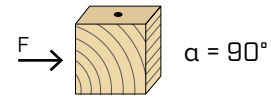
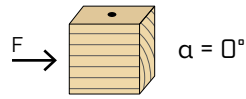


MINIMUM DISTANCES FOR SHEAR LOADS | TIMBER

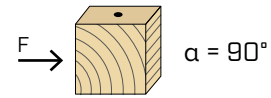
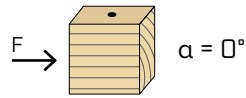
screws inserted **WITHOUT pre-drilled hole** $G \leq 0.48$



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

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

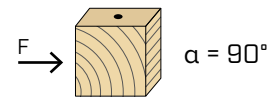
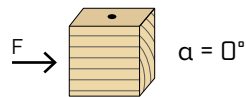
screws inserted **WITHOUT pre-drilled hole** $0.48 < G \leq 0.50$



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

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

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



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

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

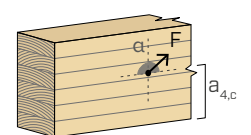
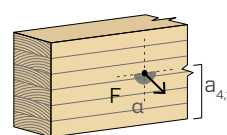
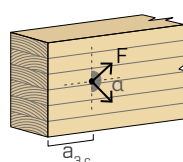
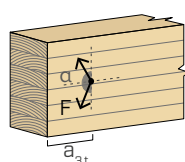
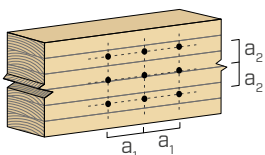
α = load-to-grain angle
 $d = d_1$ = nominal diameter of the screw

stressed end
 $-90^\circ < \alpha < 90^\circ$

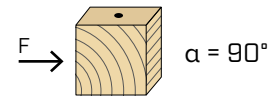
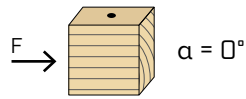
unloaded end
 $90^\circ < \alpha < 270^\circ$

stressed edge
 $0^\circ < \alpha < 180^\circ$

unload edge
 $180^\circ < \alpha < 360^\circ$

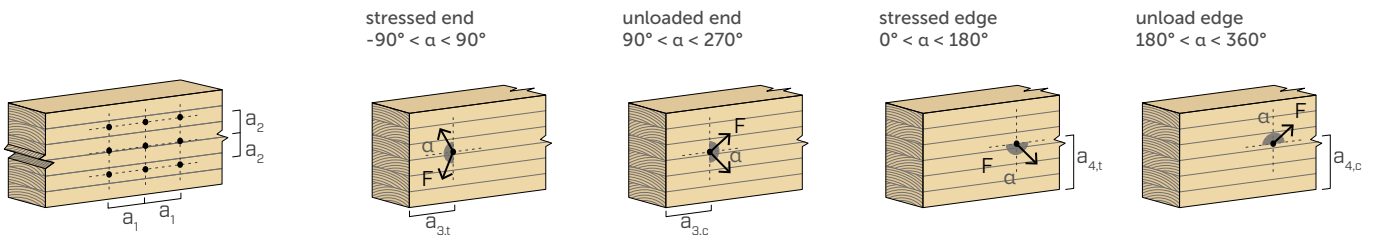


 screws inserted **WITH pre-drilled hole**



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

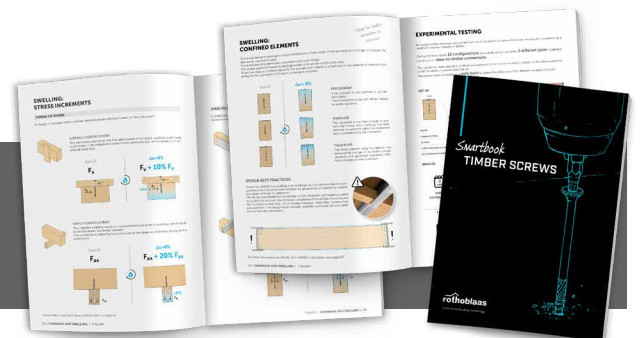
α = load-to-grain angle
 $d = d_1$ = nominal diameter of the screw



