HBS

COUNTERSUNK SCREW

AC233 ESR-4645 | BIT INCLUDED | MY PROJECT SOFTWARE | ETA-11/0030

SUPERIOR STRENGTH

Steel with superb bending yield strength (minimum of F_{yb} = 1241 N/mm² | **180,000 psi** according to ESR-4645). Very high torsional strength $f_{tor,k}$ for safer screwing.

STRUCTURAL APPLICATIONS

Evaluated by ICC-ES according to Acceptance Criteria AC 233. Withdrawal values for any angle between the screw axis and the grain (including end-grain). Asymmetric "umbrella" shape thread for improved penetration capacity into the wood member.

DUCTILITY

The bending angle is 20° greater than the minimum required by the standard, and certified according to ETA-11/0030. Cyclical SEISMIC-REV tests according to EN 12512. Seismic performance tested according to EN 14592.

CHROMIUM (VI) FREE

Total absence of hexavalent chromium. Compliance with the strictest regulations governing chemical substances (SVHC).
REACH information available.

CHARACTERISTICS

FOCUS	extremely complete range	
HEAD	countersunk with under-head ribs	
DIAMETER	from 3,5 to 12,0 mm	0.14 to 0.48 inches
LENGTH	from 30 to 600 mm	1 3/16 to 23 5/8 inches

MATERIAL

Bright zinc plated carbon steel.

FIELDS OF USE

- sawn lumber and timber
- Glued Laminated Timber
- CLT and other mass timber products
- high density woods

Dry in-service conditions.

CLT

ESR-4645 values applicable to connections with Cross Laminated Timber (CLT).

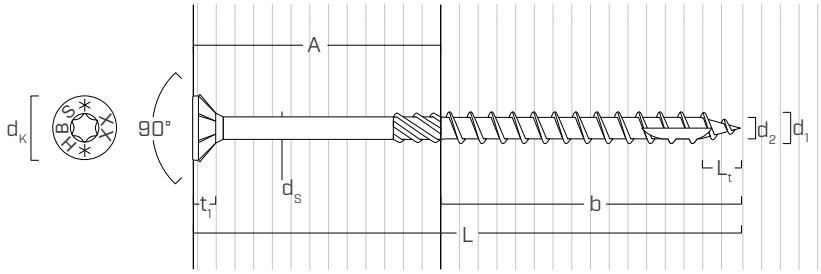
END-GRAIN

Approved ICC-ES values for application in the end-grain of timber member.

Valley jack rafter joint with HBS screws, diameter 8 mm | **0.32 inch**.

Fastening CLT walls with 6 mm | **0.24 inch** diameter HBS screws.

GEOMETRY AND MECHANICAL CHARACTERISTICS



Nominal diameter	d_1	[in](1)	0.14(*)	0.16(*)	0.18(*)	0.20(*)	0.24	0.32	0.40	0.48
Outer thread diameter	**d_1**	[mm]	3,5	4,0	4,5	5,0	6,0	8,0	10,0	12,0
		[in]	0.138	0.157	0.177	0.197	0.236	0.315	0.394	0.472
Head diameter	d_K	[in]	0.276	0.315	0.354	0.394	0.472	0.571	0.719	0.817
Root diameter	d_2	[in]	0.089	0.100	0.110	0.134	0.156	0.213	0.252	0.268
Shank diameter	d_S	[in]	0.096	0.108	0.124	0.144	0.169	0.228	0.276	0.315
Head thickness	t_1	[in]	0.087	0.110	0.110	0.122	0.177	0.177	0.228	0.283
Tip length	L_t	[in]	0.138	0.157	0.177	0.197	0.236	0.315	0.394	0.472
Pre-drilling hole diameter(2)	d_V	[in]	0.08	0.10	0.10	0.12	0.16	0.20	0.24	0.27
Bending yield strength(3)	$F_{y,b}$	[psi]	145,000	145,000	145,000	145,000	200,000	180,000	185,000	190,000
Tensile strength	f_{tens}	[lbf]	320	430	540	680	1180	2040	2700	3060

(*) Not evaluated in ESR-4645.
(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 softwood timber.
(3) Bending yield strengths for HBS screws with nominal diameters of 0.24, 0.32, 0.40 and 0.48 inches are determined in accordance with ASTM F1575 using the root diameter d_2. Bending yield strengths for HBS screws with nominal diameters of 0.14, 0.16, 0.18 and 0.20 inches are based on experimental tests according to ETA-11/0030.

CODES AND DIMENSIONS

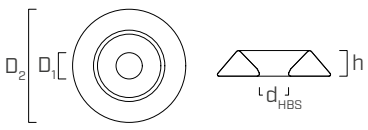
d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [mm]	A [in]	pcs
3,5 **0.14 TX 15**	**HBS3540(*)**	40	1 9/16	18	11/16	19	3/4	500
	HBS3545(*)	45	1 3/4	24	15/16	19	3/4	400
	HBS3550(*)	50	1 15/16	24	15/16	25	1	400
4 **0.16 TX 20**	**HBS430(*)**	30	1 3/16	18	11/16	6	1/4	500
	HBS435(*)	35	1 3/8	18	11/16	6	1/4	500
	HBS440(*)	40	1 9/16	24	15/16	6	1/4	500
	HBS445(*)	45	1 3/4	30	1 3/16	13	1/2	400
	HBS450(*)	50	1 15/16	30	1 3/16	19	3/4	400
	HBS460(*)	60	2 3/8	35	1 3/8	19	3/4	200
	HBS470(*)	70	2 3/4	40	1 9/16	25	1	200
	HBS480(*)	80	3 1/8	40	1 9/16	38	1 1/2	200
4,5 **0.18 TX 20**	**HBS4540(*)**	40	1 9/16	24	15/16	13	1/2	400
	HBS4545(*)	45	1 3/4	30	1 3/16	13	1/2	400
	HBS4550(*)	50	1 15/16	30	1 3/16	19	3/4	200
	HBS4560(*)	60	2 3/8	35	1 3/8	19	3/4	200
	HBS4570(*)	70	2 3/4	40	1 9/16	25	1	200
	HBS4580(*)	80	3 1/8	40	1 9/16	38	1 1/2	200
5 **0.20 TX 25**	**HBS540(*)**	40	1 9/16	24	15/16	13	1/2	200
	HBS545(*)	45	1 3/4	24	15/16	19	3/4	200
	HBS550(*)	50	1 15/16	24	15/16	25	1	200
	HBS560(*)	60	2 3/8	30	1 3/16	25	1	200
	HBS570(*)	70	2 3/4	35	1 3/8	32	1 1/4	100
	HBS580(*)	80	3 1/8	40	1 9/16	38	1 1/2	100
	HBS590(*)	90	3 1/2	45	1 3/4	44	1 3/4	100
	HBS5100(*)	100	4	50	1 15/16	44	1 3/4	100
	HBS5120(*)	120	4 3/4	60	2 3/8	57	2 1/4	100
6 **0.24 TX 30**	**HBS640**	40	1 9/16	35	1 3/8	2	1/16	100
	HBS650	50	1 15/16	35	1 3/8	10	3/8	100
	HBS660	60	2 3/8	30	1 3/16	19	3/4	100
	HBS670	70	2 3/4	40	1 9/16	25	1	100
	HBS680	80	3 1/8	40	1 9/16	38	1 1/2	100
	HBS690	90	3 1/2	50	1 15/16	38	1 1/2	100
	HBS6100	100	4	50	1 15/16	44	1 3/4	100
	HBS6110	110	4 3/8	60	2 3/8	44	1 3/4	100
	HBS6120	120	4 3/4	60	2 3/8	51	2	100
	HBS6130	130	5 1/8	60	2 3/8	64	2 1/2	100
	HBS6140	140	5 1/2	75	2 15/16	64	2 1/2	100
	HBS6150	150	6	75	2 15/16	70	2 3/4	100
	HBS6160	160	6 1/4	75	2 15/16	83	3 1/4	100
	HBS6180	180	7 1/8	75	2 15/16	102	4	100
	HBS6200	200	8	75	2 15/16	121	4 3/4	100
	HBS6220	220	8 5/8	75	2 15/16	140	5 1/2	100
	HBS6240	240	9 1/2	75	2 15/16	159	6 1/4	100
	HBS6260	260	10 1/4	75	2 15/16	178	7	100
	HBS6280	280	11	75	2 15/16	203	8	100
	HBS6300	300	11 3/4	75	2 15/16	222	8 3/4	100

