Index

M & D SPECIALISED FASTENERS cc.
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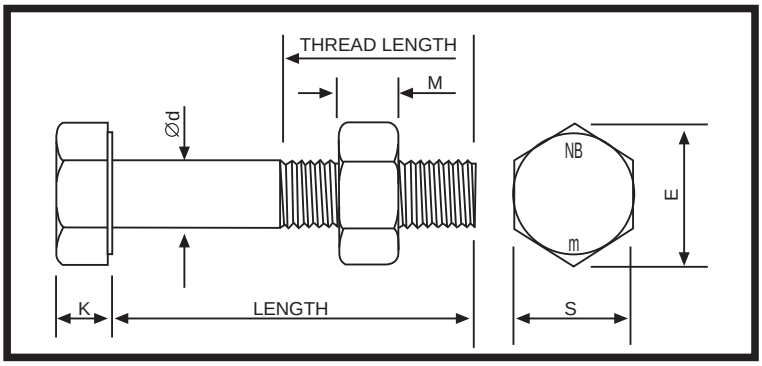


I.S.O. Metric Mild Steel Hexagon Bolts, Screws and Nuts (SABS 135/DIN 555)

Dimension		Diameter											
		M6	M8	M10	M12	M16	M20	M22	M24	(M27)	M30	M33	M36
Pitch of Thread		1,0	1,25	1,5	1,75	2,0	2,5	2,5	3,0	3,0	3,5	3,5	4,0
d	Max.	6,48	8,58	10,58	12,70	16,70	20,84	22,84	24,84	27,84	30,84	34,0	37,00
	Min.	5,52	7,42	9,42	11,30	15,30	19,16	21,16	23,16	26,16	29,16	32,0	35,00
s	Max.	10,00	13,00	17,00	19,00	24,00	30,00	34,0	36,00	41,0	46,00	50,0	55,00
	Min.	9,64	12,57	16,57	18,48	23,16	29,16	33,0	35,00	40,0	45,00	49,0	53,80
k	Max.	4,38	5,88	7,45	8,45	10,45	13,90	14,9	15,90	17,9	20,05	22,05	24,05
	Min.	3,63	5,13	6,55	7,55	9,55	12,10	13,1	14,10	16,1	17,95	19,95	21,95
m	Max.	5,38	6,88	8,45	10,45	13,55	16,55	18,90	19,65	23,05	24,65	27,05	29,65
	Min.	4,63	6,13	7,55	9,55	12,45	15,45	17,10	18,35	20,95	23,35	24,95	28,35

THREAD LENGTH ON BOLTS

Nominal Dia.	Nominal Length	Thread Length
M16-M24	Up to and including 65 mm	1,5 d *
	Over 65 mm up to and including 125 mm	2d + 6*
M6-M12 M27-M36	Up to and including 125 mm	
M6-M36	Over 125 mm up to and including 200 mm	2d + 12
	Over 200 mm	2d + 25

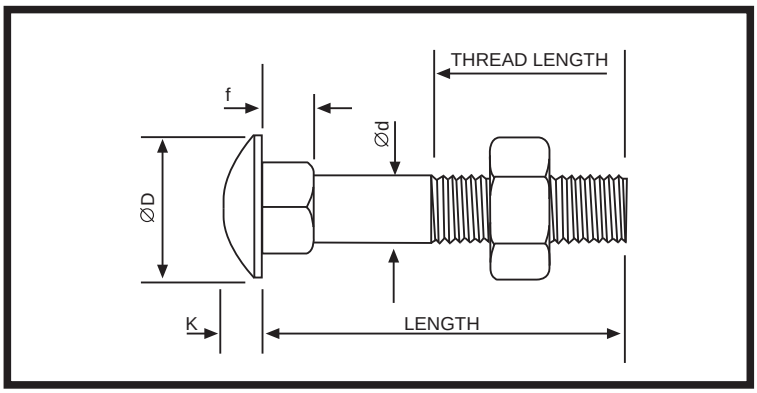
NOTE:

* For SABS 135 bolts only

* Din 601 is always 2d + 6

SET & NUT XOX
(Hexagon Head Bolts and Nuts)- Mild Steel
Quantity per 25kg bag

	Dia 6 P=1.00	Dia 8 P=1.25	Dia 10 P=1.50	Dia 12 P=1.75	Dia 16 P=2.00	Dia 20 P=2.50	Dia 24 P=3.00	Dia 27 P=3.00	Dia 30 P=3.00	???? P=4.00
25	2758	1382	790	526	242	-	-	-	-	-
30	2464	1265	728	496	232	-	-	-	-	-
35	-	1177	680	680	216	-	-	-	-	-
40	2049	1058	648	435	206	114	-	-	-	-
45	-	985	582	406	196	110	-	-	-	-
50	1760	915	547	388	185	105	65	-	-	-
55	-	853	512	352	177	100	63	-	-	-
60	-	-	-	-	170	96	60	-	-	-
65	1401	736	461	314	157	93	58	-	32	-
70	-	-	-	-	151	89	57	-	31	-
75	1258	686	415	283	145	84	55	-	31	19
80	-	328	-	-	137	80	54	-	30	-
90	1084	583	364	249	126	75	50	-	28	15
100	1001	531	328	228	117	69	45	30	27	10
110	-	501	305	214	109	65	43	30	26	10
120	868	457	285	176	102	61	41	30	24	10
130	803	443	270	183	95	58	38	30	22	10
140	774	414	246	173	90	55	36	-	21	10
150	744	389	237	162	85	53	35	-	20	10
160	681	377	227	155	81	50	33	-	20	10
180	672	332	205	140	75	45	30	-	18	10
200	-	-	184	128	68	42	28	-	10	10
220	-	-	179	129	63	39	26	-	16	10
240	-	-	161	108	59	36	24	-	15	10
260	-	-	145	102	55	34	23	-	14	10
280	-	-	140	95	51	32	21	-	13	9
300	-	-	127	91	49	30	20	-	12	9



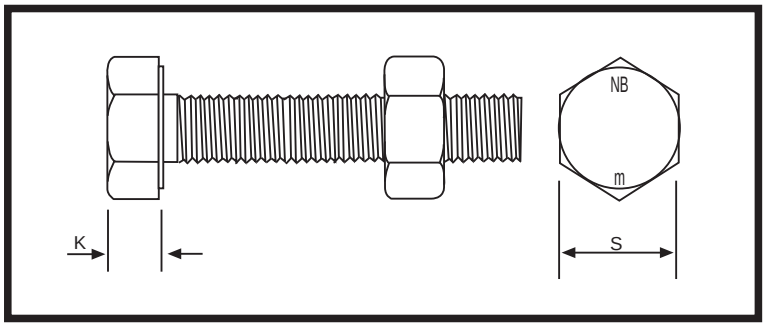
I.S.O. Metric Mild Steel Cup Square Bolts (SABS 1143/BS 4933)

Dimension		Diameter					
		M6	M8	M10	M12	M16	M20
d	Max.	6,48	8,58	10,58	12,70	16,70	20,84
	Min.	5,52	7,42	9,42	11,30	15,30	19,16
D	Max.	13,52	18,00	22,50	27,00	36,00	45,00
	Min.	12,40	16,90	21,20	25,70	34,40	43,40
k	Max.	3,60	4,80	5,80	6,80	8,90	10,90
	Min.	3,00	4,00	5,00	6,00	8,00	10,00
f	Max.	3,60	4,80	5,00	6,80	8,90	10,90
	Min.	3,00	4,00	5,80	6,00	8,00	10,00

For nut sizes see ISO Metric Mild Steel Bolts, Screws and Nuts, above.
For thread length, see table above.

CUP SQ BOLT & NUT
(Cup Head Socket Neck Bolts and Nuts)
Mild Steel
Quantity per 25kg bag

	Dia 6 P=1.00	Dia 8 P=1.25	Dia 10 P=1.50	Dia 12 P=1.75	Dia 16 P=2.00	Dia 20 P=2.50
20	2585	1250	720	-	-	-
25	2358	1177	668	396	-	-
30	2110	1090	624	373	-	-
35	1888	1038	-	-	-	-
40	1753	918	538	340	172	-
45	1635	862	503	317	-	-
50	1593	799	466	302	160	-
55	1418	770	452	287	-	-
65	1293	687	406	276	140	82
75	1157	624	368	251	128	78
90	1030	538	323	223	114	71
100	961	508	319	205	107	64
110	880	477	279	194	100	62
120	817	440	275	185	95	57
130	777	417	262	178	90	55
140	752	404	246	163	85	52
150	688	372	231	154	79	48
160	660	358	220	145	-	-
180	592	322	198	132	71	45
200	-	-	182	126	66	-
220	-	-	171	116	62	-
240	-	-	158	108	58	-
260	-	-	148	101	54	-
280	-	-	138	94	-	-
300	-	-	131	89	47	-

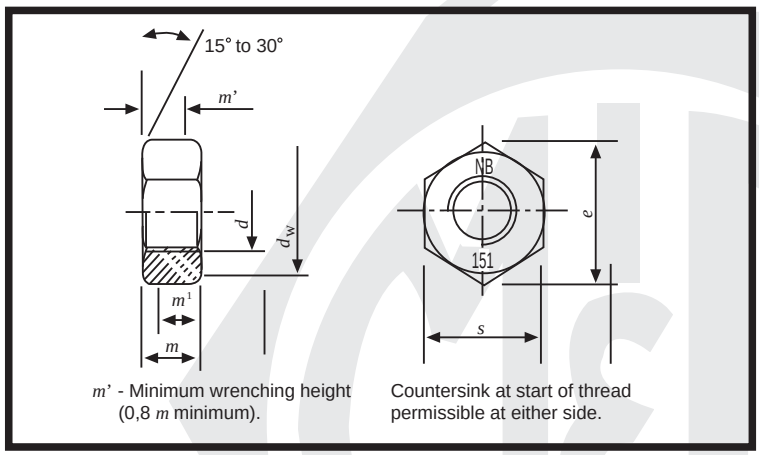


I.S.O. Metric Mild Steel Set Screws (DIN 558/ SABS 135)

Thread size		M5	M6	M8	M10	M12	M16	M20	M24	M30	M36
P^1)		0,8	1	1,25	1,5	1,75	2	2,5	3	3,5	4
Nominal size		3,5	4	5,3	6,4	7,5	10	12,5	15	18,7	22,5
k	min.	3,12	3,62	4,92	5,95	7,05	9,25	11,6	14,1	17,65	21,45
	max.	3,88	4,38	5,68	6,85	7,95	10,75	13,4	15,9	19,75	23,55
s	max. - nominal size	8	10	13	17	19	24	30	36	46	55
	min.	7,64	9,64	12,57	16,57	18,48	23,16	29,16	35	45	53,8

NOTE:

P^1 = Thread pitch



m' - Minimum wrenching height (0,8 m minimum).

Countersink at start of thread permissible at either side.

I.S.O. Metric Mild Steel Nuts (DIN 555/SABS 135)

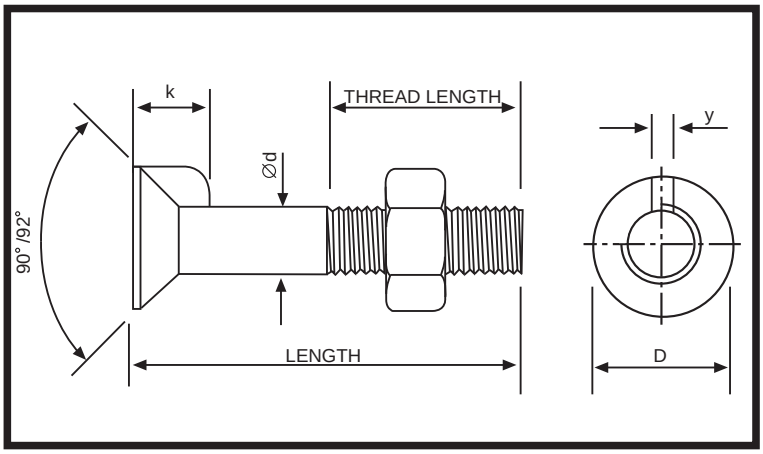
Thread size (d)		M5	M6	M8	M10	M12	M16	M20	(M22)	M24	(M27)	M30	(M33)	M36
P^1)		0,8	1	1,25	1,5	1,75	2	2,5	2,5	3	3	3,5	3,5	4
	min.	6,7	8,7	11,5	15,5	17,2	22	27,7	29,5	33,2	38	42,7	46,5	51,1
k	min.	8,63	10,89	14,2	18,72	20,88	26,17	32,95	35,03	39,55	45,2	50,85	55,37	60,79
	nominal size	4	5	6,5	8	10	13	16	18	19	22	24	26	29
s	max.	4,6	5,6	7,25	8,75	10,75	13,9	16,9	18,9	20,05	23,05	25,05	27,05	30,05
	min.	3,4	4,4	5,75	7,25	9,25	12,1	15,1	17,1	17,95	20,95	22,95	24,95	27,95
	min.	2,7	3,5	4,6	5,8	7,4	9,7	12,1	13,7	14,4	16,8	18,4	20	22,4
	max = nominal size	8	10	13	17	19	24	30	32	36	41	46	50	55
	min.	7,64	9,64	12,57	16,57	18,48	23,16	29,16	31	35	40	45	49	53,8

NOTE:

P^1 = Thread pitch

DIN 558 Approximate count per 25kg bag

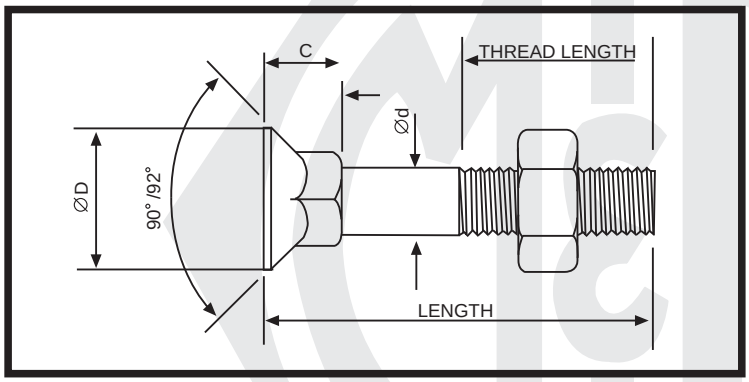
Size	M6	M8	M10	M12	M16
12	4772	2578			
16	4640	2379	1235		
20	4289	2129	1151	725	
25	3763	1874	1040	698	362
30	3205	1663	949	656	328
35	2906	1524	879	592	303
40	2716	1388	813	552	281
45	2403	1250	752	511	262
50	2232	1178	705	476	244
55	2083	1077	623	435	232
60	1985	1008	608	409	218
65	1811	966	578	393	207
70	1756	896	525	366	195
75	1664	862	517	348	187
80	1569	803	498	339	173
85	1445	764			
90	1429	730	424	309	
95	1315	698			
100	1297	684	410	284	



I.S.O. Metric Mild Steel Countersunk Nib Bolts (SABS 1143)

Dimension		Diameter				
		M10	M12	M16	M20	M24
d	Max.	10,58	12,70	16,70	20,84	24,84
	Min.	9,42	11,30	15,30	19,16	23,16
D	*Max.	20,00	24,00	32,00	40,00	48,00
	Min.	17,00	20,40	27,20	34,00	40,80
g	Max.	2,50	3,00	4,00	5,00	6,00
	Min.	2,10	2,60	3,50	4,50	5,50
k	Max.	6,30	7,50	10,00	12,50	15,00
	Min.	5,15	6,20	8,30	10,40	12,50

*D max. is the theoretical diameter to sharp corners, also countersunk diameter to give flush fit.
For nut size see ISO Metric Mild Steel Bolts, Screws and Nuts, page 2.
For thread length see page 1.



I.S.O. Metric Mild Steel Countersunk Square Bolts (SABS 1143)

Dimension		Diameter				
		M10	M12	M16	M20	M24
d	Max.	10,58	12,70	16,70	20,84	24,84
	Min.	9,42	11,30	15,30	19,16	23,16
D	*Max.	20,00	24,00	32,00	40,00	48,00
	Min.	17,00	20,40	27,20	34,00	40,80
c	Max.	7,50	9,00	12,00	15,00	18,00
	Min.	6,00	7,20	9,60	12,00	14,40

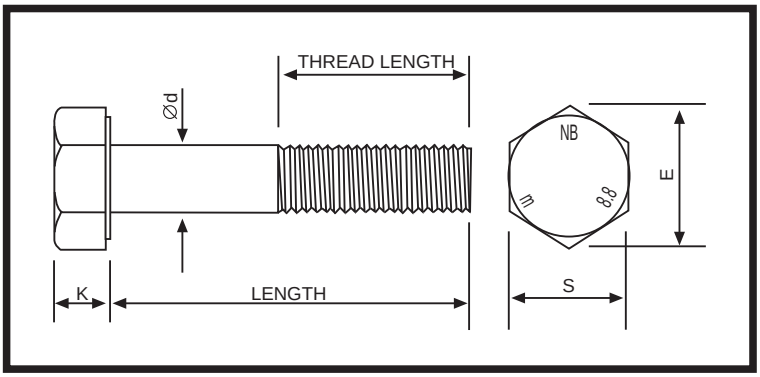
*D max. is the theoretical diameter to sharp corners, also countersunk diameter to give flush fit.
For nut size see ISO Metric Mild Steel Bolts, Screws and Nuts, page 2.
For thread length see page 1.

CSK NIB
(Countersunk Nib Bolts and Hex Nuts) Quantity per 25kg bag

	Dia 12 P=1.75	Dia 16 P=2.00	Dia 20 P=2.50
25	638	-	-
30	590	-	-
35	533	-	-
40	500	245	144
50	426	217	129
65	350	181	112
75	-	161	-
80	-	155	94
90	-	-	86
100	-	129	80
160	-	-	54

CSK SQ
(Countersunk Head Square Neck Bolts and Hex Nuts) Quantity per 25kg bag

	Dia 10 P=1.50	Dia 12 P=1.75	Dia 16 P=2.00	Dia 20 P=2.50
25	-	608	-	-
30	869	565	-	-
40	730	485	-	-
45	693	457	-	-
50	617	414	214	-
55	-	399	-	-
65	506	348	181	-
75	-	305	163	98
90	-	-	140	-
100	-	-	-	-



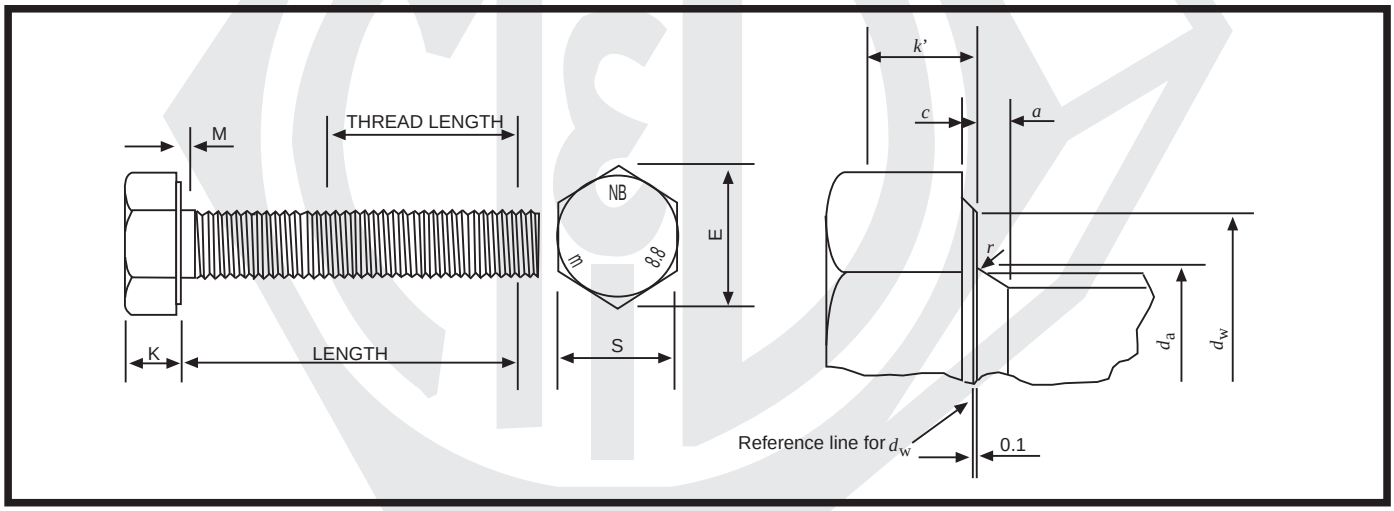
I.S.O. Metric Precision Hexagon Bolts (SABS 136/DIN 931)

Dimension		Diameter												
		(M5)	M6	M8	M10	M12	M14	M16	M20	(M22)	M24	M27	M33	M36
Pitch of Thread		0,8	1,0	1,25	1,50	1,75	2,00	2,00	2,50	2,50	3,00	3,0	3,5	4,0
d	Max.	5,00	6,00	8,00	10,00	12,00	14,00	16,00	20,00	22,00	24,00	27,00	33,00	36,00
	Min.	4,82	5,82	7,78	9,78	11,73	13,73	15,73	19,67	21,67	23,67	26,48	32,38	35,33
s	Max.	8,00	10,00	13,00	17,00	19,00	22,00	24,00	30,00	32,00	36,00	41,0	50,0	55,00
	Min.	7,85	9,78	12,73	16,73	18,67	21,67	23,67	29,67	31,61	35,38	40,0	49,0	53,80
e	Min.	8,87	11,05	14,38	18,90	21,10	24,49	26,75	33,53	35,72	39,98	45,2	55,37	60,79
k	Max.	3,65	4,15	5,65	7,18	8,18	9,18	10,18	13,22	14,22	15,22	17,35	21,42	22,92
	Min.	3,35	3,85	5,35	6,82	7,82	8,82	9,82	12,79	13,79	14,79	16,65	20,58	22,03

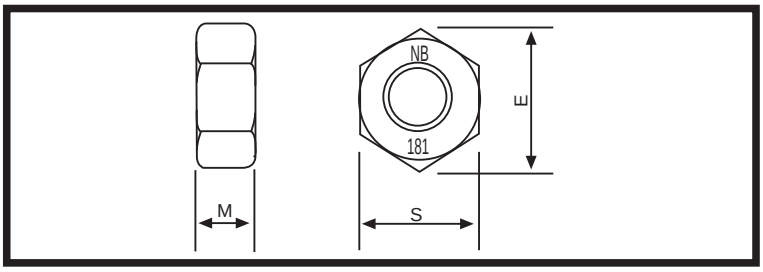
LENGTH OF THREAD (L1) ON BOLTS

Up to and including 125 mm = 2 x diameter + 6 mm
Over 125 mm up to 200 mm = 2 x diameter + 12 mm
Over 200 mm = 2 x diameter + 25 mm

I.S.O. Metric Precision Hexagon Set Screws (SABS 136/DIN 933)

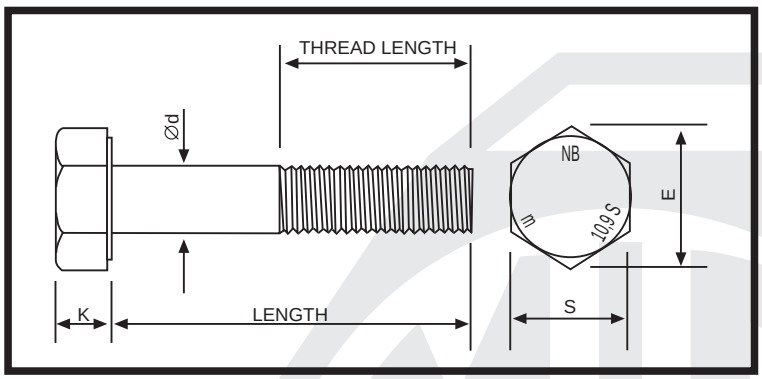


Thread size			M6	M8	M10	M12	(M14)	M16	(M18)	M20	(M22)	M24	(M27)	M30	(M33)	M36
P^1)			1	1,25	1,5	1,75	2	2	2,5	2,5	2,5	3	3	3,5	3,5	4
a^2)		max	3	3,75	4,5	5,25	6	6	7,5	7,5	7,5	9	9	10,5	10,5	12
c		min.	0,15	0,15	0,15	0,15	0,15	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
		max	0,5	0,6	0,6	0,6	0,6	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8
d		max	6,8	9,2	11,2	13,7	15,7	17,7	20,2	22,4	24,4	26,4	30,4	33,4	36,4	39,4
d	min. Product grade	A	8,9	11,6	15,6	17,4	20,5	22,5	25,3	28,2	30	33,6	-	-	-	-
		B	8,7	11,4	15,4	17,2	20,1	22	24,8	27,7	29,5	33,2	38	42,7	46.5	51,1
e	min. Product grade	A	11,05	14,38	18,9	21,1	24,49	26,75	30,14	33,53	35,75	39,98	-	-	-	-
		B	10,89	14,2	18,72	20,88	23,91	26,17	29,56	32,95	35,03	39,55	45,2	50,85	55,37	60,79
k	Nominal size		4	5,3	6,4	7,5	8,8	10	11,5	12,5	14	15	17	18,7	21	22,5
	Product grade A	min.	3,85	5,15	6,22	7,32	8,62	9,82	11,28	12,28	13,78	14,78	-	-	-	-
		max.	4,15	5,45	6,56	7,68	8,98	10,18	11,72	12,72	14,22	15,22	-	-	-	-
	B	min.	3,76	5,06	6,11	7,21	8,51	9,71	11,15	12,15	13,65	14,65	16,65	18,28	20,58	22,08
		max.	4,24	5,54	6,69	7,79	9,09	10,29	11,85	12,85	14,35	15,35	17,35	19,12	21,42	22,92
k'		min.	2,63	3,54	4,28	5,06	5,96	6,8	7,8	8,5	9,6	10,3	11,7	12,8	14,4	15,5
r		min.	0,25	0,4	0,4	0,6	0,6	0,6	0,6	0,8	0,8	0,8	1	1	1	1
s	max. = nominal size		10	13	17	19	22	24	27	30	32	36	41	46	50	55
	min. Product grade	A	9,78	12,73	16,73	18,67	21,67	23,67	26,67	29,67	31,61	35,38	-	-	-	-
		B	9,64	12,57	16,57	18,48	21,16	23,16	26,15	29,16	31	35	40	45	49	53,8



