Nuts and Bolts

Practical

Nuts and bolts are going to be either Standard (American speak for imperial units) or metric. Generally each size has a standard “fine thread” and “corse thread”. Fine thread will have a higher thread count than corse thread, which means fine thread wraps around the bolt more times for a given vertical surface of the bolt.

[diagram of bolts, showing thread count]

Corse thread is adequate for most applications. Since there are less wraps, it tightens quicker, and its easier to notice when its cross threaded, which makes cross threading less likely to happen.

A note on cross threading

[insert picture of cross threading]

Cross threading is when the nut doesnt go on correctly, and instead of sliding into the first thread, it bites on to one further down. Since a large amount of force can be applied by a screw with a wrench, you can easily carve new threads by accident. This is one of the saddest things that can happen while being a mechanic, and will usually be blamed on the nefarious “previous owner” or “that idiot mechanic”. Generally you should be able to thread a bolt 1 or 2 full rotations by hand. If you are worried you don’t have the threads engaged properly. Spin left to back the nut out, and try again to tighten it. I like to rotate it left while pushing down slightly so it can hop across the thread and get seated down into the threads properly. You can usually tell a nut is cross threaded because it takes a stupid amount of force to tighten and untight, and you can feel it carving through the bolt. Sometimes though, a bolt is just old and rusty. Dirty bolts can also be continously tough to tighten and un tighten.

Lefty loosy, righty tighty. You can also use the “right hand rule” to remember which ways nuts usually tighten. Do a thumbs down. The direction your fingers are curling is the way the nut is suppose to rotate to tighten.

Nuts are generally always hexagonal, because hexagons are the bestagons. The head of the Bolt, however, comes in many different configurations, The most common is a hexagonal head. Generally its easy to get a lot of points of contact and can be adjusted with many tools, but generally you have to access the nut from the side and cant recess the bolt unless you have a ton of space around the head.

For applications where you don’t have space around the bolt head, allen heads are generally used. They are taller and have an internal hexagon for tightening. I hate them though because it is very easy to accidentally grap an allen key slightly too small and round the shit out of the hole.

Rounding

The second most painful thing after cross threading a bolt is rounding a bolt. This happens with internal allen key bolts and external hexagonal bolts and nuts. If you use the wrong size wrench, or have it at a bad angle, or the head material is soft, you break off the sharp corners of the hexagon and round it off. It is very sad and aggravating. Its also why you try to use as many points of contact when tightening a nut, use the box end of a wrench, instead of say, an adjustable wrench. And don’t use fucking pliers on a nut and bolt, you’ll round it out and have to use vice grips to get it off when its fully rounded.

Stripping

Overtightening a bolt doesn’t make it take its clothes off, but if you are lucky enough not pull the bolt apart, you’ll usually strip the bolt. This is when the threads of the nut or bolt fail and break off, so there is nothing to bit into anymore and the nut just freely rotates. Stripping also happens when you have a part with internal threads and you break those.

Snapping a bolt is usually when the friction on the threads is too high (or you run out of travel on the bolt so it can’t move anymore, so you end up breaking the bolt in torsion.

Torque Specs

Nuts work on friction. By tightening a nut against a surface, the surface is pushing up on the nut, forcing the threads of the bolt and the nut to push against each other, which increases the friction and prevents the nut from rotating loose. This is why a “torque” spec is usually what describes how tight to tighten a particular bolt. Since torque is just rotational force, the harder it is tightened, the harder it is to rotate, and the more friction is has between the threads, which is the same friction that prevents the bolt from loosing up. By using a torque wrench, you are essientially measuring the tightness of the threads.

One thing to keep in mind is that bolts are being stretched when you tighten the nut. You can imagine the bolt like a sprin. The nut is pushing away from the plate and pulling up the bolt, and the bolt is a spring pulling the nut back down. This is useful as this is whats really generating the frictional force that keeps the nut from falling off. However, it is possible to snap a bolt this way, as the nut and threads can literally pull the bolt apart. Whats also really important to keep in mind is that while the force of the bolt is usually proportionally to the force of friction, this relationship will change based on how lubricated the threads are. This means if your threads are well oiled, it will be very easy to move the nut down, and the nut displacement is what pulls on the bolt and generates the tension in the bolt. This tension is multiplied by the coefficient of friction between the threads, generating the frictional force. This means that if you overlubricate the threads, you can snap a bolt because the torque spec now puts more tension on the bolt.

[picture of thread and bolt force]

Theory and Design Applications

[diagram of nut and bolt with forces]

Both the nut and bolt are screws, which are incline planes. The purpose of an incline plane is to reduce the force need to move something vertically, and achieves this by requiring more lateral motion. A screw does the same thing, it requires a large rotational movement for very little lateral movement, and as a result, makes the vertical force usually much stronger than the horizontal force used to tighten the bolt.

A nut and bolt also acts to transform a rotational force (torque) to a linear force.

Read Carroll Smith's "Tune to Win" and "Engineer to Win". He is very clear that the primary purpose of a bolt is to clamp two items together. For tasks such as positioning, other devices, such as dowel pins, are much better. This is very important because a bolt is often use to position parts, and to act as a shear pin. The threads on a bolt act as stress concentrators, so it is bad to the shear applied on a bolt near the threads.

This means the primary purpose of a nut and bolt is attach 2 parts, i.e. make them act and take forces as one, for something you need to take apart later. In this case, the friction on the surfaces between the 2 parts should be holding them together, not the shear force from using the bolts as a pin.

[show picture of transmission case or something]

A few good examples, using an engine as a stressed member. Crankcase of transmission. Bolting a seat to a floor. Perfect bolt application.

[show picture of fsae a-arm]

This could be done by a dowel pin with clips

Show how transmission case can use formed pins and then that helps drill the holes and screw the bolts.

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