(*) Not evaluated in ESR-4645.

d_1 [mm] [in]	CODE	L [mm]	L [in]	b [mm]	b [in]	A [mm]	A [in]	pcs
8 **0.32 TX 40**	**HBS880**	80	3 1/8	52	2 1/16	25	1	100
	HBS8100	100	4	52	2 1/16	44	1 3/4	100
	HBS8120	120	4 3/4	60	2 3/8	57	2 1/4	100
	HBS8140	140	5 1/2	60	2 3/8	76	3	100
	HBS8160	160	6 1/4	80	3 1/8	76	3	100
	HBS8180	180	7 1/8	80	3 1/8	95	3 3/4	100
	HBS8200	200	8	80	3 1/8	114	4 1/2	100
	HBS8220	220	8 5/8	80	3 1/8	140	5 1/2	100
	HBS8240	240	9 1/2	80	3 1/8	159	6 1/4	100
	HBS8260	260	10 1/4	80	3 1/8	178	7	100
	HBS8280	280	11	80	3 1/8	197	7 3/4	100
	HBS8300	300	11 3/4	100	4	197	7 3/4	100
	HBS8320	320	12 5/8	100	4	216	8 1/2	100
	HBS8340	340	13 3/8	100	4	235	9 1/4	100
	HBS8360	360	14 1/4	100	4	254	10	100
	HBS8380	380	15	100	4	279	11	100
	HBS8400	400	15 3/4	100	4	292	11 1/2	100
	HBS8440	440	17 1/4	100	4	337	13 1/4	100
	HBS8480	480	19	100	4	375	14 3/4	100
	HBS8520	520	20 1/2	100	4	419	16 1/2	100
10 **0.40 TX 40**	**HBS1080**	80	3 1/8	52	2 1/16	13	1/2	50
	HBS10100	100	4	52	2 1/16	25	1	50
	HBS10120	120	4 3/4	60	2 3/8	54	2 1/8	50
	HBS10140	140	5 1/2	60	2 3/8	70	2 3/4	50
	HBS10160	160	6 1/4	80	3 1/8	76	3	50
	HBS10180	180	7 1/8	80	3 1/8	95	3 3/4	50
	HBS10200	200	8	80	3 1/8	114	4 1/2	50
	HBS10220	220	8 5/8	80	3 1/8	140	5 1/2	50
	HBS10240	240	9 1/2	80	3 1/8	159	6 1/4	50
	HBS10260	260	10 1/4	80	3 1/8	178	7	50
	HBS10280	280	11	80	3 1/8	197	7 3/4	50
	HBS10300	300	11 3/4	100	4	197	7 3/4	50
	HBS10320	320	12 5/8	100	4	216	8 1/2	50
	HBS10340	340	13 3/8	100	4	235	9 1/4	50
	HBS10360	360	14 1/4	100	4	254	10	50
	HBS10380	380	15	100	4	279	11	50
	HBS10400	400	15 3/4	100	4	292	11 1/2	50
12 **0.48 TX 50**	**HBS12120**	120	4 3/4	80	3 1/8	38	1 1/2	25
	HBS12160	160	6 1/4	80	3 1/8	76	3	25
	HBS12200	200	8	80	3 1/8	114	4 1/2	25
	HBS12240	240	9 1/2	80	3 1/8	159	6 1/4	25
	HBS12280	280	11	80	3 1/8	197	7 3/4	25
	HBS12320	320	12 5/8	120	4 3/4	197	7 3/4	25
	HBS12360	360	14 1/4	120	4 3/4	235	9 1/4	25
	HBS12400	400	15 3/4	120	4 3/4	279	11	25
	HBS12440	440	17 1/4	120	4 3/4	318	12 1/2	25
	HBS12480	480	19	120	4 3/4	356	14	25
	HBS12520	520	20 1/2	120	4 3/4	394	15 1/2	25
	HBS12560	560	22	120	4 3/4	432	17	25
	HBS12600	600	23 5/8	120	4 3/4	470	18 1/2	25

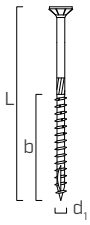
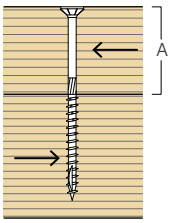
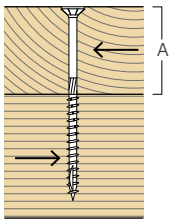
HUS COUNTERSUNK WASHER

d_{HBS} [mm] [in]	CODE	D_1 [in]	D_2 [in]	h [in]	pcs
6 **0.24**	**HUS6**	0.295	0.787	0.181	100
8 **0.32**	**HUS8**	0.335	0.984	0.213	50
10 **0.40**	**HUS10**	0.425	1.181	0.252	50
12 **0.48**	**HUS12**	0.551	1.457	0.335	25



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

HBS Ø6 | 0.24 inch - HBS Ø8 | 0.32 inch

geometry					$Z_{\parallel}$ (1)				$Z_{\perp/\parallel}$ (2)				$Z_{\perp}$ (3)			
																
d_1	L		b	A	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	[mm]	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
	40 (4)	1 9/16	1 3/8	1/16	11	15	20	24	11	15	20	24	11	15	20	24
	50	1 15/16	1 3/8	3/8	64	89	118	146	64	89	118	146	64	89	118	146
	60	2 3/8	1 3/16	3/4	86	120	142	163	86	120	142	163	86	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 9/16	1 1/2	107	149	190	211	107	149	190	211	107	149	190	211
	90	3 1/2	1 15/16	1 1/2	120	154	190	211	120	154	190	211	120	154	190	211
	100	4	1 15/16	1 3/4	129	165	190	211	129	165	190	211	129	165	190	211
	110	4 3/8	2 3/8	1 3/4	129	165	190	211	129	165	190	211	129	165	190	211
	120	4 3/4	2 3/8	2	139	165	190	211	139	165	190	211	139	165	190	211
6	130	5 1/8	2 3/8	2 1/2	139	165	190	211	139	165	190	211	139	165	190	211
0.24	140	5 1/2	2 15/16	2 1/2	139	165	190	211	139	165	190	211	139	165	190	211
	150	6	2 15/16	2 3/4	139	165	190	211	139	165	190	211	139	165	190	211
	160	6 1/4	2 15/16	3 1/4	139	165	190	211	139	165	190	211	139	165	190	211
	180	7 1/8	2 15/16	4	139	165	190	211	139	165	190	211	139	165	190	211
	200	8	2 15/16	4 3/4	139	165	190	211	139	165	190	211	139	165	190	211
	220	8 5/8	2 15/16	5 1/2	139	165	190	211	139	165	190	211	139	165	190	211
	240	9 1/2	2 15/16	6 1/4	139	165	190	211	139	165	190	211	139	165	190	211
	260	10 1/4	2 15/16	7	139	165	190	211	139	165	190	211	139	165	190	211
	280	11	2 15/16	8	139	165	190	211	139	165	190	211	139	165	190	211
	300	11 3/4	2 15/16	8 3/4	139	165	190	211	139	165	190	211	139	165	190	211
	80	3 1/8	2 1/16	1	132	179	213	244	105	143	170	195	105	143	170	195
	100	4	2 1/16	1 3/4	153	214	270	313	123	171	216	251	123	171	216	251
	120	4 3/4	2 3/8	2 1/4	184	245	282	313	147	196	225	251	147	196	225	251
	140	5 1/2	2 3/8	3	196	245	282	313	157	196	225	251	157	196	225	251
	160	6 1/4	3 1/8	3	207	245	282	313	165	196	225	251	165	196	225	251
	180	7 1/8	3 1/8	3 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	200	8	3 1/8	4 1/2	207	245	282	313	165	196	225	251	165	196	225	251
	220	8 5/8	3 1/8	5 1/2	207	245	282	313	165	196	225	251	165	196	225	251
	240	9 1/2	3 1/8	6 1/4	207	245	282	313	165	196	225	251	165	196	225	251
8	260	10 1/4	3 1/8	7	207	245	282	313	165	196	225	251	165	196	225	251
0.32	280	11	3 1/8	7 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	300	11 3/4	4	7 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	320	12 5/8	4	8 1/2	207	245	282	313	165	196	225	251	165	196	225	251
	340	13 3/8	4	9 1/4	207	245	282	313	165	196	225	251	165	196	225	251
	360	14 1/4	4	10	207	245	282	313	165	196	225	251	165	196	225	251
	380	15	4	11	207	245	282	313	165	196	225	251	165	196	225	251
	400	15 3/4	4	11 1/2	207	245	282	313	165	196	225	251	165	196	225	251
	440	17 1/4	4	13 1/4	207	245	282	313	165	196	225	251	165	196	225	251
	480	19	4	14 3/4	207	245	282	313	165	196	225	251	165	196	225	251
	520	20 1/2	4	16 1/2	207	245	282	313	165	196	225	251	165	196	225	251