I.S.O. Metric Precision Hexagon Nuts (SABS 136/DIN 934)

Dimension		Diameter												
		M5	M6	M8	M10	M12	M14	M16	M20	(M22)	M24	(M27)	M33	M36
m	Max.	4,00	5,00	6,50	8,00	10,00	11,00	13,00	16,00	18,00	19,00	23,05	27,05	30,05
	Min.	3,70	4,70	6,14	7,64	9,64	10,57	12,57	15,57	17,57	18,48	20,95	24,95	27,95
s	Max.	8,00	10,00	13,00	17,00	19,00	22,00	24,00	30,00	32,00	36,00	41,0	50,0	55,0
	Min.	7,85	9,78	12,73	16,73	18,67	21,67	23,67	29,67	31,61	35,38	40,0	49,0	53,8
e	Min.	8,87	11,05	14,38	18,90	21,10	24,49	26,75	33,53	35,72	39,98	45,2	55,37	60,79

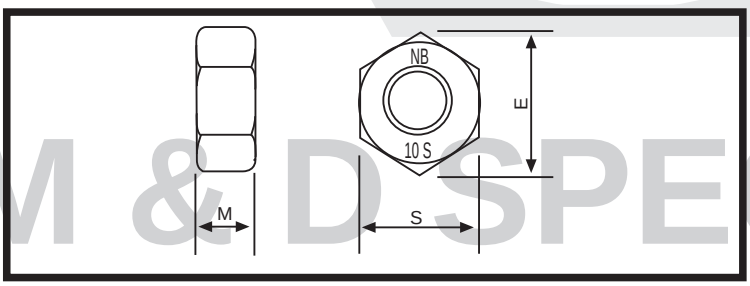


I.S.O. Metric Friction Grip Bolts (SABS 1282)

NOTE: Friction Grip Bolts differentiated from Std ISO Metric Bolts by the head markings 1.e. 8,8S 10,9S

Dimension		Diameter							
		(M12)	M16	M20	(M22)	M24	(M27)	(M30)	(M36)
d	Max.	12,70	16,70	20,84	22,84	24,84	27,84	30,84	37,0
	Min.	11,30	15,30	19,16	21,16	23,16	36,16	29,16	35,0
s	Max.	21,00	27,0	34,00	36,0	41,0	46,0	50,0	60,0
	Min.	21,16	26,16	33,00	35,0	40,0	45,0	59,0	58,8
e	Min.	22,78	29,56	37,29	39,55	45,20	50,85	55,37	66,44
k	Max.	7,95	10,75	13,40	14,9	15,9	17,9	19,75	23,55
	Min.	7,05	9,25	11,60	13,10	14,10	16,10	17,65	21,45

LENGTH OF THREAD (L1) - GENERAK GRADE BOLTS
Up to and including 125 mm = 2 x diameter + 6 mm
Over 125 mm up to 200 mm = 2 x diameter + 12 mm
Over 200 mm = 2 x diameter + 25 mm
Sizes shown in brackets are not preffered.



I.S.O. Metric Friction Grip Nuts (SABS 1282)

NOTE: Friction grip nuts differentiated from Std ISO Metric Nuts by the head markings 1.e. 8,8S 10,9S

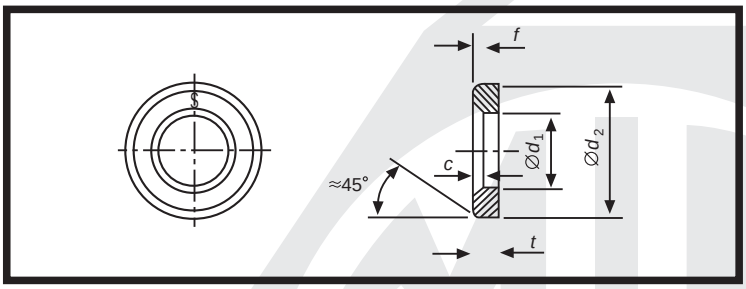
Dimension		Diameter							
		(M12)	M16	M20	(M22)	M24	(M27)	(M30)	(M36)
m	Max.	12,30	17,10	20,70	23,60	24,20	27,60	30,70	36,60
	Min.	11,87	16,40	19,40	22,30	22,90	26,30	29,10	35,0
s	Max.	21,0	27,0	34,0	36,0	41,0	46,0	50,0	60,0
	Min.	21,16	26,16	33,0	35,0	40,0	45,0	49,0	58,8
e	Min.	22,78	29,56	37,29	39,55	45,20	50,85	55,37	66,44

Sizes shown in brackets are not preffered.

Mechanical Properties for Friction Grip Bolts & Nuts (SABS 1282)

MINIMUM BOLT TENSIONS

1	2	3
Nominal Size*	Minimum bolt tension, T, kN	
of bolt	Grade 8.8 S	Grade 10.9 S
+M12	49	61
M16	91	114
M20	142	178
(M22)	176	220
M24	205	257
(M27)	266	334
M30	326	408
M36	475	595

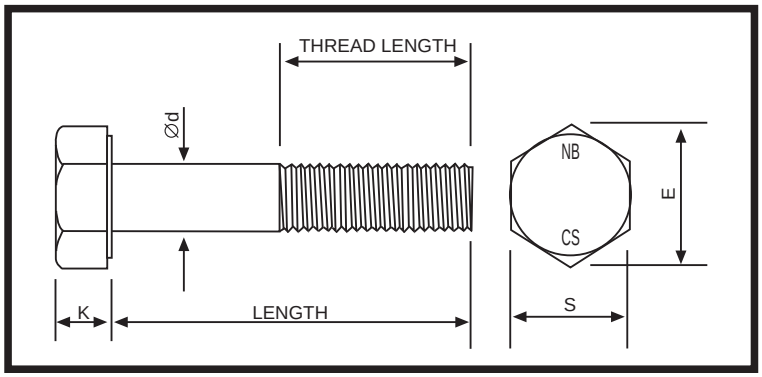


Dimensions of Flat Round Chamfered Washers Through Hardened (SABS 1282)

1	2	3	4	5	6	7	8	9	10
Nominal size* of washer, mm	Dimensions, mm								
	d_1		d_2		t		c		f
	Max.	Min.	Max.	Min.	Max.	Min.	Min.	Min.	approx.
§12	13,43	13	25	23,7			1,6	1,2	0,5
16	17,43	17	33	31,4			1,6	1,2	
20	21,52	21	40	38,4	4,6	3,4	2,0	1,6	
(22)	23,52	23	42	40,4			2,0	1,6	
24	25,52	25	47	45,4			2,0	1,6	1
(27)	28,52	28	52	50,4			2,4	2,0	
30	31,62	31	56	54,1	5,6	4,4	2,4	2,0	
36	37,62	37	66	64,1			2,8	2,4	

* Sizes shown in brackets are not preffered

§ Non-preffered for technical reasons

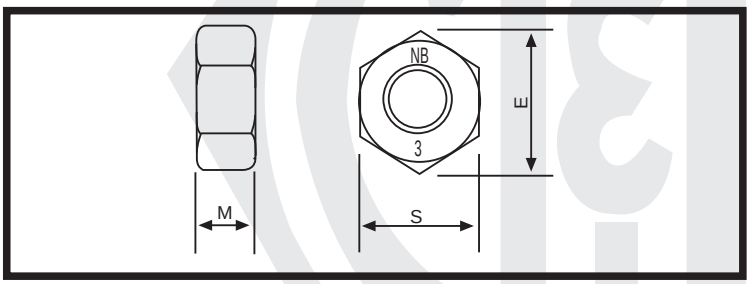


Unified Precision Hexagon Bolts and Set Screws (SABS 646)

Dimension		Diameter in inches										
		Grade CS						Grade CT				
		1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/18
d	Max.	0,250	0,313	0,375	0,438	0,500	0,563	0,625	0,750	0,875	1,000	1,125
	Min.	0,245	0,306	0,369	0,400	0,493	0,554	0,617	0,741	0,866	0,990	1,114
s	Max.	0,438	0,500	0,563	0,625	0,750	0,813	0,938	1,125	1,313	1,500	1,688
	Min.	0,428	0,489	0,551	0,612	0,736	0,798	0,922	1,100	1,285	1,469	1,631
e	Min.	0,488	0,557	0,628	0,698	0,840	0,910	0,051	1,254	1,465	1,675	1,859
k	Max.	0,163	0,211	0,291	0,291	0,323	0,371	0,403	0,483	0,563	0,627	0,718
	Min.	0,150	0,195	0,272	0,272	0,302	0,348	0,378	0,455	0,531	0,591	0,659

All dimensions are specified in inches.

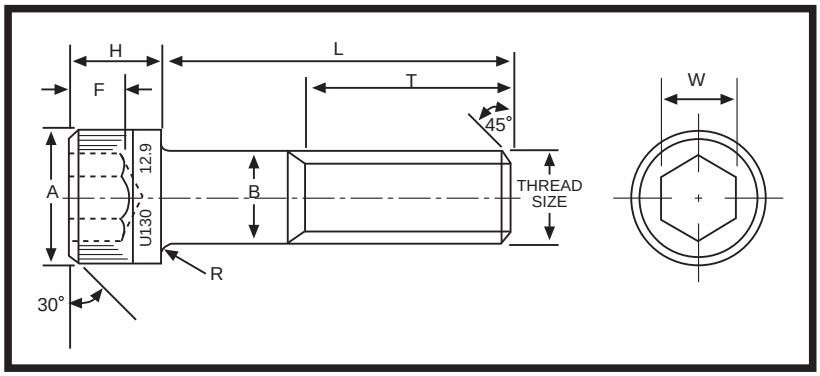
LENGTH OF THREAD (L1) -ON BOLTS
Up to and including 6"= 2 x diameter + 1/4"
Over 2" long = 2 x diameter + 1/2"



Unified Precision Hexagon Nuts (SABS 646)

Dimension		Diameter in inches										
		1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/18
m	Max.	0,226	0,273	0,337	0,385	0,448	0,496	0,559	0,665	0,776	0,887	0,999
	Min.	0,212	0,258	0,320	0,365	0,427	0,473	0,535	0,617	0,724	0,831	0,939
s	Max.	0,438	0,500	0,563	0,689	0,750	0,875	0,938	1,125	1,313	1,500	1,688
	Min.	0,428	0,489	0,551	0,675	0,736	0,861	0,922	1,088	1,269	1,450	1,631
e	Min.	0,488	0,557	0,628	0,768	0,840	0,982	1,051	1,240	1,447	1,675	1,859

All dimensions are specified in inches.



Socket Head Cap Screws (ISO Metric Series)

Dimensions										
Thread Size	Pitch	A max.	B max.	H max.	W nom.	F min.	T Basic	R max.	Shank Area (mm^2)	Stress Area (mm^2)
M1.6	0,35	3,0	1,6	1,6	1,5	0,80	15	0,2	2,01	1,27
M2	0,40	3,8	2,0	2,0	1,5	1,0	16	0,3	3,14	2,07
M2.5	0,45	4,5	2,5	2,5	2,0	1,25	17	0,3	4,91	3,39
M3	0,5	5,5	3,0	3,0	2,5	1,5	18	0,3	7,07	5,03
M4	0,7	7,0	4,0	4,0	3,0	2,0	20	0,35	12,6	8,78
M5	0,8	8,5	5,0	5,0	4,0	2,5	22	0,35	19,6	14,2
M6	1,0	10,0	6,0	6,0	5,0	3,0	24	0,4	28,3	20,1
M8	1,25	13,0	8,0	8,0	6,0	4,1	28	0,6	50,3	36,6
M10	1,5	16,0	10,0	10,0	8,0	5,0	32	0,6	78,5	58,0
M12	1,75	18,0	12,0	12,0	10,	6,0	36	1,0	113,0	84,3
M14	2,0	21,0	14,0	14.0	12,0	7,0	40	1,0	154,0	115,0
M16	2,0	24,0	16,0	16.0	14,0	8,0	44	1,0	201,0	157,0
M20	2,5	30,0	20,0	20.0	17,0	10,0	52	1,2	314,0	245,0
M24	3,0	36,0	24,0	24.0	19,0	12,0	60	1,2	452,0	353,0
M30	3,5	45,0	30,0	30.0	22,0	15,5	72	1,5	707,0	561,0
M36	4.0	54,0	36,0	36.0	27,0	19,0	84	1,5	1018,0	817,0
M42	4.5	63,0	42,0	42.0	32,0	24,0	96	1,6	1385,0	1120,0

All dimensions are specified in mm.

NOTES:

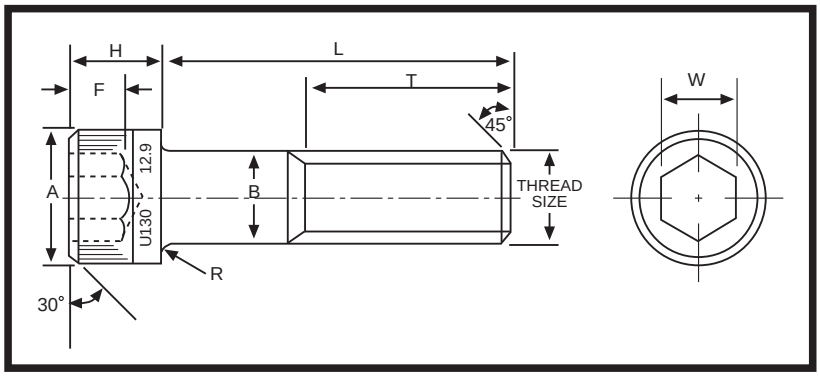
1. Material - High Grade Alloy Steel
2. Hardness - Rc 38-45 (alloy steel)
3. Tensile Strength - (alloy steel)
   1300 MPa up to M10
   1250 MPa over M10
4. Shear Strength - (alloy steel)
   780 MPa up to M10
   750 MPa over M10
5. Yield Strength - (alloy steel)
   1170 MPa up to M10
   1125 MPa over M10
6. Sizes M5 and larger stamped U130/12.9
7. Thread Class - M1.6 through M24 - 4g/6g
   over M24 - 6g

Application Data										
Thread Size	Tensile Strength min.		Yield Strength min.		Body Double Shear Strength	Recommended Seating Torque		Hole Dimmensions (mm)		
	MPa	KN	MPa	KN	KN	N-m	inch-lbf	Tap drill	Body drill†	c/bore drill
*M1.6	1300	1,65	1170	1,49	3,14	0,29	2,6	1,25	1,9	3,3
*M2	1300	2,69	1170	2,42	4,90	0,60	5,3	1,6	2,4	4,4
*M2.5	1300	4,41	1170	3,97	7,66	1,21	11	2,05	2,9	5,4
M3	1300	6,54	1170	5,89	11,0	2,1	19	2,5	3,4	6,5
M4	1300	11,4	1170	10,3	19,7	4,6	41	3,3	4,5	8,25
M5	1300	18,5	1170	16,6	30,6	9,5	85	4,2	5,6	9,75
M6	1300	26,1	1170	23,5	44,1	16	140	5	6,8	11,25
M8	1300	47,6	1170	42,8	78,4	39	350	6,75	8,8	14,25
M10	1300	75,4	1170	67,9	122	77	680	8,5	10,8	17,25
M12	1250	105	1125	95	170	135	1200	10,25	12,8	19,25
M14	1250	144	1125	129	231	215	1900	12	15	22,25
M16	1250	196	1125	177	300	330	2900	14	17	25,5
M20	1250	306	1125	276	470	650	5750	17,5	21	31,5
M24	1250	441	1125	397	680	1109	9700	21	25	37,5
M30	1250	701	1125	631	1060	2250	19900	26,5	31,5	47,5
M36	1250	1021	1125	919	1530	3850	34100	32	37,5	56,5
M42	1250	1400	1125	1260	2080	6270	55580	37,5	44	66

* Micr-Sizes

NOTE: 1KN = approx. 102 kgf (or 225lbf) &
1MPa = 1 N/mm^2 or approx. 145 psi
Tap drill sizes based on approx. 70% thread height.
Seating torques based on 800 MPa induced stress in screw threads.

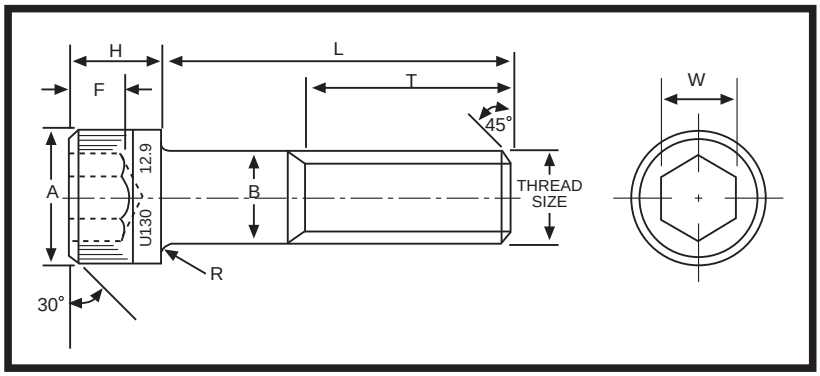
For cadmium plated screws multiply seating torque x ,75
For zinc plated screws multiply seating torque x 1,40
† Lightly chamfer body drill hole to clear screw fillet radius.



Socket Head Cap Screws (Unified Inch - 1960 Series)

Dimensions												
Thread Size	T.P.I.		A	B	H	W	F	T	R	Shank Area	Stress Area (in^2)	
	UNC	UNF	max.	max.	max.	nom.	min.	Basic	max.	(in^2)	UNC	UNF
0	-	80	,096	,060	,060	,050	,025	,500	,007	,0028	-	,0018
1	64	72	,118	,073	,073	1/16	,031	,625	,007	,0042	,0026	,0028
2	56	64	,140	,086	,086	5/64	,038	,625	,008	,0058	,0037	,0039
3	48	56	,161	,099	,099	5/64	,044	,625	,008	,0077	,0049	,0052
4	40	48	,183	,112	,112	3/32	,051	,750	,009	,0098	,0060	,0066
5	40	44	,205	,125	,125	3/32	,057	,750	,010	,0123	,0080	,0083
6	32	40	,226	,138	,138	7/64	,064	,750	,010	,0149	,0091	,0102
8	32	36	,270	,164	,164	9/64	,077	,875	,012	,0211	,0140	,0147
10	24	32	,312	,190	,190	5/32	,090	,875	,014	,0284	,0175	,0200
1/4	20	28	,375	,250	,250	3/16	,120	1,000	,014	,0491	,0318	,0364
5/16	18	24	,468	,312	,312	1/4	,151	1,125	,017	,0769	,0524	,0581
3/8	16	24	,563	,375	,375	5/16	,182	1,250	,020	,1104	,0775	,0878
7/16	14	20	,656	,437	,437	3/8	,213	1,375	,023	,1503	,1063	,1187
1/2	13	20	,750	,500	,500	3/8	,245	1,500	,026	,1964	,1419	,1599
5/8	11	18	,937	,625	,625	1/2	,307	1,750	,033	,307	,226	,256
3/4	10	16	1,125	,750	,750	5/8	,370	2,000	,039	,442	,334	,373
7/8	9	-	1,312	,875	,875	3/4	,432	2,250	,045	,601	,462	-
1	8	-	1,500	1,000	1,000	3/4	,495	2,500	,050	,785	,606	-
1 1/4	7	-	1,875	1,250	1,250	7/8	,620	3,125	,060	1,227	,970	-
1 1/2	6	-	2,250	1,500	1,500	1	,745	3,750	,070	1,767	1,405	-

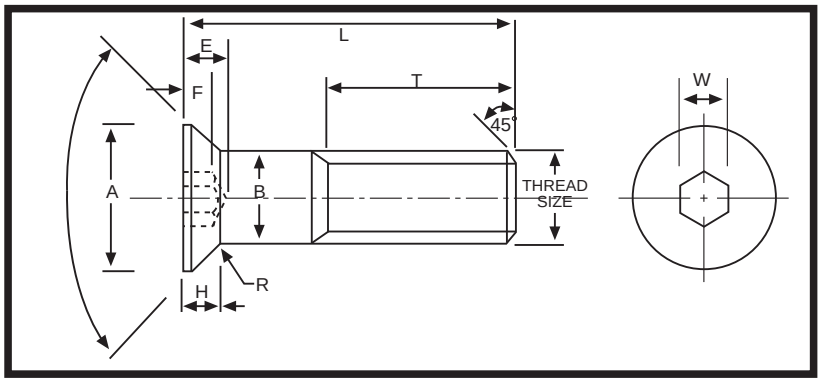
Application Data													
Thread Size	Tensile Strength KSI	Tensile Strength lbf (min)		Yield Strength KSI	Body Double Shear Strength	Recommended Seating Torque				Hole Dimensions			
						UNC		UNF		Tap Drill (mm)		Body drill	C/bore drill
	(min)	UNC	UNF	(min)	(lb min)	N-m	inch - lbf	N-m	inch - lbf	UNC	UNF	(mm)	(mm)
0	190	-	342	170	640	-	-	,23	2	-	1,25	1,75	3
1	190	499	528	170	950	,45	4	,45	4	1,55	1,55	2,05	3,6
2	190	702	749	170	1320	,68	6	,8	7	1,85	1,9	2,4	4,4
3	190	925	994	170	1750	1,13	10	1,24	11	2,1	2,15	2,75	5
4	190	1150	1260	170	2240	1,7	15	1,81	16	2,35	2,4	3,1	5,5
5	190	1510	1580	170	2800	2,26	20	2,37	21	2,65	2,7	3,5	6
6	190	1730	1930	170	3400	3,16	28	3,39	30	2,85	2,95	3,9	6,5
8	190	2660	2800	170	4800	5,54	49	5,65	50	3,4	3,5	4,6	7,8
10	190	3330	3800	170	6450	7,23	64	8,59	76	3,9	4,1	5,2	8,7
1/4	190	6050	6910	170	11200	17	150	19,2	170	5,1	5,5	6,8	10,5
5/16	190	9960	11000	170	17500	34,5	305	36,7	325	6,6	6,9	8,3	13
3/8	190	14700	16700	170	25200	61,6	545	64,4	570	8	8,5	10	15,5
7/16	190	20200	22600	170	34200	94,9	840	102	900	9,2	9,8	11,5	18
1/2	190	27000	30400	170	44700	147	1300	155	1370	10,8	11,5	13,2	20
5/8	190	42900	48600	170	69900	286	2530	301	2660	13,5	14,5	16,5	25,5
3/4	180	60200	67100	155	95400	497	4400	542	4800	16,5	17,5	19,5	30,5
7/8	180	83100	-	155	129800	791	7000	-	-	19,5	-	23	35
1	180	109000	-	155	169600	1175	10400	-	-	22	-	26	40
1 1/4	180	175000	-	155	266000	2373	21000	-	-	28	-	32,5	50
1 1/2	180	253000	-	155	381000	4125	36500	-	-	34	-	39	60



Socket Head Cap Screws (BS Inch Series)

