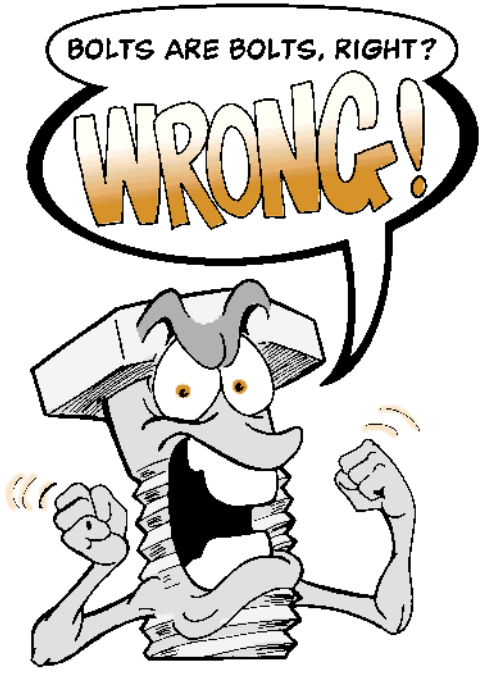
Size Up All Bolts

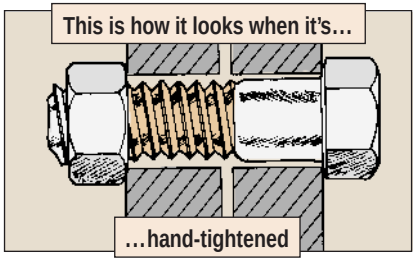


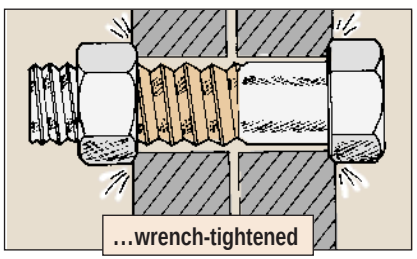
What's a Bolt?

In terms of mechanical advantage, a bolt is an inclined plane. With the added advantage of a lever—like a wrench—a bolt can generate tremendous pressure.

A bolt does its job by stretching, just like a spring or rubber band. Here's how:

The tension generated by the bolt when it's tightened keeps the nut on and the connection together. The same thing happens when you screw a machine bolt into matching threads.





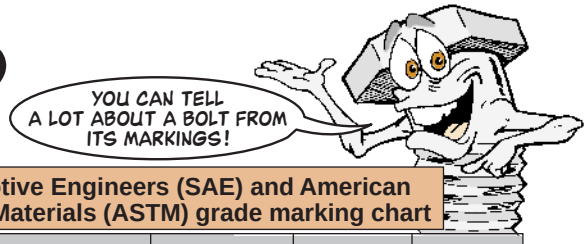
There are tough, strong bolts, light-duty bolts and all sorts of bolts in between. Make sure you're using the right one for the job at hand.

Next time you find an empty bolt hole, resist the temptation to fill it with the first right-size bolt you find.

Despite their simple appearance, bolts are really precision instruments. Their job is as critical as any other in the operation of a piece of equipment.

When you use a substitute, you put your equipment and your buddies in danger. That substitute bolt can snap at any time.

The extra leverage you can get from a wrench is fantastic. By turning and turning, you can stretch a bolt completely out of shape, snap off the head, strip threads, crack the nut, destroy washers—not to mention damaging what the bolt holds together.



Society of Automotive Engineers (SAE) and American Society for Testing Materials (ASTM) grade marking chart

