Suggested Tightening Torque1 Values To Produce Corresponding Bolt Clamping Loads

Size	Bolt Dia. *D* (in.)	Tensile Stress Area *A* (sq. in.)	SAE Grade 2 Bolts: Tensile Strength (min psi)	SAE Grade 2 Bolts: Proof Load (psi)	SAE Grade 2 Bolts: Clamp[2] Load *P* (lb.)	SAE Grade 2 Bolts: Tightening Torque Dry *K*=0.20	SAE Grade 2 Bolts: Tightening Torque Lub. *K*=0.15	SAE Grade 5 Bolts: Tensile Strength (min psi)	SAE Grade 5 Bolts: Proof Load (psi)	SAE Grade 5 Bolts: Clamp[2] Load *P* (lb.)	SAE Grade 5 Bolts: Tightening Torque Dry *K*=0.20	SAE Grade 5 Bolts: Tightening Torque Lub. *K*=0.15	SAE Grade 7[3]: Clamp[2] Load *P* (lb.)	SAE Grade 7[3]: Tightening Torque Dry *K*=0.20	SAE Grade 7[3]: Tightening Torque Lub. *K*=0.15	SAE Grade 8[4]: Clamp[2] Load *P* (lb.)	SAE Grade 8[4]: Tightening Torque Dry *K*=0.20	SAE Grade 8[4]: Tightening Torque Lub. *K*=0.15
						lb. in.	lb. in.				lb. in.	lb. in.		lb. in.	lb. in.		lb. in.	lb. in.
4-40	0.1120	0.00604	74,000	55,000	240	5	4	120,000	85,000	380	8	6	480	11	8	540	12	9
4-48	0.1120	0.00661	↓	↓	280	6	5	↓	↓	420	9	7	520	12	9	600	13	10
6-32	0.1380	0.00909	↓	↓	380	10	8	↓	↓	580	16	12	720	20	15	820	23	17
6-40	0.1380	0.01015	↓	↓	420	12	9	↓	↓	640	18	13	800	22	17	920	25	19
8-32	0.1640	0.01400	↓	↓	580	19	14	↓	↓	900	30	22	1100	36	27	1260	41	31
8-36	0.1640	0.01474	↓	↓	600	20	15	↓	↓	940	31	23	1160	38	29	1320	43	32
10-24	0.1900	0.01750	↓	↓	720	27	21	↓	↓	1120	43	32	1380	52	39	1580	60	45
10-32	0.1900	0.02000	↓	↓	820	31	23	↓	↓	1285	49	36	1580	60	45	1800	68	51
1/4-20	0.2500	0.0318	↓	↓	1320	66	49	↓	↓	2020	96	75	2500	120	96	2860	144	108
1/4-28	0.2500	0.0364	↓	↓	1500	76	56	↓	↓	2320	120	86	2860	144	108	3280	168	120
						lb. ft.	lb. ft.				lb. ft.	lb. ft.		lb. ft.	lb. ft.		lb. ft.	lb. ft.
5/16-18	0.3125	0.0524	↓	↓	2160	11	8	↓	↓	3340	17	13	4120	21	16	4720	25	18
5/16-24	0.3125	0.0580	↓	↓	2400	12	9	↓	↓	3700	19	14	4560	24	18	5220	25	20
3/8-16	0.3750	0.0775	↓	↓	3200	20	15	↓	↓	4940	30	23	6100	40	30	7000	45	35
3/8-24	0.3750	0.0878	↓	↓	3620	23	17	↓	↓	5600	35	25	6900	45	45	7900	50	35
7/16-14	0.4375	0.1063	↓	↓	4380	30	24	↓	↓	6800	50	35	8400	60	45	9550	70	55
7/16-20	0.4375	0.1187	↓	↓	4900	35	25	↓	↓	7550	55	40	9350	70	50	10700	80	60
1/2-13	0.5000	0.1419	↓	↓	5840	50	35	↓	↓	9050	75	55	11200	95	70	12750	110	80
1/2-20	0.5000	0.1599	↓	↓	6600	55	40	↓	↓	10700	90	65	12600	100	80	14400	120	90
9/16-12	0.5625	0.1820	↓	↓	7500	70	55	↓	↓	11600	110	80	14350	135	100	16400	150	110