NOTES

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

Theory, practice and experimental campaigns:
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REFERENCE LATERAL DESIGN VALUES (Z) | WOOD-TO-WOOD

geometry					$Z_{ }$				$Z_{\perp/ }$				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]	[lbF]	[lbF]
6 0.24	60	2 3/8	1 9/16	3/4	87	120	142	163	87	120	142	163	87	120	142	163	
	70	2 3/4	1 9/16	1	97	129	156	182	97	129	156	182	97	129	156	182	
	80	3 1/8	1 15/16	1	104	129	156	182	104	129	156	182	104	129	156	182	
	90	3 1/2	1 15/16	1 1/2	120	154	190	211	120	154	190	211	120	154	190	211	
	100	4	2 3/8	1 1/2	120	154	190	211	120	154	190	211	120	154	190	211	
	120-200	4 3/4-8	2 15/16	$\geq 1 3/4$	129	165	190	211	129	165	190	211	129	165	190	211	
	220-400	8 5/8-15 3/4	4	$\geq 4 1/2$	139	165	190	211	139	165	190	211	139	165	190	211	
8 0.32	40	1 9/16	1 1/4	1/4	49	68	90	112	39	54	72	89	39	54	72	89	
	60-100	2 7/8-4	2 1/16	$\geq 1/4$	49	68	90	112	39	54	72	89	39	54	72	89	
	120	4 3/4	3 1/8	1 1/2	160	202	248	292	128	161	198	233	128	161	198	233	
	140	5 1/2	3 1/8	2 1/4	191	245	282	313	153	196	225	251	153	196	225	251	
10 0.40	160-600	6 1/4-23 5/8	4	$\geq 2 1/4$	191	245	282	313	153	196	225	251	153	196	225	251	
	100	4	2 1/16	1/2	217	261	304	341	149	184	220	253	118	153	192	226	
	120	4 3/4	2 3/8	1	259	311	362	387	173	215	259	295	140	182	228	270	
	140	5 1/2	2 3/8	2 1/8	300	338	365	387	195	245	274	295	165	216	259	282	
	160	6 1/4	3 1/8	2 3/4	308	338	365	387	220	249	274	295	186	232	259	282	
	180	7 1/8	3 1/8	3 3/4	308	338	365	387	222	249	274	295	203	232	259	282	
	200-300	8-11 3/4	4	$\geq 3 3/4$	308	338	365	387	222	249	274	295	203	232	259	282	
320-600	12 5/8-23 5/8	4 3/4	$\geq 7 3/4$	308	338	365	387	222	249	274	295	203	232	259	282		
12 0.48	200-360	8-14 1/4	4 3/4	≥ 3	353	387	418	442	235	282	311	334	220	261	292	317	
	400-1000	15 3/4-39 3/8	5 1/2	≥ 10	353	387	418	442	251	282	311	334	229	261	292	317	

NOTES and GENERAL PRINCIPLES on page 100.