NOTES:

Tabulated reference lateral design values (Z) are applicable to screws installed perpendicular to the faces of the wood members and loaded as follows:

(1) $Z_{\parallel}$ both side and main members loaded parallel to the grain.

(2) $Z_{\perp/\parallel}$ side member loaded perpendicular to the grain; main member loaded parallel to the grain.

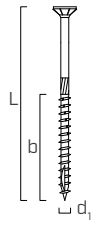
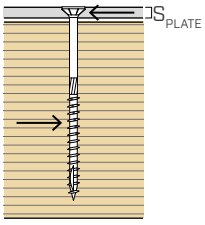
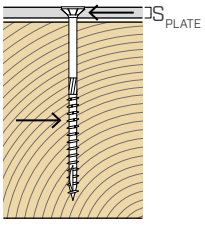
(3) $Z_{\perp}$ both side and main members loaded perpendicular to the grain.

(4) The screw penetration in the main member is 4 times the outer thread diameter, rather than 6 times the outer thread diameter as specified in ESR-4645.

Refer to page 17 for the general calculation principles.

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

HBS Ø6 | 0.24 inch - HBS Ø8 | 0.32 inch

geometry				$Z_{\parallel}$ (1)				$Z_{\perp}$ (2)				
												
d_1	L		b	steel plate thickness	G=0.35	G=0.42	G=0.49	G=0.55	steel plate thickness	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	*[mm]*	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[lbf]	[lbf]	[lbf]	[lbf]
	40	1 9/16	1 3/8		111	146	186	224		111	146	186	224
	50	1 15/16	1 3/8		134	179	205	225		134	179	205	225
	60	2 3/8	1 3/16		155	180	205	225		155	180	205	225
	70	2 3/4	1 9/16		155	180	205	225		155	180	205	225
	80	3 1/8	1 9/16		155	180	205	225		155	180	205	225
	90	3 1/2	1 15/16		155	180	205	225		155	180	205	225
	100	4	1 15/16		155	180	205	225		155	180	205	225
	110	4 3/8	2 3/8		155	180	205	225		155	180	205	225
	120	4 3/4	2 3/8		155	180	205	225		155	180	205	225
6	*130*	5 1/8	2 3/8		155	180	205	225		155	180	205	225
0.24	*140*	5 1/2	2 15/16		155	180	205	225		155	180	205	225
	150	6	2 15/16		155	180	205	225		155	180	205	225
	160	6 1/4	2 15/16		155	180	205	225		155	180	205	225
	180	7 1/8	2 15/16		155	180	205	225		155	180	205	225
	200	8	2 15/16		155	180	205	225		155	180	205	225
	220	8 5/8	2 15/16		155	180	205	225		155	180	205	225
	240	9 1/2	2 15/16		155	180	205	225		155	180	205	225
	260	10 1/4	2 15/16		155	180	205	225		155	180	205	225
	280	11	2 15/16		155	180	205	225		155	180	205	225
	300	11 3/4	2 15/16	S_{PLATE} = 1/8"	155	180	205	225	S_{PLATE} = 1/8"	155	180	205	225
	80	3 1/8	2 1/16		218	255	290	319		174	204	232	255
	100	4	2 1/16		218	255	290	319		174	204	232	255
	120	4 3/4	2 3/8		218	255	290	319		174	204	232	255
	140	5 1/2	2 3/8		218	255	290	319		174	204	232	255
	160	6 1/4	3 1/8		218	255	290	319		174	204	232	255
	180	7 1/8	3 1/8		218	255	290	319		174	204	232	255
	200	8	3 1/8		218	255	290	319		174	204	232	255
	220	8 5/8	3 1/8		218	255	290	319		174	204	232	255
	240	9 1/2	3 1/8		218	255	290	319		174	204	232	255
8	*260*	10 1/4	3 1/8		218	255	290	319		174	204	232	255
0.32	*280*	11	3 1/8		218	255	290	319		174	204	232	255
	300	11 3/4	4		218	255	290	319		174	204	232	255
	320	12 5/8	4		218	255	290	319		174	204	232	255
	340	13 3/8	4		218	255	290	319		174	204	232	255
	360	14 1/4	4		218	255	290	319		174	204	232	255
	380	15	4		218	255	290	319		174	204	232	255
	400	15 3/4	4		218	255	290	319		174	204	232	255
	440	17 1/4	4		235	274	313	344		188	220	250	275
	480	19	4		235	274	313	344		188	220	250	275
	520	20 1/2	4		235	274	313	344		188	220	250	275

NOTES:

Tabulated reference lateral design values (Z) are applicable to screws installed perpendicular to the faces of the wood members and loaded as follows:

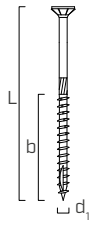
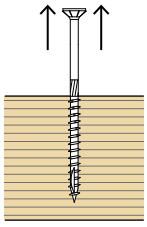
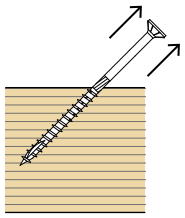
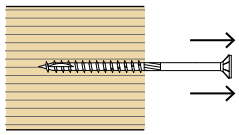
(1) $Z_{\parallel}$ main member loaded parallel to the grain.

(2) $Z_{\perp}$ main member loaded perpendicular to the grain.

Refer to page 17 for the general calculation principles.

STRUCTURAL VALUES | THREAD WITHDRAWAL (W)

HBS Ø6 | 0.24 inch - HBS Ø8 | 0.32 inch

geometry				thread withdrawal α = 90°				thread withdrawal α = 45°				thread withdrawal α = 0°			
															
d_1	L		b	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	[mm]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
	40(1)	1 9/16	1 3/8	88	102	150	163	80	92	136	149	26	30	45	49
	50(1)	1 15/16	1 3/8	88	102	150	163	80	92	136	149	26	30	45	49
	60(1)	2 3/8	1 3/16	73	84	124	135	66	77	113	123	22	25	37	41
	70(1)	2 3/4	1 9/16	103	119	175	191	94	108	160	174	31	36	53	57
	80(1)	3 1/8	1 9/16	103	119	175	191	94	108	160	174	31	36	53	57
	90(2)	3 1/2	1 15/16	133	154	227	248	121	140	207	225	40	46	68	74
	100(2)	4	1 15/16	133	154	227	248	121	140	207	225	40	46	68	74
	110	4 3/8	2 3/8	164	189	279	304	149	172	253	277	49	57	84	91
	120	4 3/4	2 3/8	164	189	279	304	149	172	253	277	49	57	84	91
6	130	5 1/8	2 3/8	164	189	279	304	149	172	253	277	49	57	84	91
0.24	140	5 1/2	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	150	6	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	160	6 1/4	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	180	7 1/8	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	200	8	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	220	8 5/8	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	240	9 1/2	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	260	10 1/4	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	280	11	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	300	11 3/4	2 15/16	209	242	356	388	190	220	324	354	63	73	107	117
	80(1)	3 1/8	2 1/16	189	217	239	301	172	197	218	274	57	65	72	90
	100(1)	4	2 1/16	189	217	239	301	172	197	218	274	57	65	72	90
	120(2)	4 3/4	2 3/8	223	256	283	356	203	233	257	324	67	77	85	107
	140(2)	5 1/2	2 3/8	223	256	283	356	203	233	257	324	67	77	85	107
	160	6 1/4	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
	180	7 1/8	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
	200	8	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
	220	8 5/8	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
	240	9 1/2	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
8	260	10 1/4	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
0.32	280	11	3 1/8	309	354	391	493	281	322	356	449	93	106	117	148
	300	11 3/4	4	395	453	500	630	359	412	455	574	118	136	150	189
	320	12 5/8	4	395	453	500	630	359	412	455	574	118	136	150	189
	340	13 3/8	4	395	453	500	630	359	412	455	574	118	136	150	189
	360	14 1/4	4	395	453	500	630	359	412	455	574	118	136	150	189
	380	15	4	395	453	500	630	359	412	455	574	118	136	150	189
	400	15 3/4	4	395	453	500	630	359	412	455	574	118	136	150	189
	440	17 1/4	4	395	453	500	630	359	412	455	574	118	136	150	189
	480	19	4	395	453	500	630	359	412	455	574	118	136	150	189
	520	20 1/2	4	395	453	500	630	359	412	455	574	118	136	150	189

