The nuts and bolts of it all…

A Simple Guide to Automotive fasteners by Ted Carlsen and (AI Copilot)

Our automotive projects are full of stripped, broken and rusted bolts, washers and nuts. Sometimes we meticulously clean and re-use the exact fastener that we removed from the car. Other times we reach into the bucket of used, past project fasteners hoping to avoid a trip to the hardware store. Other times we reach for the assortment package of nuts and bolts for the right size and thread pitch, not always respecting the grade and maybe even mixing and matching grades to get the bolt, nut, and washer we need. We then crank the bolt till it won't move anymore or hit it with an impact wrench. Other times, we use the repair manual and torque it to specifications, not always respecting the specs or condition of the fastener itself.

Bolts are crucial components in automotive applications, ensuring the structural integrity and safety of vehicles. There are numerous bolt classifications used in the automotive industry, each designed for specific purposes and requirements. Understanding these classifications helps in selecting the right bolt for the job, enhancing the vehicle's reliability and performance. Torque values are also based on the type of fastener, its size, grade and thread pitch. This article may provide you with some guidance on what type/grade of fastener to use on your project.

If this article is reaching the limit of your attention span already, try to read this short list of Do's, Don'ts and Basics, the rest you can read later when you can't get to sleep.

Don't

1. Don't hand tighten until you run out of leverage.
2. Don't hit everything with an impact wrench.
3. Don't use a lower grade bolt in higher grade applications (ask yourself: If this breaks, what happens to me?).
4. Don't use lower grade nuts or washers with higher grade bolts in high grade applications.
5. Don't leave your torque wrench in the drawer at a setting other than zero for long periods, it will alter the spring and the wrench will no longer be calibrated.

Do

1. Use new fasteners rather than re-used fasteners. An old fastener may have been taken beyond its proof (load) point or altered due to corrosion and may not be able to withstand the original load and torque specifications.
2. Hand tighten, then use a torque wrench.
3. Research the tightening and torque pattern for multiple fastener applications such as heads and wheel lugs.
4. Research your specific torque numbers for your application and fastener grade/thread pitch.
5. Make sure your torque wrench is set to zero before putting it away.

Basics

1. Each fastener grade (SAE 2,5,8/Metric 5.8,8.8,10.9,12.9) has a specific load rating with different torque values.
2. All sizes have the same load rating within their grade, but different torque limits.
3. Grades 2/M5.8 (no markings) are for low stress items like trim, brackets, interior.
4. Grades 5/M8.8 (3 radial lines) for moderate stress, high load applications like mounting bumpers or mounting brackets for engine parts, master cylinder, suspension mounts.
5. Grade 5 bolts stretch before breaking.
6. Grades 8/M10.9 (6 radial lines, gold) for high-strength applications such as suspensions, steering, motor/transmission mounts.
7. Grade 8 bolts have limited stretch and snap under severe loads.

Summary

Grade 2- no stress, light loads, cosmetic applications

Grade 5 – heavier objects, objects exposed to motion and/or stress

Grade 8 – Really heavy objects that experience high stress movement and/or weight

And now the details…

1. Grade Classification

Bolts are typically graded based on their material properties and strength. The most common grading systems are the SAE, ASTM, and ISO.

SAE Grades

The Society of Automotive Engineers (SAE) has established a grading system for bolts:

- Grade 2: Made from low or medium carbon steel, these bolts are the least strong but most affordable, suitable for light-duty applications.
    - Proof load (max non-deformation) 55,000 psi (33,000 for ¾-1.5”)
    - Yield strength (min deformation load) 57,000 psi (36,000 for ¾-1.5”)
    - Tensile strength (shear load) 74,000 psi (60,000 for for ¾-1.5”)

- Grade 5: Medium carbon steel bolts, often quenched and tempered, offering medium strength and used for moderate stress applications.
    - Proof load (max non-deformation) 85,000 psi (74,000 for ¾-1.5”)
    - Yield strength (min deformation load) 92,000 psi (81,000 for ¾-1.5”)
    - Tensile strength (shear load) 120,000 psi (74,000 for for ¾-1.5”)

- Grade 8: High-strength bolts made from medium carbon alloy steel, quenched and tempered, ideal for high-stress applications.
    - Proof load (max non-deformation) 120,000 psi
    - Yield strength (min deformation load) 130,000 psi
    - Tensile strength (shear load) 150,000 psi

2. Thread Type Classification

Bolts can also be classified by their thread types, which affect their grip and torque characteristics.