THREAD WITHDRAWAL (W) | WOOD

geometry				thread withdrawal $\alpha = 90^\circ$				thread withdrawal $\alpha = 45^\circ$				thread withdrawal $\alpha = 0^\circ$				
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]	[mm]	[in]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]
6 0.24	60-70	2 3/8-2 3/4 ⁽¹⁾	1 9/16	175	202	229	252	160	184	208	229	53	61	69	75	
	80-90	3 1/8-3 1/2 ⁽²⁾	1 15/16	227	262	296	326	207	238	270	296	68	78	89	98	
	100	4	2 3/8	279	321	364	400	253	292	331	364	84	96	109	120	
	120-200	4 3/4-8	2 15/16	356	410	465	511	324	373	423	465	107	123	139	153	
	220-400	8 5/8-15 3/4	4	485	559	633	696	441	509	576	633	145	168	190	209	
8 0.32	40	1 9/16 ⁽¹⁾	1 1/4	163	188	213	233	148	171	193	212	49	56	64	70	
	60-100	2 3/8-4 ⁽¹⁾	2 1/16	298	345	390	428	271	314	355	389	89	103	117	128	
	120-140	4 3/4-5 1/2	3 1/8	488	564	638	700	444	513	580	637	146	169	191	210	
	160-600	6 1/4-23 5/8	4	623	721	815	895	567	656	742	814	187	216	244	268	
10 0.40	100	4 ⁽¹⁾	2 1/16	341	395	446	489	310	360	406	445	102	119	134	147	
	120-140	4 3/4-5 1/2 ⁽¹⁾	2 3/8	406	470	531	583	369	428	484	530	122	141	159	175	
	160-180	6 1/4-7 1/8 ⁽²⁾	3 1/8	568	659	744	816	517	599	677	742	170	198	223	245	
	200-300	8-11 3/4	4	730	847	957	1049	664	771	871	954	219	254	287	315	
	320-600	12 5/8-23 5/8	4 3/4	892	1035	1169	1282	812	942	1064	1167	268	311	351	385	
12 0.48	200-360	8-14 1/4	4 3/4	935	1084	1225	1344	851	987	1114	1223	281	325	367	403	
	400-600	15 3/4-23 5/8	5 1/2	1109	1285	1451	1592	1009	1169	1321	1449	333	386	435	478	
	800-1000	31 1/2-39 3/8	6 1/4	1282	1486	1678	1841	1167	1352	1527	1676	385	446	503	552	

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

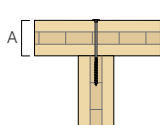
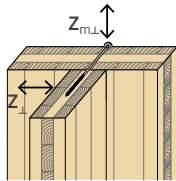
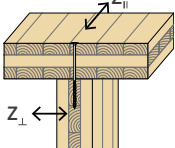
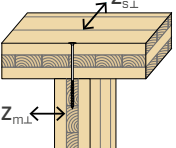
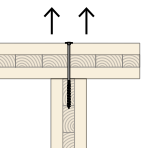
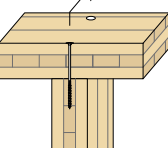
⁽²⁾ The embedded thread length does not comply with the minimum requirement of ESR-4645 (8 times the outer thread diameter for screws installed at an angle $0^\circ \leq \alpha < 90^\circ$ to the grain).

HEAD PULL-THROUGH (W_H) | WOOD

geometry			head pull through $90^\circ \leq \alpha \leq 30^\circ$			
d_1	d_k	G	0.35	0.42	0.49	0.55
			[lbf]	[lbf]	[lbf]	[lbf]
[mm]	[in]	[in]	[lbf]	[lbf]	[lbf]	[lbf]
6	0.24	0.61	182	263	357	450
8	0.32	0.75	223	322	438	552
10	0.40	0.98	314	452	615	774
12(*)	0.48	1.14	314	452	615	774

(*) Head pull-through values for TBS $\varnothing 12$ (0.48 in) are not addressed in ESR-4645. The same head pull-through values of TBS $\varnothing 10$ (0.40 in) can be considered.

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

geometry			SHEAR						TENSION	SPACING		
			wall-to-wall		floor-to-wall orientation 1		floor-to-wall orientation 2		withdrawal / head pull-through	fastener in a row		
												