NOTES:

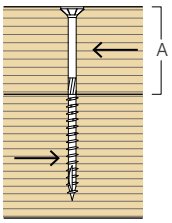
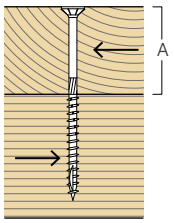
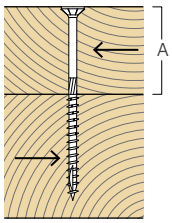
(1) The embedded thread length does not comply with the minimum requirement of ESR-4645 (6 times the outer thread diameter for screws installed at 90° to the grain and 8 times the outer thread diameter for screws installed at an angle 0°≤ α <90° to the grain).

(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).

Refer to page 17 for the general calculation principles.

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

HBS Ø10 | 0.40 inch - HBS Ø12 | 0.48 inch

geometry					$Z_{\parallel}$ (1)				$Z_{\perp/\parallel}$ (2)				$Z_{\perp}$ (3)			
																
d_1	L		b	A	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	[mm]	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
	80	3 1/8	2 1/16	1/2	123	148	173	194	67	87	109	129	67	87	109	129
	100	4	2 1/16	1	222	247	270	290	134	174	198	216	134	166	188	207
	120	4 3/4	2 3/8	2 1/8	258	310	361	387	176	218	258	292	140	182	228	269
	140	5 1/2	2 3/8	2 3/4	302	338	365	387	199	249	274	295	164	213	259	282
	160	6 1/4	3 1/8	3	308	338	365	387	220	249	274	295	188	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	8	3 1/8	4 1/2	308	338	365	387	222	249	274	295	203	232	259	282
	220	8 5/8	3 1/8	5 1/2	308	338	365	387	222	249	274	295	203	232	259	282
10 0.40	240	9 1/2	3 1/8	6 1/4	308	338	365	387	222	249	274	295	203	232	259	282
	260	10 1/4	3 1/8	7	308	338	365	387	222	249	274	295	203	232	259	282
	280	11	3 1/8	7 3/4	308	338	365	387	222	249	274	295	203	232	259	282
	300	11 3/4	4	7 3/4	308	338	365	387	222	249	274	295	203	232	259	282
	320	12 5/8	4	8 1/2	308	338	365	387	222	249	274	295	203	232	259	282
	340	13 3/8	4	9 1/4	308	338	365	387	222	249	274	295	203	232	259	282
	360	14 1/4	4	10	308	338	365	387	222	249	274	295	203	232	259	282
	380	15	4	11	308	338	365	387	222	249	274	295	203	232	259	282
	400	15 3/4	4	11 1/2	308	338	365	387	222	249	274	295	203	232	259	282
	120	4 3/4	3 1/8	1 1/2	273	308	342	372	183	211	240	266	155	197	228	255
	160	6 1/4	3 1/8	3	353	387	418	442	235	282	311	334	192	250	292	317
	200	8	3 1/8	4 1/2	353	387	418	442	251	282	311	334	226	261	292	317
	240	9 1/2	3 1/8	6 1/4	353	387	418	442	251	282	311	334	218	261	292	317
	280	11	3 1/8	7 3/4	353	387	418	442	251	282	311	334	221	261	292	317
	320	12 5/8	4 3/4	7 3/4	353	387	418	442	251	282	311	334	229	261	292	317
12 0.48	360	14 1/4	4 3/4	9 1/4	353	387	418	442	251	282	311	334	229	261	292	317
	400	15 3/4	4 3/4	11	353	387	418	442	251	282	311	334	229	261	292	317
	440	17 1/4	4 3/4	12 1/2	353	387	418	442	251	282	311	334	229	261	292	317
	480	19	4 3/4	14	353	387	418	442	251	282	311	334	229	261	292	317
	520	20 1/2	4 3/4	15 1/2	353	387	418	442	251	282	311	334	229	261	292	317
	560	22	4 3/4	17	353	387	418	442	251	282	311	334	229	261	292	317
	600	23 5/8	4 3/4	18 1/2	353	387	418	442	251	282	311	334	229	261	292	317

NOTES:

Tabulated reference lateral design values (Z) are applicable to screws installed perpendicular to the faces of the wood members and loaded as follows:

(1) $Z_{\parallel}$ both side and main members loaded parallel to the grain.

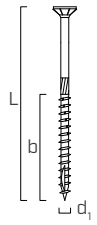
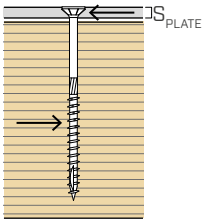
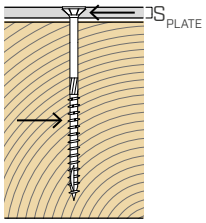
(2) $Z_{\perp/\parallel}$ side member loaded perpendicular to the grain; main member loaded parallel to the grain.

(3) $Z_{\perp}$ both side and main members loaded perpendicular to the grain.

Refer to page 17 for the general calculation principles.

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

HBS Ø10 | 0.40 inch - HBS Ø12 | 0.48 inch

geometry				$Z_{\parallel}$ (1)				$Z_{\perp}$ (2)				
												
d_1	L		b	steel plate thickness	G=0.35	G=0.42	G=0.49	G=0.55	steel plate thickness	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	*[mm]*	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[lbf]	[lbf]	[lbf]	[lbf]
10 **0.40**	*80*	3 1/8	2 1/16	S_{PLATE} = 1/4"	333	389	418	440	S_{PLATE} = 1/4"	192	239	289	324
	100	4	2 1/16		361	391	418	440		232	273	302	324
	120	4 3/4	2 3/8		361	391	418	440		242	273	302	324
	140	5 1/2	2 3/8		361	391	418	440		242	273	302	324
	160	6 1/4	3 1/8		361	391	418	440		242	273	302	324
	180	7 1/8	3 1/8		361	391	418	440		242	273	302	324
	200	8	3 1/8		361	391	418	440		242	273	302	324
	220	8 5/8	3 1/8		361	391	418	440		242	273	302	324
	240	9 1/2	3 1/8		361	391	418	440		242	273	302	324
	260	10 1/4	3 1/8		361	391	418	440		242	273	302	324
	280	11	3 1/8		361	391	418	440		242	273	302	324
	300	11 3/4	4		361	391	418	440		242	273	302	324
	320	12 5/8	4		361	391	418	440		242	273	302	324
	340	13 3/8	4		361	391	418	440		242	273	302	324
	360	14 1/4	4		361	391	418	440		242	273	302	324
	380	15	4		361	391	418	440		242	273	302	324
	400	15 3/4	4		361	391	418	440		242	273	302	324
12 **0.48**	*120*	4 3/4	3 1/8	S_{PLATE} = 1/4"	403	437	467	491	S_{PLATE} = 1/4"	267	301	332	358
	160	6 1/4	3 1/8		403	437	467	491		267	301	332	358
	200	8	3 1/8		403	437	467	491		267	301	332	358
	240	9 1/2	3 1/8		403	437	467	491		267	301	332	358
	280	11	3 1/8		403	437	467	491		267	301	332	358
	320	12 5/8	4 3/4		403	437	467	491		267	301	332	358
	360	14 1/4	4 3/4		403	437	467	491		267	301	332	358
	400	15 3/4	4 3/4		403	437	467	491		267	301	332	358
	440	17 1/4	4 3/4		403	437	467	491		267	301	332	358
	480	19	4 3/4		403	437	467	491		267	301	332	358
	520	20 1/2	4 3/4		533	578	619	651		339	383	424	457
	560	22	4 3/4		533	578	619	651		339	383	424	457
	600	23 5/8	4 3/4		533	578	619	651		339	383	424	457

