOR ON ACID WOOD
Martensitic stainless steel. This stainless steels offers the highest mechanical performance compared to the other available stainless steels. Suitable for outdoor applications and on acid wood, but away from corrosive agents (chlorides, sulphides, etc.).

SMALL ELEMENTS FASTENING
The smaller diameter versions are ideal for fixing beads or small elements, the 0.14 inch (3,5 mm) diameter version is perfectly suited for fastening tongue-and-groove boards.



BIT INCLUDED

DIAMETER [in]	0.12	0.14 – 0.32	0.48
LENGTH [in]	1/2	1 9/16 – 11	39 3/8
EXPOSURE CONDITION	EC1 EC3 WET	
ATMOSPHERIC CORROSIVITY	C1 C2	
WOOD CORROSIVITY	T1 T2 T3 T4	
MATERIAL	410 AISI — martensitic stainless steel AISI 410	

FIELDS OF USE

- timber based panels
- solid timber
- glulam (Glued Laminated Timber)
- CLT, LVL
- high-density woods and acid woods

WINDOWS AND DOORS ON THE OUTSIDE

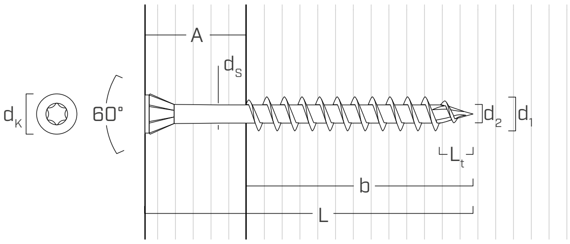
SHS AISI140 is the right choice for fastening small outdoor elements such as beads, façades and window/door frames.

External casing slats fixed with 0.24 and 0.32 inch (6 and 8 mm) diameter SHS AISI410 screws.

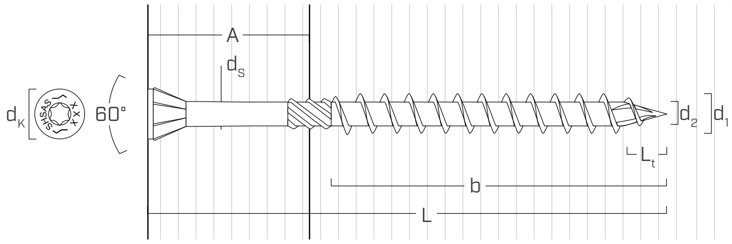
Fastening hardwood and acid wood in far-from-sea environments with SHS AISI410 0.32 inch (8 mm) diameter.

GEOMETRY AND MECHANICAL CHARACTERISTICS

Ø0.14 in



Ø0.18 in - Ø0.20 in - Ø.24 in - Ø0.32 in



GEOMETRY

Nominal diameter	d_1	[in][(1)]	**0.14**	**0.18**	**0.20**	**0.24**	**0.32**
Outer thread diameter	d_1	[mm]	3,5	4,5	5	6	8
		[in]	**0.138**	**0.177**	**0.197**	**0.236**	**0.315**
Head diameter	d_K	[in]	0.226	0.295	0.335	0.433	0.512
Root diameter	d_2	[in]	0.089	0.110	0.134	0.156	0.213
Shank diameter	d_S	[in]	0.104	0.124	0.144	0.169	0.228
Head thickness	t_1	[in]	0.157	0.183	0.201	0.268	0.283
Tip Length	L_t	[in]	0.138	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).

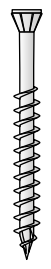
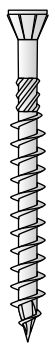
MECHANICAL PARAMETERS

Nominal diameter	d_1	[in]	0.18	0.20	0.24	0.32
Tensile strength (allowable)	f_{tens}	[lbf]	740	810	1170	2180
Bending yield strength (specified)	$F_{y,b}$	[psi]	185000	164000	150000	180000

Nominal diameter	d_1	[in]		0.18	0.20	0.24	0.32
Withdrawal (design value)	W_{90}	[lbf/in]	G = 0.35	86	103	131	172
			G = 0.42	99	119	151	199
			G = 0.49	111	133	171	225
			G = 0.55	121	146	188	247
minimum embedded length		[in]		1 1/16	1 3/16	1 7/16	1 7/8