Dimensions													
Thread Size	T.P.I.			A	B	H	W	F	T	R	Shank Area	Stress Area (in^2)		
	BSW	BSF	BA	max.	max.	max.	nom.	min.	Basic	max.	(in^2)	BSW	BSF	BA
8BA	-	-	59,1	,140	,087	,087	1/16	,039	,625	,008	,006	-	-	,0039
6BA	-	-	47,9	,187	,110	,110	5/64	,050	,750	,009	,010	-	-	,0063
5BA	-	-	43,7	,219	,126	,126	3/32	,058	,750	,010	,013	-	-	,0085
4BA	-	-	38,5	,219	,142	,142	3/32	,066	,750	,010	,016	-	-	,0107
3BA	-	-	34,8	,250	,161	,161	1/8	,075	,875	,012	,020	-	-	,0139
2BA	-	-	31,4	,312	,185	,187	5/32	,089	,875	,014	,027	-	-	,0186
1BA	-	-	28,2	,312	,209	,209	5/32	,100	1,000	,014	,034	-	-	,0240
0BA	-	-	25,4	,375	,236	,236	3/16	,113	1,000	,014	,044	-	-	,0306
1/8	40		-	,219	,125	,125	3/32	,058	,750	,010	,012	,0079		-
3/16	24	32	-	,312	,187	,187	5/32	,090	,875	,014	,028	,0170	,0194	-
1/4	20	26	-	,375	,250	,250	3/16	,120	1,000	,014	,049	,0321	,0358	-
5/16	18	22	-	,437	,312	,312	7/32	,151	1,125	,017	,077	,0527	,0569	-
3/8	16	20	-	,563	,375	,375	5/16	,182	1,250	,020	,110	,0779	,0839	-
7/16	14	18	-	,625	,437	,437	5/16	,213	1,375	,023	,151	,1069	,1160	-
1/2	12	16	-	,750	,500	,500	3/8	,245	1,500	,026	,196	,1385	,1521	-
5/8	11	14	-	,875	,625	,625	1/2	,307	1,750	,033	,307	,227	,243	-
3/4	10	12	-	1,000	,750	,750	9/16	,370	2,000	,039	,442	,336	,353	-
7/8	9	-	-	1,125	,875	,875	9/16	,432	2,250	,045	,601	,464	-	-
1	8	-	-	1,312	1,000	1,000	5/8	,495	2,500	,050	,785	,608	-	-
1 1/4	7	-	-	1,750	1,250	1,250	3/4	,620	3,125	,060	1,227	,980	-	-
1 1/2	6	-	-	2,000	1,500	1,500	1	,745	3,750	,070	1,767	1,410	-	-

Application Data													
Thread Size	Tensile Strength KSI (min)	Tensile Strength lbf (min)		Yield Strength KSI (min)	Body Double Shear Strength (lb min)	Recommended Seating Torque				Hole Dimensions			
						BSW		BA/ BSF		Tap Drill (mm)		Body drill (mm)	C/bore drill (mm)
		BSW	BA/ BSF			N-m	inch - lbf	N-m	inch - lbf	BSW	BA/ BSF		
8BA	190	-	741	170	1368	-	-	,79	7		1,8	2,4	4
6BA	190	-	1197	170	2166	-	-	1,8	16		2,3	3	5,3
5BA	190	-	1615	170	2850	-	-	2,94	26		2,65	3,5	6
4BA	190	-	2033	170	3625	-	-	3,62	32		3	4	6
3BA	190	-	2641	170	4630	-	-	5,54	49		3,4	4,5	7
2BA	190	-	3534	170	6130	-	-	8,02	71		3,9	5,1	8,7
1BA	190	-	4560	170	7820	-	-	10,3	91		4,5	5,7	8,7
0BA	190	-	5814	170	9960	-	-	16,3	144		5,1	6,4	10,5
1/8	190	1500	-	170	2800	2.26	20	-	-	2,55	-	3,5	6
3/16	190	3230	3690	170	6300	7	62	8,3	74	3,7	3,9	5,1	8,7
1/4	190	6100	6800	170	11200	17,1	151	18,9	167	5,1	5,3	6,8	10,5
5/16	190	10000	10810	170	17500	34,7	307	36	319	6,5	6,7	8,3	12,2
3/8	190	14800	15940	170	25200	61,9	548	63,3	560	7,9	8,2	10	15,5
7/16	190	20300	22000	170	34200	95,5	845	99,4	880	9,2	9,5	11,5	17
1/2	180	24920	27400	155	42300	144	1270	147	1303	10,5	11	13,2	20
5/8	180	40830	43770	155	66200	287	2540	295	2595	13,5	14	16,5	24
3/4	180	60480	63540	155	95400	500	4420	515	4540	16,5	17	19,5	27
7/8	180	83500	-	155	129800	795	7035	-	-	19	-	23	30,5
1	180	109400	-	155	169600	1175	10400	-	-	22	-	26	35
1 1/4	180	176400	-	155	265000	1944	17200	-	-	28	-	32,5	46
1 1/2	180	253800	-	155	381000	3865	34200	-	-	33,5	-	39	54



Flat Head Socket Screws (ISO Metric Series)

Dimensions												
Thread Size	Pitch	A max.	B max.	E max.	H Ref.	F min.	R Ref.	T min.	W nom.	Shank area (mm^2)	Core area (mm^2)	Stess area (mm^2)
M3	0,5	6,72	3,0	1,85	1,7	1,05	0,5	18	2	7,07	4,47	5,03
M4	0,7	8,96	4,0	2,69	2,3	1,49	0,7	20	2,5	12,6	7,75	8,78
M5	0,8	11,20	5,0	3,18	2,8	1,86	0,7	22	3	19,6	12,7	14,2
M6	1,0	13,44	6,0	3,58	3,3	2,16	0,85	24	4	28,3	17,9	20,1
M8	1,25	17,92	8,0	4,42	4,4	2,85	1,2	28	5	50,3	32,8	36,6
M10	1,5	22,40	10,0	6,01	5,5	3,60	1,5	32	6	78,5	52,3	58,0
M12	1,75	26,88	12,0	6,85	6,5	4,35	1,85	36	8	113	76,2	84,3
M16	2,0	33,60	16,0	8,10	7,5	4,89	1,85	44	10	201	144	157
M20	2,5	40,32	20,0	8,70	8,5	5,45	1,85	52	12	314	225	245
M24	3,0	40,42	24	16,05	14	10,15	2,2	60	14	452	324	353

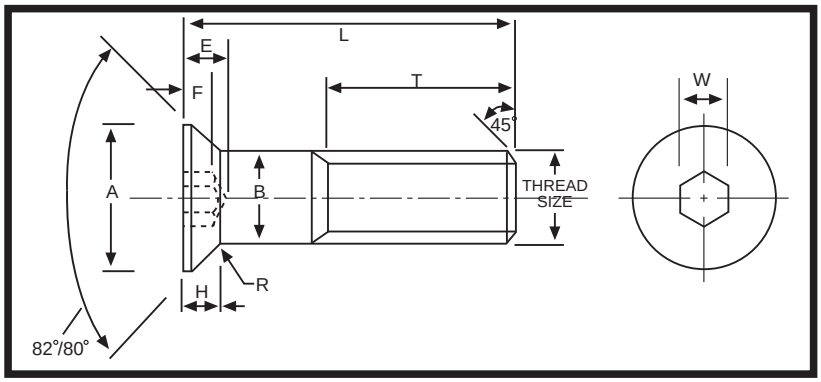
All dimensions in mm
A - Max. Theoretical Sharp Corners

NOTES:

1. Material - High Grade Alloy Steel
2. Hardness - Rc 36-45 (alloy steel)
3. Tensile Strength - (alloy steel) 1050 MPa
4. Shear Strength - (alloy steel) 630 MPa
5. Yield Strength - (alloy steel) 945 MPa
6. Thread Class - 4g/6g
7. Head angle shall be:
   92˚/90˚ up to M20
   62˚/60˚ over M20

Application Data										
Thread Size	Tensile Strength min.		Yield Strength min.		Double Shear Strength (Body)	Double Shear Strength (Core)	Recommended Seating Torque		Hole Dimensions	
	MPa	KN	MPa	KN	KN	KN	N-m	inch-lbf	Tap drill	Body drill
M3	1050	5,28	945	4,75	8,91	5,63	1,2	11	2,5	3,4
M4	1050	9,22	945	8,30	15,88	9,77	2,8	25	3,3	4,5
M5	1050	14,91	945	13,42	24,70	16,00	5,5	50	4,2	5,6
M6	1050	21,11	945	19,00	35,66	22,55	9,5	85	5	6,8
M8	1050	38,43	945	34,6	63,4	41,3	24	210	6,75	8,8
M10	1050	60,9	945	54,8	99	66	47	415	8,5	10,8
M12	1050	88,5	945	79,7	142	96	82	725	10,25	12,8
M16	1050	165	945	148	253	181	205	1800	14	17
M20	1050	257	945	232	396	284	400	3550	17,5	21
M24	1050	371	945	334	570	408	640	5650	21	25

NOTE: 1KN = approx. 102 kgf (or 225lbf) &
1MPa = 1 N/mm^2 or approx. 145 psi
Tap drill sizes based on approx. 70% thread height.
Seating torques based on 420 MPa induced stress in screw threads.



Flat Head Socket Screws (Unified Inch Series)

Dimensions															
Thread Size	T.P.I.		A	B	E	H	F	R	T	W	Shank Area	Stress Area (in^2)		Core Area (in^2)	
	UNC	UNF	max.	max.	max.	ref.	min.	ref	Basic	nom.	(in^2)	UNC	UNF	UNC	UNF
0		80	,138	,060	,042	,045	,031	,006	,500	,035	,0028	-	,0018	-	,0015
1	64	72	,168	,073	,057	,055	,036	,007	,625	,050	,0042	,0026	,0028	,0022	,0024
2	56	64	,197	,086	,063	,064	,043	,009	,625	,050	,0058	,0037	,0039	,0031	,0034
3	48	56	,226	,099	,072	,073	,049	,010	,625	1/16	,0077	,0049	,0052	,0041	,0045
4	40	48	,255	,112	,079	,082	,055	,011	,750	1/16	,0098	,0060	,0066	,0050	,0057
5	40	44	,281	,125	,088	,090	,061	,012	,750	5/64	,0123	,0080	,0083	,0067	,0072
6	32	40	,307	,138	,094	,097	,066	,014	,750	5/64	,0149	,0091	,0102	,0075	,0087
8	32	36	,359	,164	,120	,112	,076	,016	,875	3/32	,0111	,0140	,0147	,0120	,0129
10	24	32	,411	,190	,130	,127	,087	,019	,875	1/8	,0284	,0175	,0200	,0145	,0175
1/4	20	28	,531	,250	,151	,162	,111	,025	1,000	5/32	,0491	,0318	,0364	,0269	,0326
5/16	18	24	,656	,312	,187	,198	,135	,031	1,125	3/16	,0769	,0524	,0581	,0454	,0524
3/8	16	24	,781	,375	,230	,234	,159	,037	1,250	7/32	,1104	,0775	,0878	,0678	,0809
7/16	14	20	,844	,437	,236	,234	,159	,044	1,375	1/4	,1503	,1063	,1187	,0933	,1090
1/2	13	20	,937	,500	,269	,251	,172	,050	1,500	5/16	,1964	,1419	,1599	,1257	,1486
5/8	11	18	1,188	,625	,308	,324	,220	,050	1,750	3/8	,307	,226	,256	,202	,240
3/4	10	16	1,438	,750	,317	,396	,220	,050	2,000	1/2	,442	,334	,373	,302	,351
7/8	9	-	1,688	,875	,416	,468	,248	,050	2,250	9/16	,601	,462	-	,419	-
1	8	-	1,938	1,000	,570	,540	,297	,050	2,500	5/8	,785	,606	-	,551	-

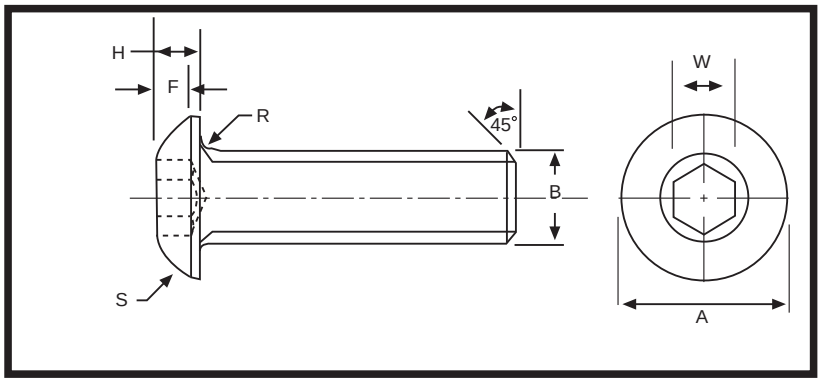
A - Max. Theoretical Sharp Corners

NOTES:

1. Material - High Grade Alloy Steel
2. Hardness - Rc 36-45
3. Tensile Strength - (alloy steel) 160 KSI
4. Shear Strength - (alloy steel) 96 KSI
5. Yield Strength - (alloy steel) 144 KSI
6. Thread Class - 3A

Application Data														
Thread Size	Tensile Strength KSI min.	Tensile Strength lbf - min.		Yield Strength KSI min.	Double Shear Strength (Body) lbf - min.	Double Shear Strength (Core) lbf - min.		Recommended Seating Torque				Hole dimmensions (mm)		
		UNC	UNF			UNC	UNF	UNC		UNF		Tap drill		Body drill
								N-m	inch - lbf	N-m	inch - lbf	UNC	UNF	
0	160	-	265	144	542	-	288	-	-	,17	1,5	-	1,25	1,75
1	160	390	390	144	804	422	461	,28	2,5	,28	2,5	1,55	1,55	2,05
2	160	555	555	144	1112	595	653	,51	4,5	,51	4,5	1,85	1,9	2,4
3	160	725	725	144	1478	787	864	,79	7	,79	7	2,1	2,15	2,75
4	160	1040	1040	144	1892	960	1094	,9	8	,9	8	2,35	2,4	3,1
5	160	1260	1310	144	2360	1286	1382	1,36	12	1,47	13	2,65	2,7	3,5
6	160	1440	1620	144	2880	1440	1670	1,7	15	1,92	17	2,85	2,95	3,9
8	160	2220	2240	144	4060	2304	2477	3,39	30	3,5	31	3,4	3,5	4,6
10	160	2780	3180	144	5440	2784	3360	4,52	40	5,1	45	3,9	4,1	5,2
1/4	160	5070	5790	144	9420	5165	6260	11,3	100	12,4	110	5,1	5,5	6,8
5/16	160	8350	9250	144	14720	8720	10060	22,6	200	24,9	220	6,6	6,9	8,3
3/8	160	12400	14000	144	21200	13020	15530	39,6	350	45,2	400	8	8,5	10
7/16	160	16900	18900	144	28800	17910	20930	63,3	560	70,6	625	9,2	9,8	11,5
1/2	160	22800	25600	144	37700	24130	28530	96,1	850	113	1000	10,8	11,5	13,2
5/8	160	36000	40800	144	58900	38780	46080	192	1700	215	1900	13,5	14,5	16,5
3/4	160	53200	59300	144	84800	57980	67390	340	3000	360	3200	16,5	17,5	19,5
7/8	160	73900	-	144	115400	80450	-	570	5000	-	-	19,5	-	23
1	160	97000	-	144	150700	105800	-	820	7200	-	-	22	-	26

Tap drill sizes based on approx. 70% thread height.



Socket Button Head Screws (ISO Metric Series)

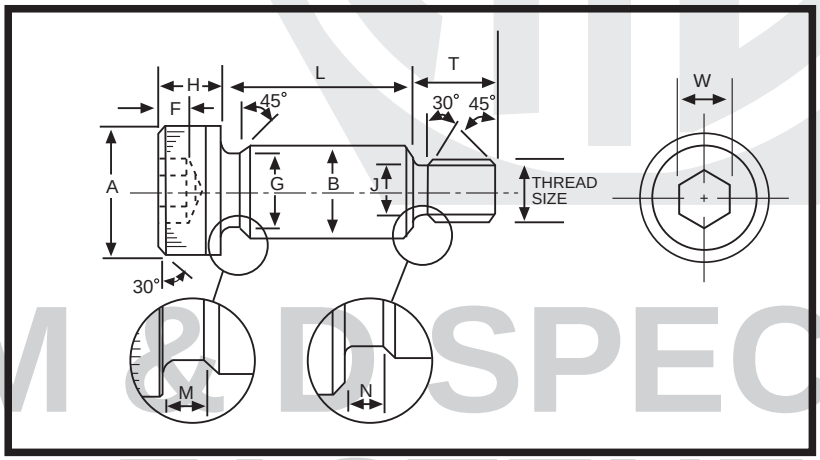
Dimensions											
Thread Size	Pitch	A max.	B max.	H max.	F min.	S Ref.	R Ref.	W nom.	Shank Area (mm^2)	Core Area (mm^2)	Stress Area (mm^2)
M3	0,5	5,7	3,0	1,65	1,04	2,95	,35	2	7,07	4,47	5,03
M4	0,7	7,6	4,0	2,2	1,3	4,1	,35	2,5	12,6	7,75	8,78
M5	0,8	9,5	5,0	2,75	1,56	5,2	,45	3	19,6	12,7	14,2
M6	1,0	10,5	6,0	3,3	2,08	5,6	,45	4	28,3	17,9	20,1
M8	1,25	14,0	8,0	4,4	2,6	7,5	,45	5	50,3	35,8	36,6
M10	1,5	18,0	10,0	5,5	3,12	10,0	,6	6	78,5	52,3	58,0
M12	1,75	21,0	12,0	6,6	4,16	11,0	,6	8	113	76,2	84,3

Application Data										
Thread Size	Tensile Strength min.		Yield Strength min.		Double Shear Strength (Core)	Recommended Seating Torque		Hole Dimensions (mm)		Grip Length
	MPa	KN	MPa	KN	KN	N-m	inch-lbf	Tap drill	Body drill	
M3	1050	5,28	945	4,75	5,63	1,2	11	2,5	3,4	All std items thread to head
M4	1050	9,22	945	8,30	9,77	2,8	25	3,3	4,5	
M5	1050	14,19	945	13,42	16,00	5,5	50	4,2	5,6	
M6	1050	21,11	945	19,00	22,55	9,5	85	5	6,8	
M8	1050	38,43	945	34,6	41,3	24	210	6,75	8,8	
M10	1050	60,9	945	54,8	66	47	415	8,5	10,8	
M12	1050	88,5	945	79,7	96	82	725	10,25	12,8	

All dimensions in mm. Tap drill sizes based on approx. 70% thread height.

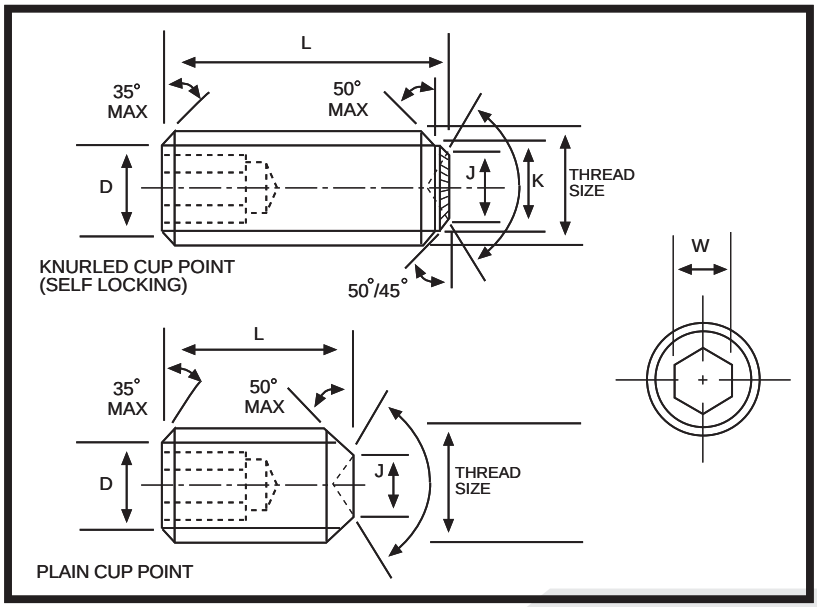
NOTES:

1. Material - High Grade Alloy Steel
2. Hardness - Rc 36-45
3. Tensile Strength - (alloy steel) 1050 MPa
4. Shear Strength - (alloy steel) 630 MPa
5. Yield Strength - (alloy steel) 945 MPa
6. Squareness - Bearing surface of head to be square with body within 2˚.



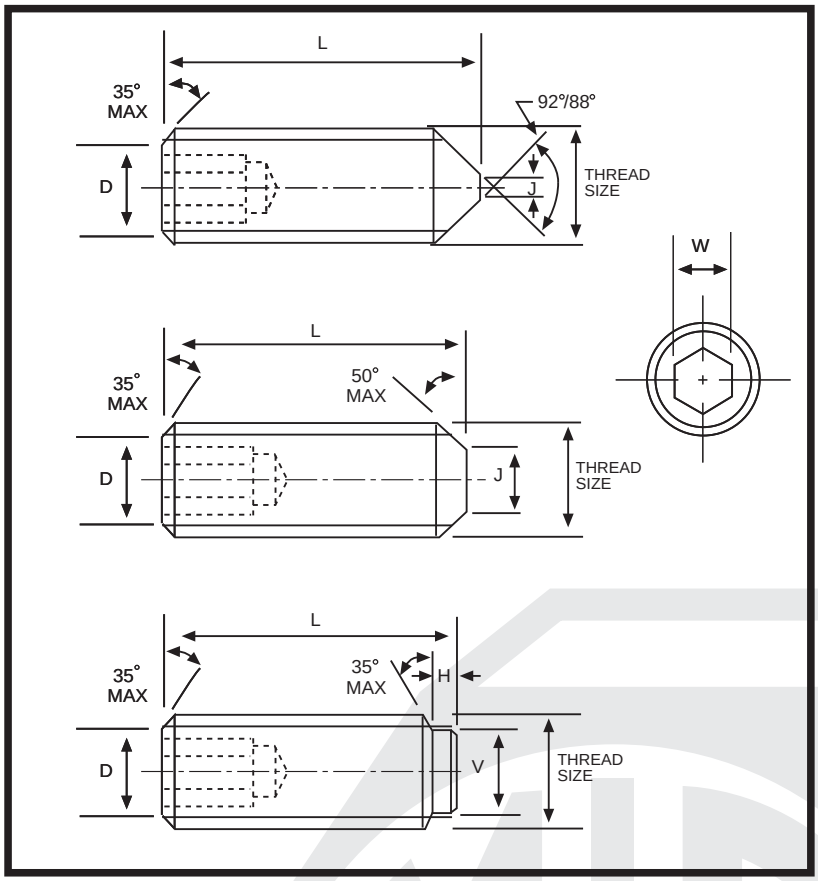
Socket Shoulder Screws (Metric Series)

Dimensions												Application Data		
Nom. Size B	Thread Size	Pitch	A max.	F min.	G max.	H max.	J min.	M max.	N max.	T max.	W nom.	Recommended Seating Torque N-m	Recommended Seating Torque inch - lbf	Tap Drill (mm)
6,00	M5	0,8	10,00	2,4	5,62	4,50	3,66	1,85	2,00	9,75	3	7	60	4,2
8,00	M6	1,0	13,00	3,3	7,62	5,50	4,38	1,85	2,50	11,25	4	12	105	5
10,00	M8	1,25	16,00	4,2	9,62	7,00	6,03	1,85	2,80	13,25	5	29	255	6,75
12,00	M10	1,5	18,00	4,9	11,62	9,00	7,69	1,85	3,00	16,25	6	57	500	8,5
16,00	M12	1,75	24,00	6,9	15,62	11,00	9,34	1,85	4,00	18,25	8	100	885	10,25
20,00	M16	2,0	30,00	8,8	19,62	14,00	13,00	2,5	4,80	22,25	10	240	2125	14
24,00	M20	2,5	36,00	10,0	23,62	16,00	16,29	2,65	5,60	27,25	12	470	4160	17,5



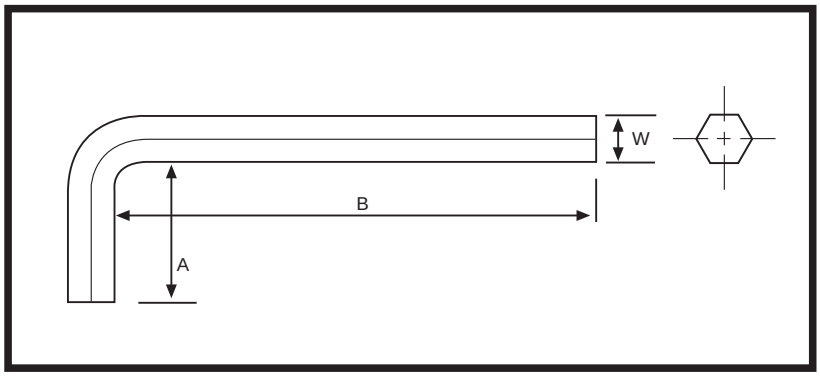
Socket Set Screws (ISO Metric Series Knurled & Plain Cup Point)