GRADE MARKING	SPECIFICATION	MATERIAL	BOLT & SCREW SIZE (in)	PROOF LOAD (psi)*	TENSILE STRENGTH (min. psi)
NO MARK	SAE-Grade 1 ASTM-A 307	Low carbon steel	1/4 – 1 1/2 1/4 – 4	33,000 —	60,000 60,000
NO MARK	SAE-Grade 2	Low carbon steel	1/4 – 3/4 over 3/4 – 1 1/2	55,000 33,000	74,000 60,000
	SAE-Grade 5	Medium carbon steel, quenched and tempered	1/4 – 1 over 1 – 1 1/2	85,000 74,000	120,000 105,000
	ASTM-A 449		1/4 – 1 over 1 – 1 1/2 over 1 1/2 – 3	85,000 74,000 55,000	120,000 105,000 90,000
	SAE-Grade 5.1	Medium carbon steel, quenched and tempered w/assembled lock washer	No. 6 – 3/8	85,000	120,000
	SAE-Grade 5.2	Low carbon Martensite steel, quenched and tempered	1/4 – 1	85,000	120,000
	ASTM-A325 Type 1	Medium carbon steel, quenched and tempered	1/2 – 1 1 1/8 – 1 1/2	85,000 74,000	120,000 105,000
	ASTM-A325 Type 2	Low carbon Martensite steel, quenched and tempered	1/2 – 1	85,000	120,000
	ASTM-A325 Type 3	Atmospheric corrosion resisting steel, quenched and tempered	1/2 – 1 1 1/8 – 1 1/2	85,000 74,000	120,000 105,000
	ASTM-A 354 Grade BB	Alloy steel, quenched and tempered	1/4 – 2 1/2 2 3/4 – 4	80,000 75,000	105,000 100,000
	ASTM-A 354 Grade BC	Alloy steel, quenched and tempered	1/4 – 2 1/2 2 3/4 – 4	105,000 95,000	125,000 115,000
	SAE-Grade 7	Medium carbon alloy steel, quenched and tempered, roll threaded after heat treatment	1/4 – 1 1/2	105,000	133,000
	SAE-Grade 8 ASTM-A 354 Grade BD	Medium carbon alloy steel, quenched and tempered Alloy steel, quenched and tempered	1/4 – 1 1/2	120,000	150,000
	SAE-Grade 8.2	Low carbon Martensite steel, quenched and tempered	1/4 – 1	120,000	150,000
	ASTM-A 490	Alloy steel, quenched and tempered	1/2 – 1 1/2	120,000	150,000 min 170,000 max

* *Proof Load is the measure of load that can be applied without causing permanent set.*

Bolts Torque to You

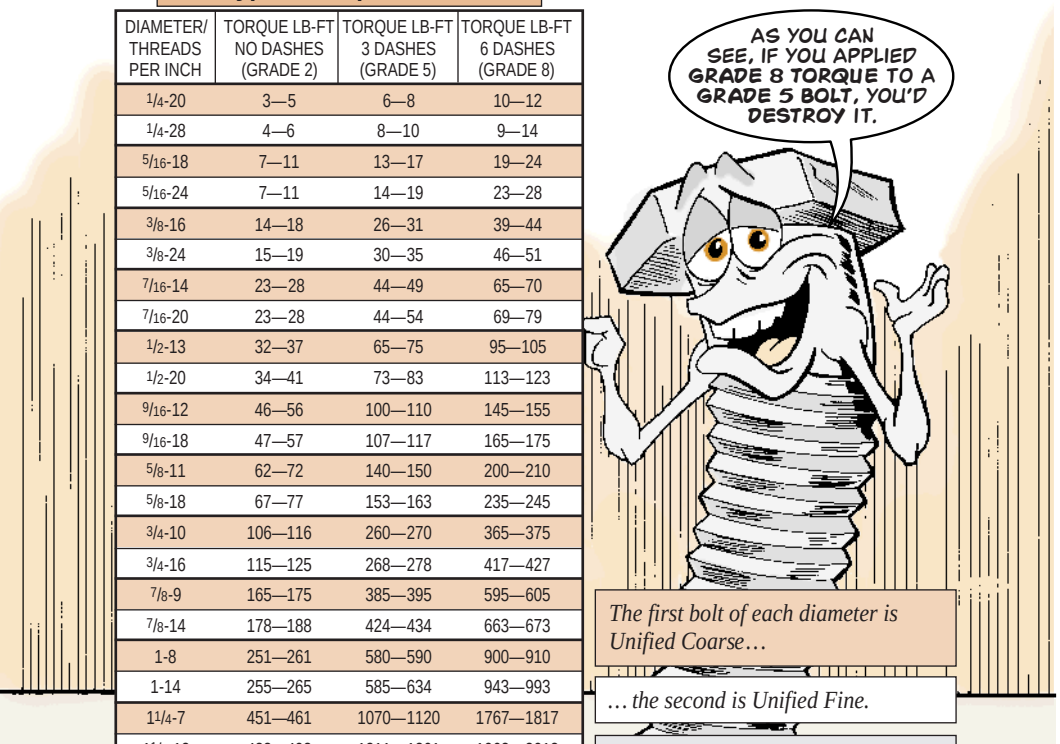
To get the best from any bolt, you've got to use the right torque. The torque called out in the TM isn't somebody's best guess, it's the value built into the bolt.

PS MORE

The right torque depends on what the bolt is made of and how it's made.