CODES AND DIMENSIONS

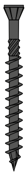
SHS XS AISI410

d1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
3,5 0.14 #6 TX 10	SHS3540AS(*)	40	1 9/16	26	1 1/32	1/2	500
	SHS3550AS(*)	50	1 15/16	34	1 5/16	1/2	500
	SHS3560AS(*)	60	2 3/8	40	1 9/16	3/4	500
4,5 0.18 #9 TX 20	SHS4550AS	50	1 15/16	30	1 3/16	3/4	500
	SHS4560AS	60	2 3/8	35	1 3/8	3/4	500
	SHS4570AS	70	2 3/4	40	1 9/16	1	200
5 0.20 #11 TX 25	SHS550AS	50	1 15/16	24	15/16	1	200
	SHS560AS	60	2 3/8	30	1 3/16	1	200
	SHS570AS	70	2 3/4	35	1 3/8	1 1/4	100
	SHS580AS	80	3 1/8	40	1 9/16	1 1/2	100
	SHS5100AS	100	4	50	1 15/16	1 3/4	100

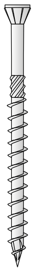
(*)Not evaluated in ERS-4645.

SHS N AISI410 - black version



d1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
4,5 0.18 #9 TX 20	SHS4550ASN	50	1 15/16	30	1 3/16	3/4	100
	SHS4560ASN	60	2 3/8	35	1 3/8	3/4	100
5 0.20 #11 TX 25	SHS550ASN	50	1 15/16	24	15/16	1	100
	SHS560ASN	60	2 3/8	30	1 3/16	1	200

SHS AISI410



d1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [in]	pcs
6 0.24 #14 TX 30	SHS680AS	80	3 1/8	40	1 9/16	1 1/2	100
	SHS6100AS	100	4	50	1 15/16	1 3/4	100
	SHS6120AS	120	4 3/4	60	2 3/8	2 1/4	100
	SHS6140AS	140	5 1/2	75	2 15/16	2 1/2	100
	SHS6160AS	160	6 1/4	75	2 15/16	3 1/4	100
	SHS6180AS	180	7 1/8	75	2 15/16	4	100
	SHS6200AS	200	8	75	2 15/16	4 3/4	100
8 0.32 TX 40	SHS8120AS	120	4 3/4	60	2 3/8	2 1/4	100
	SHS8140AS	140	5 1/2	60	2 3/8	3	100
	SHS8160AS	160	6 1/4	80	3 1/8	3	100
	SHS8180AS	180	7 1/8	80	3 1/8	3 3/4	100
	SHS8200AS	200	8	80	3 1/8	4 1/2	100
	SHS8220AS	220	8 5/8	80	3 1/8	5 1/2	100
	SHS8240AS	240	9 1/2	80	3 1/8	6 1/4	100
	SHS8260AS	260	10 1/4	80	3 1/8	7	100
	SHS8280AS	280	11	80	3 1/8	7 3/4	100

APPLICATION

Oak
Quercus petraea
ρ_k = 42-47 lb/ft^3
pH ~ 3,9

Oak or European oak
Quercus robur
ρ_k = 43-60 lb/ft^3
pH = 3,4-4,2

Douglas fir
Pseudotsuga menziesii
ρ_k = 32-47 lb/ft^3
pH = 3,3-5,8

American black cherry
Prunus serotina
ρ_k = 31-39 lb/ft^3
pH ~ 3,9

European chestnut
Castanea sativa
ρ_k = 36-37 lb/ft^3
pH = 3,4-3,7

Red oak
Quercus rubra
ρ_k = 34-61 lb/ft^3
pH = 3,8-4,2

Blue Douglas fir
Pseudotsuga taxifolia
ρ_k = 32-47 lb/ft^3
pH = 3,1-4,4

Maritime pine
Pinus pinaster
ρ_k = 31-39 lb/ft^3
pH ~ 3,8

Possible installation on acid wood but away from corrosive agents (chlorides, sulphides, etc.).