Dimensions									Application Data		
Thread Size	Thread Pitch	D	J (max.)		K	L (min. pref.)		W	Recommended Seating Torque		Tap Drill
		max.	Plain Cup	Knurled Cup	max.	Plain Cup	Knurled Cup	nom.	N-m	inch - lbf	Size
1,6	,35	1,0	,8	-	-	2,0	-	,7	,08	,7	1,25
2	,4	1,32	1,0	-	-	2,5	-	,9	,15	1,3	1,6
2,5	,45	1,75	1,25	-	-	3,0	-	1,3	,42	3,7	2,05
3	,5	2,1	1,5	1,4	2,06	3,0	3,0	1,5	,6	5,0	2,5
4	,7	2,75	2,0	2,1	2,74	3,0	3,0	2,0	2,0	18,0	3,3
5	,8	3,7	2,5	2,4	3,48	4,0	4,0	2,5	4,0	35,0	4,2
6	1,0	4,35	3,0	3,3	4,14	4,0	5,0	2,0	7,0	62,0	5
8	1,25	6,0	5,0	5,0	5,62	5,0	6,0	4,0	17,0	150	6,75
10	1,5	7,4	6,0	6,0	7,12	6,0	8,0	5,0	34,0	300	8,5
12	1,75	8,6	8,0	8,0	8,58	8,0	10,0	6,0	60,0	530	10,25
16	2,0	12,35	10,0	10,0	11,86	12,0	14,0	8,0	150	1325	14
20	2,5	16,0	14,0	14,0	14,83	16,0	18,0	10,0	300	2650	17,5
24	3,0	18,95	16,0	16,0	17,80	20,0	20,0	12,0	475	4200	21



Socket Set Screws (ISO Metric Series Cone, Flat & Dog Point)

Dimensions													Application Data		
Thread Size	Thread Pitch	D max.	J (max.)		V max.	L (min. pref.)			H (max.)		Full Dog applies to lengths above	W nom.	Rec. Seating Torque		Tap Drill Size
			Cone Point	Flat Point		Cone Point	Flat Point	Dog Point	Half Dog Point	Full Dog Point			N-m	inch - lbf	
M3	,5	2,1	0,3	2,0	2,0	4,0	3,0	5,0	0,75	1,50	5,0	1,5	,6	5,0	2,5
M4	,7	2,75	0,4	2,5	2,5	4,0	3,0	5,0	1,00	2,00	6,0	2,0	2,0	18,0	3,3
M5	,8	3,7	0,5	3,5	3,5	5,0	4,0	6,0	1,25	2,50	6,0	2,5	4,0	35,0	4,2
M6	1,0	4,35	1,5	4,0	4,0	6,0	4,0	6,0	1,50	3,00	8,0	3,0	7,0	62,0	5
M8	1,25	6,0	2,0	5,5	5,5	6,0	5,0	8,0	2,00	4,00	10,0	4,0	17,0	150	6,75
M10	1,5	7,4	2,5	7,0	7,0	8,0	6,0	8,0	2,50	5,00	12,0	5,0	34,0	300	8,5
M12	1,75	8,6	3,0	8,5	8,5	10,0	8,0	12,0	3,00	6,00	16,0	6,0	60,0	530	10,25
M16	2,0	12,35	4,0	12,0	12,0	14,0	12,0	16,0	4,00	8,00	20,0	8,0	150	1325	14
M20	2,5	16,0	6,0	15,0	15,0	18,0	14,0	20,0	5,00	10,00	25,0	10,0	300	2650	17,5
M24	3,0	18,95	8,0	18,0	18,0	20,0	20,0	22,0	6,00	12,00	30,0	12,0	475	4200	21



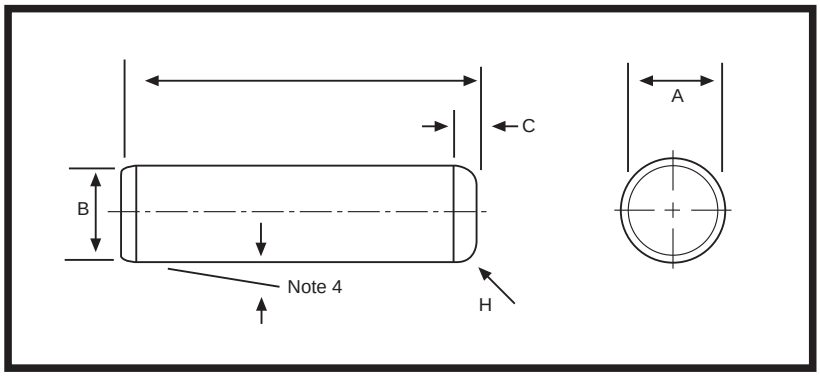
High Titan Hexagon Wrenches (ISO Metric Series)

Dimensions						Application Data			
nom	W		A	B		Torsional Shear Strength (min.)		Torsional Yield Strength (min.)	
	max.	min.		std. series	long series	N-m	inch - lbf	N-m	inch - lbf
,71	0,711	0,689	5,5	34	62	0,13	1,2	0,12	1,1
,89	0,889	0,876	9,0	34	62	0,27	2,4	0,24	2,1
1,27	1,270	1,244	13,5	44	84	0,79	7	0,68	6
1,5	1,500	1,470	14	45	90	1,2	10,5	1,02	9
2	2,000	1,970	16	50	100	3	26,5	2,7	24
2,5	2,500	2,470	18	56	112	6,2	55	5,4	48
3	3,000	2,960	20	63	126	10,5	93	9,1	80
4	4,000	3,960	25	70	142	24,9	220	21,7	190
5	5,000	4,960	28	80	160	48,8	430	42,5	375
6	6,000	5,950	32	90	180	83,5	740	72,8	645
8	8,000	7,950	36	100	200	199	1760	173	1530
10	10,000	9,950	40	112	224	386	3420	336	2970
12	12,000	11,950	45	125	250	634	5610	561	4880
14	14,000	16,930	55	140	280	995	8800	867	7700
17	17,000	16,930	60	160	320	1710	15100	1490	13200
19	19,000	18,930	70	180	360	2380	21000	2070	18300
22	22,000	21,930	80	200	400	3270	28900	2850	25200
24	24,000	23,930	90	224	448	4250	37600	3700	32700
27	27,000	26,820	100	250	500	5970	52800	5190	45900
32	32,000	31,820	125	315	630	8350	73900	7260	64200

All dimensions are specified in mm.

NOTES:

1. All wrenches ≥ 2mm nom size stamped for easy identification.
2. Wrenches are made to higher requirements than ISO or DIN wrenches, which may not properly torque M & D strength screws.



Dowel Pins (Metric Series Parallel Precision Ground)

Dimensions								Application Data		
Nominal Size	A - Pin Diameter		B - Point Diameter		C Crown Height max.	R Crown Radius min.	L_1 Point Angle Transition Length (note 4)	Double Shear Stength kN Minimum	Recommended Hole Size	
	max.	min.	max.	min.					max.	min.
3	3,008	3,003	2,9	2,6	,8	0,3	8	14	3,000	2,987
4	4,008	4,003	3,9	3,6	,9	0,4	10	25	4,000	3,987
5	5,008	5,003	4,9	4,6	1,0	0,4	10	39	5,000	4,987
6	6,009	6,003	5,8	5,4	1,1	0,4	12	57	6,000	5,987
8	8,009	8,003	7,8	7,4	1,3	0,5	12	100	8,000	7,987
10	10,009	10,003	9,8	9,4	1,4	0,6	16	155	10,000	9,987
12	12,009	12,003	11,8	11,4	1,6	0,6	20	225	12,000	11,987
16	16,009	16,003	15,8	15,3	1,8	0,8	20	400	16,000	15,987
20	20,009	20,003	19,8	19,3	2,0	0,8	25	630	20,000	19,987
25	25,009	25,003	24,8	24,3	2,3	1,0	25	980	25,000	24,987

All dimensions are specified in mm.

NOTES:

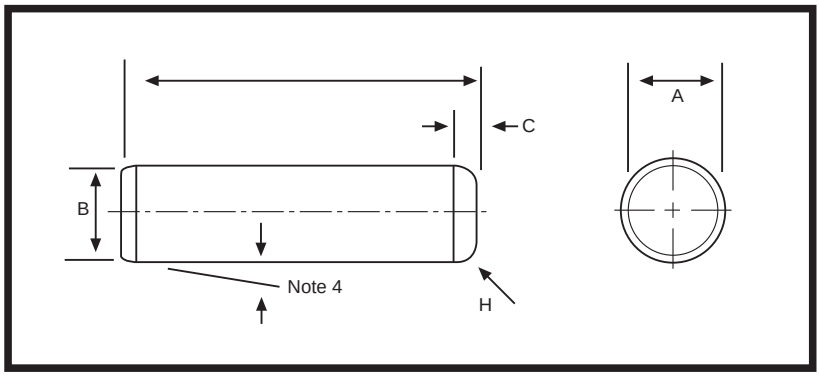
1. Material - Alloy Steel
2. Hardness - Rockwell C60-64 (case)
   - Rockwell C50-58 (core)
3. Surface finish - 0,2 micrometers max.
4. Point Angle - 4°-8° for lengths "L_1" and longer
   - 10°-16° for lengths shorter than "L_1"
5. Shear Strength - 1050 MPa

Dowel Pins are not fasteners. They are used primarily to prevent lateral movement between precision parts where dimensional accuracy must be maintained, such as dies, tools, jigs, fixtures etc.

Where space permits it is advisable to use pins 5 mm diameter or larger to ensure precision fit. Dowel pin engagement should never be less than 2 diameters in length; whilst 4 are preferable 10 diameters are more than ample.

This allows 5 diameters of contact for each section the dowel engages.

When shearing action takes place at the junction of assembly, the length relation of the pin to the parts (as long as it is 2 diameters or more) has no additional significance.

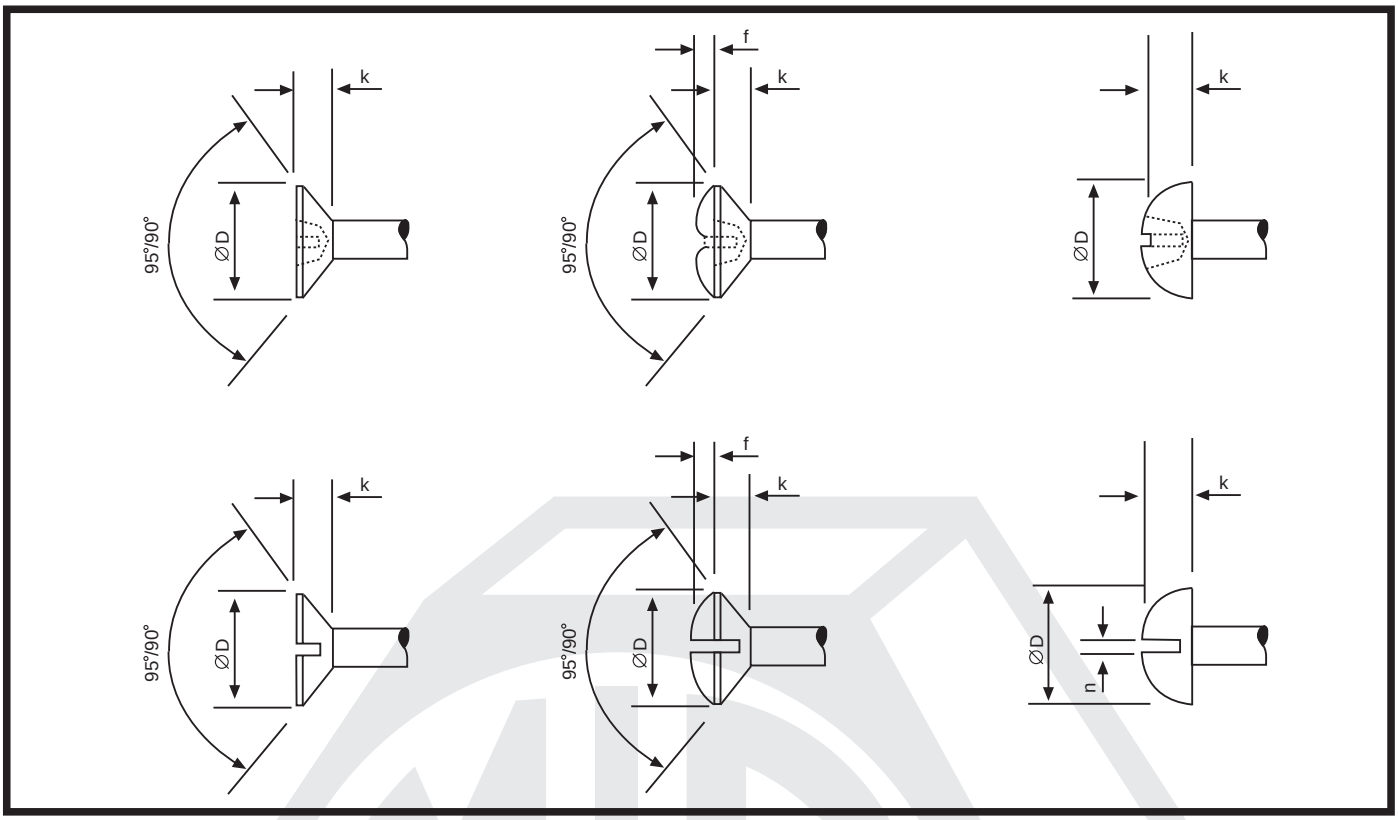


Sel-Lok Spring Pins (Metric Series)

Dimensions								
	A	min.	B	C	Wall Thickness	Min. Double Shear KN	Recommended Hole Size	
nom.	max. diameter Go Ring Gauge	D1 + D2 + D3 3	max.	min.			max.	min.
1.5	1,70	1,60	ON APPLICATION	ON APPLICATION	0,3	1,5	1,58	1,5
2	2,25	2,15			0,4	2,8	2,09	2,0
2.5	2,75	2,65			0,5	4,3	2,59	2,5
3	3,25	3,15			0,6	6,2	3,09	3,0
3.5	3,90	3,70			0,7	8,5	3,59	3,5
4	4,40	4,20			0,8	11	4,12	4,0
4.5	4,90	4,70			0,9	14	4,62	4,5
5	5,40	5,20			1,0	17	5,12	5,0
6	6,40	6,20			1,2	25	6,12	6,0
8	8,60	8,30			16	45	8,15	8,0
10	10,60	10,30			2,0	69	10,15	10,0
12	12,60	12,30			2,0	86	10,20	12,0

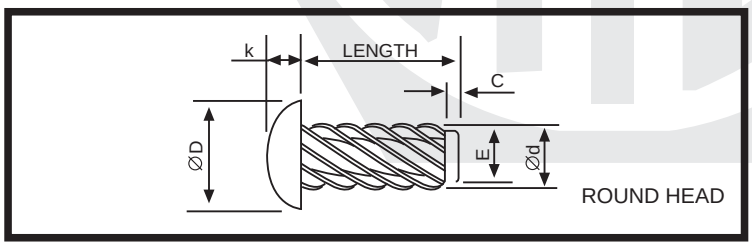
Length Tolerances			Length Increments		
Dia.	Length	Tolerance	Dia.	Length	'L' Increment
All	Up to 10	+ 0,5 - 0,0	All	4 - 26	2
	10-50	+ 1,0 - 0,0		30 - 80	5
	over 50	+ 1,5 - 0,0		Over 80	10

Slotted and Pozidriv® Wood Screws



Screw No.	Nom. Dia mm	Countersunk and Raised Countersunk				Round		All Slotted heads	Pozidriv
		D (max)	D (min)	k (max)	f (nom.)	D (max)	k (max)	n (min)	Point No
3	2,5	5,08	4,33	1,50	0,60	5,38	4,62	0,66	1
4	3,0	5,98	5,23	1,65	0,75	6,38	5,62	0,86	1
6	3,5	6,95	6,05	1,93	0,90	7,45	6,55	0,86	2
8	4,0	7,95	7,05	2,20	1,00	8,45	7,55	1,06	2
9	4,5	8,75	7,85	2,35	1,10	9,45	8,55	1,06	2
10	5,0	9,65	8,75	2,50	1,25	10,45	9,55	1,26	2
12	5,5	10,75	9,65	2,75	1,40	11,55	10,45	1,26	3
14	6,0	11,55	10,45	3,00	1,50	12,55	11,45	1,66	3
16	7,0	13,05	11,95	3,50	1,80	14,55	13,45	2,00	3

D is the theoretical diameter to sharp corners, also countersunk diameter to give flush fit.

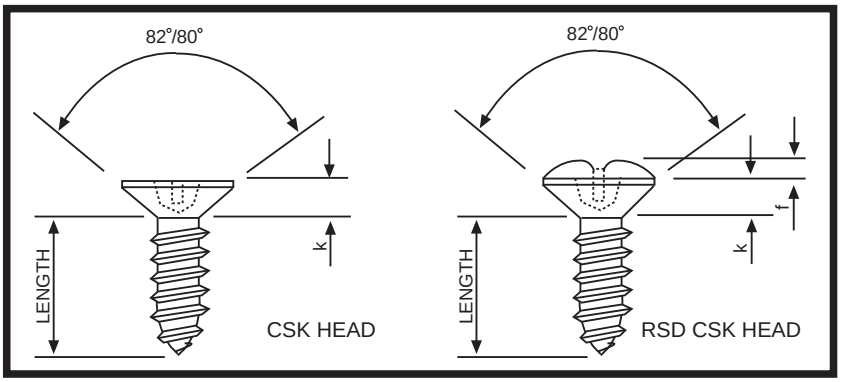


Hammer Drive screws Type “U” Round Head

Screw No.	Major dia. d Max.	Point dia. E Max.	Head dia. D Max.	Head depth k Max.
00	1,52	1,24	2,51	0,86
0	1,90	1,60	3,22	1,24
2	2,54	2,11	4,11	1,75
4	2,95	2,44	5,36	2,18
6	3,56	2,95	6,60	2,62
7	3,91	3,20	7,24	2,82
8	4,24	3,45	7,85	3,05
10	4,62	3,81	9,12	3,48
12	5,38	4,50	10,36	3,89

LENGTH OF PILOT

Length of screw	Below 3.2	3.2 to 4	4.5 to 8	9.5 to 13	16 to 22	25 an over
Length of pilot C Min.	0,5	0,9	1,2	1,6	2,0	3,2

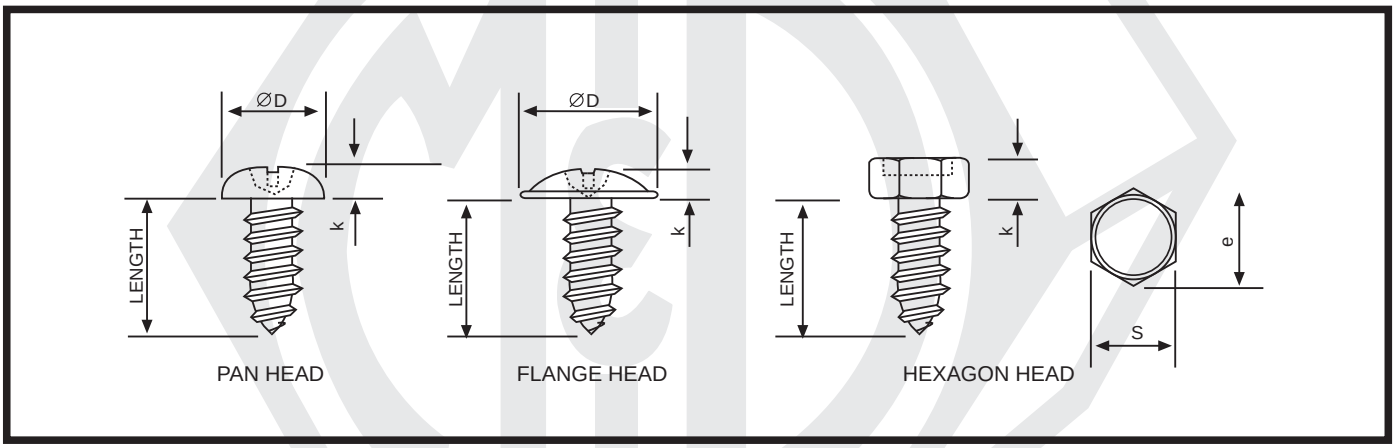


Pozidriv®
Self Tapping Screws
Type AB & B

Screw		Countersunk and raised countersunk heads			Raised csk heads only	Pozidriv
		Diameter of head		Depth of head	Height of raise	Point No
No.	Dia (mm)	* D Max.	*D* Min.	*k* ref	*f* (nom.)	
2	2,2	4,3	4,0	1,3	0,7	1
4	2,9	5,5	5,2	1,7	0,9	1
6	3,5	6,8	6,44	2,1	1,2	2
8	4,2	8,1	7,74	2,5	1,4	2
10	4,8	9,5	9,14	3,0	1,5	2
12	5,5	10,8	10,37	3,4	1,7	3
14	6,3	12,4	11,97	3,8	2,0	3

* D is the theoretical diameter to sharp corners..

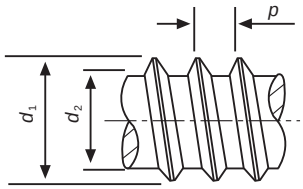
Pozidriv® and Hex Self Tapping Screws Type AB & B



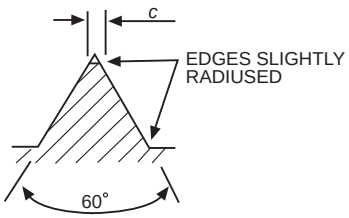
Screw		Pan Head		Flange Head		Hexagon Head		
		Diameter of head	Depth of head	Diameter of head	Depth of head	Width across flats*	Width across corners	Depth of head
No.	Dia (mm)	D Max.	k Max.	D Max.	k Max.	S Max.	e min.	k nom.
2	2,2	4,2	1,8	-	-	3,2	3,41	1,3
4	2,9	5,6	2,2	6,53	1,60	5,0	5,45	1,5
6	3,5	6,9	2,6	8,15	1,88	5,5	6,0	2,3
8	4,2	8,2	3,05	9,75	2,36	7,0	7,66	2,8
10	4,8	9,5	3,55	11,38	2,90	8,0	8,76	3,0
12	5,5	10,8	3,95	13,00	3,15	8,0	8,76	4,0
14	6,3	12,5	4,55	14,55	3,68	10,0	11,05	4,8

Self Tapping Thread Form Dimensions and Point Details

THREAD ST

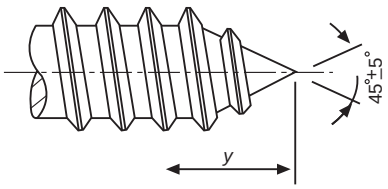


THREAD PROFILE

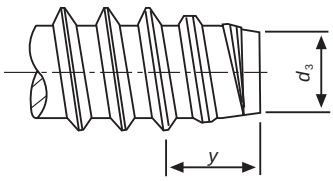


THREAD ENDS

TYPE C, WITH CONE END *)
(IN ISO PREVIOUSLY TYPE AB, IN DIN STANDARDS PREVIOUSLY TYPE B)



TYPE F, WITH FLAT END
(IN ISO PREVIOUSLY TYPE B, IN DIN STANDARDS PREVIOUSLY TYPE BZ)



Thread size		ST 2,2	ST 2,9	ST 3,5	ST 4,2	ST 4,8	ST 5,5	ST 6,3	ST 8	ST 9,5
P	≈	0,8	1,1	1,3	1,4	1,6	1,8	1,8	2,1	2,1
d_1	max.	2,24	2,9	3,53	4,22	4,8	5,46	6,25	8	9,65
	min.	2,1	2,76	3,35	4,04	4,62	5,28	6,03	7,78	9,43
d_2	max.	1,63	2,18	2,64	3,1	3,58	4,17	4,88	6,2	7,85
	min.	1,52	2,08	2,51	2,95	3,43	3,99	4,7	5,99	7,59
d_3	max.	1,47	2,01	2,41	2,84	3,3	3,86	4,55	5,84	7,44
	min.	1,37	1,88	2,26	2,69	3,12	3,68	4,34	5,64	7,24
c	max.	0,1	0,1	0,1	0,1	0,15	0,15	0,15	0,15	0,15
y max[1])	Type C	2	2,6	3,2	3,7	4,3	5	6	7,5	8
	Type F	1,6	2,1	2,5	2,8	3,2	3,6	3,6	4,2	4,2
	Number[2])	2	4	6	8	10	12	14	16	20

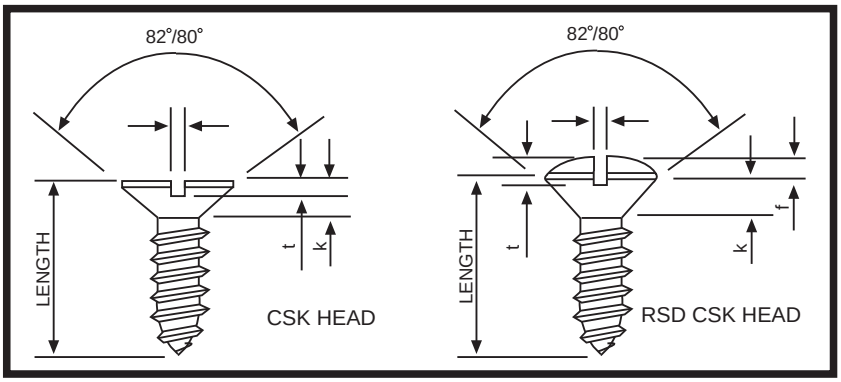
1) Length of incomplete thread (cone end or flat end)
2) Only for information on customary code numbers used on in-house documents.
*) No extrusion of excess metal beyond the apex of the type C cone end resulting from thread rolling shall be permissible. A slight rounding of the point is desirable.

