SUPER STRONG?

Faster than a speeding bullet, more powerful than a locomotive, able to leap tall buildings in a single bound… sound familiar? Well, even super-heroes like composites need your help to perform at their best.

This month we will talk about the exceptional strength of composites—and its archenemies.

Many people use the term strength as an all-encompassing umbrella. They believe that if something is *stronger* it means it lasts longer, doesn't dent, doesn't bend and survives more abuse. But is that realistic?

What is strength?

Engineers look at strength in terms of a material's ability to withstand outside forces without permanently bending or breaking. There are different types of strengths, two of which are *yield* and *ultimate*. A material's yield strength is the amount of force needed to permanently deform the material. It is expressed in pounds per square inch. A strength of 30 ksi means that it takes 30,000 pounds of force on a square inch of material to deform or bend it.

Ultimate strength is a measurement of the amount of force it takes to actually tear apart the material. This is generally measured by a tensile test on a machine that pulls a sample of the material apart.

Before the material pulls apart, it will yield. So the ultimate strength will always be greater than the yield strength.

What happens between the yielding and the eventual breaking reveals other critical material properties like elongation, ductility, and toughness.

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Strength alone is not enough to justify the use of a particular material. For instance, glass has very high strength properties, but because glass lacks the ability to flex (i.e. low ductility), it would not be a good choice for bicycle components.

The fact is, there are many properties that should be considered in evaluating which material is best suited for a given application. However, be aware that there are always tradeoffs. That's why there is such a wide range of materials being used for bicycle components and frames: steel, aluminum, carbon composites, thermoplastics, titanium and magnesium.

Nobody's perfect

Steel was the metal of preference in cycling for many years, with good reason. It's strong and ductile but it's heavy. Aluminum is lighter, but needs larger diameter tubes for strength and stiffness which can deliver a harsher ride.

Carbon composites are incredibly strong, light and stiff, but they are low in ductility. This means they require extra care during installation.

Handle bar with care

Toughness and ductility are critical factors. We know composites are much higher in strength than aluminum. In a drop test, composite bars can withstand up to ten times more impact force than aluminum bars. So why are there warnings on composite bars about over tightening bolts on bar ends, stems and brake levers?

A tensile test machine designed to measure ultimate strength pulls apart a metal sample. A computer read out attached to a strain gauge displays load versus elongation. At the yield point of the material the curve flattens out.

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The challenge is low ductility. In other words, carbon does not stretch much before breaking. When clamping forces exceed recommended torque, carbon components can crack. Care must be taken when installing handlebars and when mounting brake levers and bar ends. Scoring caused by sharp edges and/or rotating clamps can cause permanent damage to the bar. Similarly, care must be taken when inserting composite seatposts. Any twisting motion against a sharp edge of the bicycle's seat tube can potentially score or scratch the post.

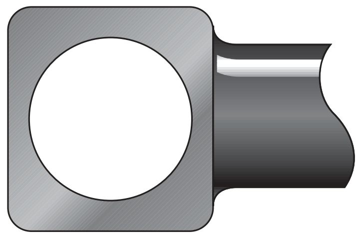
This is why it is especially important to read and follow the assembly instructions provided by the manufacturer for any bicycle product!

Composite-friendly components

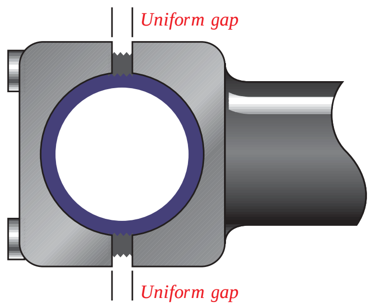
Not every component is manufactured with composites in mind. Composites do not tolerate sharp edges or burrs.

Make sure of the compatibility between your components. Be sure to inspect and remove any sharp edges that may potentially damage your composite handlebar or seatpost. Never try to force components together. If you're unsure, consult with your local independent bicycle dealer.

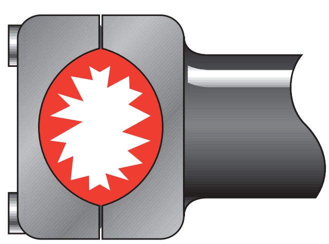
Handlebar Installation



Stem fabricators bore a hole into the stem that is the correct diameter for the intended handlebar. Ideally, there are no sharp edges or burrs where the handlebar contacts the stem. (Unfortunately, this is not an ideal world — you should carefully check your stem prior to bar installation.)



The stem bolts are intended to exert even, secure pressure on the handlebar allowing the bar to retain it's original circular shape. When properly tightened, there should be uniform gaps between the front plate and body of the stem.



The stem clamp can act as a vice and when over tightened can exert enough pressure to cause a composite bar to crack. If you hear a cracking noise, you'll know you've gone too far and it's time for a new handlebar. It is far better to use a torque wrench and avoid costly and dangerous errors.

Don't get too uptight

Most people install components on their bicycles by feel. While this often works, today's super-light, high-tech components need more consideration.

As you tighten an *aluminum* bar into a stem, at some point you are tight enough to do the job. However, without a torque wrench you quickly pass the point where the bar was *tight enough* and move into the plastic range. The bar begins to yield and deform under the pressure. Your hands sense this

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continued

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and back off. While the bar may be overly tight, you have only reached the yield point of the bar and its ability to perform is not compromised.

With *composites*, it's a different story. The composite bar *feels* much more solid. The composite's higher stiffness gives you a sense of confidence as you tighten the bar. You keep going until finally you feel *the give*. Unfortunately you just cracked your bar. The difference between the composite's *yield* and *ultimate* strength is virtually nil. This is why composites must be over-built in terms of strength in order to create a safe, performance-oriented product. Since composites have low ductility, they must be strong enough to handle any thing your riding can dish out.

The composite edge

Composites are higher in strength, higher in stiffness and lower in density than metals. This allows for some exciting possibilities for component design. The higher strength allows for thinner walls and/or less material. Lower density means that the same volume of material weighs less; higher stiffness and strength allow for smaller tube diameters. All of this allows for lighter weight and more compliancy in the final product.

Composites will outlast, out perform, and weigh less than any component made from metal assuming that the manufacturer's installation instructions are properly followed. In addition, the ride comfort and vibration damping characteristics of composite components are hard to beat.

Heavy-handed responsibility

In the vast majority of cases, when composites fail, the cause can be directly traced to a failure to follow manufacturer's recommended installation and usage instructions.

The only limitation composite components impose is the amount of heavy-handed abuse they can withstand. The exceptional strength of composites ensures dependability and enhanced performance on even the most challenging trails. Composites will even withstand the stress from crashing better than metal.

With proper installation and care, composite components are truly remarkable for their light weight and strength. They are the choice of cycling's elite throughout the world.

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BOLT TIGHTENING PATTERN

When installing the stem's face plate, it is important to tighten the bolts gradually and uniformly. With a four-bolt stem, this is best accomplished using a diagonal pattern starting with position 1 then proceeding to 2, 3, and 4 (shown below). This pattern should be repeated several times with increasing torque. Start with a pass using 20 in/lb of torque and work up in 10 in/lb increments until manufacturer's torque specifications are achieved.

With a two-bolt pattern, alternate between the two bolts, increasing torque as above. Ideally, pressure will be evenly distributed on all bolts when you are finished, and there will be a uniform gap between the face plate and the body of the stem.