Find out the pH and density of the various wood species on page 354.

pH ≤ 4
"aggressive" woods
high acidity

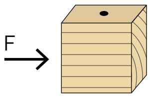
pH > 4
"standard" timbers
low acidity

FAÇADES IN DARK TIMBER

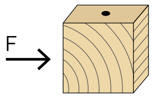
Specially designed to match façades made of charred wood, the black SHS N variant ensures perfect compatibility and offers an excellent aesthetic result. Thanks to its resistance to corrosion, it can be used outdoors, allowing to create striking and long-lasting black façades.

MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

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



α = 0°

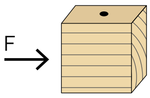


α = 90°

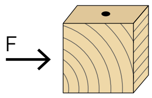
d_1	[in]		0.14	0.18	0.20	0.24	0.32
	[mm]		3,5	4,5	5	6	8
a_1	[in]	15·d	2 1/16	2 11/16	2 15/16	3 1/2	3 1/8
a_2	[in]	5·d	11/16	7/8	1	1 3/16	1 9/16
$a_{3,t}$	[in]	15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
$a_{3,c}$	[in]	10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,t}$	[in]	10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,c}$	[in]	5·d	11/16	7/8	1	1 3/16	1 9/16

	0.14	0.18	0.20	0.24	0.32
	3,5	4,5	5	6	8
10·d	1 3/8	1 3/4	1 15/16	2 3/8	1 9/16
5·d	11/16	7/8	1	1 3/16	1 9/16
15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
5·d	11/16	7/8	1	1 3/16	1 9/16

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



α = 0°

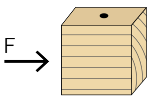


α = 90°

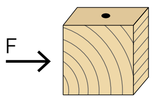
d_1	[in]		0.14	0.18	0.20	0.24	0.32
	[mm]		3,5	4,5	5	6	8
a_1	[in]	15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
a_2	[in]	5·d	11/16	7/8	1	1 3/16	1 9/16
$a_{3,t}$	[in]	15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
$a_{3,c}$	[in]	10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,t}$	[in]	10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
$a_{4,c}$	[in]	5·d	11/16	7/8	1	1 3/16	1 9/16

	0.14	0.18	0.20	0.24	0.32
	3,5	4,5	5	6	8
10·d	1 3/8	1 3/4	1 15/16	2 3/8	2 3/16
5·d	11/16	7/8	1	1 3/16	1 9/16
15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
5·d	11/16	7/8	1	1 3/16	1 9/16

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



α = 0°

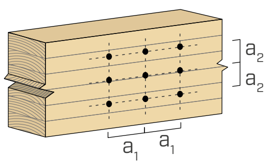


α = 90°

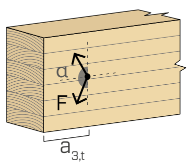
d_1	[in]		0.14	0.18	0.20	0.24	0.32
	[mm]		3,5	4,5	5	6	8
a_1	[in]	15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
a_2	[in]	7·d	1	1 1/4	1 3/8	1 5/8	2 3/16
$a_{3,t}$	[in]	20·d	2 3/4	3 1/2	4	4 3/4	6 1/4
$a_{3,c}$	[in]	15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
$a_{4,t}$	[in]	12·d	1 5/8	2 1/8	2 3/8	2 13/16	3 3/4
$a_{4,c}$	[in]	7·d	1	1 1/4	1 3/8	1 5/8	2 3/16

	0.14	0.18	0.20	0.24	0.32
	3,5	4,5	5	6	8
10·d	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
7·d	1	1 1/4	1 3/8	1 5/8	2 3/16
20·d	2 3/4	3 1/2	4	4 3/4	6 1/4
15·d	2 1/16	2 11/16	2 15/16	3 1/2	4 3/4
12·d	1 5/8	2 1/8	2 3/8	2 13/16	3 3/4
7·d	1	1 1/4	1 3/8	1 5/8	2 3/16

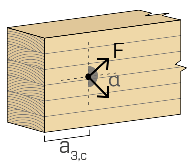
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