NOTE 1: The above dimensions are for uncoated screws and may be exceeded after coating.

Recommended Torsional Strength for Self Tapping Screws

Screw size (No.)	Minimum torsional load		
	lbf in	kgf cm	Nm
2	4	5	0,49
4	13	15	1,47
6	24	28	2,74
8	39	45	4,41
10	56	64	6,27
12	88	101	10,78
14	142	163	15,98

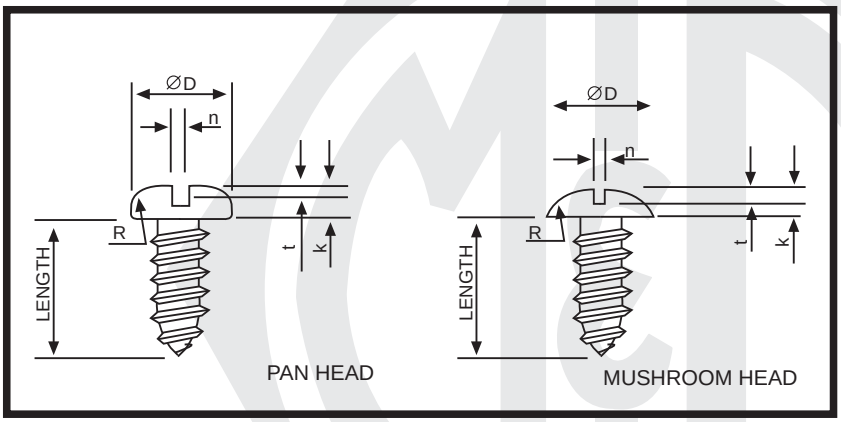
For the torsional strength test, the shank of the screw is clamped so that at least two threads protrude above the clamping device. Using a calibrated torque measuring device, torque is applied until fracture occurs. Screws have to meet the minimum torsional strengths shown in the table.



Slotted Self Tapping Screws
Type AB and B

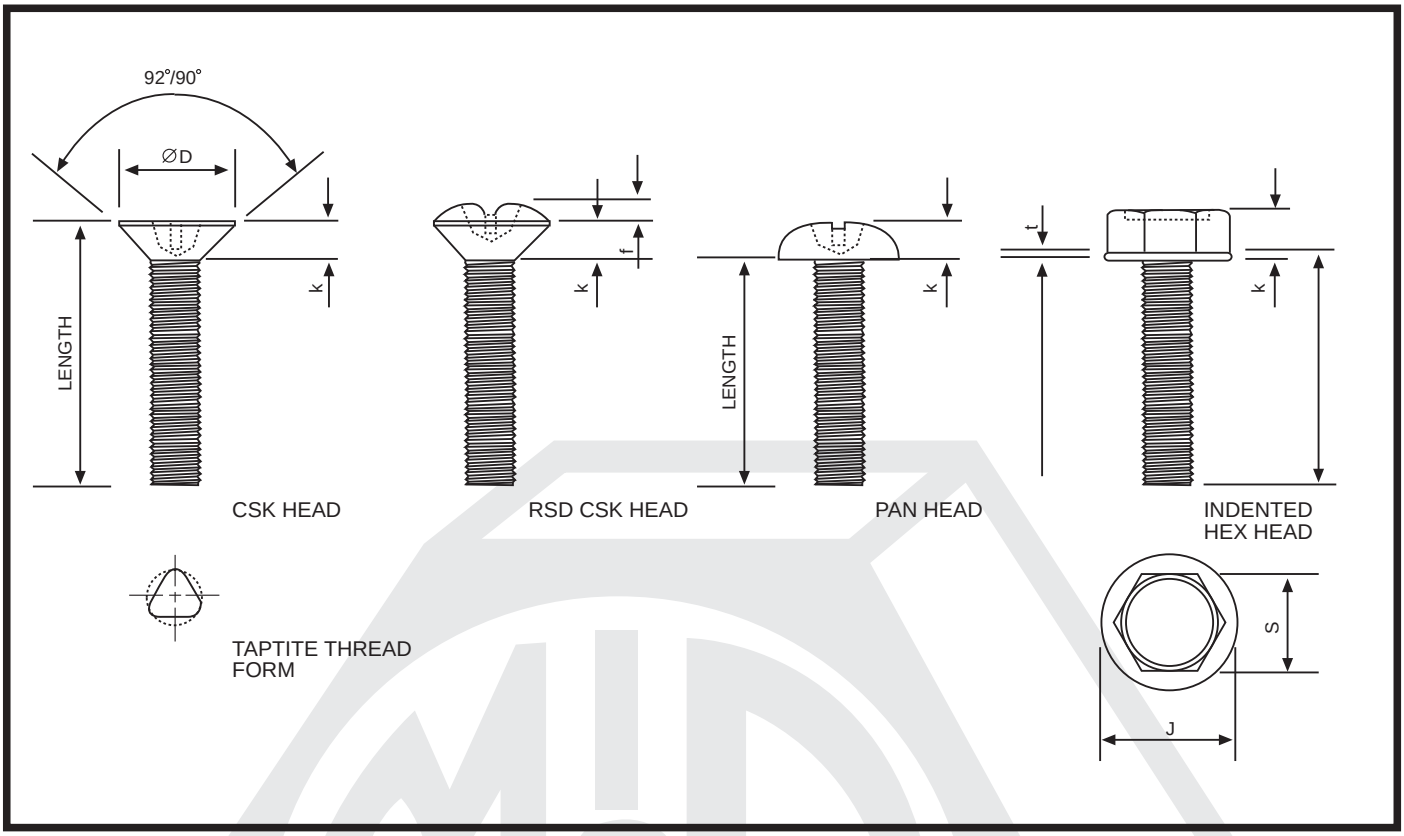
Screw		Countersunk and raised countersunk heads							
		Diameter of head		Depth of head	Slot width *n*		Depth of slot *t*		Height of raise
No.	Nom Dia (mm)	* D Max.	*D* Min.	*k* Ref	Max.	Min.	Csk Max.	Rsd Csk Max.	f Nom
2	2,2	4,3	4,0	1,3	0,80	0,66	0,6	1,15	0,7
4	2,9	5,5	5,2	1,7	1,00	0,86	0,75	1,5	0,9
6	3,5	6,8	6,44	2,1	1,20	1,06	0,95	1,9	1,2
8	4,2	8,1	7,74	2,5	1,51	1,26	1,15	2,25	1,4
10	4,8	9,5	9,14	3,0	1,51	1,26	1,35	2,6	1,5
12	5,5	10,8	10,37	3,4	1,91	1,66	1,50	2,95	1,7
14	6,3	12,4	11,97	3,8	1,91	1,66	1,75	3,45	2,0

* D is the theoretical diameter to sharp corners..



Screw		Pan and mushroom heads			Pan head only					Mushroom head only				
		Slot Width *n*		Slot Depth *t*	Diameter of head *D*		Depth of head *k*		Radius of head *R*	Diameter of head *D*		Depth of head *k*		Radius of head *R*
No.	Nom Dia (mm)	Max.	Min.	Max.	Max.	Min.	Max.	Min.	Nom.	Max.	Min.	Max.	Min.	Nom.
2	2,2	0,80	0,66	0,8	4,2	3,9	1,35	1,15	0,9	-	-	-	-	
4	2,9	1,00	0,86	1,0	5,6	5,3	1,75	1,5	1,0	6,53	6,12	1,75	1,50	4,30
6	3,5	1,20	1,06	1,25	6,9	6,54	2,10	1,85	1,2	8,15	7,70	2,18	1,88	5,36
8	4,2	1,51	1,26	1,5	8,2	7,84	2,45	2,15	1,3	9,75	9,24	2,60	2,24	6,45
10	4,8	1,51	1,26	1,7	9,5	9,14	2,8	2,5	1,6	11,38	10,80	3,00	2,62	7,20
12	5,5	1,91	1,66	1,95	10,8	10,37	3,2	2,85	2	13,00	12,37	3,40	3,00	8,53
14	6,3	1,91	1,66	2,2	12,5	12,07	3,65	3,3	2,2	14,55	13,87	3,81	3,38	9,52

Pozidriv® Machine Screws and Taptite® Thread Forming Screws



ISO Metric dimensions in mm

Diameter	Countersunk and raised countersunk			Raised csk only	Pan		Hexagon Washer			
	Diameter of head		Depth of head	Height of raise	Diameter of head	Depth of head	Diameter of washer	Depth of washer	Width across flats	Depth of head
	D* Max.	*D* Min.	*k* Ref.	*f* Nom.	*D* Max.	*k* Max.	*J* Max.	*T* Max.	*S* Max.	*k* Max.
M2,5	5,50	4,45	1,5	0,60	5,00	1,95	5,2	0,42	4,0	1,52
M3	6,30	5,25	1,65	0,75	6,00	2,30	6,5	0,52	5,0	1,82
M3,5	7,35	6,12	1,93	0,90	7,00	2,45	7,2	0,57	5,5	2,12
M4	8,40	7,04	2,20	1,00	8,00	2,80	8,4	0,67	5,5	2,80
M5	10,00	8,75	2,50	1,25	10,00	3,50	10,4	0,83	8,0	3,65
M6	12,00	10,50	3,00	1,50	12,00	4,20	13,0	1,04	10,0	4,15
M8	16,00	14,00	4,00	2,00	16,00	5,60	16,9	1,35	13,0	5,65
M10	20,00	17,50	5,00	2,50	20,00	7,00	22,1	1,76	17,0	7,18

* D is the theoretical diameter to sharp corners.

DRIVER SIZES

Diameter size	POZIDRIV ® Recess and Driver No.
M2,5	1
M3	1
M3,5	2
M4	2
M5	2
M6	3
M8	4
M10	4

Pilot Hole Sizes
Taptite® Thread Forming Screws

MATERIAL AND HOLES

Taptile Screws perform well in a wide range of materials such as mild steel, stainless steel, brass, copper, zinc and aluminium based die-castings and some plastics. Holes in these materials may be drilled, cored or extruded.

Recommended holes in steel or die-castings are tabulated below. For recommendations for the use of Taptile in extruded holes in other materials, please contact the Technical Department of M & D Specialised Fasteners CC.

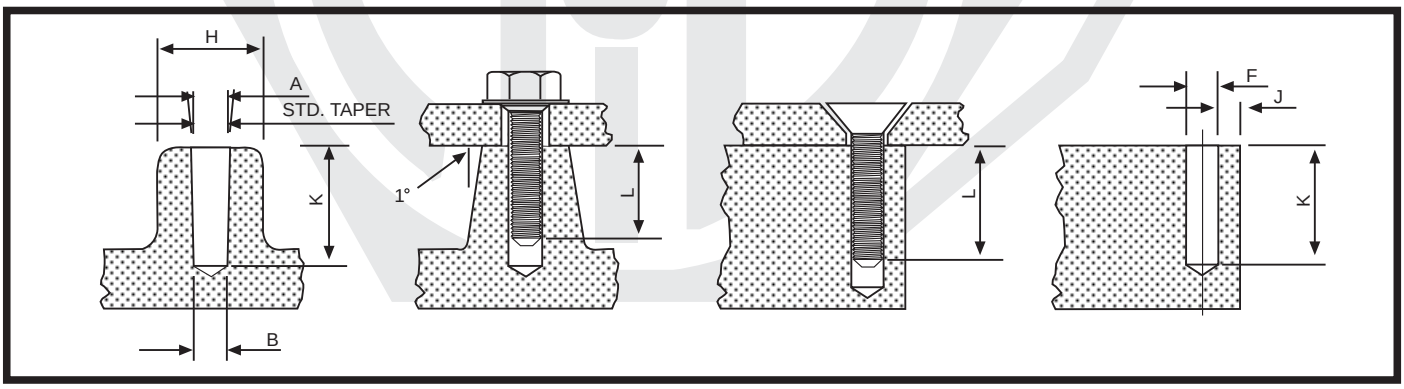
RECOMMENDED PILOT HOLE SIZES FOR STEEL SHEET AND BAR

Screw Size Diameter	Material Thickness				
	0,50 - 2,00	**1,50 - 3,50**	**3,00 - 6,50**	**6,00 - 8,00**	**8,00 - 12,00**
M3	2,70	2,75	2,80	-	-
M3,5	3,10	3,20	3,20	3,30	3,30
M4	3,60	3,70	3,70	3,80	3,80
M5	-	4,50	4,60	4,70	4,70
M6	-	5,40	5,50	5,60	5,70
M8	-	7,30	7,40	7,50	7,60
M10	-	-	9,20	9,30	9,40

RECOMMENDED PILOT HOLE SIZES FOR ALUMINIUM SHEET AND BAR

Screw Size Diameter	Material Thickness				
	0,50 - 2,00	**1,50 - 3,00**	**3,00 - 6,50**	**6,00 - 8,00**	**8,00 - 12,00**
M3	2,60	2,70	2,75	-	-
M3,5	3,10	3,10	3,20	3,20	3,20
M4	-	3,60	3,70	3,70	3,70
M5	-	4,50	4,50	4,60	4,70
M6	-	5,40	5,40	5,50	5,60
M8	-	7,30	7,30	7,40	7,50
M10	-	-	9,20	9,20	9,30

RECOMMENDED CORED AND DRILLED HOLE SIZES IN DIE-CASTINGS



Note: The Standard taper on cored holes is 1 ° 11'

Screw Size Diameter	Cored Hole + 0 - 0,075		Drilled Hole + 0,1 - 0	Minimum Boss Diameter	Distance to edge Minimum for no measurable distortion	Hole Depth as cast or drilled	Length of thread engagement to develop strength of screw
	A	B	F	H	J	K	L
M3	2,88	2,74	2,75	5,0	1,5	7	6
M3,5	3,35	3,19	3,20	5,8	1,7	8	7
M4	3,82	3,64	3,65	6,7	2,0	9	8
M5	4,80	4,58	4,60	8,3	2,7	11	10
M6	5,74	5,48	5,50	10,0	3,2	13	12
M8	7,69	7,35	7,40	13,3	3,7	17	16
M10	9,64	9,22	9,30	16,6	4,1	21	20

Recommended Pilot Hole and Drill Sizes

TYPES AB AND B SELF-TAPPING SCREWS

CASE HARDENED STEEL SCREWS

In mild steel, brass, aluminium alloy, stainless steel plates etc.

Screw No.	Nom. dia mm	Metal thickness mm	Drilled or clean punched hole dia. mm	Alternate drill sizes mm	Screw No. mm	Nom. dia mm	Metal thickness mm	Drilled or clean punched hole dia. mm	Alternate drill sizes mm
2	2,2	0,45	1,60	52	10	4,8	0,71	3,40	29
		0,91	1,85	49			1,22	3,60	28
		1,62	1,95	48			1,62	3,80	25
4	2,9	0,45	2,05	46			2,64	4,10	20
		0,91	2,30	43			3,18	4,30	18
		1,62	2,40	41			4,75	4,50	16
		2,03	2,60	38	12	5,5	0,71	4,10	20
6	3,5	0,45	2,35	42			1,22	4,30	18
		0,91	2,80	35			1,62	4,50	16
		1,62	2,95	32			2,64	4,80	12
		2,03	3,10	31			3,18	4,90	10
		2,64	3,20	30			4,75	5,10	7
8	4,2	0,71	2,90	32	14	6,3	1,22	4,80	12
		0,91	3,10	31			1,62	5,20	5
		1,22	3,20	30			2,03	5,40	3
		1,62	3,40	29			3,18	5,70	1
		2,64	3,70	26			4,75	5,90	A
		3,18	3,80	25			6,35	6,00	B

18-8 STAINLESS STEEL PLATE ETC. SELF TAPPING SCREWS

In mild steel, and aluminium alloy plates etc.

Screw No.	Nom. dia mm	Metal thickness mm	Drilled or clean punched hole dia. mm	Alternate drill sizes
4	2,9	0,45	2,20	44
		0,91	2,30	43
6	3,5	0,45	2,70	36
		0,91	2,80	35
8	4,2	0,71	3,00	32
		1,22	3,20	30
		1,62	3,40	29
10	4,8	0,71	3,50	29
		1,22	3,70	26
		1,62	3,80	25
14	6,3	1,22	5,40	3
		1,62	5,40	3

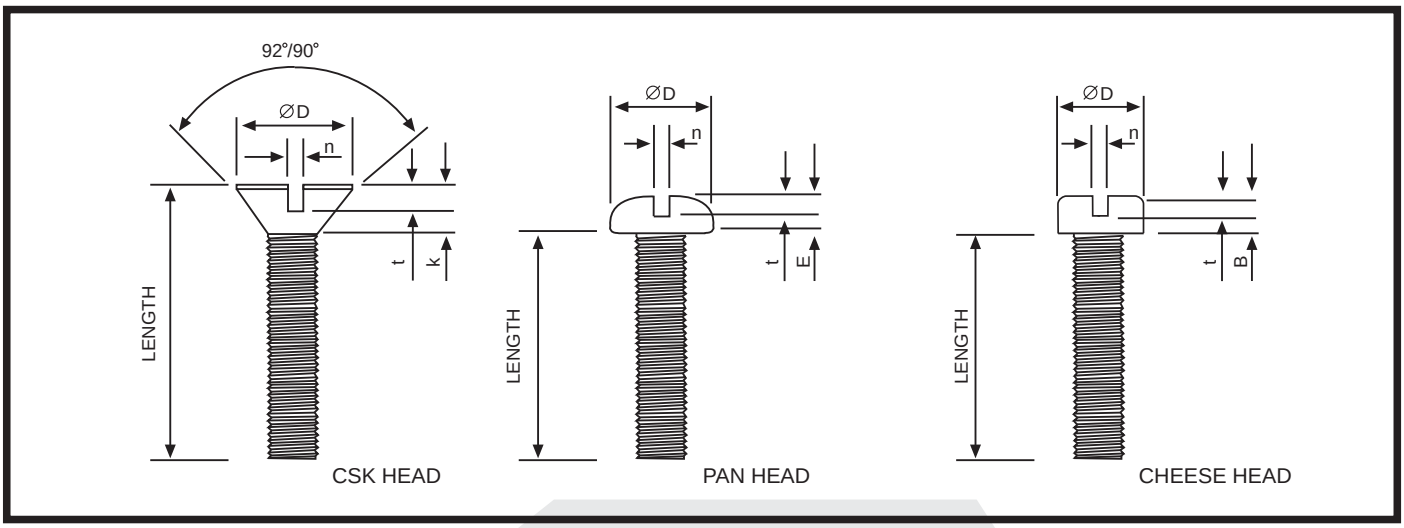
NOTE: 18-8 quality stainless steel self-tapping screws are softer than case hardened steel screws and, therefore, care must be exercised in using them. They cannot be used in very hard material.

HAMMER DRIVE SCREWS TYPE U

Screw No.	Thin sheet metal, non-ferrous castings, plastics, etc.		Cast iron, thick sheet metal		Screw No.	Thin sheet metal, non-ferrous castings, plastics, etc.		Cast iron, thick sheet metal	
	Hole dia. mm	Alt. drill	Hole dia. mm	Alt. drill		Hole dia. mm	Alt. drill	Hole dia. mm	Alt. drill
00	1,30	55	1,40	54	7	3,40	29	3,60	27
0	1,65	52	1,75	50	8	3,70	26	3,90	24
2	2,20	44	2,30	42	10	4,10	20	4,30	18
4	2,55	39	2,70	36	12	4,80	12	5,00	9
6	3,10	31	3,30	30	14	5,50	3	5,80	1

NOTE: It is important that the correct hole size is used and the recommendations above should be followed, but if very hard material is being used a hole size slightly larger may have to be used, and in very soft material a smaller hole size may be necessary.

Technical Data for I.S.O. Metric Slotted machine Screws



DIN STD

Nominal size	Pitch	DIN 963 COUNTERSUNK HEAD					DIN 85 PAN HEAD				DIN 85 CHEESE HEAD			
		Diameter of head		Depth of head	Width of slot	Depth of slot	Diameter of head	Depth of head	Width of slot	Depth of slot	Diameter of head	Depth of head	Width of slot	Depth of slot
		D Max	D Min	K Max	n Max	t Max	C Max	E Max	n Max	t Max	A Max	B Max	n Max	t Max
M3	0,5	5,60	5,3	1,65	1,0	0,85	6,0	1,8	1,0	0,95	5,5	2,0	1,0	1,15
M4	0,7	7,5	7,14	2,2	1,2	1,1	8,0	2,4	1,2	1,30	7,0	2,6	1,2	1,50
M5	0,8	9,2	8,84	2,5	1,51	1,3	10,0	3,0	1,51	1,50	8,5	3,3	1,51	1,80
M6	1,0	11,0	10,5	3,0	1,91	1,6	12,0	3,6	1,91	1,90	10,0	3,9	1,91	2,20
M8	1,25	14,5	14,07	4,0	2,31	2,1	16,0	4,8	2,31	2,40	13,0	5,0	2,31	2,60
M10	1,5	18,0	17,57	5,0	2,81	2,6	20,0	6,0	2,81	3,0	16,0	6,0	2,81	3,0
M3,5	0,6	6,50	6,14	1,93	1,0	1,0	7,0	2,1	1,0	1,10	6,0	2,4	1,0	1,40

Suggested Tightening Torques (ISO Metric Slotted Machine Screws)

Diameter	M3	M3,5	M4	M5	M6	M8	M10
Stress Area (mm^2)	5,03	6,78	8,78	14,2	20,1	36,6	58
Screw tension (kN)	1,3	-	2,2	3,6	5,1	9,3	-
Torque (Nm)	0,77	-	1,79	3,62	6,15	14,93	-

The above torque figures are only suggested values and are based on a strength grade of 5,8 for the machine screw and normal frictional conditions.

HIGH STRENGTH FRICTION-GRIP BOLTS

General

Friction –grip bolted connections are connections in which shear force is transmitted by the friction developed between the faying surfaces of the connected parts, which are clamped together by high pre-tension forces in the bolts. The bolts are of high-strength material and are pre-tensioned during installation to a force of at least 70 per cent of their tensile resistance. The holes are usually 2mm larger in diameter than the bolts, but a high degree of stiffness (i.e. resistance to slip) is achieved because of the use of friction to transfer the shear. Friction or slip-resistant joints are only specified for connections which are subject to load reversal under normal loading conditions, or where slipping into bearing cannot be tolerated for any other reason.

Friction joints are designed to transmit working (i.e. not factored) loads. They usually have a considerable reserve of strength above their slip resistance (i.e. the load at which the friction is overcome and bolts slip into bearing). If slip only causes unserviceability of the structure and not collapse, it may be possible in the design to mobilize this post-slip reserve for the ultimate limit state.

The design of friction-grip connections is covered by SABS 094-1982. Tables 1 to 3 from that code, which give friction coefficients, bolt tensions and load factors respectively, are reproduced below.

Dimensional and strength requirements

The dimensional and strength requirements for HSFG bolts are covered by specification SABS 1282-1982, whilst the requirements of the use of the bolts in connections are dealt with in code SABS 094-1982. Mechanical properties, dimensions and masses of bolt, nuts and washers are given in the Tables on pages 5 and 6.