NOTES:

Tabulated reference lateral design values (Z) are applicable to screws installed perpendicular to the faces of the wood members and loaded as follows:

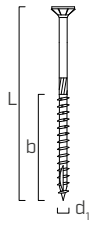
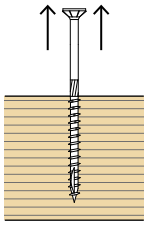
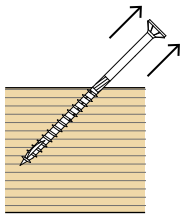
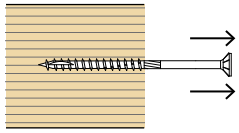
(1) $Z_{\parallel}$ main member loaded parallel to the grain.

(2) $Z_{\perp}$ main member loaded perpendicular to the grain.

Refer to page 17 for the general calculation principles.

STRUCTURAL VALUES | THREAD WITHDRAWAL (W)

HBS Ø10 | 0.40 inch - HBS Ø12 | 0.48 inch

geometry				thread withdrawal α = 90°				thread withdrawal α = 45°				thread withdrawal α = 0°			
															
d_1	**L**		**b**	**G=0.35**	**G=0.42**	**G=0.49**	**G=0.55**	**G=0.35**	**G=0.42**	**G=0.49**	**G=0.55**	**G=0.35**	**G=0.42**	**G=0.49**	**G=0.55**
[mm] [in]	*[mm]*	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
	80[1]	3 1/8	2 1/16	231	266	311	339	211	242	283	308	69	80	93	102
	100[1]	4	2 1/16	231	266	311	339	211	242	283	308	69	80	93	102
	120[1]	4 3/4	2 3/8	276	317	370	404	251	288	337	367	83	95	111	121
	140[1]	5 1/2	2 3/8	276	317	370	404	251	288	337	367	83	95	111	121
	160[2]	6 1/4	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
	180[2]	7 1/8	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
	200[2]	8	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
	220[2]	8 5/8	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
10 **0.40**	*240*[2]	9 1/2	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
	260[2]	10 1/4	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
	280[2]	11	3 1/8	386	444	518	565	351	404	471	514	116	133	155	169
	300	11 3/4	4	496	570	666	726	451	519	606	661	149	171	200	218
	320	12 5/8	4	496	570	666	726	451	519	606	661	149	171	200	218
	340	13 3/8	4	496	570	666	726	451	519	606	661	149	171	200	218
	360	14 1/4	4	496	570	666	726	451	519	606	661	149	171	200	218
	380	15	4	496	570	666	726	451	519	606	661	149	171	200	218
	400	15 3/4	4	496	570	666	726	451	519	606	661	149	171	200	218
	120[1]	4 3/4	3 1/8	551	632	712	776	502	575	648	707	165	190	214	233
	160[1]	6 1/4	3 1/8	551	632	712	776	502	575	648	707	165	190	214	233
	200[1]	8	3 1/8	551	632	712	776	502	575	648	707	165	190	214	233
	240[1]	9 1/2	3 1/8	551	632	712	776	502	575	648	707	165	190	214	233
	280[1]	11	3 1/8	551	632	712	776	502	575	648	707	165	190	214	233
	320	12 5/8	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
12 **0.48**	*360*	14 1/4	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
	400	15 3/4	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
	440	17 1/4	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
	480	19	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
	520	20 1/2	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
	560	22	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370
	600	23 5/8	4 3/4	876	1003	1131	1233	797	913	1029	1122	263	301	339	370

NOTES:

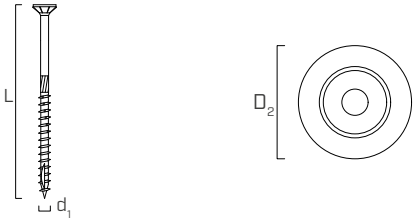
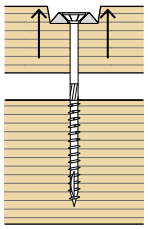
(1) The embedded thread length does not comply with the minimum requirement of ESR-4645 (6 times the outer thread diameter for screws installed at 90° to the grain and 8 times the outer thread diameter for screws installed at an angle 0°≤ α <90° to the grain).

(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).

Refer to page 17 for the general calculation principles.

STRUCTURAL VALUES | HEAD PULL-THROUGH (W_H)

HBS Ø6 | 0.24 inch - HBS Ø8 | 0.32 inch - HBS Ø10 | 0.40 inch - HBS Ø12 | 0.48 inch

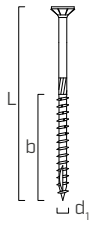
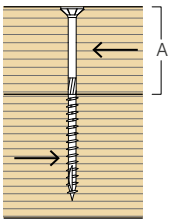
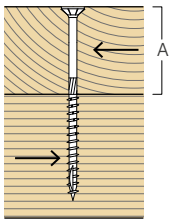
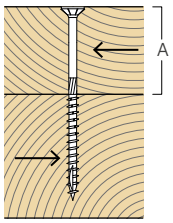
geometry					head pull-through			
								
d_1 [mm] [in]	L [mm]	L [in]	countersunk washer	washer outer diameter D_2 [in]	minimum side member thickness [in]	G=0.35 [lbf]	G=0.42 [lbf]	G=0.49 [lbf]	G=0.55 [lbf]
6 **0.24**	*from 40 to 300*	from 1 9/16 to 11 3/4	**HUS6**	0.787	1 1/2	166	239	270	294
8 **0.32**	*from 80 to 520*	from 3 1/8 to 20 1/2	**HUS8**	0.984	1 1/2	166	239	325	410
10 **0.40**	*from 80 to 400*	from 3 1/8 to 15 3/4	**HUS10**	1.181	1 1/2	166	239	325	410
12 **0.48**	*from 120 to 600*	from 4 3/4 to 23 5/8	**HUS12**	1.457	1 1/2	166	239	325	410

NOTES:

Refer to page 17 for the general calculation principles.

STRUCTURAL VALUES | REFERENCE LATERAL DESIGN VALUES (Z) | WOOD-TO-WOOD[*]

HBS Ø3,5 | 0.14 inch - HBS Ø4 | 0.16 inch - HBS Ø4,5 | 0.18 inch - HBS Ø5 | 0.20 inch

geometry					$Z_{\parallel}$ [1]				$Z_{\perp/\parallel}$ [2]				$Z_{\perp}$ [3]			
																