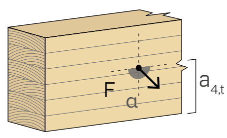
stressed end
-90° < α < 90°



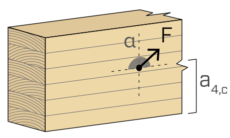
unloaded end
90° < α < 270°



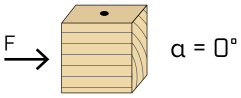
stressed edge
0° < α < 180°

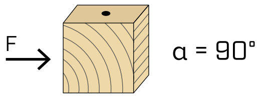


unload edge
180° < α < 360°



screws inserted **WITH pre-drilled hole**





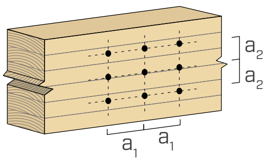
α = 0°

d_1	[in]		0.14	0.18	0.20	0.24	0.32
	[mm]		3,5	4,5	5	6	8
a_1	[in]	**10·d**	1 3/8	1 3/4	1 15/16	2 3/8	3 1/8
a_2	[in]	**4·d**	9/16	11/16	13/16	15/16	1 1/4
$a_{3,t}$	[in]	**12·d**	1 5/8	2 1/8	2 3/8	2 13/16	3 3/4
$a_{3,c}$	[in]	**7·d**	1	1 1/4	1 3/8	1 5/8	2 3/16
$a_{4,t}$	[in]	**7·d**	1	1 1/4	1 3/8	1 5/8	2 3/16
$a_{4,c}$	[in]	**3·d**	7/16	9/16	9/16	11/16	15/16

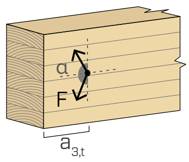
α = 90°

	0.14	0.18	0.20	0.24	0.32
	3,5	4,5	5	6	8
5·d	11/16	7/8	1	1 3/16	1 9/16
4·d	9/16	11/16	13/16	15/16	1 1/4
12·d	1 5/8	2 1/8	2 3/8	2 13/16	3 3/4
7·d	1	1 1/4	1 3/8	1 5/8	2 3/16
7·d	1	1 1/4	1 3/8	1 5/8	2 3/16
3·d	7/16	9/16	9/16	11/16	15/16

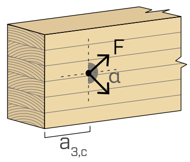
α = load-to-grain angle
d = d_1 = nominal diameter of the screw



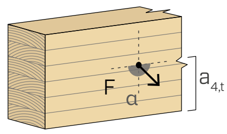
stressed end
-90° < α < 90°



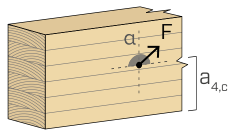
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°

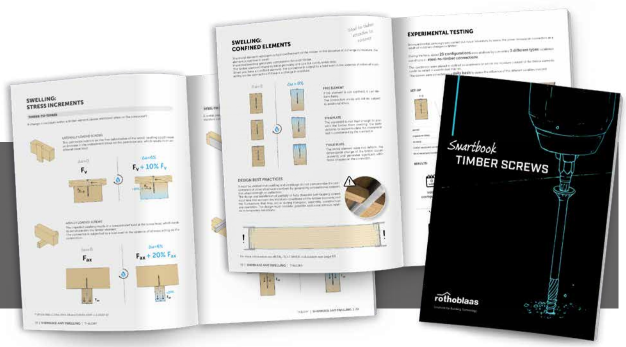


unload edge
180° < α < 360°

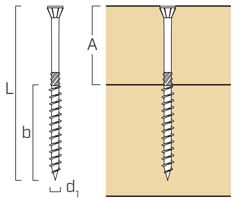
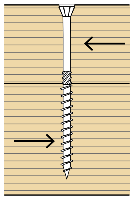
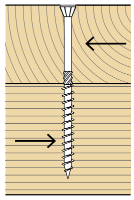
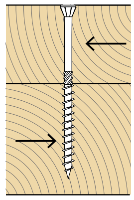


NOTES

- 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.