The above specification and code cover two grades of bolt, viz. 8.8S and 10.9S, previously known as ‘general’ and ‘higher’ grade respectively. The significance of the grade designations is as described under “Bearing bolts” in Section 6.2, but the suffix “S” identifies the bolts as friction grip. The material strength is thus nominally the same as for the corresponding grades of precision bearing bolt, but the shank diameter tolerances are coarser. The width across flats of the heads and nuts and the height of nut are greater than for corresponding sizes of precision bolts; this is because of the high pre-tension force applied.

Threads for all HSFG bolts are to the standard ISO coarse form (as for precision bolts) and medium class of fit is used.

SABS 094-1982 – TABLE 1: COEFFICIENT OF FRICTION OF FAYING SURFACES

1	2	3
Class	Surface condition of faying surfaces	Coefficient of friction (μ)
A	Weathered rusted steel millscale	0,35
B	Clean millscale, wire brushed	0,35
C	Blast-cleaned	0,50
D	Hot-dip galvanized	0,15
E	Hot-dip galvanized and lightly blast cleaned with fine grit	0,35
F	Blast-cleaned, painted with inorganic zinc-rich paint	0,35
G	Blast-cleaned, zinc or aluminium metal-sprayed	0,50

NOTE:

1. Ensure that all surfaces are free of dirt, oil, lacquer and other foreign matter and, except where a coating is specified, of paint and other coatings.
2. Ensure that Class C surfaces are assembled as soon after blast-cleaning as reasonably possible and in any event before formation of rust becomes apparent.
3. Ensure the blast-cleaning of Class E surfaces is carried out immediately before assembly.
4. Carefully select the grit or shot used in blast-cleaning to ensure a roughened surface with the required coefficient of friction is achieved.
5. Ensure that in Class F surfaces the paint coatings have a dry film thickness not exceeding 0,1 mm and are thoroughly dry before assembly.
6. Red lead primer and similar oil or long oil resin-based paints are not recommended for faying surfaces.

SABS 094-1982-TABLE 2:
MINIMUM BOLT TENSIONS

1	2	3
Nominal size*	Minimum bolt tension, *T* (kN)	
of bolt	Grade 8.8S	Grade 10.9S
M12**	49	61
M16	91	114
M20	142	178
(M22)	176	220
M24	205	257
(M27)	266	334
M30	326	408
M36	475	595

* Sizes shown in bracketsare non-preffered
** Non-preffered for technical reasons

SABS 094-1982-TABLE 3:
LOAD FACTORS

1	2
Joints	Load factor (k)
Joints subject to dynamic loading, vibration, or impact	1,45
Other joints	1,25

Nuts are specified by proof load stress and hardness value only. The former corresponds to a stress in the bolt significantly higher than specified for the bolt; this is to preclude nut failure under tensile loading because of concern about the lack of ductility of this mode of failure. Nut hardness also differs from that of the bolt, so as to avoid cold welding that can occur between the threads if two materials of similar hardness are rubbed together under high bearing pressure. Hardened washers may be used to prevent the element that is being turned (whether nut or bolt head) from digging into the softer material of the connected parts. They are mandatory for the controlled-torque method of tightening, but not for the turn –of-nut method.

Tightening methods

In a friction-grip bolted connection it is necessary to ensure that after the bolts in a group have been tightened they are all tensioned to the minimum value given in SABS 094-1982, viz 0,7 times the bolt tensile strength. The methods of tightening recognized by the code are the following:

1. *Turn-of-nut method:* In essence this method induces an extension of the bolt by applying a prescribed rotation of the nut or head. To be effective the head and nut must have a solid base to react against. It is essential that, before applying the prescribed turn, all plies of the connection at all bolt positions are pulled into close contact, called the “snug-tight” condition. After suitable marks are made so that subsequent rotation between bolt and nut may be observed, the nut or head is subject to the appropriate rotation, viz 0,5 to 1,25 turns depending on grip length. This is probably the most common method of tightening and is to be recommended because of its reliability.

2. *Torque-control method:* Here each bolt in the group is subjected to a certain predetermined torque in sequence. To overcome possible interaction between bolts if the plies do not readily draw up, the sequence is repeated until all bolts refuse to turn further.

   Most of the torque effort (80 per cent to 90 per cent) is lost in overcoming friction in the threads and between nut and plate. It follows that small vibrations in friction will result in substantial variations in bolt pre-tension and great care is therefore necessary to achieve consistent results. The required torque is determined by calibrating the tightening device (at least once every shift) to produce a tension on a specimen bolt of 1,1 times the specified tension. It is important that the frictional resistance of all bolts in the connection is consistent with that of the specimen bolt.

   This method tends to be unpopular, both with contractors and inspectors, because of the variability in the ratio of applied torque to shank pre-tension. Its use is not recognized in North American practice.

3. *Part torque, part turn method*: This is a variation of the turn-of-nut method, where the pulling up to the snug tight condition is quantified by first applying a specified reduced tension to all bolts in the group in sequence up to the point of refusal and then applying 90° turn of the nut (or head) to bring the bolts to their full required pre-tension.

4. *Proprietary load indicating devices:* Various proprietary load indicating bolts and washers are available. Two of these are the ‘Coronet’ load indicating washer and the GKN ‘Lib’ or load indicating bolt. These indicate the tensile load in the bolt by producing a measurable gap variation in the presence of local yielding. This change is usually irreversible and these systems cannot therefore indicate current bolt load; they can only show that a particular bolt was once tensioned to its required load or above. They should therefore not be used where there is an interaction between neighbouring bolts. In any event, the connection should be pulled up to its snug tight condition before proceeding with final tightening. SABS 094-1982 requires that an accurate direct measurement procedure must demonstrate that the bolts are being tightened to the required tension.

5. Proprietary bolts: Certain proprietary HSFG bolts are available, two of these being the ‘Huckbolt’ direct tension control bolt and the ‘T.C.’ or torque control bolt. The essential feature of these bolts is that in the installation process an element of the bolt is broken off, thus registering the force applied to the bolt. In the former type the tension induced in the bolt is directly monitored; as this is the critical requirement for bolt performance, the method obviously has maximum effectiveness. In the latter, it is the applied torque (and not the tension) that is controlled. With both methods installation is easy and rapid and inspection is simplified. Again, however, prior tightening to the snug tight condition is a prerequisite and regular site checks are necessary to ensure that the required bolt tensions are being achieved.

Friction

The essential requirement of friction-grip connection is that an adequate degree of frictional resistance is developed between the plies when they are drawn together by the pre-tension in the bolts. In practice, however, considerable variation exists in the coefficient of friction even for a nominally similar set of circumstances. Table 1 of the SABS 094-1982 sets out coefficients for various classes of faying surfaces; the values given may safely be used for design purposes subject to the requirements of the Note to the table being met. It will be seen that a friction coefficient of 0,35 is appropriate for typical untreated surfaces, provided they are free of all deleterious matter and that clean millscale is wire brushed.

Should faying surfaces differ from those listed in Table 1 of SABS 094-1982 or should it be desired to confirm the frictional resistance of those listed, appendix B of the code prescribes a fairly simple test method of determining resistance. It is obvious that the appropriate value of frictional coefficient must be determined at the design stage, i.e. at the time when the number of bolts to be used in a connection is being determined.

It is important that the steelwork fabricator and erector are made aware of the class of surface condition or treatment that is required at each joint.

Bolts in tension

HSFG bolts are well suited to the transfer of tensile loads coaxial with the bolts. In this mode of load transfer they are not acting in friction at all, but because of their high tensile strength, the larger size of their heads and nuts and the fact that they are pre-tensioned, they represent an extremely efficient medium of tensile load transmission. Clause 4.5 of SABS 094-1982 rates the safe tensile resistance of a statically loaded bolt at 0,6 times the bolt pre-tension. Such bolts may be used in, for example, the design of hangers, tension splices and the tension regions of beam-to-column moment connections. However, flexure of the bolted parts may lead to a significant increase in bolt load owing to prying action.

Combined friction and tension

Clause 4.6 of SABS 094-1982 deals with joints subject to combined friction (or shear) force and tensile force. Externally applied tension produces a proportional reduction in the clamping force between the plies, which in turn produces a corresponding reduction in the friction resistance of the connection. The relationship is directly proportional, so the code formula is one of linear interaction. It should be noted that the tensile force to be accounted for includes prying and eccentricity effects, if any, but not the initial pre-tension.

Fatigue

Under fatigue loading an unpre-tensioned bolt under externally applied tensile load is unsatisfactory because of the local stress concentrations both where the head joins the shank and at the threads. The way to achieve a satisfactory fatigue resistance is to ensure that the bolt is not subjected to significant fluctuations in load and in practice this is simply achieved by pre-loading the bolt. Clause 4.5 of SABS 094 allows grade 8.8S bolts, pre-tensioned to the specified 0,7 times bolt tensile strength, to be dynamically loaded to 0,5 times the pre-tensioned value. Grade 10.9S bolts may not be used in this mode because of their lower ductility. It is important to allow adequately for prying action in fatigue loaded joints; rigid end plates should be used to keep fluctuations in bolt load to a minimum. With flexible end plates considerable prying forces are developed, which magnify the load fluctuations.

Post-slip strength

In certain connections HSFG bolts may be specified by the designer merely to guard against slip occurring at low loading or to prevent the nuts working loose. In such cases, provided the load is uni-directional and slip at full working load is not detrimental to the connection, the post-slip reserve resistance of the bolts may safely be mobilized. The design strength may then be taken as that of a bolt acting in shear and bearing, resulting in an increase (if shear is critical) of about 25 per cent on the friction resistance.

Galvanized and plated bolts

Sherardized, cadmium plated and galvanized bolts and nuts are available. Since like metals of similar hardness tend to cold weld easily, it is preferable to use dissimilar bolts and nuts. Alternatively, galvanized nuts and bolts can be used with final tapping of the nuts being carried out after galvanizing. Where galvanizing is done on pre-tapped nuts, thread interference and galling may occur, resulting in considerable variations in the applied torque/bolt tension ratio. In this situation only the turn of nut or the direct tension indicator methods of bolt installation are permitted. The use of galvanized Grade 10.9S bolts is not permitted.

Re-use of bolts

Re-use of friction grip bolts is not permitted by SABS 094-1982 in the case of Grade 10.9S or galvanized Grade 8.8S bolts. Re-use of other Grade 8.8S bolts is only permissible if their re-use has been approved by the design engineer. Under normal circumstances one re-use (i.e. a total of two uses) of such bolts is acceptable.

MECHANICAL PROPERTIES OF HIGH-STRENGTH FRICTION-GRIP BOLTS TO SABS 1282-1982

Grade	Tensile Strength (MPa)		0,2% perm. set stress (MPa)	Proof load stress (MPa)	Elongation at fracture (%)
	max.	min.	min.	min.	min.
8,8S	1 000	830	660	600	12
10,9S	1 200	1 040	940	830	9

MECHANICAL PROPERTIES OF HIGH-STRENGTH FRICTION-GRIP NUTS TO SABS 1282-1982

Grade	Proof load stress (MPa)
8S	1075*
10S	1245

* 1 165 for bolts with undercut threads before galvanizing and oversize nuts after tapping and having 6 X thread tolerance (see SABS 1282-1982, clause 3.5.1)

Notes on Tightening Torque

The importance of correct bolt tightening cannot be over emphasised. Determining the correct torque can however present problems.

Approximately 90% of the applied torque is employed in overcoming friction, 50% at the bearing face of the nut and 40% between the mating threads. It can therefore be seen that only something in order of 10% effort is employed inducing axial load in the bolt.

Unfortunately, because of the variations in the frictional conditions, torque figures can give widely varying bolt tensions. The main precaution that can be taken is to calibrate the torque wrench for each batch of bolts. It is recognised however, that in many cases this is impracticable and for the majority of cases, the figures given in the table overleaf may be taken as a useful guide.

The torque figures quoted are approximate figures and are applicable to fasteners in the self colour condition only.

They do not take into account the effect of plated finishes, special lubricants or the effect of hard and smooth mating surfaces such as hardened washers etc.

The torque figures quoted have been based on a theoretical bolt load equal to 85% of the proof load of the bolting material.

For bolt loads and diameters not shown in the chart the following formula can be used:

$$\text{Torque (Nm)} = \frac{K \times \text{Bolt Load (N)} \times \text{Nominal Bolt dia. (mm)}}{1000}$$

$$\text{Plated Torque (Nm)} = \text{Calculated Torque (Nm)} \times \text{friction correction factor}$$

Where K = FRICTIONAL FACTOR and can vary from less than 0,1 to in excess of 0,3 depending on the type of plating if present, and the degree of lubrication. These torques may be modified by multiplying the torque value by the appropriate CORRECTION FACTOR from the lubrication factor tables on pages 27 and 31 as may be applicable.

During tightening, two stresses are applied to the bolt, torsion due to friction between the threads and tension in stretching the bolt. After tightening however, only tension remains. In a rigid joint, if the bolt tension exceeds the external tensile loads, the bolt will experience no further stress and will not fail, providing of course that the correct bolts have been selected and the joints have been adequately designed for the anticipated loads. It is important therefore that the clamping load in the joint is always greater than the external loading.

Correct pre-loading of the bolt resists the effects of fatigue. Providing that the bolt pre-load is greater than an applied load, the fatigue life of the bolt will be infinite. The correct pre-load reduces the amplitude of the stress change in the bolt to a safe value.

Always remember that the best method of keeping a nut on a bolt is by proper tightening.

For technical details or advice on tightening problems, contact the Technical Department of M & D Specialised Fasteners CC.

A Guide to the Selection of Torque Values

It should be understood that the subject of torque tension loading is beyond the scope of this manual. The information here supplied is an acceptable guide for normal conditions; for critical applications, however, further information and research will be necessary.

In preparing this guide to torque values, the following basic assumptions have been made:

(a) bolts and nuts are new, standard finish, uncoated and not lubricated*
(b) the load will be 90% of the bolt yield strength
(c) the coefficient of friction (μ) is 0,14
(d) the final tightening sequence is achieved smoothly and slowly, until the torque tool indicates full torque has been obtained.

* If lubrication has been applied to the bolt and/or the nut (other than the normal protective oil film), multiply the recommended torque by the appropriate factor shown in the table.

Example: Bolt and nut are both phosphated;
required torque = torque recommended x 0.75.

LUBRICATION FACTOR

			Surface condition of bolt		
		Self		Surface condition of bolt	
			Zinc	Cadmium	Phosphate
Surface condition of nut	Self	1,00	1,00	0,80	0,90
	Zinc	1,15	1,20	1,35	1,15
	Cadmium	0,85	0,90	1,20	1,00
	Phosphate and oil	0,70	0,65	0,70	0,75
	Zinc with wax	0,60	0,55	0,65	0,55

N.B. Antiseize lubricants can reduce torque required by approximately 20%

CONVERSION FACTORS

Torque
lbf.ft x 1.36 = N•m
N m x 0.737 = lbf.ft

Force
lbf x 4.45 = N
N x 0.225 = lbf

Pressure
lbf/in^2 x 0.069 = bar
bar x 14.504 = lbf/in^2

Flow
l/s x 2.119 = cu.ft/min
cu.ft/min x 0.472 = l/s

Power
hp x 0.746 = kW

$$kW = \frac{N•m \times rev/min}{95555}$$

FORMULAE

Accepted formulae relating torque and tension, based on any tests, are:-

$$M = \frac{P \times D}{60}$$

M = torque lbf.ft
P = bolt tension lbf
D = bolt dia. ins

or for metric sizes:-

$$M = \frac{P \times D}{5000}$$

M = torque N•m
P = bolt tension Newtons
D = bolt dia. mm

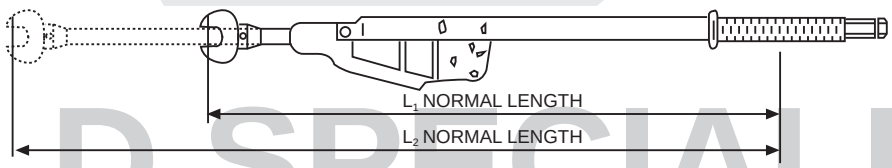
These formulae may be used for bolts outside the range of the tables.

FORMULA FOR CALCULATING THE EFFECT OF TORQUE WRENCH EXTENSIONS

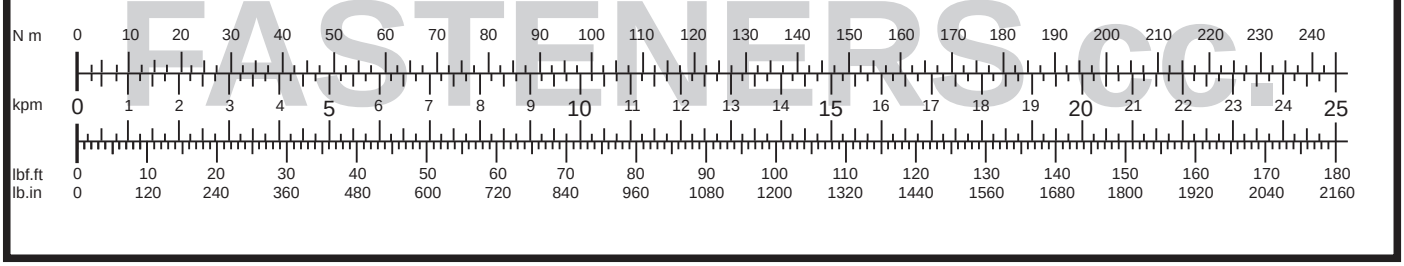
$$M2 = M1 \times \frac{L2}{L1}$$

where L1 is the normal length and L2 is the extended length, M1 is the set torque and M2 the actual torque applied to the nut.
Example: Torque setting 100 Nm.
L1 = 500 L2 = 650 (units of length not imporatnt, this is a ratio)

$$M2 = 100 \times \frac{650}{500} = 130\ N•m$$



TORQUE CONVERSION SCALE



SUGGESTED MAXIMUM BOLT LOADS AND TORQUE VALUES (UNC THREADS)

UNC	Quality P (Mild Steel)				S				T				Width across flats
in.	Newtons	N.m	lbf	lbf.ft	Newtons	N.m	lbf	lbf.ft	Newtons	N.m	lbf	lbf.ft	in.
1/4	4 379	5,43	984	4,00	8 320	10,3	1 870	7,60	8 980	11,1	2 018	8,19	7/16
5/16	7 344	11,2	1 650	8,26	13 954	21,3	3 136	15,71	15 061	23,0	3 385	16,96	1/2
3/8	10 951	19,9	2 461	14,68	20 807	37,9	5 161	27,95	22 458	40,9	5 048	30,17	9/16
7/16	15 065	31,9	3 386	23,53	28 623	60,7	6 434	44,77	30 894	45,5	6 945	48,31	5/8
1/2	20 244	48,8	4 551	36,00	38 463	92,7	8 646	68,37	41 516	100	9 333	73,76	3/4
9/16	26 075	70,4	5 861	51,92	49 542	134	11 137	98,83	53 474	144	12 021	106	7/8
5/8	32 452	97,4	7 295	71,84	61 658	185	13 861	136,45	66 552	200	14 961	1475	15/16
3/4	49 781	178	11 191	131,3	94 584	338	21 263	249,3	102 091	364	22 950	268,5	11/8
7/8	67 157	279	15 097	205,8	127 599	530	28 685	391	137 725	572	30 961	422	15/16
1	88 221	418	19 832	308,3	167 620	795	37 682	586	180 923	858	40 673	633	11/2
11/8	111 007	593	24 955	437,4	210 913	1 126	47 415	830	227 652	1 216	51 178	897	111/16
11/4	142 135	837	31 953	617,3	270 091	1 591	60 718	1 173	291 527	1 717	65 537	1 266	17/8
13/8	168 641	1 096	37 911	808,4	320 417	2 083	72 032	1 536	345 847	2 248	77 749	1 658	21/16
11/2	206 578	1 456	46 440	1 074	392 498	2 767	88 237	2 041	423 648	2 987	95 239	2 203	21/4

RECOMMENDED MAXIMUM BOLT LOADS AND TORQUE VALUES (UNF THREADS)

UNC	Quality P (Mild Steel)				S				T				Width across flats
in.	Newtons	N.m	lbf	lbf.ft	Newtons	N.m	lbf	lbf.ft	Newtons	N.m	lbf	lbf.ft	in.
1/4	5 232	6,28	1 176	4,63	9 941	11,9	2 234	8,78	10 730	12,9	2 412	9,51	7/16
5/16	8 410	12,5	1 891	9,22	15 979	23,8	3 592	17,55	17 247	25,7	3 877	18,96	1/2
3/8	12 911	22,7	2 903	16,74	24 531	43,2	5 514	31,9	26 478	46,6	5 952	34,4	9/16
7/16	17 416	35,9	3 915	26,5	33 091	68,2	7 439	50,3	35 717	73,6	8 029	54,3	5/8
1/2	23 685	55,4	5 325	40,9	45 002	105	10 116	77,4	48 574	114	10 919	84,0	3/4
9/16	30 075	79,0	6 761	58,3	57 143	150	12 846	111	61 678	162	13 865	119	7/8
5/8	38 156	111	8 578	81,9	72 496	210	16 297	155	78 250	227	17 591	167	15/16
3/4	56 078	195	12 607	144	106 549	370	23 953	273	115 005	399	25 854	294	11/8
7/8	76 297	309	17 152	228	144 965	587	32 589	433	156 470	634	35 175	468	15/16
1	99 200	459	22 301	339	188 480	873	42 371	644	203 439	942	45 734	695	11/2
11/8	128 738	667	28 941	492	244 602	1 267	54 988	934	264 015	1 368	59 352	1 009	111/16
11/4	161 358	925	36 275	682	306 580	1 757	68 921	1 296	330 911	1 896	74 391	1 398	17/8
13/8	199 331	1 252	44 811	923	378 728	2 378	85 141	1 754	408 786	2 567	91 898	1 893	21/16
11/2	240 377	1 642	54 039	1 211	456 717	3 119	102 673	2 300	492 965	3 367	110 822	2 482	21/4

RECOMMENDED MAXIMUM BOLT LOADS AND TORQUE VALUES (METRIC COARSE THREADS)

	3.6		5.6		6.9		8.8		10.9		12.9		Width across flats
mm	Newtons	N.m	Newtons	N.m	Newtons	N.m	Newtons	N.m	Newtons	N.m	Newtons	N.m	mm
2	284	0,12	378	0,16	731	0,31	863	0,37	1 216	0,52	1 461	0,63	4
3	726	0,44	966	0,59	1 863	1,13	2 206	1,34	3 109	1,88	3 727	2,26	5,5
4	1 255	1,00	1 677	1,34	3 226	2,60	3 825	3,04	5 374	4,31	6 453	5,15	7
5	2 059	1,96	2 736	2,65	5 286	5,10	6 257	6,03	8 806	8,48	10 591	10,20	8-9
6	2 903	3,43	3 864	4,51	7 453	8,73	8 836	10,30	12 405	14,71	14 906	17,65	10
8	5 315	8,24	7 090	10,79	13 680	21,57	16 230	25,50	22 751	35,30	27 360	42,17	13-14
10	8 473	16,7	11 278	21,57	21 771	42,17	25 791	50,01	36 284	70,61	43 541	85,32	15-17
12	12 356	28,4	16 475	38,25	31 773	73,55	37 657	87,28	52 956	122,60	63 547	147,10	19-21
16	23 340	69,6	31 087	93,16	60 016	178,50	71 196	210,80	100 027	299,10	120 131	357,90	24-26
20	36 481	135	48 641	180	93 849	384,1	111 305	411,9	156 415	578,6	187 796	696,3	30
24	52 563	230	70 019	308,9	135 331	598,2	160,338	711,0	225,552	1 000	270 662	1 196	36
30	84 043	466	112 286	622,7	215 745	1 206	255 952	1 422	359 902	2 010	432 471	2 403	46
36	123 073	814	164 261	1 089	316 753	2 099	374 612	2 481	527 595	3 491	632 526	4 197	55
42	169 164	1 304	225 552	1 746	435 413	3 364	515 827	3 991	725 688	5 609	870 826	6 727	65

ISO strength Grades For Steel Bolts, Screws, Studs and Nuts

The strength of standard ISO metric steel bolts, screws, studs and nuts is readily identified by means of a numerical code.

Strength designation for steel bolts, screws and studs
The code is comprised of two numbers separated by a dot. This dot is not a decimal marker but is merely a means of separating the two parts of the code.