d_1	L		b	A	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	*[mm]*	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
3,5 **0.14**	*40*[4]	1 9/16	11/16	3/4	30	42	52	58	30	42	52	58	30	42	52	58
	45	1 3/4	15/16	3/4	34	43	52	58	34	43	52	58	34	43	52	58
	50	1 15/16	15/16	1	37	45	52	58	37	45	52	58	37	45	52	58
4 **0.16**	*30*[4]	1 3/16	11/16	1/4	27	38	48	53	27	38	48	53	27	38	48	53
	35	1 3/8	11/16	1/4	27	38	48	53	27	38	48	53	27	38	48	53
	40	1 9/16	15/16	1/4	27	38	48	53	27	38	48	53	27	38	48	53
	45	1 3/4	1 3/16	1/2	36	44	53	62	36	44	53	62	36	44	53	62
	50	1 15/16	1 3/16	3/4	41	52	65	75	41	52	65	75	41	52	65	75
	60	2 3/8	1 3/8	3/4	41	52	65	75	41	52	65	75	41	52	65	75
	70	2 3/4	1 9/16	1	47	58	67	75	47	58	67	75	47	58	67	75
	80	3 1/8	1 9/16	1 1/2	49	58	67	75	49	58	67	75	49	58	67	75
4,5 **0.18**	*40*[4]	1 9/16	15/16	1/2	40	52	62	72	40	52	62	72	40	52	62	72
	45	1 3/4	1 3/16	1/2	43	52	62	72	43	52	62	72	43	52	62	72
	50	1 15/16	1 3/16	3/4	47	60	74	88	47	60	74	88	47	60	74	88
	60	2 3/8	1 3/8	3/4	47	60	74	88	47	60	74	88	47	60	74	88
	70	2 3/4	1 9/16	1	54	70	81	90	54	70	81	90	54	70	81	90
	80	3 1/8	1 9/16	1 1/2	60	70	81	90	60	70	81	90	60	70	81	90
5 **0.20**	*40*[4]	1 9/16	15/16	1/2	49	68	88	100	49	68	88	100	49	68	88	100
	45[4]	1 3/4	15/16	3/4	51	72	95	116	51	72	95	116	51	72	95	116
	50[4]	1 15/16	15/16	1	57	80	106	126	57	80	106	126	57	80	106	126
	60	2 3/8	1 3/16	1	69	92	115	133	69	92	115	133	69	92	115	133
	70	2 3/4	1 3/8	1 1/4	80	104	120	133	80	104	120	133	80	104	120	133
	80	3 1/8	1 9/16	1 1/2	88	104	120	133	88	104	120	133	88	104	120	133
	90	3 1/2	1 3/4	1 3/4	88	104	120	133	88	104	120	133	88	104	120	133
	100	4	1 15/16	1 3/4	88	104	120	133	88	104	120	133	88	104	120	133
	120	4 3/4	2 3/8	2 1/4	88	104	120	133	88	104	120	133	88	104	120	133

NOTES:

[*] The screws are not evaluated in ESR-4645.

Tabulated reference lateral design values (Z) are applicable to screws installed perpendicular to the faces of the wood members and loaded as follows:

[1] $Z_{\parallel}$ both side and main members loaded parallel to the grain.

[2] $Z_{\perp/\parallel}$ side member loaded perpendicular to the grain; main member loaded parallel to the grain.

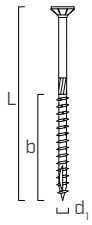
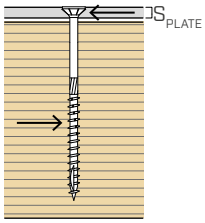
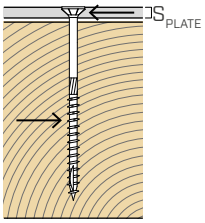
[3] $Z_{\perp}$ both side and main members loaded perpendicular to the grain.

[4] The screw penetration in the main member is lower than 6 times the outer thread diameter.

Refer to page 17 for the general calculation principles.

STRUCTURAL VALUES | REFERENCE LATERAL DESIGN VALUES (Z) | STEEL-TO-WOOD[*]

HBS Ø3,5 | 0.14 inch - HBS Ø4 | 0.16 inch - HBS Ø4,5 | 0.18 inch - HBS Ø5 | 0.20 inch

geometry				$Z_{\parallel}$ [1]				$Z_{\perp}$ [2]				
												
d_1	L		b	steel plate thickness	G=0.35	G=0.42	G=0.49	G=0.55	steel plate thickness	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	*[mm]*	[in]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[lbf]	[lbf]	[lbf]	[lbf]
3,5 **0.14**	*40*	1 9/16	11/16	S_{PLATE} = 1/16"	43	50	57	63	S_{PLATE} = 1/16"	43	50	57	63
	45	1 3/4	15/16		43	50	57	63		43	50	57	63
	50	1 15/16	15/16		43	50	57	63		43	50	57	63
4 **0.16**	*30*	1 3/16	11/16	S_{PLATE} = 1/16"	50	63	71	78	S_{PLATE} = 1/16"	50	63	71	78
	35	1 3/8	11/16		54	63	71	78		54	63	71	78
	40	1 9/16	15/16		54	63	71	78		54	63	71	78
	45	1 3/4	1 3/16		54	63	71	78		54	63	71	78
	50	1 15/16	1 3/16		54	63	71	78		54	63	71	78
	60	2 3/8	1 3/8		54	63	71	78		54	63	71	78
	70	2 3/4	1 9/16		54	63	71	78		54	63	71	78
	80	3 1/8	1 9/16		54	63	71	78		54	63	71	78
4,5 **0.18**	*40*	1 9/16	15/16	S_{PLATE} = 1/16"	64	74	84	93	S_{PLATE} = 1/16"	64	74	84	93
	45	1 3/4	1 3/16		64	74	84	93		64	74	84	93
	50	1 15/16	1 3/16		64	74	84	93		64	74	84	93
	60	2 3/8	1 3/8		64	74	84	93		64	74	84	93
	70	2 3/4	1 9/16		64	74	84	93		64	74	84	93
	80	3 1/8	1 9/16		64	74	84	93		64	74	84	93
5 **0.20**	*40*	1 9/16	15/16	S_{PLATE} = 1/16"	88	106	121	133	S_{PLATE} = 1/16"	88	106	121	133
	45	1 3/4	15/16		91	106	121	133		91	106	121	133
	50	1 15/16	15/16		91	106	121	133		91	106	121	133
	60	2 3/8	1 3/16		91	106	121	133		91	106	121	133
	70	2 3/4	1 3/8		91	106	121	133		91	106	121	133
	80	3 1/8	1 9/16		91	106	121	133		91	106	121	133
	90	3 1/2	1 3/4		91	106	121	133		91	106	121	133
	100	4	1 15/16		91	106	121	133		91	106	121	133
	120	4 3/4	2 3/8		91	106	121	133		91	106	121	133

NOTES:

[*]The screws are not evaluated in ESR-4645.

Tabulated reference lateral design values (Z) are applicable to screws installed perpendicular to the faces of the wood members and loaded as follows:

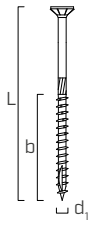
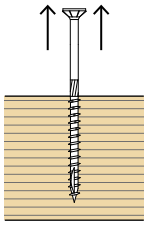
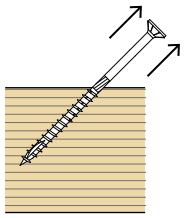
[1] $Z_{\parallel}$ main member loaded parallel to the grain.

[2] $Z_{\perp}$ main member loaded perpendicular to the grain.

Refer to page 17 for the general calculation principles.

STRUCTURAL VALUES | THREAD WITHDRAWAL[*]

HBS Ø3,5 | 0.14 inch - HBS Ø4 | 0.16 inch - HBS Ø4,5 | 0.18 inch - HBS Ø5 | 0.20 inch

geometry				thread withdrawal α = 90°				thread withdrawal α = 45°				thread withdrawal α = 0°			
															