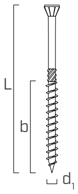
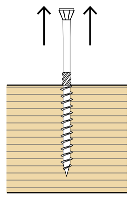
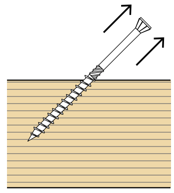
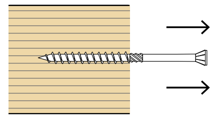


REFERENCE LATERAL DESIGN VALUES (Z) | WOOD-TO-WOOD

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]
	40	1 9/16	1 1/32	1/2	33	44	53	60	33	44	53	60	33	44	53	60
3,5 **0.14**	50	1 15/16	1 5/16	1/2	37	44	53	60	37	44	53	60	37	44	53	60
	60	2 3/8	1 9/16	3/4	40	50	61	72	40	50	61	72	40	50	61	72
	50	1 15/16	1 3/16	3/4	49	64	79	92	49	64	79	92	49	64	79	92
4,5 **0.18**	60	2 3/8	1 3/8	3/4	51	64	79	92	51	64	79	92	51	64	79	92
	70	2 3/4	1 9/16	1	57	74	92	102	57	74	92	102	57	74	92	102
	50	1 15/16	15/16	1	57	80	106	129	57	80	106	129	57	80	106	129
	60	2 3/8	1 3/16	1	69	95	118	140	69	95	118	140	69	95	118	140
5 **0.20**	70	2 3/4	1 3/8	1 1/4	81	108	127	142	81	108	127	142	81	108	127	142
	80	3 1/8	1 9/16	1 1/2	92	110	127	142	92	110	127	142	92	110	127	142
	100	4	1 15/16	1 3/4	93	110	127	142	93	110	127	142	93	110	127	142
	80	3 1/8	1 9/16	1 1/2	107	143	164	183	107	143	164	183	107	143	164	183
	100	4	1 15/16	1 3/4	121	143	164	183	121	143	164	183	121	143	164	183
	120	4 3/4	2 3/8	2 1/4	121	143	164	183	121	143	164	183	121	143	164	183
6 **0.24**	140	5 1/2	2 15/16	2 1/2	121	143	164	183	121	143	164	183	121	143	164	183
	160	6 1/4	2 15/16	3 1/4	121	143	164	183	121	143	164	183	121	143	164	183
	180	7 1/8	2 15/16	4	121	143	164	183	121	143	164	183	121	143	164	183
	200	8	2 15/16	4 3/4	121	143	164	183	121	143	164	183	121	143	164	183
	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
8 **0.32**	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

NOTES and **GENERAL PRINCIPLES** on page 33.

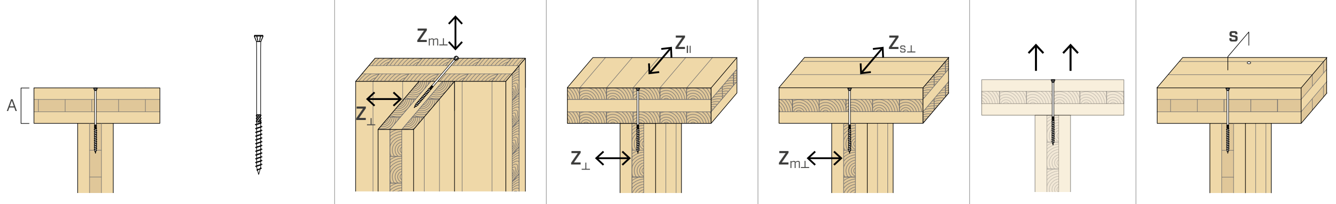
THREAD WITHDRAWAL (W) | WOOD

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]
3,5 **0.14**	40	1 9/16(2)	1 1/32	76	88	98	107	69	80	89	98	23	26	29	32
	50	1 15/16	1 5/16	103	119	133	145	94	108	121	132	31	36	40	44
	60	2 3/8	1 9/16	124	142	160	174	112	129	145	158	37	43	48	52
4,5 **0.18**	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
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(2)	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
	100	4	1 15/16	182	211	236	259	166	192	214	235	55	63	71	78
6 **0.24**	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**	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

(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).

