

Technical Data [ข้อมูลทางเทคนิค] [อ้างอิงจาก Black Book Hot Sheet F12]

1. Tightening Torque Values For UNC & UNF Bolts

Torque is a very indirect indication of tension and there are many factors such as friction, lubrication, surface texture, rust, material type, the use of washers or prevailing-torque nuts, thread conditions, debris etc. that affect the outcome.

Most of the torque/tension table have been calculated using the formula. Tightening torque values has been calculated by arbitrarily assuming that usable bolt strength is 75% of bolt proof-load time tensile stress area.

$$T = K \times d \times P$$

Where T = Torque

K = Coefficient or friction factor

d = Nominal thread diameter [inches]

P = Tension induced in fastener [lbs.]

Fastener Finish Factor	[K]
Plain Steel [black]	0.20+
Zinc Plating [dry]	0.20+
Cadmium Plating [dry]	0.18 - 0.19
Black Oxide Treatment [lightly]	0.15 - 0.17
Moly-disulphide, white lead, wax	0.10 - 0.14

Table 1. Tightening Torque Values [UNC Threads]

Bolts Diameter	UNC Grade 2 Bolts			UNC Grade 5 Bolts			UNC Grade 8 Bolts			Nuts [Width Across Flats] [in]
	Tightening Torque [lb·ft]			Tightening Torque [lb·ft]			Tightening Torque [lb·ft]			
	*K = 0.20 Plain [Dry]	*K = 0.15 Lightly Lubricated	*K = 0.10 Well Lubricated	*K = 0.20 Plain [Dry]	*K = 0.15 Lightly Lubricated	*K = 0.10 Well Lubricated	*K = 0.20 Plain [Dry]	*K = 0.15 Lightly Lubricated	*K = 0.10 Well Lubricated	
1/4 - 20	5	4	3	8	6	4	12	9	6	7/16
5/16 - 18	11	8	6	17	13	9	25	18	12	1/2
3/8 - 16	20	15	10	31	23	15	44	35	22	9/16
7/16 - 14	32	24	16	49	35	25	70	55	35	5/8
1/2 - 13	49	35	24	75	55	38	107	80	53	3/4
9/16 - 12	70	55	35	109	80	54	154	110	77	7/8
5/8 - 11	97	75	48	150	110	75	212	170	106	15/16
3/4 - 10	173	130	86	266	200	133	376	280	188	1.1/8
7/8 - 9	166	125	83	429	320	215	606	460	303	1.5/16
1 - 8	250	190	125	644	480	322	909	680	454	1.1/2
1 1/8 - 7	354	270	177	794	600	397	1,287	960	644	1.11/16
1 1/4 - 7	500	380	250	1,120	840	560	1,875	1,360	938	1.7/8
1 3/8 - 6	655	490	327	1,469	1,100	734	2,382	1,780	1,191	2.1/16
1 1/2 - 6	870	650	435	1,950	1,460	975	3,161	2,360	1,581	2.1/4

Table 2. Tightening Torque Values [UNF Threads]

Bolts Diameter	UNF Grade 2 Bolts			UNF Grade 5 Bolts			UNF Grade 8 Bolts			Nuts [Width Across Flats] [in]
	Tightening Torque [lb·ft]			Tightening Torque [lb·ft]			Tightening Torque [lb·ft]			
	*K = 0.20 Plain [Dry]	*K = 0.15 Lightly Lubricated	*K = 0.10 Well Lubricated	*K = 0.20 Plain [Dry]	*K = 0.15 Lightly Lubricated	*K = 0.10 Well Lubricated	*K = 0.20 Plain [Dry]	*K = 0.15 Lightly Lubricated	*K = 0.10 Well Lubricated	
1/4 - 28	6	5	3	10	7	5	14	10	7	7/16
5/16 - 24	13	9	6	19	14	10	27	20	14	1/2
3/8 - 24	23	17	11	35	26	17	49	37	25	9/16
7/16 - 20	36	27	18	55	41	28	78	58	39	5/8
1/2 - 20	55	41	28	85	64	43	120	90	60	3/4
9/16 - 18	79	59	39	122	91	61	172	129	86	7/8
5/8 - 18	110	83	55	170	128	85	240	180	120	15/16
3/4 - 16	192	144	96	297	223	149	420	315	210	1.1/8
7/8 - 14	184	138	92	474	355	237	668	501	334	1.5/16
1 - 12	274	205	137	705	529	353	995	746	498	1.1/2
UNS 1 - 14	280	210	140	721	541	361	1,019	764	509	1.1/2
1 1/8 - 12	397	297	198	890	668	445	1,444	1,083	722	1.11/16
1 1/4 - 12	553	415	277	1,241	930	620	2,013	1,509	1,006	1.7/8
1 3/8 - 12	746	559	373	1,672	1,254	836	2,712	2,034	1,356	2.1/16
1 1/2 - 12	979	734	489	2,194	1,645	1,097	3,557	2,668	1,778	2.1/4