Unified Thread Standard (UTS)

The UTS is common in the United States, with classifications such as:

- UNC (Unified National Coarse): Coarse threads, providing good grip and easy installation.
- UNF (Unified National Fine): Fine threads, offering better grip and higher strength.
- UNEF (Unified National Extra Fine): Extra fine threads for precise applications with thin-walled components.

Metric Thread

Common in Europe and many other parts of the world, metric threads are categorized by the pitch of the threads:

- Coarse Thread (M): General-purpose threads, easy to assemble and disassemble.
- Fine Thread (MF): Fine threads for higher strength and better holding power.

3. Material Classification

The material of the bolt affects its strength, corrosion resistance, and suitability for specific environments.

Steel Bolts

The most common material, offering a good balance of strength, durability, and cost. They can be plain or coated with various finishes for corrosion resistance.

Stainless Steel Bolts

Resistant to corrosion and very durable, ideal for use in harsh environments or where aesthetics matter.

Titanium Bolts

Lightweight and extremely strong, used in high-performance and aerospace applications, but more expensive than steel.

Brass Bolts

Good corrosion resistance and conductivity, used in electrical and decorative applications.

4. Torque

Bolt torque is the measurement of the force required to turn a fastener. The torque spec is the range of force where the fastener stretches (torque tension) to ensure the desired clamping force. **All fasteners stretch when tightened**, this torque tension provides the clamping force without failure. Fasteners are rated by: tensile strength, proof load, and clamp load. These ratings are critical in the ability for any fastener to maintain clamping force; exceeding these specs results in failures.

- **Tensile strength** is a material's resistance to breaking under tension.
- **Proof load** is the yield point where the fastener is near 90% of the tensile strength and is the maximum load before permanent deformation. A bolt loaded to its proof point is reusable as long as it has not been taken beyond that load point. If a fastener is overloaded beyond the 90% range, it will take a "set", which means it is permanently stretched and has weakened.
- **Clamp load** is where the fastener is at about 70% yield strength. This is the force range where most fasteners are torqued to. They are re-useable many times at this point.

Conclusion

Choosing the right bolt for automotive applications involves understanding these classifications and their implications. Each type of bolt has its unique properties and suitability for different tasks, ensuring the safety, reliability, and performance of the vehicle. By selecting the appropriate bolt, you can maintain the integrity of automotive assemblies and contribute to the overall success of your project.

If you don't have a torque spec, you can use a standard maximum torque table such as the one displayed here.

U.S. Recommended Bolt Torque Table

Size	Recommended Torque											
	Grade 2		Grade 5		Grade 8		18-8 S/S		Bronze		Brass	
	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine
* #4	-	-	-	-	-	-	5.2	-	4.8	-	4.3	-
* #6	-	-	-	-	-	-	9.6	-	8.9	-	7.9	-
* #8	-	-	-	-	-	-	19.8	-	18.4	-	16.2	-
*#10	-	-	-	-	-	-	22.8	31.7	21.2	29.3	18.6	25.9
1/4	4	4.7	6.3	7.3	9	10	6.3	7.8	5.7	7.3	5.1	6.4
5/16	8	9	13	14	18	20	11	11.8	10.3	10.9	8.9	9.7
3/8	15	17	23	26	33	37	20	22	18	20	16	18
7/16	24	27	37	41	52	58	31	33	29	31	26	27
1/2	37	41	57	64	80	90	43	45	40	42	35	37
9/16	53	59	82	91	115	129	57	63	53	58	47	51
5/8	73	83	112	128	159	180	93	104	86	96	76	85
3/4	125	138	200	223	282	315	128	124	104	102	118	115
7/8	129	144	322	355	454	501	194	193	178	178	159	158
** 1	188	210	483	541	682	764	287	289	265	240	235	212

*Sizes from 4 to 10 are in *in.-lbs.*
Sizes from 1/4 up are in *ft.-lbs.*

**Fine thread figures are for 1-14.
Grade 2, 5, and 8 values are for plated bolts.