



There are no good vibrations

STORY BY JAN HEINE

Reduce vibrations and increase comfort

→ TOURING cyclists have sought comfort since they began to roam the roads on their two-wheelers, but in recent years, racers also have realized the benefits of a comfortable bike. A comfortable bike does allow you more power, but there is more to it. Even for the same power output, a comfortable bike is faster. When bike and rider vibrate, energy is lost to friction. Most of this friction occurs within the rider's body; the discomfort of vibrations is caused by body tissues rubbing against each other. Friction converts energy into heat, and that energy is no longer available to propel the bike forward. Realizing this has had a profound impact on our understanding of bicycles, we now realize that inflating our tires super hard provides no benefit. What we gain due to reduced tire deformation, we lose due to added vibrations. This means that a more comfortable bike, as long as you keep all other things equal, is also a faster bike. Professional racers have begun to realize this so they now ride 25mm-wide tires instead of the 23s they used until recently and inflate them to 100 PSI instead of 130. We'll see where it all goes, but tests indicate that 32mm tires are just as fast as 25s.

When I write "comfort," I'm talking about eliminating vibrations from the road surface, not discomfort due to poor bike fit or simply riding longer



Testing comfort on the rumble strips of a highway. The smooth surface next to the rumble strips provides a reference for comparison. Comparing power outputs for different setups quantified the power losses due to vibrations.

distances than your body is trained for. Vibrations are the inevitable by-product of riding on real roads rather than on glass surfaces. The most beautiful roads with the least traffic often have the roughest surfaces because few cars use them and they are a low priority for repaving. A comfortable bike allows you to enjoy the best roads whereas an uncomfortable machine will tempt you to seek out the newest, smoothest roads,

even if they are full of traffic.

Vibrations reach the rider's body at the contact points with the bike: saddle, handlebars and, to a lesser extent, pedals. I always find it interesting to see where riders experience problems. Slower riders often complain about their saddles because they tend to ride in upright positions with most of the weight resting on their posterior. Faster riders have fewer saddle issues — they pedal harder so less weight is on the saddle. For them, problems with hands, wrists, and shoulders are common.

It can be tempting to try to mitigate the discomfort where it is felt — for example, by wearing padded gloves or using a gel saddle. This doesn't work very well because vibrations are best eliminated close to their source. The reason is something suspension engineers call "unsprung weight," which refers to the weight that moves up and down before it reaches the suspension. The more weight is moving up and down, the harder it is to dampen the vibrations. (Imagine trying to catch a pea rolling off a table versus a bowling ball.) The "sprung weight" — the weight on the other side of the suspension — actually provides inertia that resists the up-and-down motion of the vibrations. Higher sprung weight increases comfort — that's why a bike with loaded panniers is more comfortable than an unloaded one. Luxury sedans make great use of this physical concept. Their

heavy bodies (high sprung weight) are equipped with lightweight aluminum wheels and independent suspension (low unsprung weight). Their wheels react to road irregularities without disturbing the body.

For bicycles, this means that tires are the most important component for comfort. That's why we ride air-filled tires despite their propensity for punctures. If it weren't for unsprung weight, we could ride solid rubber tires and just deal with the vibrations with suspension in forks and seatposts.

When the tire hits the irregularities of the road surface and deforms around the bump rather than transmitting the upward motion to the rest of the bike, the unsprung mass is just a few grams — a piece of tire the size of one or two quarters. It's easy to flex that little bit of rubber and inner tube.

What about suspension forks? They are located "upstream" from the wheels. By the time the vibrations reach the suspension, the entire wheel is moving up and down so you are dealing with two to four pounds of unsprung weight. Even at a relatively slow 10 MPH, road vibrations occur with a frequency of about 200 Hz (200 vibrations per second). Imagine the amount of energy required to stop a two-pound wheel moving up and down 200 times a second. It would be huge. If a shock absorber could dampen such a high-frequency vibration, it would get very hot (shock absorbers dampen vibrations by converting them to heat.) That's why suspension forks aren't good at reducing "road buzz."

By the time the vibrations reach the handlebars or the saddle, half the bicycle is moving up and down. The unsprung weight is 10 pounds or more, and handlebar tape will do little to dampen vibrations.

Now that we've established that tires are your first line of defense as far as vibrations are concerned, let's look at how to make tires that absorb

vibrations better. The first approach is simple — reduce the inflation pressure. Of course you can only go so far until you get pinch flats or sidewalls deform so much that the tire self-destructs over time. That's why wider tires are more comfortable. You can ride them at lower pressures without negative

THE MOST BEAUTIFUL ROADS WITH THE LEAST TRAFFIC OFTEN HAVE THE ROUGHEST SURFACES BECAUSE THEY'RE A LOW PRIORITY FOR PAVING

effects. However, low tire pressure is of little use if the tire casing is so stiff that the tire cannot flex and absorb road irregularities. For optimal comfort, you want a supple casing. If your tire has a very thick tread, it also stiffens the tire. So you also want a relatively thin tread, especially on the shoulders of the tire where the tread doesn't wear, unless you constantly ride around corners.

A supple casing and thin tread make a tire more comfortable and also faster, but there's a catch: They are easier to puncture. We talked about flats in an earlier column (*Flat Tires and Tire Savers*, June 2013), so I'll just summarize that your best defense against flats is a wider tire that runs at a lower pressure. It will simply roll over debris that would puncture a narrower tire that is inflated to harder pressures. And a more comfortable bike will entice you to get off the shoulders of busy highways where debris accumulates. On scenic backroads, you ride in the main lane that is relatively clean so you will have fewer flats.

Unless you ride a fatbike with 100-mm-wide tires, big jolts will be too large for your tires to absorb. Fortunately, those jolts are relatively infrequent — think tree roots on bike trails, frost heaves on mountain roads, or the expansion joints between concrete road panels in cities. This is where added

suspension comes in handy. It's perfect for absorbing large, but infrequent, bumps. Suspension can simply take the form of flexible steel fork blades like those on many classic bikes. When raked with a bend toward the bottom of the fork (rather than straight like many modern forks), these fork blades

can flex significantly as the bike goes over bumps. Carbon forks must be stiff — they'd delaminate over time if they flexed significantly over bumps so they don't absorb bigger bumps well. On the rear, some builders have experimented with bent seatstays in the hopes of absorbing some of the bigger bumps. In the mountain bike world, suspension must deal with large bumps that come in quick succession. This requires dedicated suspension and separate dampers.

Padding on handlebar tape, gloves, and saddles can be useful to eliminate pressure points that could cause discomfort, but it does little to dampen vibrations. Understanding how these components work together allows you to optimize the comfort of your bike.

Reducing vibrations improves your bike's comfort and speed. Damping is most effective near the source of vibrations where the unsprung weight is lowest. Tires are most effective at reducing vibrations whereas suspension can absorb bigger, less frequent bumps. Focus on comfort when you set up your bike and your next tour (or ride) will be much more enjoyable. **AG**

Jan Heine is the editor of Bicycle Quarterly, a magazine about the culture, technology, and history of cycling. His company, Compass Bicycles, imports and sells tires. Most of all, he enjoys riding on the scenic backroads of the Cascades in his home state of Washington.