Reuse of Fasteners

Mechanically, bolts may be reused provided the bolt never exceeded its yield point: a simple enough definition, but one that is more complicated than it may appear. This is because it is nearly impossible to verify if a bolt has ever been tensioned past the yield point.

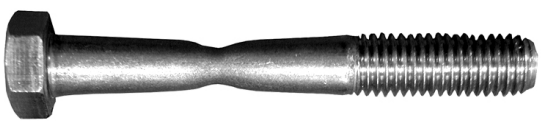
The proof load represents the usable strength range of the fastener. By definition, the proof load is the applied tensile load the fastener can support without permanent deformation. When a bolt is functioning in its proof range, it will return to its original shape upon removal of the load.

Thus, it would appear as long as the initial installation of the fastener did not stretch the material beyond the proof load and send it into the plastic range, reuse should be completely acceptable. This carries some truth; however, the complex issue of service conditions must also be accounted for.

As the fastened joint is put into use, it will encounter all types of various external loads including tension, shear, cyclic, prying, and other loads which may be a combination of these. These loads may be produced by outside factors, e.g. pressure changes in a pipeline, vibration from an engine, or the impact of a hydraulic ram. These loads either add to or subtract from the initial load of the fastener. In extreme cases these loads may even yield the fastener.

Other external factors, such as heat, will lower the yield value of the fastener. The yield strengths (as listed in most reference material) are determined at room temperature. ASTM A193 B7 has a yield strength of 75-105 ksi at 70°F (75 ksi for sizes over 4 inches in diameter and 105 ksi for material in diameters up to 2 ½ inches), and drops to approximately 53-74 ksi at 800°F. So, if a user installs a B7 fastener of 2 ½ inch diameter or smaller at room temperature, it is reasonable to expect each fastener to support a tensile load of 85 ksi. However, if enough heat is introduced to the joint, the temperature increase could cause the fastener to yield under the same 85 ksi stress.

Another factor that can affect the reusability is the control of the initial installation. Was the fastener installed properly? This is one of the most difficult questions to answer. Extreme caution should always be used if the fastener was installed using an indirect method of tensioning. Even among those methods which directly indicate tension, many are still unable to indicate over-tightening of a fastener; thus, even with a direct method, it is very difficult to guarantee that a fastener has not yielded during installation or service.

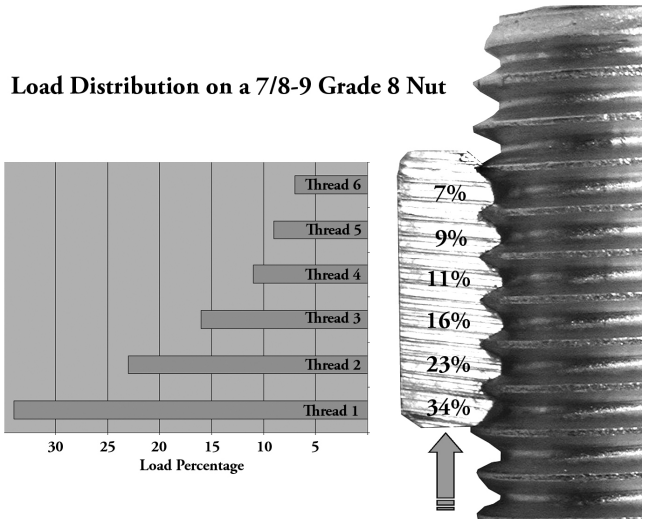


Although in extreme cases such as the one illustrated here, you may be able to visibly detect yield in an externally threaded fastener. Typically, the amount of stretching may be as little as 0.001-in. In most cases there is no way to know whether or not the fastener has yielded, so, it is advisable to never reuse fasteners in critical applications.

Before reusing a fastener that shows signs of corrosion, some consideration to the application is warranted. If the environment is sour, caustic, acidic, basic, or generally corrosive, the fastener should be replaced if any corrosion is evident. If the environment is not corrosive in nature, then the amount of corrosion exhibited on the product should be noted. Plain and black oxide finished fasteners offer no corrosion protection and some surface oxidation (or rust) would be expected after time spent in service or even during shipping or storage. These do come with a light oil coating, but over time, this oil becomes less and less effective at preventing oxidation. These fasteners can be reused if the amount of rust doesn't prohibit the fastener from being assembled or disassembled from the joint. If the joint is critical in nature, i.e. holds a substantial load or would result in personal harm or equipment damage upon failure, we recommend you do not reuse the fastener. The cost of replacing a relatively cheap fastener with the cost of replacing a potentially expensive assembly should be considered when determining whether a fastener can be reused. If you are unsure if your fasteners can be reused, contact the FEDS department and we will provide assistance.

Re-use of Fasteners and Torque

In the event that a fastener is reused, attention must be given to the method of reinstalling the fastener. Upon reuse, a nut and bolt combination will require an increased torque value to reach the desired clamp load. This results from the deformation of the nut threads.



As the fastener elongates, it starts to apply a compressive load to the nut. The first engaged thread of the bolt experiences an enormous amount of tension. Some of this load is transferred to the adjacent nut thread causing less tension in the bolt at the second engaged thread. Then, this thread transfers part of this load to the third nut thread, and so on. The threads of the bolt will stretch. At the same time, the compressive forces acting on the bearing surface of the nut squeeze the bottom threads of the nut together. This is illustrated on the load distribution diagram. This type of load distribution is critical to the performance of the fastened assembly. If a larger proportion of the loading was concentrated on first engaged thread, the fastener would be more susceptible to fatigue failures, loosening or other modes of failure. However, due to this deformation causing an uneven load distribution, the first few internal threads may plastically deform (yield).

The first few threads of the nut will support the majority of the load. Research has shown in some cases involving UNC threaded nuts that the first thread will have to support nearly 35% of the load. The second thread will support about 25% of the load, and the third thread about 18%. In this case the first three threads support 78% of the load.

To allow this distribution, nut threads are designed to be softer than bolt thread and will conform to the contour of the bolt threads when tensioned. If a nut were reused, there would no longer be a "ideal" thread match. This will create more friction between the threads during installation, which will significantly alter the installation torque.

On a demonstration with a ½-13 zinc plated SAE J429 Grade 5 hex cap screw and zinc plated SAE J995 Grade 5 hex nut with an installation torque of 70 ft-lbs to obtain a clamp load of 9000 lbs (without any added lubrication). On the second installation, this torque had increased to 95 ft-lbs to obtain 9000 lbs. By the fourth installation, we required 145 ft-lbs to reach a clamp load of 9000 lbs.

There are a number of clear indications that the fastener should not be reused, however typically the decision comes down to the economics of the fastener(s) vs. the cost of a failure of the fastened assembly.