FASTENER TORQUE AND WHAT IT MEANS TO THE CLASSIC CAR RESTORER

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with additional technical information from ARP Fasteners website

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I remember when I was young and my father was always working on his cars, trucks, tractors and anything else that had an engine and wheels. He never had a service manual other than some old dark blue MoTor Manuals to follow for instructions and specifications. One thing I know he never had was a torque wrench. This was not unusual at the time. Even our 1946-1958 Rolls-Royce Silver Wraith service manuals contain no mention of the use of torque wrenches or torque requirements for fasteners. The instructions state only that the fastener should be "pulled up snugly by an experienced fitter with a six-inch Tommy Bar." Look at any early service manual for a Classic Car or any other type of car from the 1920s, 1930s and 1940s and you will seldom, if ever find a reference to fastener torque. Today we know better and the importance of properly and evenly tightening fasteners should not be overlooked. If you build or rebuild your own engines and chassis components or just install your road wheels, fastener torque is critical to safety and reliability.

What is torque as it relates to fasteners?

In dictionary terms (or from my Ultimate Collector Car Guide) torque is "The twisting effort measured in foot-pounds or Newton-meters." In our discussion here it is the tightening or clamping force on bolts and nuts. How does this twisting force apply to tightening these fasteners and why does it matter? In order for a fastener to function properly it must be "stretched" a specific amount. The material's ability to "rebound" like a spring is what provides the clamping force. If you were to simply "finger-tighten" a bolt there would be no preload. However, when you apply torque or rotate a fastener a specific amount and stretch it, you will be applying clamping force.

The amount of preload you can achieve from any bolt or stud depends on the material used and its ductility, heat treat, and the diameter of the fastener. Of course, every fastener has a "yield" point! The yield point or yield strength of a fastener is the point at which the fastener has been over tightened and stretched too much, and will not return to its original manufactured length. As a general rule, if you measure a fastener and it is .0005˝ (or more) longer than its original length it has been compromised and must be replaced. Some modern engines such as the Chrysler Gen III Hemi use "Torque to yield" OE fasteners that are designed to be discarded after one use and replaced.

How is torque measured?

There are a number of ways that fastener torque may be measured. The most common is by the use of a torque wrench. A torque wrench is calibrated to measure the amount of twisting force applied to a fastener and this amount is shown on a scale that may be manual or analog, with a needle moving across the handle, a snap mechanism inside the handle that clicks when the amount indicated on the twist dial is reached, or digital, where the torque reading is measured and shown on an electronic digital dial.
Any of these methods will work but in all cases, any torque wrench must be checked regularly for proper calibration and accuracy. They all must be properly cared for to maintain this accuracy. A torque wrench should never be dropped or damaged in any way or its accuracy may be affected. A click type with a twisting dial on the handle must be turned back to zero when your work is completed or its accuracy will be affected.

Any type of torque wrench must be used properly to work accurately. Since torque is measured in foot-pounds, the technician must hold the handle in the proper position with the force of your hand at the center of the grip on the handle. This insures that the length of the handle overall equals the one foot length for the measurement. This is why some manual torque wrench grips pivot on the handle to maintain this centering of force when it is pulled. It is always proper to pull rather than push a torque wrench handle to maintain even force.

Another and more accurate method of measurement is to measure the precise stretch of any fastener. Since stretch can only be measured with the use of specialty gauges or expensive ultra-sonic measuring equipment, it is only practical for measuring the stretch on connecting rod bolts and other fasteners where it is possible to monitor the overall length as it is being tightened. Since most fasteners are installed blind and can't be accessed from both ends to monitor stretch, a torque wrench of some type must be used.

The last method used to measure fastener torque is called the torque angle method, long the standard of civil engineering applications. Since the amount that a bolt or nut advances on the thread per degree of rotation is determined by the thread pitch, any amount of stretch in a given bolt or stud can be accurately predicted be measuring the degrees of turn from the point where the underside of the bolt head or nut face contacts the work surface, termed the "torque angle". The problem with the torque angle method is that it is dependent on calibration specific for each operation. It is used by some high performance engine building shops.

Factors that affect fastener torque values

One of the most important factors that affect torque is the quality and strength of the fastener. If a fastener is a standard grade 1 to 6 or a high strength grade 8 makes a big difference in the correct torque value. In many cases, the grade and quality of the fastener cannot be a choice such as when original fasteners must be used. This is usually true when working with antique and Classic cars but even in those cases, a new and stronger modern fastener can sometimes be found and used without detracting from the originality and appearance. In some cases, especially with more popular cars, correct reproductions may be available. An old fastener may have been stretched and retorqued many times over the years so replacing it with new materials could make a difference in the final quality of your assembly. An old fastener may also be worn, rusted or corroded and those factors might affect its strength and torque value. Those details must be kept in mind when working on old cars.

An example of the difference in torque value as it relates to fastener quality and strength is shown in a standard torque value chart such as the one in my Restorer's Classic Car Shop Manual. These grades indicate the tensile strength in psi of the fasteners and this strength will range from 65,000 lbs. for a low grade to 140,000 lbs. for a Grade 6 automotive fastener to 160,000 lbs. for a Grade 8. Aftermarket fasteners like ARP 2000 have a tensile strength of 200,000 lbs. For example, a 7/16 -14 low grade fastener may have a torque value of 32 ft. lbs. while a Grade 5 automotive fastener will have a torque value of 58 ft. lbs.

There are also variations in modern fasteners as to the material used in their manufacture. Originally, it may have been choice between low carbon or high carbon steel, but today, fastener material can be much more varied and the choices will be determined by its ultimate usage. Stainless, variations of chrome, moly, aluminum and other metals make up the modern fastener.

Also, high quality fasteners will have their threads rolled rather than cut to increase strength. Cheap hardware store fasteners are not always the best choice for critical attachment when rebuilding your Classic Car.

Another important factor when measuring torque is friction. Friction is a very important factor in the installation of a threaded fastener in any application. Friction is at its highest value when a fastener is first tightened. The friction is reduced each time a fastener is tightened and loosened so it becomes more consistent over repeated cycles. This is why fasteners need to sometimes be retorqued to get the most efficient clamping force. Friction reduces the ability of a newly torqued fastener to achieve its desired preload. The other piece in this puzzle is the lubrication. If an improper lubricant is used that is too slick it will reduce the amount of torque required to reach the proper preload by 20% to 30%. ARP uses a special Ultra-Torque lubricant that increases the accuracy of the initial torque, thus reducing the additional cycling required when other lubricants are used...

A last tip is to always use a thread chaser to clean and clear threads before installing a bolt or stud. Also, when using studs in an engine application, the studs should be hand-tightened only.