9/16-18	0.5625	0.2030	↓	↓	8400	80	60	↓	↓	12950	120	90	16000	150	110	18250	170	130
5/8-11	0.6250	0.2260	↓	↓	9300	100	75	↓	↓	14400	150	110	17800	190	140	20350	220	170
5/8-18	0.6250	0.2560	↓	↓	10600	110	85	↓	↓	16300	170	130	20150	210	160	23000	240	180
3/4-10	0.7500	0.3340	↓	↓	13800	175	130	↓	↓	21300	260	200	26300	320	240	30100	380	280
3/4-16	0.7500	0.3730	↓	↓	15400	195	145	↓	↓	23800	300	220	29400	360	280	33600	420	320
7/8-9	0.8750	0.4620	60,000	33,000	11400	165	125	↓	↓	29400	430	320	36400	520	400	41600	600	460
7/8-14	0.8750	0.5090	↓	↓	12600	185	140	↓	↓	32400	470	350	40100	580	440	45800	660	500
1-8	1.0000	0.6060	↓	↓	15000	250	190	↓	↓	38600	640	480	47700	800	600	54500	900	680
1-12	1.0000	0.6630	↓	↓	16400	270	200	↓	↓	42200	700	530	52200	860	660	59700	1000	740
1-1/8-7	1.1250	0.7630	↓	↓	18900	350	270	105,000	74,000	42300	800	600	60100	1120	840	68700	1280	960
1-1/8-12	1.1250	0.8560	↓	↓	21200	400	300	↓	↓	47500	880	660	67400	1260	940	77000	1440	1080
1-1/4-7	1.2500	0.9690	↓	↓	24000	500	380	↓	↓	53800	1120	840	76300	1580	1100	87200	1820	1360
1-1/4-12	1.2500	1.0730	↓	↓	26600	550	420	↓	↓	59600	1240	920	84500	1760	1320	96600	2000	1500
1-3/8-6	1.3750	1.1550	↓	↓	28600	660	490	↓	↓	64100	1460	1100	91000	2080	1560	104000	2380	1780
1-3/8-12	1.3750	1.3150	↓	↓	32500	740	560	↓	↓	73000	1680	1260	104000	2380	1780	118400	2720	2040
1-1/2-6	1.5000	1.4050	↓	↓	34800	870	650	↓	↓	78000	1940	1460	111000	2780	2080	126500	3160	2360
1-1/2-12	1.5000	1.5800	↓	↓	39100	980	730	↓	↓	87700	2200	1640	124005	3100	2320	142200	3560	2660

Notes:

1. Tightening torque values are calculated from the formula $T = KDP$, where T = tightening torque, lb-in.; K = torque-friction coefficient; D = nominal bolt diameter, in.; and P = bolt clamping load developed by tightening. lb.

2. Clamp load is also known as preload or initial load in tension on bolt. Clamp load (lb.) is calculated by arbitrarily assuming usable bolt strength is 75% of bolt proof load (psi) times tensile stress area (sq. in.) of threaded section of each bolt size. Higher or lower values of clamp load can be used depending on the application requirements and the judgement of the designer.

3. Tensile strength (min psi) of all Grade 7 bolts is 133,000. Proof load is 105,000 psi.

4. Tensile strength (min psi) of all Grade 8 bolts is 150,000 psi. Proof load is 120,000 psi.

Ref.: Fastening Reference. Machine Design. Nov. 1977.

Bolt Clamping Force vs. Tightening Torque for Unlubricated Steel Bolts.