TORQUE CONVERSION

$1 \text{ lb}\cdot\text{ft} = 1.355817948 \text{ N}\cdot\text{m}$ \leftarrow $1 \text{ N}\cdot\text{m} = 0.737562149 \text{ lb}\cdot\text{ft}$
 $1 \text{ psi} = 0.006894757 \text{ MPa}$ \rightarrow $1 \text{ MPa} = 145.0377 \text{ psi}$

2. Tightening Torque Values For Metric Coarse & Metric Fine Bolts

Important Note: The tables below lists the maximum permissible tightening torques and resulting maximum preload for standard hex head bolts & socket head cap screws based on 90% utilization of the bolt's yield point. They do not include any safety factor and should be used with caution because the coefficient of friction μ is subject to many application variables & as a result, an entirely different preload figure would result.

Coefficient of friction: $\mu = 0.14+$ is for standard zinc plated bolts [dry]
 $\mu = 0.10$ is for standard black bolts [lubricated]

Table 3. Tightening Torque Values [Metric Coarse]

Bolts Diameter	Class 4.6 Bolts				Class 8.8 Bolts				Nuts [Width Across Flats] [mm]
	* $\mu = 0.10$		* $\mu = 0.14$		* $\mu = 0.10$		* $\mu = 0.14$		
	Tightening Torque [N·m]	Preload [kN]	Tightening Torque [N·m]	Preload [kN]	Tightening Torque [N·m]	Preload [kN]	Tightening Torque [N·m]	Preload [kN]	
M5 × 0.8	1.9	2.74	2.4	2.59	5.2	7.40	6.5	7.00	8
M6 × 1.0	3.3	3.87	4.1	3.65	9.0	10.40	11.3	9.90	10
M8 × 1.25	8.0	7.10	10.1	6.70	21.6	19.10	27.3	18.10	13
M10 × 1.5	16.1	11.30	20.3	10.70	43.0	30.30	54.0	28.80	17
M12 × 1.75	27.0	16.40	34.0	15.50	73.0	44.10	93.0	41.90	19
M14 × 2.0	44.0	22.50	55.0	21.30	117.0	60.60	148.0	57.50	22
M16 × 2.0	67.0	30.90	85.0	29.30	180.0	82.90	230.0	78.80	24
M18 × 2.5	93.0	37.70	118.0	35.70	259.0	104.00	329.0	99.00	27
M20 × 2.5	131.0	48.30	167.0	45.80	363.0	134.00	464.0	127.00	30
M22 × 2.5	176.0	60.10	225.0	57.10	495.0	166.00	634.0	158.00	32
M24 × 3.0	226.0	69.50	287.0	65.90	625.0	192.00	798.0	183.00	36
M27 × 3.0	331.0	91.20	424.0	86.70	915.0	252.00	1176.0	240.00	41
M30 × 3.5	450.0	111.00	575.0	105.30	1,246.0	307.00	1597.0	292.00	46

Table 4. Tightening Torque Values [Metric Coarse]