d_1	L		b	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=0.55	G=0.35	G=0.42	G=0.49	G=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)	1 9/16	11/16	26	30	43	47	23	27	39	43	8	9	13	14
	45(1)	1 3/4	15/16	36	42	61	67	33	38	56	61	11	13	18	20
	50(1)	1 15/16	15/16	36	42	61	67	33	38	56	61	11	13	18	20
4 0.16	30(1)	1 3/16	11/16	28	33	31	52	26	30	29	48	8	10	9	16
	35(1)	1 3/8	11/16	28	33	31	52	26	30	29	48	8	10	9	16
	40(1)	1 9/16	15/16	40	46	45	75	37	42	41	68	12	14	13	22
	45(2)	1 3/4	1 3/16	52	60	58	97	48	55	53	88	16	18	18	29
	50(2)	1 15/16	1 3/16	52	60	58	97	48	55	53	88	16	18	18	29
	60(2)	2 3/8	1 3/8	62	72	70	116	57	66	63	106	19	22	21	35
	70	2 3/4	1 9/16	72	84	81	135	66	76	74	123	22	25	24	40
	80	3 1/8	1 9/16	72	84	81	135	66	76	74	123	22	25	24	40
4,5 0.18	40(1)	1 9/16	15/16	45	51	75	82	41	47	68	75	13	15	23	25
	45(1)	1 3/4	1 3/16	58	67	98	107	53	61	90	98	17	20	30	32
	50(1)	1 15/16	1 3/16	58	67	98	107	53	61	90	98	17	20	30	32
	60(2)	2 3/8	1 3/8	70	80	118	128	63	73	107	117	21	24	35	39
	70(2)	2 3/4	1 9/16	81	94	137	150	74	85	125	136	24	28	41	45
	80(2)	3 1/8	1 9/16	81	94	137	150	74	85	125	136	24	28	41	45
5 0.20	40(1)	1 9/16	15/16	48	55	82	89	44	50	74	81	14	17	24	27
	45(1)	1 3/4	15/16	48	55	82	89	44	50	74	81	14	17	24	27
	50(1)	1 15/16	15/16	48	55	82	89	44	50	74	81	14	17	24	27
	60(1)	2 3/8	1 3/16	63	73	107	117	57	66	98	107	19	22	32	35
	70(2)	2 3/4	1 3/8	76	87	129	141	69	80	117	128	23	26	39	42
	80(2)	3 1/8	1 9/16	88	102	150	164	80	93	137	149	26	31	45	49
	90	3 1/2	1 3/4	101	117	172	187	92	106	156	171	30	35	51	56
	100	4	1 15/16	113	131	193	211	103	119	176	192	34	39	58	63
	120	4 3/4	2 3/8	139	160	236	258	126	146	215	234	42	48	71	77

NOTES:

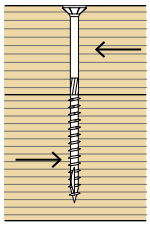
(*)The screws are not evaluated in ESR-4645.

(1) The embedded thread length is lower than 6 times the outer thread diameter.

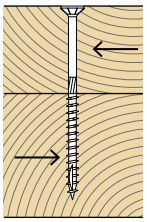
(2) The embedded thread length is lower than 8 times the outer thread diameter.

Refer to page 17 for the general calculation principles.

MINIMUM DISTANCES FOR LATERAL LOADING



Load-to-grain angle α = 0°



Load-to-grain angle α = 90°

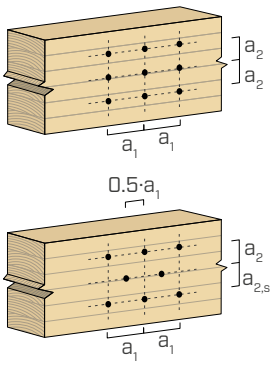
Screws inserted without pre-drilling hole G < 0.50

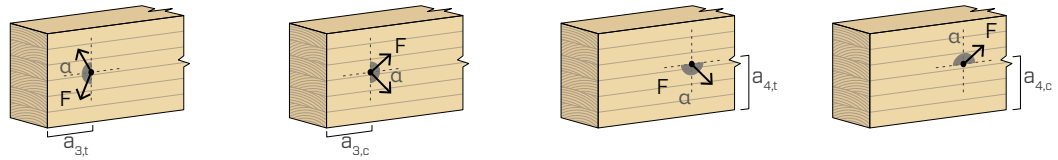
d_1	[mm]		3,5(*)	4(*)	4,5(*)	5(*)	6	8		10	12		3,5(*)	4(*)	4,5(*)	5(*)	6	8		10	12
	[in]		0.14	0.16	0.18	0.20	0.24	0.32		0.40	0.48		0.14	0.16	0.18	0.20	0.24	0.32		0.40	0.48
a_1	[in]	**15·d**	2 1/16	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4	**15·d**	6	7 1/8	**10·d**	1 3/8	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8	**10·d**	4	4 3/4
a_2	[in]	**5·d**	11/16	13/16	7/8	1	1 3/16	1 9/16	**5·d**	1 15/16	2 3/8	**5·d**	11/16	13/16	7/8	1	1 3/16	1 9/16	**5·d**	1 15/16	2 3/8
$a_{2,s}$	[in]	**2.5·d**	3/8	3/8	1/2	1/2	9/16	13/16	**5·d**	1 15/16	2 3/8	**2.5·d**	3/8	3/8	1/2	1/2	9/16	13/16	**5·d**	1 15/16	2 3/8
$a_{3,t}$	[in]	**15·d**	2 1/16	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4	**15·d**	6	7 1/8	**10·d**	1 3/8	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8	**10·d**	4	4 3/4
$a_{3,c}$	[in]	**10·d**	1 3/8	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8	**10·d**	4	4 3/4	**10·d**	1 3/8	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8	**10·d**	4	4 3/4
$a_{4,t}$	[in]	**5·d**	11/16	13/16	7/8	1	1 3/16	1 9/16	**5·d**	1 15/16	2 3/8	**10·d**	1 3/8	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8	**10·d**	4	4 3/4
$a_{4,c}$	[in]	**5·d**	11/16	13/16	7/8	1	1 3/16	1 9/16	**5·d**	1 15/16	2 3/8	**5·d**	11/16	13/16	7/8	1	1 3/16	1 9/16	**5·d**	1 15/16	2 3/8

Screws inserted without pre-drilling hole G ≥ 0.50

d_1	[mm]		3,5(*)	4(*)	4,5(*)	5(*)	6	8		10	12		3,5(*)	4(*)	4,5(*)	5(*)	6	8		10	12
	[in]		0.14	0.16	0.18	0.20	0.24	0.32		0.40	0.48		0.14	0.16	0.18	0.20	0.24	0.32		0.40	0.48
a_1	[in]	**15·d**	2 1/16	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4	**15·d**	6	7 1/8	**10·d**	1 3/8	1 9/16	1 3/4	1 15/16	2 3/8	3 1/8	**10·d**	4	4 3/4
a_2	[in]	**7·d**	1	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16	**7·d**	2 3/4	3 5/16	**7·d**	1	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16	**7·d**	2 3/4	3 5/16
$a_{2,s}$	[in]	**3·d**	7/16	1/2	9/16	9/16	11/16	15/16	**5·d**	1 15/16	2 3/8	**3·d**	7/16	1/2	9/16	9/16	11/16	15/16	**5·d**	1 15/16	2 3/8
$a_{3,t}$	[in]	**20·d**	2 3/4	3 1/8	3 1/2	4	4 3/4	6 1/4	**20·d**	8	9 1/2	**15·d**	2 1/16	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4	**15·d**	6	7 1/8
$a_{3,c}$	[in]	**15·d**	2 1/16	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4	**15·d**	6	7 1/8	**15·d**	2 1/16	2 3/8	2 11/16	2 15/16	3 1/2	4 3/4	**15·d**	6	7 1/8
$a_{4,t}$	[in]	**7·d**	1	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16	**7·d**	2 3/4	3 5/16	**12·d**	1 5/8	1 7/8	2 1/8	2 3/8	2 13/16	3 3/4	**12·d**	4 3/4	5 11/16
$a_{4,c}$	[in]	**7·d**	1	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16	**7·d**	2 3/4	3 5/16	**7·d**	1	1 1/8	1 1/4	1 3/8	1 5/8	2 3/16	**7·d**	2 3/4	3 5/16

d = nominal screw diameter



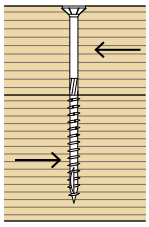


NOTES:

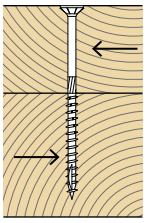
(*) Not evaluated in ESR-4645.

- The minimum spacing and distances comply with Table 9 of ESR-4645, where d refers to the nominal diameter of the screw.
- Values for spacing between staggered rows $a_{2,s}$ apply where fasteners in adjacent rows are offset by half of the spacing between fasteners in a row ($0.5 \cdot a_1$).
- Wood member stresses must be checked in accordance with Section 11.1.2 and Appendix E of the NDS, and end distances, edge distances and fastener spacing may need to be increased accordingly.

