TWO BOLTS VS. FOUR BOLTS

Should form follow function…or fashion? How many bolts does it take to hold your handlebar securely without squeezing the life out of it? Two? Four? Six? Eight?

The other day we were in our favorite bike shop admiring a beautiful new Easton EA70 road stem. The face plate of the stem attached with two bolts. "It's a cool stem," exclaimed the shop owner, "it would be even cooler if it had four bolts." "Really, why is that?" we asked. "Because four-bolt stems are the current fashion and style," the store owner offered.

Suddenly, our excitement about the stem made us feel like we had we left the office wearing one blue sock and one black sock. But we were walking better than ever, so in our defense we asked, "If four bolts is cool wouldn't six or eight be even cooler?"

What does the number of bolts have to do with anything anyway? Well, here is where we may get ourselves into trouble with the fashion police. (We're sure a warrant is being prepared even as we write this.)

Function vs. fashion

The purpose of stem bolts is to secure the handlebars between the stem's front cap and rear perch. The bolts should allow the front cap to be tightened securely enough to keep the bar from rotating or slipping during use. Does a four-bolt stem offer any advantages over a two-bolt stem…or vice versa?

> *"Steel bolts are heavier than aluminum and titanium, but more than make up for it in strength, toughness and dependability."*

Let's start by looking at the bolts themselves. Bolts are available in a myriad of materials, diameters and number of threads per inch. Typical stem bolts are made from aluminum, titanium or chromoly steel. Each of these materials has different properties.

Aluminum has the lowest density and offers the lowest weight. But nothing comes for free. Aluminum bolts just don't have the necessary strength. Since durability and strength are important attributes, aluminum may not be the best choice. How about titanium? While stronger than aluminum, Ti bolts still don't offer enough strength and toughness for this application. They are somewhat brittle and subject to breaking under load.

Steel bolts are heavier than aluminum and titanium, but more than make up for it in strength, toughness and dependability.

Weight is a factor in any performance product, and two bolts are definitely lighter than four (assuming the bolts are the same size). But before we decide that a two-bolt stem is superior to a four-bolt stem, let's consider how the bolts and the face plate interact and function.

Hold on a minute

Today's handlebars are getting lighter and lighter. Aluminum road bars are around 200 grams and composite bars are even lighter. While these bars are

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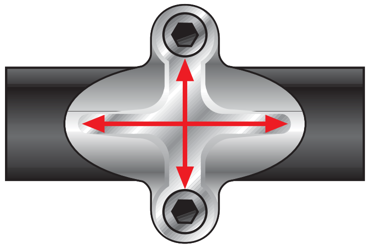
very strong, they got this light by using less material. As a result, they have thinner walls.

A two-bolt system has definite advantages when it comes to clamping bars with thinner walls. It does a better job of spreading the clamping force evenly over the entire area of the face plate. The center of the bar suffers less trauma when tightened.

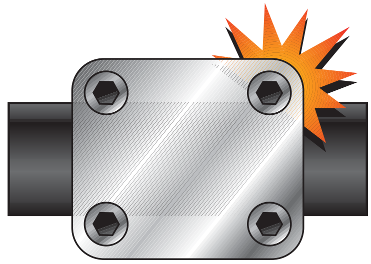
Four-bolt stems pose a couple of challenges. First, most four-bolt stems use smaller diameter bolts. This is done partly to compensate for the increased weight of the extra bolts. To further offset this weight issue, stem designers will often use bolts made from titanium. Either way, they are not as strong as the chromoly bolts used with a two-bolt stem.

A second drawback is the way that four bolts apply clamping force to the bar. It's much more of a challenge to apply even clamping pressure across the center of the bar with a four-bolt system. If installed improperly, four-bolt face plates can pinch the bars at the corners of the face plate, damaging the center area of the bar.

Even with proper assembly, a four-bolt stem places maximum clamping stress at the edge of the stem/bar interface. This is the location of the bar's maximum bending stress during use. These combined stresses can lead to premature fatigue failure or crack initiation.



Two-bolt pattern distributes stress evenly over the entire area of the faceplate.



Four-bolt pattern is prone to stress hot spots when individual bolts are over-tightened.

A two-bolt design is self centering; it allows clamping stresses to dissipate before reaching the edge of the stem where the bar exits.