NOTES and GENERAL PRINCIPLES on page 33.

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

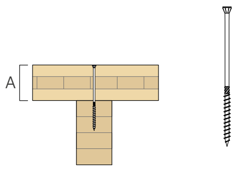
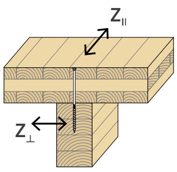
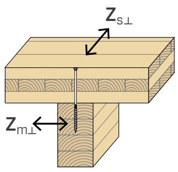
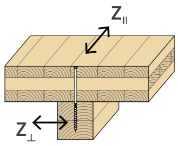
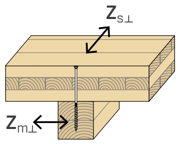
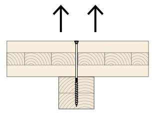
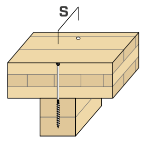


	geometry				SHEAR wall-to-wall		SHEAR floor-to-wall orientation 1		SHEAR floor-to-wall orientation 2		TENSION withdrawal / head pull-through	SPACING fastener in a row	
	side member thickness (wall/floor) = A		suggested screw		$Z_{\perp}$	$Z_{m\perp}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{m\perp}$	$Z_{s\perp}$	W(*)	minimum	typical
	[mm]	[in]	CODE		[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]
3 PLY	60	2 3/8	SHS6120AS	or longer	96	96	96	96	96	96	165	3 1/2	6
			SHS8120AS		131	131	131	164	131	131	264	3 1/8	6
	79	3 1/8	SHS6160AS		96	96	96	96	96	96	165	3 1/2	6
			SHS8160AS		131	131	131	164	131	131	264	3 1/8	6
	105	4 1/8	SHS6180AS		96	96	96	96	96	96	165	3 1/2	6
			SHS8200AS		131	131	131	164	131	131	264	3 1/8	6
	120	4 3/4	SHS6200AS		96	96	96	96	96	96	165	3 1/2	6
			SHS8220AS		131	131	131	164	131	131	264	3 1/8	6
5 PLY	100	3 15/16	SHS6180AS	or longer	96	96	96	96	96	96	165	3 1/2	6
			SHS8180AS		131	131	131	164	131	131	264	3 1/8	6
	140	5 1/2	SHS8220AS		131	131	131	164	131	131	264	3 1/8	6
	175	6 7/8	SHS8260AS		131	131	131	164	131	131	264	3 1/8	6
	200	7 7/8	SHS8280AS		131	131	131	164	131	131	264	3 1/8	6
7 PLY	140	5 1/2	SHS8220AS	or longer	131	131	131	164	131	131	264	3 1/8	6
	191	7 1/2	SHS8280AS		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 33.

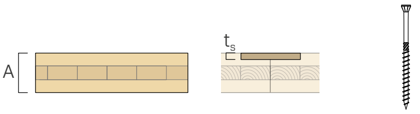
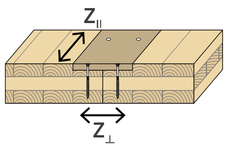
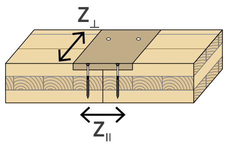
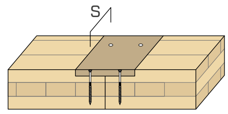
CLT | FLOOR-TO-BEAM