MINIMUM DISTANCES FOR LATERAL LOADING



Load-to-grain angle α = 0°



Load-to-grain angle α = 90°

Screws inserted without pre-drilling hole G ≤ 0.47

d_1	[mm]		3,5	4	4,5		5	6	8	10	12		3,5	4	4,5		5	6	8	10	12
	[in]		0.14	0.16	0.18		0.20	0.24	0.32	0.40	0.48		0.14	0.16	0.18		0.20	0.24	0.32	0.40	0.48
a_1	[in]	**10·d**	1 3/8	1 9/16	1 3/4	**12·d**	2 3/8	2 13/16	3 3/4	4 3/4	5 11/16	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8
a_2	[in]	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8
$a_{3,t}$	[in]	**15·d**	2 1/16	2 3/8	2 11/16	**15·d**	2 15/16	3 1/2	4 3/4	6	7 1/8	**10·d**	1 3/8	1 9/16	1 3/4	**10·d**	1 15/16	2 3/8	3 1/8	4	4 3/4
$a_{3,c}$	[in]	**10·d**	1 3/8	1 9/16	1 3/4	**10·d**	1 15/16	2 3/8	3 1/8	4	4 3/4	**10·d**	1 3/8	1 9/16	1 3/4	**10·d**	1 15/16	2 3/8	3 1/8	4	4 3/4
$a_{4,t}$	[in]	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8	**7·d**	1	1 1/8	1 1/4	**10·d**	1 15/16	2 3/8	3 1/8	4	4 3/4
$a_{4,c}$	[in]	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8

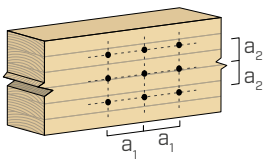
Screws inserted without pre-drilling hole G > 0.47

d_1	[mm]		3,5	4	4,5		5	6	8	10	12		3,5	4	4,5		5	6	8	10	12
	[in]		0.14	0.16	0.18		0.20	0.24	0.32	0.40	0.48		0.14	0.16	0.18		0.20	0.24	0.32	0.40	0.48
a_1	[in]	**15·d**	2 1/16	2 3/8	2 11/16	**15·d**	2 15/16	3 1/2	4 3/4	6	7 1/8	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16
a_2	[in]	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16
$a_{3,t}$	[in]	**20·d**	2 3/4	3 1/8	3 1/2	**20·d**	4	4 3/4	6 1/4	8	9 1/2	**15·d**	2 1/16	2 3/8	2 11/16	**15·d**	2 15/16	3 1/2	4 3/4	6	7 1/8
$a_{3,c}$	[in]	**15·d**	2 1/16	2 3/8	2 11/16	**15·d**	2 15/16	3 1/2	4 3/4	6	7 1/8	**15·d**	2 1/16	2 3/8	2 11/16	**15·d**	2 15/16	3 1/2	4 3/4	6	7 1/8
$a_{4,t}$	[in]	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16	**9·d**	1 1/4	1 7/16	1 5/8	**12·d**	2 3/8	2 13/16	3 3/4	4 3/4	5 11/16
$a_{4,c}$	[in]	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16

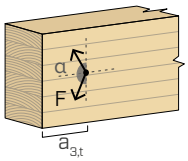
Screws inserted with pre-drilling hole

d_1	[mm]		3,5	4	4,5		5	6	8	10	12		3,5	4	4,5		5	6	8	10	12
	[in]		0.14	0.16	0.18		0.20	0.24	0.32	0.40	0.48		0.14	0.16	0.18		0.20	0.24	0.32	0.40	0.48
a_1	[in]	**5·d**	11/16	13/16	7/8	**5·d**	1	1 3/16	1 9/16	1 15/16	2 3/8	**4·d**	9/16	5/8	11/16	**4·d**	13/16	15/16	1 1/4	1 9/16	1 7/8
a_2	[in]	**3·d**	7/16	1/2	9/16	**3·d**	9/16	11/16	15/16	1 3/16	1 7/16	**4·d**	9/16	5/8	11/16	**4·d**	13/16	15/16	1 1/4	1 9/16	1 7/8
$a_{3,t}$	[in]	**12·d**	1 5/8	1 7/8	2 1/8	**12·d**	2 3/8	2 13/16	3 3/4	4 3/4	5 11/16	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16
$a_{3,c}$	[in]	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16	**7·d**	1	1 1/8	1 1/4	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16
$a_{4,t}$	[in]	**3·d**	7/16	1/2	9/16	**3·d**	9/16	11/16	15/16	1 3/16	1 7/16	**5·d**	11/16	13/16	7/8	**7·d**	1 3/8	1 5/8	2 3/16	2 3/4	3 5/16
$a_{4,c}$	[in]	**3·d**	7/16	1/2	9/16	**3·d**	9/16	11/16	15/16	1 3/16	1 7/16	**3·d**	7/16	1/2	9/16	**3·d**	9/16	11/16	15/16	1 3/16	1 7/16

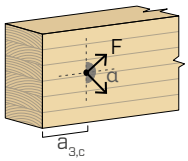
d = nominal screw diameter



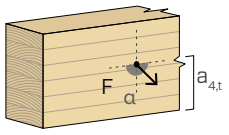
stressed end
-90° < α < 90°



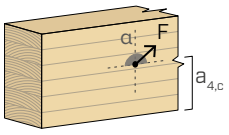
unloaded end
90° < α < 270°



stressed edge
0° < α < 180°



unload edge
180° < α < 360°



NOTES:

- The tabulated values for the minimum spacing and distances are according to the European Technical Assessment ETA-11/0030. The values from ETA-11/0030 are based on extensive research studies carried out in Europe and are according to the well-established provisions from EN 1995:2014 (Eurocode 5). Designers may adopt, under their responsibility, the minimum spacing and distances from ETA-11/0030.
- Specific gravity of G = 0.47 is equivalent to a characteristic density of ρ_k = 420 kg/m^3.
- The minimum spacing for all steel-to-timber connections (a_1 and a_2) can be multiplied by a coefficient of 0.7.

GENERAL PRINCIPLES:

- Tabulated values must be multiplied by all adjustment factors included in the NDS for dowel-type fasteners to determine allowable loads for use with ASD, design loads for use with LRFD or both.
- As part of the connection design, the structural wood members must be checked for load-carrying capacity in accordance with Section 11.1.2 of the NDS and local stresses within multiple-fastener connections must be checked against Appendix E of the NDS to ensure the capacity of the connection and fastener group.
- The design of connection with steel side plate must comply with Section 11.2.3 of the NDS.
- Connections with multiple screws must be designed in accordance with Sections 11.2.2 and 12.6 of the NDS and the requirements in Section 4.1.7.3.1 of ESR-4645.
- HBS screws must be installed and used in dry in-service conditions in accordance with the NDS (wet service factor for connection C_M is 1.0)
- Sizing and verification of the timber elements and steel plates must be done separately by the designer.

REFERENCE LATERAL DESIGN VALUES:

- Tabulated values are determined from the yield model equations in Section 12.3 and Table 12.3.1A of the NDS.
- 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 NDS and Section 4.1.6.2 of 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 less 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 less the thickness of the steel side member.

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 Table 7 of ESR-4645 and are reported below.

d_1	Reference withdrawal design values W_{ref}			
	G=0.35	G=0.42	G=0.49	G=0.55
[mm] [in]	[lbf/in]	[lbf/in]	[lbf/in]	[lbf/in]
3.5 **0.14(*)**	45	52	76	83
4 **0.16(*)**	51	59	87	95
4.5 **0.18(*)**	58	67	98	107
5 **0.20(*)**	64	74	109	119
6 **0.24**	77	89	131	143
8 **0.32**	109	125	138	174
10 **0.40**	140	161	188	205
12 **0.48**	206	236	266	290

(*) Not evaluated in 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:

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

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

Tabulated values at page 7, 10 and 14 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 $0° \le \alpha < 90°$ 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 $\alpha \le 15°$.
- The reference withdrawal design values must be less than f_{tens} of the screw.

REFERENCE HEAD-PULL THROUGH DESIGN VALUES:

- Tabulated values are valid for HBS screws in combination with HUS countersunk washers installed perpendicular to the faces of the wood members.
- The reference head pull-through values must be less than f_{tens} of the screw.
- The head pull-through design values for HBS screws with diameter 3,5 mm | 0.14 inch, 4,0 mm | 0.16 inch, 4,5 mm | 0.18 inch and 5,0 mm | 0.20 inch screws can be determined according to the NDS.