Time to talk torque

It seems like everybody is bent (pun intended) on over-tightening components. Why is this? Lots of reasons: people are afraid that their components will come loose; people compulsively tighten their bolts (sometimes before every ride); and finally, people don't use torque wrenches.

Let's assume that we do use a torque wrench. Our owner's manual or assembly instructions generally recommend a torque specification. But is this a suggestion or a requirement? If 60 in/lbs of torque is good, why not use 90 in/lbs for that added security?

At some point the bar is tight enough to function and not slip. Is the torque value supplied by the stem manufacturer not enough, just enough, or too much in relation to what it takes to hold the bar securely without slipping? How do manufacturers arrive at their recommended torque values?

The torque values supplied by manufacturers are frequently based on the forces that *the bolt* can withstand. The bar is probably tight enough at some point prior to reaching the maximum torque specified. Does this mean that you should not tighten to the recommended torque value? The fact is you probably don't need that much force to secure the bar. Just make sure that you NEVER

Stem Bolt Torque Guidelines

Two-Bolt Stem* Torque (in/lbs)	Description
45	Adequate to safely secure most handlebars.
50 – 60	Torque that can readily be generated by hand with a screwdriver.
70	The *maximum* safe torque for lightweight handlebars.
80	Torque level that can permanently damage lightweight aluminum or composite bars.
50 – 110	Torque value that could be indicated as the maximum value by a stem manufacturer (based on the torque specs of the bolts used).

* Four-bolt stems exert twice the pressure on a handlebar as two-bolt stems at any given torque value.

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tighten beyond the recommended torque value.

This is an important issue because there are so many people who suffer from Chronic Compulsive Tightening Syndrome (CCTS). (You who suffer from this affliction know who you are.) The problem occurs when, with the best of intentions, they install a bar and torque the stem bolts to the recommended torque value, And then, prior to the week's epic ride feel the need to…you know, just snug them up a bit. It isn't long before the maximum torque specification has been left in the dust. The center of the bar is crushed and the bolts are just one big bump away from snapping.

Four-bolt stems are much easier to over-tighten than their two-bolt brethren. That's because when tightened to the same torque value, four bolts exert twice as much pressure on the bar as do two bolts. It is very easy to reach dangerous levels of torque by simply hand-tightening with an allen wrench.

Recently, at a major race in Europe, one of the larger stem manufacturers sent their engineers to the race to offer technical advice to the various team's mechanics. The engineers provided torque wrenches and set up each rider's bike with a stem and bar torqued to the correct specification. A week later, at the end of the race, the engineers returned and rechecked the torque on the bikes. They discovered that, on average, every stem bolt was nearly double the maximum torque allowed. When questioned, the mechanics acknowledged "snugging up" the bolts after each days stage.

The moral of this story is tight enough…*is tight enough*. Once you have reached the maximum torque value there is no need to constantly snug-up the bolts. If you feel the need to recheck the bolts, break out the torque wrench to ensure against over-tightening. Your bolts and bar depend on it.

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More twists and turns

The issue of over-tightening also applies to brake levers and bar ends. While none of us want to have our components slip during a ride, we often compensate by squeezing the life out of our bars and seatposts.

Clamp designs vary, but the best designs allow the brake lever, bar end or seatpost clamp to remain round as pressure is increased. In any event, there is no reason to tighten the brake lever to the point that, in a crash, the lever breaks rather than rotates around the bar. By not over tightening you get to reposition the lever rather than replace it with a new one.

The distinctive "snake bite" is evidence that a carbon component has been cracked by over-tightening a clamp (bar end, seat collar, brake lever).

Lightweight aluminum and carbon seatposts also suffer from over tightening. The most common symptom is what we call a snake bite — a vertical crack that is generated by over tightening the seat collar, forcing the frame to dig into the outer layers of the composite. This eventually leads to premature failure of the seatpost.

May the force be with you

With proper installation and care, modern, lightweight components are designed to last for many seasons. Mankind is their only natural enemy. When installing components, don't just rely on *feel* — rely on an accurate torque wrench (or a mechanic that possesses and uses one). Leave the breaker bar in your fanny pack. Take out your stress on the trail, not on your bolts.