side member thickness (wall/floor) = A		suggested screw	Z _⊥	Z _∥	Z _⊥	Z _∥	Z _∥	Z _⊥	W ^(*)	minimum	typical	
[mm]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]	
3 PLY	60	2 3/8	TBS6140	110	110	110	110	110	110	263	3 1/2	6
			TBS8140	131	131	131	164	131	131	322	3 1/8	6
			TBS10140	144	164	144	226	164	155	452	4	8
			TBS12200	158	189	158	258	189	168	452	4 3/4	10
	79	3 1/8	TBS6160	110	110	110	110	110	110	263	3 1/2	6
			TBS8180	131	131	131	164	131	131	322	3 1/8	6
			TBS10180	155	167	155	226	167	167	452	4	8
			TBS12200	175	189	175	259	189	189	452	4 3/4	10
	105	4 1/8	TBS6180	110	110	110	110	110	110	263	3 1/2	6
			TBS8220	131	131	131	164	131	131	322	3 1/8	6
			TBS10220	155	167	155	226	167	167	452	4	8
			TBS12240	175	189	175	259	189	189	452	4 3/4	10
120	4 3/4	TBS6200	110	110	110	110	110	110	263	3 1/2	6	
		TBS8220	131	131	131	164	131	131	322	3 1/8	6	
		TBS10220	155	167	155	226	167	167	452	4	8	
		TBS12240	175	189	175	259	189	189	452	4 3/4	10	
5 PLY	100	3 15/16	TBS6180	110	110	110	110	110	110	263	3 1/2	6
			TBS8200	131	131	131	164	131	131	322	3 1/8	6
			TBS10200	155	167	155	226	167	167	452	4	8
			TBS12240	175	189	175	259	189	189	452	4 3/4	10
	140	5 1/2	TBS6240	110	110	110	110	110	110	263	3 1/2	6
			TBS8240	131	131	131	164	131	131	322	3 1/8	6
			TBS10240	155	167	155	226	167	167	452	4	8
			TBS12280	175	189	175	259	189	189	452	4 3/4	10
	175	6 7/8	TBS6280	110	110	110	110	110	110	263	3 1/2	6
			TBS8280	131	131	131	164	131	131	322	3 1/8	6
			TBS10280	155	167	155	226	167	167	452	4	8
			TBS12320	175	189	175	259	189	189	452	4 3/4	10
200	7 7/8	TBS6300	110	110	110	110	110	110	263	3 1/2	6	
		TBS8300	131	131	131	164	131	131	322	3 1/8	6	
		TBS10300	155	167	155	226	167	167	452	4	8	
		TBS12320	175	189	175	259	189	189	452	4 3/4	10	
7 PLY	140	5 1/2	TBS6240	110	110	110	110	110	110	263	3 1/2	6
			TBS8240	131	131	131	164	131	131	322	3 1/8	6
			TBS10240	155	167	155	226	167	167	452	4	8
			TBS12280	175	189	175	259	189	189	452	4 3/4	10
	191	7 1/2	TBS6300	110	110	110	110	110	110	263	3 1/2	6
			TBS8300	131	131	131	164	131	131	322	3 1/8	6
			TBS10300	155	167	155	226	167	167	452	4	8
			TBS12320	175	189	175	259	189	189	452	4 3/4	10
	244	9 5/8	TBS6360	110	110	110	110	110	110	263	3 1/2	6
			TBS8360	131	131	131	164	131	131	322	3 1/8	6
			TBS10380	155	167	155	226	167	167	452	4	8
			TBS12400	175	189	175	259	189	189	452	4 3/4	10
280	11	TBS6400	110	110	110	110	110	110	263	3 1/2	6	
		TBS8400	131	131	131	164	131	131	322	3 1/8	6	
		TBS10400	155	167	155	226	167	167	452	4	8	
		TBS12440	175	189	175	259	189	189	452	4 3/4	10	

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

NOTES and GENERAL PRINCIPLES on page 100.