Bolts Diameter	Class 10.9 Bolts				Class 12.9 Bolts				Nuts [Width Across Flats] [mm]
	*μ = 0.10		*μ = 0.14		*μ = 0.10		*μ = 0.14		
	Tightening Torque [N·m]	Preload [kN]	Tightening Torque [N·m]	Preload [kN]	Tightening Torque [N·m]	Preload [kN]	Tightening Torque [N·m]	Preload [kN]	
M5 × 0.8	7.6	10.80	9.5	10.30	8.9	12.70	11.2	12.00	8
M6 × 1.0	13.2	15.30	16.5	14.50	15.4	17.90	19.3	17.00	10
M8 × 1.25	31.8	28.00	40.1	26.60	37.2	32.80	46.9	31.10	13
M10 × 1.5	63.0	44.50	79.0	42.20	73.0	52.10	93.0	49.40	17
M12 × 1.75	108.0	64.80	137.0	61.50	126.0	75.90	160.0	72.00	19
M14 × 2.0	172.0	88.90	218.0	84.40	201.0	104.10	255.0	98.90	22
M16 × 2.0	264.0	121.70	338.0	115.70	309.0	142.40	395.0	135.40	24
M18 × 2.5	369.0	149.00	469.0	141.00	432.0	174.00	549.0	165.00	27
M20 × 2.5	517.0	190.00	661.0	181.00	605.0	223.00	773.0	212.00	30
M22 × 2.5	704.0	237.00	904.0	225.00	824.0	277.00	1,057.0	264.00	32
M24 × 3.0	890.0	274.00	1,136.0	260.00	1,041.0	320.00	1,329.0	305.00	36
M27 × 3.0	1,304.0	359.00	1,674.0	342.00	1,526.0	420.00	1,959.0	400.00	41
M30 × 3.5	1,775.0	437.00	2,274.0	416.00	2,077.0	511.00	2,662.0	487.00	46
M33 × 3.5	2,392.0	543.00	3,078.0	517.00	2,799.0	635.00	3,601.0	605.00	50
M36 × 4.0	3,082.0	638.00	3,957.0	608.00	3,607.0	747.00	4,631.0	711.00	55
M39 × 4.5	3,975.0	765.00	5,123.0	729.00	4,652.0	895.00	5,994.0	853.00	60

Table 5. Tightening Torque Values [Metric Fine]

Bolts Diameter	Class 8.8 Bolts				Class 10.9 Bolts				Class 12.9 Bolts				Nuts [Width Across Flats] [mm]
	*μ = 0.10		*μ = 0.14		*μ = 0.10		*μ = 0.14		*μ = 0.10		*μ = 0.14		
	Tightening Torque [N·m]	Pre-Load [kN]	Tightening Torque [N·m]	Pre-Load [kN]	Tightening Torque [N·m]	Pre-Load [kN]	Tightening Torque [N·m]	Pre-Load [kN]	Tightening Torque [N·m]	Pre-Load [kN]	Tightening Torque [N·m]	Pre-Load [kN]	
M8 × 1.0	22.0	19.00	27.0	18.00	30.0	27.00	38.0	25.00	36.0	33.00	45.0	31.00	13
M10 × 1.25	42.0	30.00	52.0	28.00	59.0	43.00	73.0	40.00	71.0	51.00	88.0	48.00	17
M12 × 1.25	76.0	47.00	95.0	43.00	105.0	65.00	135.0	61.00	130.0	78.00	160.0	73.00	19
M14 × 1.5	120.0	63.00	150.0	58.00	165.0	88.00	210.0	82.00	200.0	106.00	250.0	99.00	22
M16 × 1.5	180.0	85.00	225.0	79.00	250.0	120.00	315.0	111.00	300.0	144.00	380.0	133.00	24
M18 × 1.5	260.0	111.00	325.0	103.00	365.0	156.00	460.0	145.00	435.0	187.00	550.0	174.00	27
M20 × 1.5	360.0	140.00	460.0	130.00	510.0	197.00	640.0	183.00	610.0	236.00	770.0	220.00	30
M22 × 1.5	480.0	172.00	610.0	161.00	680.0	242.00	860.0	226.00	810.0	291.00	1,050.0	271.00	32
M24 × 2.0	610.0	197.00	780.0	183.00	860.0	277.00	1,100.0	257.00	1,050.0	332.00	1,300.0	309.00	36