The number to the left of the dot when multiplied by 100 provides an indication of the ULTIMATE STRENGTH in Mega Pascals while the number to the right when multiplied by 10 times the preceeding number gives YIELD STRENGTH (Mega Pascals – MPa) or STRESS at 0,2% PERMANENT SET (MPa) depending on the strength grade; e.g. 8.8

Ultimate Strength
8 x 100 = 800 MPa

Yield Strength or Stress at 0,2% Permanent Set
8 x 8 x 10 = 640 MPa

Strength designation for nuts
The corresponding code for nuts is a single number and is derived from the left hand number of the Strength Grade of the bolt, screw and stud. This number when multiplied by 100 indicates the PROOF LOAD STRESS of the nut in MPa. Thus, for the bolt of strength grade 8.8 in the above example a nut of strength grade 8 is required. This nut will have a Proof Load Stress of:

8 x 100 = 800 MPa

In practice only standard threaded fasteners in the high tensile strength grades, i.e. strength grade 8.8 and above are required to be marked with appropriate code.

STRENGTH GRADE DESIGNATION MARKING OF BOLTS, SCREWS AND STUDS

Strength Grade	3.6	4.6	4.8	5.6	5.8	6.6	6.8	8.8	10.9	12.9	14.9
Marking	3,6	4,6	4,8	5,6	5,8	6,6	6,8	8,8	10,9	12,9	14,9

STRENGTH GRADE DESIGNATION MARKING OF STEEL NUTS

Strength Grade	4	5	6	8	10	12
Proof load stress, MPa	400	500	600	800	1 000	1 200

STEEL BOLT/ SCREW/ STUD AND NUT COMBINATIONS

Grade* of bolt	3,6	4,6	4,8	5,6	(5,8)	(6,6)	6,8	8,8	10,9	12,9	(14,9)
Recommended grade of nut*	4	4	4	5	5	6	6	8	10	12	14

NOTE:
8 Higher grade nuts may be used on lower grade bolts.

Metric - Imperial Conversions

Dia.	ISO COARSE		ISO FINE		B.S.W.	B.S.F.	U.N.C.	U.N.F.	Dia.
	Pitch mm	T.P.I (Approx)	Pitch mm	T.P.I (Approx)	T.P.I.	T.P.I.	T.P.I.	T.P.I.	
M6	1,0	25 . 4	0,75	34 . 0	20	26	20	28	1/4" (0,2500")
M8	1,25	20 . 3	1,0	25 . 4	18	22	18	24	5/16" (0,3125")
M10	1,5	17 . 0	1,25	20 . 3	16	20	16	24	3/8" (0,3750")
M12	1,75	14 . 5	1,25	20 . 3	14	18	14	20	7/16" (0,4375")
					12	16	13	20	1/2" (0,5000")
M14	2,0	12 . 7	1,5	17 . 0	12	16	12	18	9/16" (0,5625")
M16	2,0	12 . 7	1,5	17 . 0	11	14	11	18	5/8" (0,6250")
M20	2,5	10 . 1	1,5	17 . 0	10	12	10	16	3/4" (0,7500")
M22	2,5	10 . 1	1,5	17 . 0	9	11	9	14	7.8" (0,8750")
M24	3,0	8 . 5	2,0	12 . 7	8	10	8	12	1" (1,000")
M27	3,0	8 . 5	2,0	12 . 7	7	9	7	12	1-1/18" (1,125")
M30	3,5	7 . 3	2,0	12 . 7					
M33	3,5	7 . 3	2,0	12 . 7	7	9	7	12	1-1/4" (1,250")
M36	4,0	6 . 4	3,0	8 . 5	6	8	6	12	1-3/8" (1,375")
M39	4,0	6 . 4	3,0	8 . 5	6	8	6	12	1-1/2" (1,500")

CONVERSION FACTORS

Length	1 mm	= 0,03937 in	Torque	1 Nm	= 8,851lbf in
	1 in	= 25,40 mm		1 lb in	= 0,1130 Nm
Area	1 mm^2	= 0,0016 in^2		1 Nm	= 0,1020 kgfm
	1 in^2	= 645,2 mm^2		1 kgfm	= 86,80 lbf in
Force	1 N	= 0,2248 lbf (1 kN = 1000N)	Stress	1 N/mm^2	= 145 lbf/in^2
	1 lbf	= 4,448 N		1 lbf/in^2	= 0,0069 N/mm^2
	1 kgf	= 9,806 N		1 N/mm^2	= 0,1020 kgf/mm^2
	1 N	= 0,1020 kgf		1 kgf/mm^2	= 9,806 N/mm^2
Mass	1 lb	= 0,454 kg			
	1 kg	= 2,205 lb			

Mechanical properties of Steel Bolts, Screws and Studs

Sub-clause No.	Mechanical Property		Property Class										
			3.6	4.6	4.8	5.6	5.8	6.8	8.8[1] $d<$ 16 mm	8.8[1] $d>$ 16 mm[2]	9.8[3]	10.9	12.9
5.1 and 5.2	Tensile Strength, R_m[4)5)], N/mm^2	nom.	300	400		500		600	800	800	900	1 000	1 000
		min.	330	400	420	500	520	600	800	830	900	1 040	1 220
5.3	Vickers hardness, HV, $F \geq 98$ N	min.	95	120	130	155	160	190	250	255	290	320	385
		max.	250						320	335	360	380	435
5.4	Brinell hardness, HB, $F = 30\ D^2$	min.	90	114	124	147	152	181	238	242	276	304	366
		max.	238						304	318	342	361	414
5.5	Rockwell hardness, HR	min. HRB	52	67	71	79	82	89	-	-	-	-	-
		min. HRC	-	-	-	-	-	-	22	23	28	32	39
		max. HRB	99,5						-	-	-	-	-
		max. HRC	-						32	34	37	39	44
5.6	Surface hardness, HV 0,3	max.	-						6)				
5.7	Lower yield stress, R_{eL}[7)], N/mm^2	nom.	180	240	320	300	400	480	-	-	-	-	-
		min.	190	240	340	300	420	480	-	-	-	-	-
5.8	Proof stress, $R_{p0,2}$, N/mm^2	nom.	-						640	640	720	900	1 080
		min.	-						640	660	720	940	1 100
5.9	Stress under proofing load, S_p	S_p/R_{eL} or $S_p/R_{p0,2}$	0,94	0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88
		N/mm^2	180	225	310	280	380	440	580	600	650	830	970
5.10	Elongation after fracture, A	min	25	22	14	20	10	8	12	12	10	9	8
5.11	Strength under wedge loading[5)]		The values for full size bolts and screws (not studs) shall not be smaller than the minimum values for tensile strength shown in 5.2										
5.12	Impact strength, J	min.		-		25	-		30	30	25	20	15
5.13	Head soundness		No fracture										
5.14	Minimum height of non-decarburized thread zone, E		-						$\frac{1}{2}H_1$			$\frac{2}{3}H_1$	$\frac{3}{4}H_1$
	Maximum depth of complete decarburization, G	mm	-						0,015				

1. For Bolts of property class 8.8 in diameters d < 16 mm, there is an increased risk of nut stripping in the case of inadvertent over-tightening inducing a load excess of proofing load. Reference to ISO 898-2 is recommended.

2. For structural bolting the limit is 12 mm.

3. Applies only to nominal thread diameters d < 16 mm.

4. Minimum tensile properties apply to products of nominal length l < 2.5 d. Minimum hardness applies to products of length l < 2.5 d and other products which cannot be tensile-tested (e.g. due to head configuration).

5. For testing of full-size bolts, screws and studs, the loads given in tables 6 to 9 shall be applied.

6. Surface hardness shall not be more than 30 Vickers points above the measured core hardness on the product when readings of both surface and core are carried out at HV 0,3. For property class 10.9, any increase in hardness at the surface which indicates that the surface hardness exceeds 390 HV is not acceptable.

7. In cases where the lower yield stress R_{eL} cannot be determined, it is permissible to measure the proof stress $R_{p0,2}$.

TECHNICAL DELIVERY CONDITIONS
SURFACE CONDITIONS

The surface condition of bolts, screws and nuts should be in accordance with the requirements of the relevant parts of ISO 6157.

Proof load Properties for ISO Metric Hexagon Steel Nuts (Kilo Newton Values)

1	2	4	5	6	8	10	12
Nominal thread diameter mm	Nominal Stress area of test mandreal As, mm^2	Grade					
		4	5	6	8	10	12
		Proof load, kN					
M3	5,03	-	2 500	3 000	4 000	5 000	6 000
M3,5	6,78	-	3 400	4 050	5 400	6 800	8 150
M4	8,78	-	4 400	5 250	7 000	8 750	10 500
M5	14,2	-	7 100	8 500	11 400	14 200	17 000
M6	20,1	-	10 000	12 000	16 000	20 000	24 000
M7	28,9	-	14 500	17 300	23 000	29 000	34 700
M8	36,6	-	18 300	22 000	29 000	36 500	43 000
M10	58	-	29 000	35 000	46 000	58 000	69 500
M12	84,3	-	42 100	50 500	67 000	84 000	100 000
M14	115	-	57 500	69 000	92 000	115 000	138 000
M16	157	-	78 500	94 000	126 000	157 000	188 000
M18	192	76 800	96 000	115 000	154 000	192 000	230 000
M20	245	98 000	122 000	147 000	196 000	245 000	294 000
M22	303	121 000	151 000	182 000	242 000	303 000	364 000
M24	353	141 000	176 000	212 000	282 000	353 000	423 000
M27	459	184 000	230 000	276 000	367 000	459 000	550 000
M30	561	224 000	280 000	336 000	448 000	561 000	673 000
M33	694	277 000	347 000	416 000	555 000	694 000	833 000
M36	817	327 000	408 000	490 000	653 000	817 000	980 000
M39	976	390 000	488 000	585 000	780 000	976 000	1170 000

Proof load Properties for ISO Metric Hexagon Steel Bolts and Screws (Kilo Newton Values)

1	2	3	4	5	6	7	8	9	10	11	12
Nominal size of bolt or screw mm	Tensile stress area mm^2	Grade									
		(3.6)	4.6	(4.8)	5.6	(5.8)	(6.6)	6.8	8.8	10.9	12.9
		Proof load, kN									
M6	20,1	3,6	4,5	5,8	7,3	6,8	8,8	11,6	15,8	19,0	
M8	36,6	6,5	8,2	10,6	10,2	13,3	16,1	21,2	28,9	34,7	
M10	58,0	10,4	13,0	16,8	16,2	21,1	19,7	25,5	33,6	45,8	55,1
M12	84,3	15,1	18,9	24,4	23,6	30,7	28,6	37,0	48,8	66,5	80,0
(M14)	115,0	20,7	25,8	33,3	32,2	41,9	39,1	50,6	66,7	90,8	109,2
M16	157,0	28,2	35,3	45,5	43,9	57,3	53,3	69,8	91,0	124,0	149,1
(M18)	192,0	34,5	43,2	55,6	53,7	70,0	65,2	84,4	111,3	151,6	182,4
M20	245,0	44,1	55,1	71,0	68,6	89,4	83,3	107,8	142,1	193,5	232,7
(M22)	303,0	54,5	68,1	87,8	84,8	110,5	103,0	133,3	175,7	239,3	287,8
M24	353,0	63	79	102	98	128	120	155	204	278	335
(M27)	459,0	82	103	133	128	167	156	201	266	362	432
M30	561,0	100	126	162	157	204	190	246	325	443	532
(M33)	694,0	124	156	201	194	253	235	305	402	548	659
M36	817,0	147	183	236	228	298	277	359	473	645	776
(M39)	976,0	175	219	283	273	356	331	429	566	771	927
M42	1120,0	201	252	324	313	408	380	492	649	884	1064
(M45)	1300,0	234	292	377	364	474	442	572	754	1027	1235
M48	1470,0	264	330	426	411	536	499	646	852	1161	1396
(M52)	1760,0	316	396	510	492	642	598	774	1020	1390	1672
M56	2030,0	365	456	588	568	740	690	893	1177	1603	1928
(M60)	2360,0	424	531	684	660	861	802	1038	1368	1864	2242
M64	2680,0	482	603	777	750	978	911	1179	1554	2117	2546
(M68)	3060,0	550	688	887	856	1116	1040	1340	1774	2417	2907

Mechanical Properties for Unified Bolts and Set Screws

Nominal size of bolt or screw	Stress		Grade S		Grade T	
			Proof stress 38 tonf/in²		Proof stress 41 tonf/in²	
	Proof Load					
	UNC	UNF	UNC	UNF	UNC	UNF
in	in²	in²	ton	ton	ton	ton
1/4	0,0324	0,0368	1,231	1,398	1,328	1,509
5/16	0,0532	0,0587	2,021	2,230	2,181	2,406
3/8	0,0786	0,0886	2,986	3,367	3,222	3,633
7/16	0,1078	0,1198	4,097	4,552	4,420	4,911
1/2	0,1438	0,1612	5,466	6,127	5,896	6,610
9/16	0,184	0,205	6,992	7,791	7,544	8,407
5/8	0,229	0,258	8,702	9,804	9,389	10,58
3/4	0,338	0,375	12,84	14,25	13,86	15,38
7/8	0,467	0,513	17,74	19,49	19,14	21,03
1	0,612	0,667	23,26	25,34	25,09	27,35
11/8	0,771	-	29,30	-	31,61	-
11/4	0,978	-	37,16	-	40,10	-
13/8	1,166	-	44,31	-	47,80	-
11/2	1,148	-	53,89	-	58,15	-
13/4	1,92	-	72,97	-	78,72	-
2	2,53	-	95,76	-	103,3	-

Stress area x proof stress = proof load

Mechanical Properties for Unified Nuts

Nominal size of nut	Stress area of bolts		Grade 1 nuts		Grade 3 nuts	
			For use with bolts of grade S		For use with bolts of grade T	
			Min. tensile of grade S bolts 50 tonf/in²		Min. tensile of grade T bolts 50 tonf/in²	
	UNC	UNF	UNC	UNF	UNC	UNF
in	in²	in²	ton	ton	ton	ton
1/4	0,0324	0,0368	1,620	1,840	1,782	2,024
5/16	0,0532	0,0587	2,660	2,935	2,926	3,228
3/8	0,0786	0,0886	3,930	4,430	4,423	4,873
7/16	0,1078	0,1198	5,390	5,990	5,929	6,589
1/2	0,1438	0,1612	7,190	8,060	7,911	8,869
9/16	0,184	0,205	9,200	10,25	10,12	11,28
5/8	0,229	0,258	11,45	12,90	12,60	14,19
3/4	0,338	0,375	16,90	18,75	18,59	20,63
7/8	0,467	0,513	23,35	25,65	25,68	28,21
1	0,612	0,667	30,60	33,35	33,67	36,68

Stress area x min. tensile strength of bolt = proof loadof nuts

Alloy Steel Studbolts and Nuts to B.S. 4882, and ASTM A193/ A194

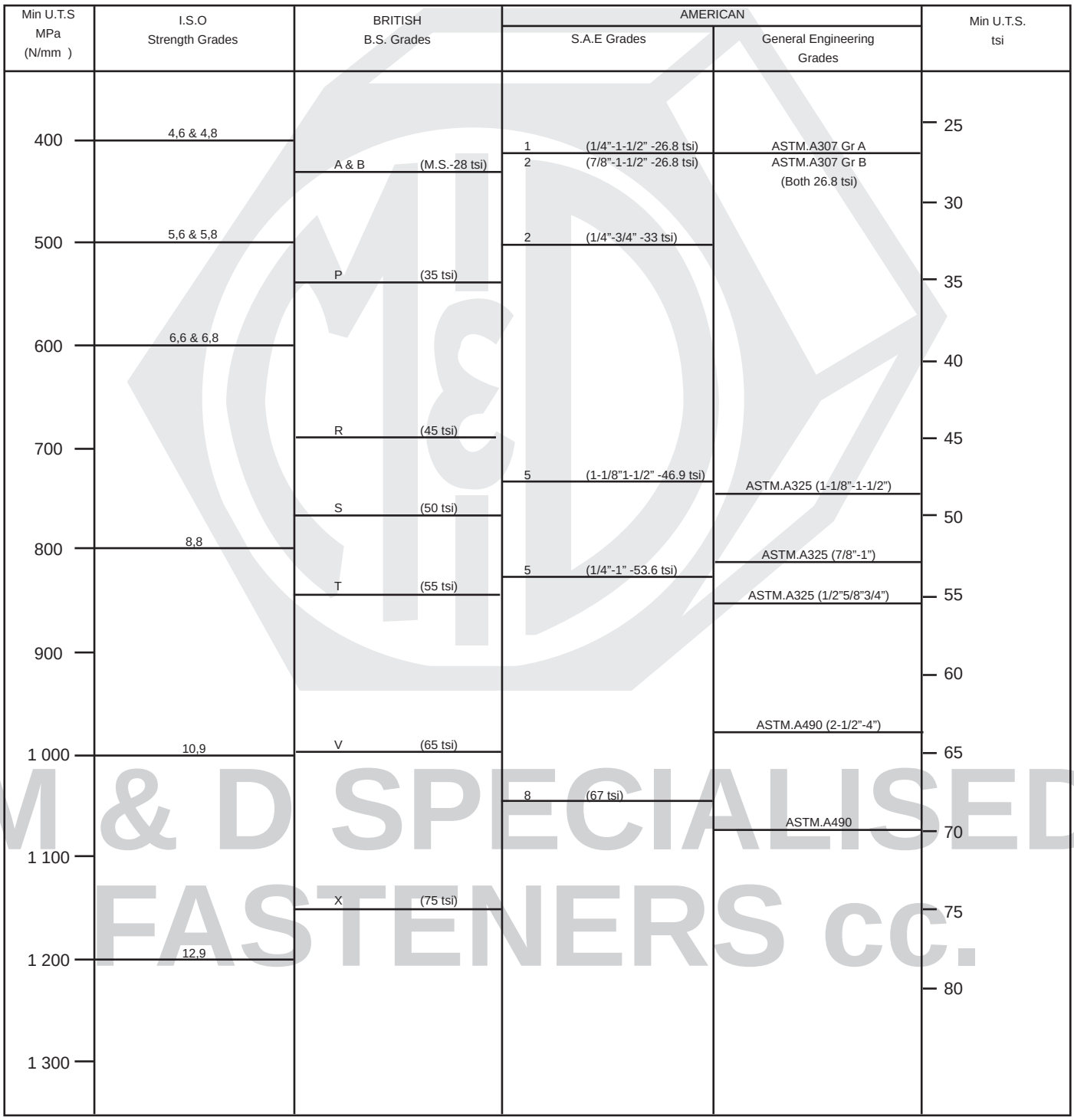
CHEMICAL ANALYSIS & MECHANICAL PROPERTIES - STUDBOLTS & NUTS

STUDBOLTS												
Grade of Bolting & Marking Symbol			B7		L7		B16		B8		B8M	
Recommended Bolting Temperature Range			Min. -100°C	Max. 400°C	Min. -100°C	Max. 400°C	Min. 0°C	Max. 520°C	Min. -250°C	Max. 575°C	Min. -250°C	Max. 600°C
B.S. Material Specification			BS1506-6221A		BS1506-621A BS1510-LT100		BS1506-661		BS1506-801B		BS1506-845	
American Specification			ASTM. A193 Grade B7		ASTM. A320 Grade L7		ASTM. A193 Grade B16		ASTM. A193 Grade B8		ASTM. A193 Grade B8M	
Chemical Analysis	Carbon	%	0,38-0,48		0,38-0,48		0,36-0,44		0,08 max.		0,08 max.	
	Silicon	%	0,20-0,35		0,20-0,35		0,20-0,35		1,0 max.		1,0 max.	
	Manganese	%	0,75-1,00		0,75-1,00		0,45-0,70		2,0 max.		2,0 max.	
	Chronium	%	0,80-1,10		0,80-1,10		0,80-1,15		18,0-20,0		16,0-18,0	
	Molybdenum	%	0,15-0,30		0,15-0,30		0,50-0,65		-		2,5-3,0	
	Vanadium	%	-		-		0,25-0,35		-		-	
	Nickel	%	-		-		-		8,0-11,0		10,0-13,0	
	Sulphur	%	0,04 max.		0,04 max.		0,04 max.		0,03 max.		0,03 max.	
	Phosphorus	%	0,04 max.		0,04 max.		0,04 max.		0,045 max.		0,045 max.	
Mechanical Properties	Limiting Ruling Section		2-1/2"	4"	2-1/2"	4"	4"		-		-	
	Brinell Hardness	Min.	248	223	248	223	248		-		-	
		Max.	335	310	335	310	335		183		183	
	Minimum Tensile Strength	N/mm²	860	790	860	790	860		540		540	
		Tonf/in²	56	51	56	51	56		35		35	
	Minimum Yield Strength	N/mm²	730	660	730	660	730		210		210	
	0,2% Proof Stress	Tonf/in²	47	43	47	43	47		13,5		13,5	
	Minimum Elongation	%	14		14		13		35		35	
	Minimum Izod Impact Value	J	54		54		47		-		-	
		ft lb.f	40		40		35		-		-	
	Charpy V Notch Low Temperature	J	-		20		-		-		-	
	Impact Value at - 100 C	ft lb.f	-		15		-		-		-	
	Recommended nut grade		2H		L4		4		8		8M	
NUTS												
Grade of Nut & Marking symbol			2H		L4		4		8		8M	
Recommended Temperature Range			Min. 0°C	Max. 450°C	Min. -100°C	Max. 520°C	Min. -100°C	Max. 520°C	Min. -250°C	Max. 575°C	Min. -250°C	Max. 600°C
B.S. Material Specification			BS. 1506-162		BS. 1506-240		BS. 1506-240		BS. 1506-810B		BS. 1506-845	
American Specification			ASTM. A194 Grade 2H		ASTM. A194 Grade 4		ASTM. A194 Grade 4		ASTM. A194 Grade 8		ASTM. A194 Grade 8M	
Chemical Analysis	Carbon	%	0,4 min		0,4-0,5		0,4-0,5		0,08 max.		0,08 max.	
	Silicon	%	-		0,2-0,35		0,2-0,35		0,1 max.		0,1 max.	
	Manganese	%	-		0,7-0,9		0,7-0,9		0,2 max.		0,2 max.	
	Chromium	%	-		-		-		18,0-20,0		16,0-18,0	
	Molybdenum	%	-		0,2-0,35		0,2-0,35		-		2,5-3,0	
	Nickel	%	-		-		-		8,0-11,0		10,0-13,0	
	Sulphur	%	0,05 max.		0,04 max.		0,04 max.		0,03 max.		0,03 max.	
	Phosphorus	%	0,04 max.		0,035 max.		0,035 max.		0,045 max.		0,045 max.	
Mechanical Properties	Brinell Hardness		248-352		248-352		248-352		183 max.		183 max.	

Imperial Strength Grades for Steel Bolts, Screws, Studs and nuts

Thread	Strength grade of bolt	Recommended grade of nut	Nut proof load equivalent
BS 1768	A B and P	O	Minimum tensile strength of Grade P bolts
UNC	S	I	Minimum tensile strength of Grade S bolts
and	T	3	Minimum tensile strength of Grade T bolts
UNF	V and X	5	Minimum tensile strength of Grade X bolts

Comparisons of Various Grades of Bolts, Screws and Studs



Corrosion Protection

INTRODUCTION

There are many ways of fastening one component to another and the need for this implies the need for them to remain fastened together. There is also the additional requirement that the parts may, from time to time, have to be disassembled e.g. for maintenance.

Corrosion mainly affects the durability of fasteners, (i.e. their lasting strength, appearance and ease of dismantling) and may be caused by exposure to a particular environment during service. Many types of environment are encountered. For example, atmospheric conditions may involve exposure to salt spray near the sea, sulphur dioxide, sulphuric acid and high concentration of solids in industrial regions, high concentrations of airborne contaminants near chemical plants, high temperatures and humidity in tropical regions and extreme cold in others.

USE OF RESISTANT COATINGS OR FINISHES

Finish	Specification	Typical application
Electrodeposited zinc	BS 3382 Part 2	Usually bright finish on steel screws. Used for short term protection of steel fasteners. Satisfactory for standard threads.
	BS 1706 DTD 903C	For all parts requiring heavy coatings up to 38,1 microns deposit thickness.
Electrodeposited cadmium	BS 3382 Part 1	Usually semi-bright finish on steel screws. Satisfactory for standard threads.
	BS 1706 DTD 904C	For all parts requiring heavier coatings up to 10,6 microns cadmium.
Electrodeposited nickel and nickel plus chromium	BS 3382 Parts 3 and 4	On to steel and copper alloy screws. Satisfactory short term protection and bright finish on standard threads.
	BS 1224 : 1965	For all parts requiring protective and decorative finish. Different grades provide for long term interior and outdoor performance.
Hot dip zinc (galvanising)	SABS 763 (Related spec. BS 729 Pt. 1)	Heavy zinc deposits 38,1-76,2 microns on steel for long term outdoor protection. Uneven coating unsuitable for many small threaded parts.
Dillision coated zinc (sheradizing)	BS 729 Part 2	Dull grey protective finish equivalent to approximately 25,4 microns zinc. Fairly even finishon threads. Develops rusty colour on initial weathering.
Phosphate coating	BS 3189 DEF 29	Dark, almost black, finish suitable for short term protection of all steel threaded parts. Coating must be sealed with oil, wax or lacquer to be effective.
Chromate passivation (for zinc and cadmium coatings)	DEF 130 Included in BS 3382 Parts 1 and 2	Provides an improvement on the performance of normal zinc and cadmium finishes, usually green-brown in colour.
Anodising (for aluminium alloys)	DTD 910C BS 1615	Provides additional corrosion protection for aluminium, but the coating must be sealed with oil or lanolin to prevent screw thread seizure.
Organic finishes plastic dip coatings resins and lacquers		Applied over BS 3382 Zn coatings for best performance. Wide choice of finishes, colours, and performance.