Typical Torque Values

DIAMETER/ THREADS PER INCH	TORQUE LB-FT NO DASHES (GRADE 2)	TORQUE LB-FT 3 DASHES (GRADE 5)	TORQUE LB-FT 6 DASHES (GRADE 8)
1/4-20	3—5	6—8	10—12
1/4-28	4—6	8—10	9—14
5/16-18	7—11	13—17	19—24
5/16-24	7—11	14—19	23—28
3/8-16	14—18	26—31	39—44
3/8-24	15—19	30—35	46—51
7/16-14	23—28	44—49	65—70
7/16-20	23—28	44—54	69—79
1/2-13	32—37	65—75	95—105
1/2-20	34—41	73—83	113—123
9/16-12	46—56	100—110	145—155
9/16-18	47—57	107—117	165—175
5/8-11	62—72	140—150	200—210
5/8-18	67—77	153—163	235—245
3/4-10	106—116	260—270	365—375
3/4-16	115—125	268—278	417—427
7/8-9	165—175	385—395	595—605
7/8-14	178—188	424—434	663—673
1-8	251—261	580—590	900—910
1-14	255—265	585—634	943—993
1 1/4-7	451—461	1070—1120	1767—1817
1 1/4-12	488—498	1211—1261	1963—2013
1 1/2-6	727—737	1899—1949	3111—3161
1 1/2-12	816—826	2144—2194	3506—3556



The first bolt of each diameter is Unified Coarse…

… the second is Unified Fine.

Use this chart only if your TM gives no torque values.

If you torque a bolt beyond its built-in limits (and it doesn't break), it stretches so far it can't snap back. You won't know it's sprung, so you keep on torquing.

Even if you get the torque reading you're looking for, it's wrong. The first bit of stress, and the bolt will snap or the nut will back off.

It's a sure bet what you've joined together will come apart sooner or later.

Wet or Dry Torque?

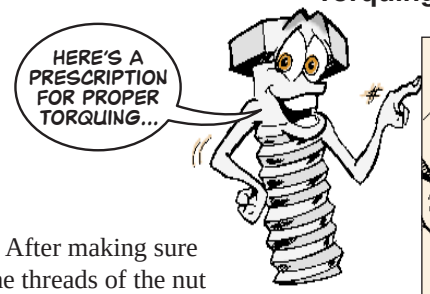
Some 90 percent of the torque you apply goes to overcome friction. Only 10 percent goes to tighten.

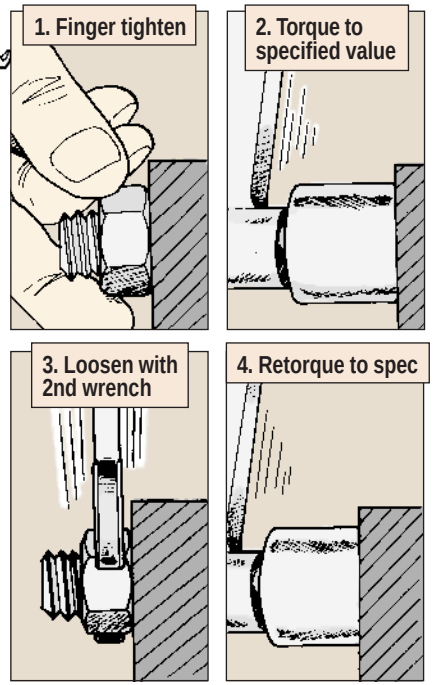
When you use a lube, you reduce friction. That means the same amount of torque will create more tightening force, probably too much.

On the other hand, using a wet value on a dry bolt will not get the right amount of clamping force.

If you use lube, make sure you use the wet torque value in your TM, not the dry one.

Torquing Tips





After making sure the threads of the nut and bolt are clean, do the following:

1. Run the nut up by hand until it begins to tighten.

2. Torque the nut to the specified value in one steady, continuous motion.

3. Loosen the fastener with another wrench. (Never use a torque wrench to loosen a fastener.) Loosening cleans the threads of burrs and dirt and lets the mating surfaces seat and align with each other.

4. Torque to specs.

Use the Right Washer

Always use the washer called for in your manuals, too. It must be able to stand up to the torque without thinning out. A soft washer will lose its shape under load, leaving the bolt loose enough to fail.

Once Is Enough

You won't get the same clamping force with the same amount of torque on a nut or bolt that's been used a number of times.

Increased friction because of deformed threads takes more and more of the torquing effort, meaning you get less and less holding force.

As an example, a new bolt might have a tension load of 13,250 pounds with 170 lb-ft of torque. The sixth time the nut is installed, the 170 lb-ft of torque produces only 7,500 pounds of load, a loss of 43.5 percent.

If your TM calls for new fasteners, use them. Otherwise, you're asking for trouble.