CLT | FLOOR-TO-BEAM

geometry		SHEAR								TENSION	SPACING				
		floor-to-beam orientation 1		floor-to-beam orientation 2		floor-to-double lumber 2" orientation 1		floor-to-double lumber 2" orientation 2		withdrawal / head pull-through	fastener in a row				
side member thickness (wall/floor) = A		suggested screw	Z _L	Z	Z _{m,L}	Z _{s,L}	Z _L	Z	Z _{m,L}	Z _{s,L}	W(*)	minimum	typical		
[mm]	[in]	CODE	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[lbf]	[in]	[in]		
5 PLY	100	3 15/16	TBS6180	165	165	110	165	165	165	110	165	263	3 1/2	6	
			TBS8200	196	245	131	196	196	245	131	196	322	3 1/8	6	
			TBS10180	232	338	167	249	232	338	167	249	452	4	8	
			TBS12200	261	387	189	282	261	387	189	282	452	4 3/4	10	
	140	5 1/2	TBS6240	165	165	110	165	165	165	110	165	263	3 1/2	6	
			TBS8240	196	245	131	196	196	245	131	196	322	3 1/8	6	
			TBS10240	232	338	167	249	232	338	167	249	452	4	8	
			TBS12240	261	387	189	282	261	387	189	282	452	4 3/4	10	
	175	6 7/8	TBS6260	165	165	110	165	165	165	110	165	263	3 1/2	6	
			TBS6280	165	165	110	165	-	-	-	-	263	3 1/2	6	
			TBS8260	196	245	131	196	196	245	131	196	322	3 1/8	6	
			TBS8280	196	245	131	196	-	-	-	-	322	3 1/8	6	
			TBS10260	232	338	167	249	232	338	167	249	452	4	8	
			TBS10280	232	338	167	249	-	-	-	-	452	4	8	
	200	7 7/8	TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10	
			TBS6300	165	165	110	165	165	165	110	165	263	3 1/2	6	
			TBS8300	196	245	131	196	196	245	131	196	322	3 1/8	6	
			TBS10300	232	338	167	249	232	338	167	249	452	4	8	
	7 PLY	140	5 1/2	TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10
				TBS6240	165	165	110	165	165	165	110	165	263	3 1/2	6
				TBS8240	196	245	131	196	196	245	131	196	322	3 1/8	6
				TBS10240	232	338	167	249	232	338	167	249	452	4	8
		191	7 1/2	TBS6280	165	165	110	165	165	165	110	165	263	3 1/2	6
				TBS6300	165	165	110	165	-	-	-	-	263	3 1/2	6
				TBS8280	196	245	131	196	196	245	131	196	322	3 1/8	6
				TBS8300	196	245	131	196	-	-	-	-	322	3 1/8	6
				TBS10280	232	338	167	249	232	338	167	249	452	4	8
				TBS10300	232	338	167	249	-	-	-	-	452	4	8
244		9 5/8	TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10	
			TBS6320	165	165	110	165	165	165	110	165	263	3 1/2	6	
			TBS6360	165	165	110	165	-	-	-	-	263	3 1/2	6	
			TBS8360	196	245	131	196	-	-	-	-	322	3 1/8	6	
			TBS10380	232	338	167	249	-	-	-	-	452	4	8	
280		11	TBS12400	261	387	189	282	-	-	-	-	452	4 3/4	10	
	TBS6360		165	165	110	165	165	165	110	165	263	3 1/2	6		
	TBS6400		165	165	110	165	-	-	-	-	263	3 1/2	6		
	TBS8380		196	245	131	196	196	245	131	196	322	3 1/8	6		
	TBS10400		232	338	167	249	-	-	-	-	452	4	8		
9 PLY	180	7 1/16	TBS12440	261	387	189	282	-	-	-	-	452	4 3/4	10	
			TBS6280	165	165	110	165	165	165	110	165	263	3 1/2	6	
			TBS8280	196	245	131	196	196	245	131	196	322	3 1/8	6	
			TBS10280	232	338	167	249	232	338	167	249	452	4	8	
	267	10 1/2	TBS12320	261	387	189	282	-	-	-	-	452	4 3/4	10	
			TBS6400	165	165	110	165	-	-	-	-	263	3 1/2	6	
			TBS8380	196	245	131	196	-	-	-	-	322	3 1/8	6	
			TBS10400	232	338	167	249	-	-	-	-	452	4	8	
			TBS12440	261	387	189	282	-	-	-	-	452	4 3/4	10	

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