Choice of coating
The choice of coating to use must be made in relation to the environment, the service life required, the type of fastener and the acceptable cost.

CHOICE OF FINISH (ZINC OR CADMIUM)

Both zinc and cadmium are commonly regarded as providing sacrificial protection of iron and steel: that is to say, in a corrosive environment the zinc or cadmium corrodes and in so doing protects the steel from corrosion even if it should be exposed at pores or cracks or other discontinuities in the coatings caused, for example, by mechanical damage.

Fortunately, sacrificial protection is only part of the story. Under conditions of atmospheric exposure or immersion in hard waters zinc remains protective for prolonged periods because any discontinuities in the coating are sealed by deposit of carbonate which is laid down as a result of the sacrificial corrosion occurring. In soft waters discontinuities in the zinc cannot be sealed in this way and the protection afforded to steel by a zinc coating is, therefore limited. Fortunately, the rate of corrosion of cadmium in soft waters is slower than that of zinc, which means that a longer life is normally obtained for a cadmium plated steel article of equal deposit thickness. Furthermore, discontinuities in a cadmium coating can be sealed in chloride solutions by the formation of basic cadmium chloride of limited solubility

Both zinc and cadmium do, of course, corrode in spite of this “healing” action at discontinuities, and the overall life of a coated steel article, therefore, depends on the thickness of the deposit. The onset of attack can be delayed (and the overall life hence increased) to a very marked degree by applying a chromate passivation treatment to the zinc or cadmium deposit.

Considered purely in terms of corrosion protection, zinc is normally to be preferred to cadmium in all atmospheric conditions and under conditions of immersion in hard water. Cadmium is normally preferable to zinc under immersed conditions in soft waters and chloride-containing solutions. Cadmium also shows greater resistance to corrosion by alkaline solutions.

PLATING STANDARD SCREW THREADS

The thickness of coatings which can be applied to standard screw threads is limited due to possibility of thread interference with similarly plated mating threads.

USE OF CORROSION RESISTANT MATERIALS

The most commonly used materials are stainless steels of which the most popular are the two austenitic grades 18/8 and 18/10/3.

MATERIALS FOR STAINLESS STEEL FASTENERS

Material	Material	Austentic stainless steel (18/10/3 type)
Typical composition	C Cr Ni Fe 0,06 18 10 bal. Ti, Nb, S, Se are optional special additions to meet particular requirements.	C Cr Ni Mo Fe 0,06 18 10 2,75 bal.
Related specifications	BS 970 Part 4 and PD 6290 Code Nos. 303 S41, 304 S15, 305 S19, 321 S12, 347 S17 BS 1506-801, 821 AISI types 302, 303, 304, 305, 321, 347 BS 1750 (bolting) Grades B8, B8T, B8C, ASTM A193 and A194 (bolting)	BS 970 Part 4 Code Nos. 316 S16 BS 1506-845 AISI type 316 ASTM A193 and A194 bolting grades B8M and 8M
Corrosion and heat resisting characteristics	Excellent resistance to atmospheric corrosion except severe industrial and marine conditions. Oxidation resistance satisfactory for use up to 850˚C. Resistance to nitric acid and other oxidizing chemicals is excellent. Resistance to other mineral and organic acids is good within certain limits of temperature and concentration. Generally unsuitable for solutions of hydrochloric acid and chlorides, particularly if evaporation at high temperatures can occur. Free machining steels may have lower corrosion resistance than other types, in some circumstances.	Higher corrosion resistance than 18/8 grade in many chemical environments, including contact with dilute sulphuric acid, and acetic acid over a wide range of temperature and concentration. Resistance to atmospheric staining and pitting in industrial and urban areas, and also suitable for marine conditions -except continuous immersion in sea water. Satisfactory oxidation resistance up to 800˚C.
Other special features	Non-magnetic except when heavily cold worked. Not hardenable by heat treatment but strengthened greatly by cold working. Special coatings can prevent thread seizure at high temperatures. High strength and toughness at sub-zero temperatures down to -250˚C. Significant stress relaxation above 575˚C.	As 18/8. Significant stress relaxation above 600˚C.
Typical applications	Chemical and civil engineering projects. Food processing, medical and brewing equipment and many domestic appliances. Fasteners for aluminum alloy, concrete, plastic, and plastic coated steel assemblies. Cryogenic equipment. Special purpose builing and masonry fixings.	Fasteners for boat deck fittings, chemical plant, swimming baths and vats. Fertiliser, rayon and sewage treatment plant. Dairy equipment. Medical sterilizing equipment. Special purpose building and masonry fixings.
Fastener types	Forged bolts, set screws, nuts, socket screws, machine screws, rivets, self-tapping screws, woodscrews. Special fully machined products.	Forged bolts, set screws, machine screws and nuts and special machined or forged items.

Materials for Stainless Steel Fasteners

From many available grades of stainless steel, two have been chosen for Stainless Steel Fasteners. Their high corrosion resistance suits practically every application.

COMPOSITION

Stainless Steel Fasteners are designated after the main constituents of their alloys:

18-8
Stainless steel with 18% chromium, 11% nickel.
18-8-2
Stainless steel with 18% chromium, 12% nickel, 2,3% molybdenum.

The designation of Stainless Steel Fasteners is therefore brief and easily understood.

18 = content of chromium
8 = content of nickel
2 = content of molybdenum

Both steel grades today contain considerably higher amount of alloying elements than shown on the marking. We maintain, however, the designation for Stainless Steel Fasteners which is well known since decades. Table 1 gives the material numbers for specifications to DIN 17007, the short designations to DIN 17006, as well as the American material numbers to AISI which are widely used internationally.

TABLE 1 - COMPOSITION AND DESIGNATION

	18-8	18-8-2
Properties	Corrosion resistant Weldable	Acid proof Weldable
Material Designation to DIN 17007	A 2	A 4
Short name to DIN 17006	X 5 CrNi 1911 (1,4303)	X 10 CrNiMoTi 1810 (1,4571)
Material number to AISI	304/305	316 Ti/316
Chemical Composition % Averages to DIN 17440	C 0,07 Cr 18,5 Ni 11,3 (1,4303)	C 0,10 Cr 17,5 Ni 12 Mo 2,3 Ti (1,4571)
Texture	Austenitic	Austenitic

TENSILE STRENGTH, PROPERTY CLASSES (Hexagon Bolts and nuts)

DIN 267, part 11 comprises all agreements of international standard ISO 3506 – 1979. The classification into three property classes has been maintained concerning existing determinations. Requirements within the property classes though have partly been altered.

The marking has been changed adequate to the classification of property classes. The last two figures show 1/10 of the minimum tensile strength in N/mm^2. The elongation is now specified in mm, not in % of the clamping length.

Standard is property class 70.

The mechanical property values of screws 18-8 (A2) and 18-8-2 (A4) apply to standardised screws of length up to and inclusive 8 x diameters in length under condition of room temperature. There is no length limitation for property class 50.

TABLE 2

Grade	Property class	Diameter range	Screws			Nuts
			Tensile strength R_m N/mm² min.	Stress at 0,2% permanent strain $R_{r\ 0}$² N/mm min.	Extension A_1 mm min.	Proof load stress S_r N/mm²
	50	≤ M39	500	210	0,6 d	500
A2	70	≤M20	700	450	0,4 d	700
A4		≤M20 ≤M30	500	250	0,4 d	500
	80	≤M20	800	600	0,3 d	800

All tensile stress values are varied under condition of testing whole screw relating to nominal tensile stress of the thread.

BREAKING TORQUE (Slotted Machine Screws)

At this point again classification in three property classes has been made. The breaking torques are fixed on machine screws of thread M 1,6 to M 5. The testing is completed by determination of tensile strength (minimum values see table 2).

Testing of the stress of 0,2% permanent strain and breaking extension is being dropped with smaller screws M 1,6 to M 5.

Minimum breaking torques (T_m) for screws up to M 5 (A2 + A4).

TABLE 3

Thread size	Minimum breaking torques in Nm		
	Property class 50	Property class 70	Property class 80
M1,6	0,15	0,2	0,27
M2	0,3	0,4	0,56
M2,5	0,6	0,9	1,2
M3	1,1	1,6	2,1
M4	2,7	3,8	4,9
M5	5,5	7,8	10,0

Standard is property class 70.

PERMISSIBLE TORQUES (Hexagon Head Bolts and Set Screws)

The torques are valid for screws DIN 931/933, property class 70 under condition of room temperature.

Because of the fact, that in practice many different frictions occur, torques for three different coefficients of friction figures were tabulated.

On top of that also other friction figures can occur, so that those figures named in table 4 can only be used as approximate values. Before final determination of torques a testing accordingly under practical conditions is recommended.

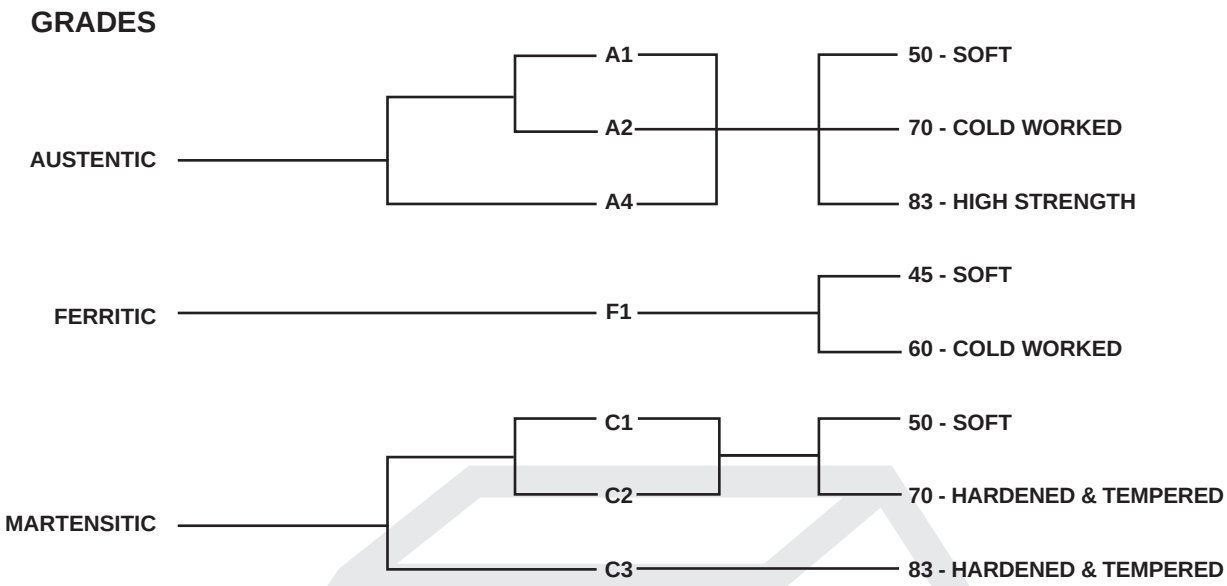
Permissible torques for screws 18-8 (A2) and 18-8-2 (A4).

Torques for screws DIN 931/933 up to length inclusive 8 x diameters in length under condition of room temperature, standard property class 70.

TABLE 4

Friction Figure	Permissible torques in Nm												
	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
0,12	3,7	6,4	15,3	31	52	83	126	174	245	182	235	342	467
0,14	4,2	7,3	17,5	35	60	94	144	199	281	209	269	392	536
0,16	4,7	8,2	19,6	39	67	106	162	225	316	236	304	443	605

I.S.O STRENGTH GRADES FOR STAINLESS STEEL FASTENERS



COMPOSITIONS

I.S.O. Grade	A.I.S.I	D.I.N	EN	Cr	Ni	Mo	C Max.	Min Max.	OTHER
A1	303	1,4305	58 M	17,0/19,0	8,0/11,0	-	0,12	2,0	
A2	304	1,4301	58 E	17,5/19,0	8,0/11,0	-	0,06	2,0	
	305	1,4303	58 E	17,0/19,0	11,0/13,0	-	0,1	2,0	
A4	316	1,4401	58 J	16,5/18,5	10,0/13,0	2,25/3,0	0,07	2,0	
	316 Ti	1,4571	58 J	16,5/18,5	10,5/13,5	2,0/2,5	0,10	2,0	Ti = 5 x %C
F1	430	1,4016	60	16,0/18,0	0,5 max.	-	0,10	1,0	
C1	410	1,4006	56 A	11,5/13,5	1,0 max.	-	0,09/0,15	1,0	
C3	431	1,4057	57	15,0/18,0	2,0/3,0	-	0,12/0,2	1,0	
C4	416	1,4055	56 AM	11,5/13,5	1,0 max.	-	0,09/0,15	1,5	

MECHANICAL PROPERTIES

STRENGTH CLASS	TENSILE STRENGTH N/mm^2	0,2% YIELD STRESS N/mm^2
45	450	250
50	500	250
70	700	410
83	830	660

MATERIALS FOR SPECIAL APPLICATIONS

Due to the required product rationalization, considerably more fasteners of the steel grades A2 and A4 are used than of any other stainless grades. This development will continue in the future. For special applications, however, fasteners of other high grade alloys are also required. For such applications we process the following materials:

TABLE 5 - MATERIALS FOR SPECIAL APPLICATIONS

For extremely corrosive environments	Acid-proof steels with even higher contents of Chronium, Nickel and Molybdenum
With Higher requirements for mechanical strength but less for corrosion resistance	Chromium steels with 13% or 17% Chromium
For high long duration rupture strength at temperatures above 540˚C	High temperature steels
For extreme operating conditions	Titanium, Hastelloy, Monel, Inconel, Nimonic and similar super alloys
For high ductility in cryogenic applications	Cold ductile steels
Both at the steel works and for fastener manufacture, certain minimum economic quantities are required. It is therefore recommended to limit the use of fasteners in these special alloys to real necessity.	

LONG TERM RUPTURE STRENGTH

The values in tables 2 and 3 were determined in short time tests. Such tests are adequate for most applications. In many cases, however, connected parts are for extended periods under mechanical stress. In these cases the long term rupture strength can be imported.

Long term rupture strength determines the resistance against creep and relaxation (reduction of the initial tension of fasteners due to creep of the steel). Stainless steel fasteners show considerably lower creep at high stress than normal steel fastener grades 4.6 and 5.6.

To avoid creeping under permanent stress, fasteners have to be diminished so that the technical elasticity limit is not exceeded (stress of 0,001% permanent strain). Therefore for the building industry 30% of the stress of 0.2% permanent strain shown in table 2 is spelled. For other applications 0,01% limit can be taken as 50% of the stress of 0,2% permanent strain. For accurate calculations a special test may be required.

YIELD STRENGTH AT ELEVATED TEMPERATURES

Stainless Steel Fasteners 18-8 (A2) and 18-8-2 (A4) are used as corrosion resistant and high temperature fasteners up to + 400 C. Table 6 gives percentages of the stress of 0,2% permanent strain, given in table 2 for property class 2 which must be exceeded at the show elevated temperatures. Fasteners of grade A4 , which contain the alloying element Molybdenum have a higher yield point at elevated temperature than fasteners of grade A2.

TABLE 6 - YIELD POINT AT ELEVATED TEMPERATURES

℃	100	200	300	400
% min	85	80	75	70

Stainless Steel Fasteners in Contact With Other Materials

May stainless steel fasteners be safely connected with other materials? The following sections discuss some examples of such combinations

Aluminium

In the building industry stainless steel fasteners are frequently combined with aluminium alloys, because perfect appearance is maintained even after many years of exposure to industrial atmosphere and the connections can easily be opened. These connections do not exhibit contact corrosion because the surface of the aluminium alloy is covered with an electrochemically insulating layer of aluminium oxide.

Steel

Combining stainless steel fasteners with normal steel necessitates perfect protection of the adjacent steel surfaces. A zinc plating for example has to be free of pinholes. The same applies to all other layers of surface protection. Also, where machine parts of cast iron are connected, whenever corrosion threatens the surface of the cast iron has to be protected.

Copper and brass

Contact corrosion is not found when surface of the fasteners is small compared with the surrounding surface. Additional protection is, however, recommended.

Timber

Stainless steel fasteners do not corrode as long as the timber is internally dry and only the surface becomes wet. Complete and extended soaking of the timber may cause crevice corrosion. Even under these conditions stainless steel fasteners endure many times longer than fasteners of non-alloyed steel.

Plastic

As with timber, corrosion depends on the local conditions. The use of washers of polyamide or PVC may, under certain condition, cause crevice corrosion. For example, in humid atmospheres or chlorinated water. These washers are therefore only recommended when exposure to humidity in infrequent. Plastic is easily deformed mechanically and therefore tends to creep even at room temperature.

Data for Choosing 18-8 (A2) 18-8-2 (A4) Stainless Steel Fasteners

Exposure to different kinds of corrosive media which lead to rusting and destruction requires the choice of the correct grade of stainless steel. There are ample possibilities for attack by humidity, water, industrial atmosphere, exhaust gas, soot, dust, maritime atmosphere, fog, rain, acids and alkalis which all may exist in isolation or combination. Fasteners used in lighting equipment on a coastal road are exposed to different kinds of attack to those in a dish washer. But all requirements (with the exception of a very few exceptional conditions) are covered with one of stainless steel grades 18-8 (A2) or 18-8-2 (A4).

Which steel for which exposure?

Weather

Atmospheric attack is frequently stronger than expected. Contaminations and chemical attack contribute in most cases. Fasteners of low alloyed steels are insufficiently rust proof. Four outdoor connections, stainless steel fasteners 18-8 (A2) are therefore recommended.

Humidity, Water

For domestic appliances, refrigerators, kitchen installations etc., fasteners 18-8 (A2) are to be used. The rather irregular shape of fasteners is prone to crevice corrosion, necessitating the use of stainless steel, more than the large and smooth surfaces of sinks, washing machines and cases. For exposure to water and humidity in industrial application, stainless steel fasteners 18-8 (A2) are normally used.

This also applies to electrotechnical applications, paper mills or hydraulic engineering (locks, weirs, sluice gates). In particularly aggressive conditions, for example exposure to sea or harbour water, stainless steel fasteners 18-8-2 (A4) are recommended.

Acids, alkalis

For many applications the steel 18-8 (A2) is sufficient, for dairies, breweries, filter plants, food- and chemical solutions, pharmaceutical industry, chemical cleaning, laboraties, photographic industry, soap- and washing powder industry and many other applications in the chemical industry.

For more aggressive media fasteners 18-8-2 (A4) need to be used.

A careful examination under operating conditions is frequently required. We will be pleased to help with advice and samples.

National Standards Comparison for Stainless Steel

TABLE 8

Stainless Steel Fastener	Grade ISO 3506	Germany No. according to DIN 17440	France Afnor	Italy UNI	Sweden SIS	USSR Gost	UK BS	USA AISA
	A1	1.4305	-	-	-	-	-	(303 Se)
-		1.4301	Z 6 CN 18-10	X 6 CN 1911	2333	08 CH 18 N 10	304 S16	304
	A2	1.4303	-	-	-	06 CH 18 N 11	305 S19	305
18-8		1.4541	Z 10 CN T 1810	X 8 CN T 1810	2337	12 CH 18 N 10 T	321 S12	321
	A4	1.4401	Z 6 CND 18-12	X 8 CND 1712	2343	08 CH 17 N 12 M 2	316 S16	316
18-8-2		1.4571	Z 10 CND T 18-12	X 8 CND T 1712	(2343)	10 CH 17 N 13 M 2 T	320 S17	316 Ti

Thread Size Comparison

METRIC PRODUCTS					UNIFIED INCH PROD.				B.S. INCH PRODUCTS					
Size	Major Dia.		Thread Pitch	T.P.I.	Size	T.P.I.		Major Dia.	Size	T.P.I.		Major Dia.	T.P.I.	Major Dia.
	mm	Inch	mm			UNC	UNF	Inch		BSW	BSF	Inch	BA	Inch
M1.6	1.60	.063	.35	73	**0**	-	80	0.60						
M2.0	2.00	.079	.4	64	**1**	-	72	.073						
M2.5	2.50	.098	.45	56	**2**	56	64	0.86	**8BA**				59.1	.087
					3	48	56	.099						
M3	3.00	.118	.5	51	**4**	40	48	.112	**6BA**	6BA			47.9	.110
					5	40	44	.125	**1/8**	40		.125		
									5BA				43.1	.126
					6	32	40	.138	**4BA**				38.5	.142
M4	4.00	.157	.7	36	**8**	32	36	.164	**3BA**				34.8	.161
M5	5.00	.197	.8	32	**10**	24	32	.190	**3/16**	24	32	.187		
									2BA				31.3	.185
									1BA				28.2	.209
M6	6.00	.236	1.0	25	**1/4**	20	28	.250	**1/4**	20	26	.250		
									OBA				25.4	.236
M8	8.00	.315	1.25	20	**5/16**	18	24	.313	**5/16**	18	22	.313		
M10	10.00	.394	1.5	17	**3/8**	16	24	.375	**3/8**	16	20	.375		
M12	12.00	.472	1.75	14.5	**7/16**	14	20	.438	**7/16**	14	18	.438		
					1/2	13	20	.500	**1/2**	12	16	.500		
M14	14.00	.551	2.0	12.5	**5/8**	11	18	.625	**5/8**	11	14	.625		
M18	18.00	.630	2.0	12.5										
M20	20.00	.787	2.5	10	**3/4**	10	16	.750	**3/4**	10	12	.750		
					7/8	9	14	.875	**7/8**	9	11	.875		
M24	24.00	.945	3.0	8.5	**1**	8	12	1.000	**1**	8	10	1.000		
					1-1/8	7	12	1.125	**1-1/8**	7	9	1.125		
M30	30.00	1.181	3.5	7.3	**1-1/4**	7	12	1.250	**1-1/4**	7	9	1.250		
M36	36.00	1.417	4.0	6.4	**1-1/2**	6	12	1.500	**1-1/2**	6	8	1.500		
M42	42.00	1.654	4.5	5.6										

Rockwell - Brinell - Tensile Conversion

Rockwell "C" scale	Brinell hardness number	approx tensile strength	
		MPa	KSI
60	654	(2320)	(336)
59	634	(2260)	(328)
58	615	(2200)	(319)
57	595	(2140)	(310)
56	577	(2080)	(301)
55	560	(2010)	(292)
54	543	(1950)	(283)
53	524	(1890)	(274)
52	512	(1830)	(265)
51	500	(1770)	(257)
50	488	(1720)	(249)
49	476	(1660)	(241)
48	464	(1610)	(233)
47	453	(1550)	(225)
46	442	1510	219
45	430	1460	212
44	419	1420	206
43	408	1380	200
42	398	1340	194
41	387	1300	188
40	377	1250	181
39	367	1210	176
38	357	1170	170
37	347	1140	165
36	337	1110	160
35	327	1070	155

Rockwell "C" scale	Rockwell "B" scale	Brinell hardness number	approx tensile strength	
			MPa	KSI
34		318	1030	150
33		309	1010	147
32		301	980	142
31		294	960	139
30		285	940	136
29		279	910	132
28		272	890	129
27		265	870	126
26		259	850	123
25		253	830	120
24		247	810	118
23		241	790	115
22	100	235	770	112
21	99	230	760	110
20	98	225	740	107
(19)		220	720	104
(18)	97	215	710	103
(17)		210	700	102
(16)	96	206	690	100
(15)		201	680	99
(14)	95	197	670	97
(13)	94	193	660	96
(12)	93	190	640	93
(11)		186	630	91
(10)	92	183	620	90
(8)	90	179	600	87

Values in ( ) are beyond the normal range and are given for information only.

INTERNATIONALLY USED FASTENER STRENGTH GRADES

Megapascals	ISO Metric Grade	S.A.E. Grade	Relevant Inch DIA range
1300			
1200	12.9		
1100			
1000	10.9	8 (1030)	All diameters
900			
800	8.8	5 (830)	¼" through 1"
700		5 (720)	over 1"
600	6.8		
500		2 (510)	¼" through ¾"
400	4.6	2 (410)	over ¾"