				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	SHS6160AS	143	143	96	143	143	143	96	143	165	3 1/2	6
			SHS8120AS	196	245	131	196	196	245	131	196	264	3 1/8	6
	79	3 1/8	SHS6160AS	143	143	96	143	143	143	96	143	165	3 1/2	6
			SHS8160AS	196	245	131	196	196	245	131	196	264	3 1/8	6
	105	4 1/8	SHS6180AS	143	143	96	143	143	143	96	143	165	3 1/2	6
			SHS8200AS	196	245	131	196	196	245	131	196	264	3 1/8	6
	120	4 3/4	SHS6200AS	143	143	96	143	143	143	96	143	165	3 1/2	6
			SHS8220AS	196	245	131	196	196	245	131	196	264	3 1/8	6
5 PLY	100	3 15/16	SHS6180AS	143	143	143	143	143	143	143	143	165	3 1/2	6
			SHS8180AS	196	245	196	196	196	245	196	196	264	3 1/8	6
	140	5 1/2	SHS8220AS	196	245	196	196	196	245	196	196	264	3 1/8	6
	175	6 7/8	SHS8260AS	196	245	196	196	196	245	196	196	264	3 1/8	6
	200	7 7/8	SHS8280AS	196	245	196	196	196	245	196	196	264	3 1/8	6
7 PLY	140	5 1/2	SHS8220AS	196	245	196	196	196	245	196	196	264	3 1/8	6
	191	7 1/2	SHS8280AS	196	245	196	196	196	245	196	196	264	3 1/8	6
9 PLY	180	7 1/16	SHS8260AS	196	245	196	196	196	245	196	196	264	3 1/8	6

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

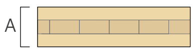
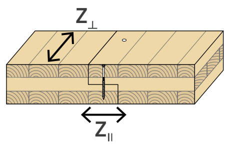
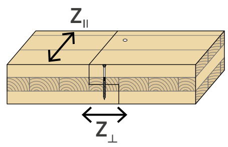
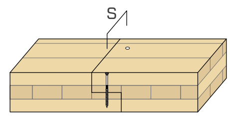
NOTES and GENERAL PRINCIPLES on page 33.

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	SHS550AS	79	79	79	79	2 15/16	3
			3/4	SHS560AS	85	85	85	85	2 15/16	3
			1	SHS570AS	95	95	95	95	2 15/16	3
	86	3 3/8	1/2	SHS560AS	79	79	79	79	2 15/16	3
				SHS680AS	101	101	101	101	3 1/2	4
			3/4	SHS570AS	85	85	85	85	2 15/16	3
				SHS680AS	107	107	107	107	3 1/2	4
			1	SHS580AS	95	95	95	95	2 15/16	3
				SHS680AS	117	117	117	117	3 1/2	4
	105	4 1/8	1/2	SHS570AS	79	79	79	79	2 15/16	3
				SHS680AS	101	101	101	101	3 1/2	4
			3/4	SHS580AS	85	85	85	85	2 15/16	3
				SHS680AS	107	107	107	107	3 1/2	4
			1	SHS5100AS	95	95	95	95	2 15/16	3
				SHS6100AS	117	117	117	117	3 1/2	4
5 PLY	130	5 1/8	3/4	SHS680AS	107	107	107	107	3 1/2	4
				SHS8120AS	173	139	173	139	3 1/8	4
			1	SHS6100AS	117	117	117	117	3 1/2	4
				SHS8120AS	179	143	179	143	3 1/8	4
	140	5 1/2	3/4	SHS6100AS	107	107	107	107	3 1/2	4
				SHS8120AS	173	139	173	139	3 1/8	4
			1	SHS6120AS	117	117	117	117	3 1/2	4
				SHS8120AS	179	143	179	143	3 1/8	4
	175	6 7/8	3/4	SHS6120AS	107	107	107	107	3 1/2	4
				SHS8120AS	173	139	173	139	3 1/8	4
			1	SHS6140AS	117	117	117	117	3 1/2	4
				SHS8140AS	179	143	179	143	3 1/8	4
7 PLY	191	7 1/2	3/4	SHS680AS	107	107	107	107	3 1/2	4
				SHS8120AS	173	139	173	139	3 1/8	4
			1	SHS6100AS	117	117	117	117	3 1/2	4
				SHS8140AS	179	143	179	143	3 1/8	4
	220	8 5/8	3/4	SHS6120AS	107	107	107	107	3 1/2	4
				SHS8160AS	173	139	173	139	3 1/8	4
			1	SHS6140AS	117	117	117	117	3 1/2	4
				SHS8160AS	179	143	179	143	3 1/8	4
	244	9 5/8	3/4	SHS6160AS	107	107	107	107	3 1/2	4
				SHS8180AS	173	139	173	139	3 1/8	4
			1	SHS6180AS	117	117	117	117	3 1/2	4
				SHS8180AS	179	143	179	143	3 1/8	4

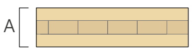
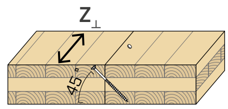
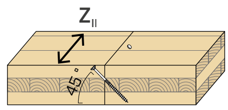
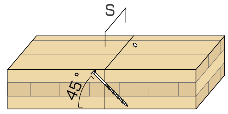
NOTES and GENERAL PRINCIPLES on page 33.

