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Don't Let Torquing Ruin Your Job - 3 Useful Tables

That Humble Bolt Isn't Just as Simple as You Thought . . .
Most of you can probably relate to the grief of broken bolts if you've done any mechanical work at all yourself. Now, let's ask a question. If you wanted to know that a bolt was done up tight enough, what would you do? Logical thing is to use a torque wrench . . . correct. But - did you realise that the torque reading on your wrench may mean precious little! The truth is, what you really want to know is how much ***tension*** is in the bolt when you've finished tightening up but what a torque wrench tells you is how hard you've been turning the nut or the head of the bolt. It doesn't tell you how hard the bolt is clamping or pulling down at all!!
The pull-down or clamping force is tension. The rotational force on your torque wrench is torque, and although they're related, the relationship is not ideal. You may say - so why use a torque wrench? The answer is simple there is no easy way of getting tension readings so torque readings are better than nothing at all. To explain the problem, the main reason torque readings are unreliable is because of big variations in the surface finish of threads, heads of bolts, nuts and washers, galvanising and any lubricant or even Loctite used in the fastener assembly. For instance, if surface finishes are rough or dry you will use up far more of the total torque you apply just to overcome friction in the fastener assembly. You can see this by comparing lubricated and unlubricated readings in the tables at right. So for a given torque readout only a percentage of the figure relates to the tension applied to the bolt and a good bit of the reading is force needed to overcome friction.
Then, what's the answer to this relationship problem . . . Well, there really isn't a complete answer but you can take one big step to help and that's use lubrication every time you do up any fastener assembly. Lubricate all parts to be used including the underneath of bolt heads, washers, nuts and the bolt threads. Even Loctite is a lubricant in it's uncured state. By lubricating the whole assembly you remove most of the friction component of tightening up and your torque reading relates more accurately to the final tension in the fastener.

There's one other thing we should mention - that is "stretch" bolts. This type of bolt was invented to try and get around the torque / tension problem we've just referred to. In crude terms stretch bolts are made of special alloy so that they can stretch a bit more than ordinary bolts without snapping. This extra stretch gives the bolt a constant spring-type action that is more predictable than an ordinary bolt. It also holds the tension far more constant over the lifetime of the fastener assembly until it is undone again. For a little more on stretch bolts go to the blog page from the link at the bottom of this page.

You've asked for data on how much torque to use for a given bolt diameter - so the tables at right are an attempt to help. But please remember they are only a guide. There are too many variables (as already explained) to give fixed and final values. If you use the contents of these tables, you assume full risk for results. The only real way to to determine correct torque for any assembly is through experimentation and to duplicate conditions each time this type of assembly is used e.g. the same surface finishes, washers, plating and lubrication every time the fastening system is duplicated. For the more tech-minded, the clamp load in our tables is calculated at about 65% to 70% of the ultimate yield strength of the bolt.

Mild Steel (Low Carbon)

		Approx. Torque Reading at Clamp Load Lubricated		Approx. Torque Reading at Clamp Load Unlubricated	
Bolt Diameter	Clamp Load	ft/ lbs	Nm	ft/lbs	Nm
1/4" (6mm)	859lbs - 390Kg	2	2.7	4	5.4
5/16" (8mm)	1415lbs - 642Kg	4	5.4	7	9.5
3/8" (10mm)	2093lbs - 949Kg	7	9.5	13	17.6
7/16" (11mm)	2870lbs - 1302Kg	10	13.5	21	28.5
1/2" (13mm)	3831lbs - 1738Kg	16	21.7	32	43.4
9/16" (14mm)	4912lbs - 2229Kg	23	31	46	62.4
5/8" (16mm)	6102lbs - 2768Kg	32	43.4	64	86.8
3/4" (19mm)	9018lbs - 4119Kg	56	76	113	153
7/8" (22mm)	11,400lbs - 5171Kg	83	112.5	166	225
1" (25mm)	15,000lbs - 6804Kg	125	169	250	339

Grade 5 Hi-Tensile

		Approx. Torque Reading at Clamp Load Lubricated		Approx. Torque Reading at Clamp Load Unlubricated	
Bolt Diameter	Clamp Load	ft/ lbs	Nm	ft/lbs	Nm
1/4" (6mm)	2025lbs - 919Kg	4	5.4	8	11
5/16" (8mm)	3338lbs - 1514Kg	9	12	17	23
3/8" (10mm)	4950lbs - 2245Kg	15	20	31	42
7/16" (11mm)	6788lbs - 3079Kg	25	34	49	66
1/2" (13mm)	9038lbs - 4100Kg	38	51.5	75	102
9/16" (14mm)	11,588lbs - 5256Kg	54	73	109	148
5/8" (16mm)	14400lbs - 6532Kg	75	101.5	150	203
3/4" (19mm)	21,300lbs - 9662Kg	133	180	266	361
7/8" (22mm)	29,438lbs - 13,353Kg	215	219.5	429	582
1" (25mm)	38,652lbs - 17,520Kg	322	437	644	873

Grade 8 Hi-Tensile

		Approx. Torque Reading at Clamp Load Lubricated		Approx. Torque Reading at Clamp Load Unlubricated	
Bolt Diameter	Clamp Load	ft/ lbs	Nm	ft/lbs	Nm
1/4" (6mm)	2850lbs - 1293Kg	6	8	12	16
5/16" (8mm)	4725lbs - 2143Kg	12	16	25	34
3/8" (10mm)	6975lbs - 3164Kg	22	30	44	60
7/16" (11mm)	9563lbs - 4338Kg	35	47.5	70	95
1/2" (13mm)	12,788 - 5801Kg	53	72	107	145
9/16" (14mm)	16,388lbs - 7433Kg	77	104.5	154	209
5/8" (16mm)	20,325lbs - 9219 Kg	106	144	212	287
3/4" (19mm)	30,075lbs - 13,642Kg	188	255	376	510
7/8" (22mm)	41,588lbs - 18,864 Kg	303	411	606	822
1" (25mm)	54,525lbs - 24,732 Kg	454	615.5	909	1232

This Newsletter's Teaser
Name the main 2 laws of physics that are used in tension related calculations.

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