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	105	4 1/8	SHS5100AS	110	110	110	110	2 15/16	4
			SHS6100AS	143	143	143	143	3 1/2	6
	120	4 3/4	SHS5100AS	110	110	110	110	2 15/16	4
			SHS6100AS	143	143	143	143	3 1/2	6
5 PLY	100	3 15/16	SHS580AS	98	98	98	98	2 15/16	4
			SHS680AS	119	119	119	119	3 1/2	6
	140	5 1/2	SHS6120AS	143	143	143	143	3 1/2	6
			SHS8120AS	178	222	178	222	3 1/8	6
	175	6 7/8	SHS6160AS	143	143	143	143	3 1/2	6
			SHS8160AS	196	245	196	245	3 1/8	6
	200	7 7/8	SHS6180AS	143	143	143	143	3 1/2	6
			SHS8180AS	196	245	196	245	3 1/8	6
7 PLY	140	5 1/2	SHS6120AS	143	143	143	143	3 1/2	6
			SHS8120AS	178	222	178	222	3 1/8	6
	191	7 1/2	SHS6180AS	143	143	143	143	3 1/2	6
			SHS8180AS	196	245	196	245	3 1/8	6
	244	9 5/8	SHS6200AS	143	143	143	143	3 1/2	6
			SHS8220AS	196	245	196	245	3 1/8	6
	280	11	SHS8240AS	196	245	196	245	3 1/8	6
9 PLY	180	7 1/16	SHS6160AS	143	143	143	143	3 1/2	6
			SHS8160AS	196	245	196	245	3 1/8	6
	267	10 1/2	SHS8220AS	196	245	196	245	3 1/8	6
	314	12 3/8	SHS8260AS	196	245	196	245	3 1/8	6
	360	14 3/16	SHS8280AS	196	245	196	245	3 1/8	6

NOTES and GENERAL PRINCIPLES on page 33.

CLT | BUTT JOINT

				SHEAR		SPACING	
	geometry			**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	SHS570AS	73	73	2 15/16	4
3 PLY	105	4 1/8	SHS6120AS	96	96	3 1/2	6
3 PLY	105	4 1/8	SHS8120AS	131	164	3 1/8	6
3 PLY	120	4 3/4	SHS6160AS	96	96	3 1/2	6
3 PLY	120	4 3/4	SHS8160AS	131	164	3 1/8	6
5 PLY	100	3 15/16	SHS6120AS	96	96	3 1/2	6
5 PLY	100	3 15/16	SHS8120AS	131	164	3 1/8	6
5 PLY	140	5 1/2	SHS6180AS	96	96	3 1/2	6
5 PLY	140	5 1/2	SHS8180AS	131	164	3 1/8	6
5 PLY	175	6 7/8	SHS6200AS	96	96	3 1/2	6
5 PLY	175	6 7/8	SHS8220AS	131	164	3 1/8	6
5 PLY	200	7 7/8	SHS8260AS	131	164	3 1/8	6
7 PLY	140	5 1/2	SHS6180AS	96	96	3 1/2	6
7 PLY	140	5 1/2	SHS8180AS	131	164	3 1/8	6
7 PLY	191	7 1/2	SHS8240AS	131	164	3 1/8	6
7 PLY	244	9 5/8	SHS8280AS	131	164	3 1/8	6
9 PLY	180	7 1/16	SHS8240AS	131	164	3 1/8	6

NOTES and GENERAL PRINCIPLES on page 33.

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.
- SHS AISI410 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:

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

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

  Tabulated values at page 27 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.
- $Z_{\parallel}$: 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.