PSI RX

Tire pressure and load

by Jan Heine

With optimal tire pressure you get both the best performance and most comfort from your bicycle. What is the optimal tire pressure for your bike, both when riding empty and when touring with camping gear? Tire makers print either a maximum pressure or a recommended range on the sidewalls of their tires, but these generalized values provide little guidance about what is right for you and your bike.

The Function of Tires

We tolerate pneumatic tires and their inevitable punctures only because the alternative — solid tires — is even less appealing. Pneumatic tires use air to absorb road shocks. This not only makes them more comfortable, but also much faster. Have you ever used a handcart with solid tires? Then you know how hard it can be to push, compared to a bicycle with pneumatic tires. To understand how pneumatic tires work, we need to look at two different types of resistance.

GREG SIPLE

Suspension losses

A bike that vibrates and bounces from one bump to the next is lifted up time and again. Lifting the bike requires energy. Part of this energy is absorbed in the rider's body and, on a touring bike, by the luggage. The rest is returned as the bike rolls off the bump. When you accidentally ride into the rumble strips that separate many U.S. highways from the shoulder, you are not only very uncomfortable, but you also slow down immediately as energy is absorbed in your body. By smoothing out the bumps, pneumatic tires save energy.

Deformation losses

The downside of a soft and squishy tire is the deformation of the tire as the wheel rotates. Most of the energy necessary to bend the tire casing is returned as it springs back into shape at the rear of the contact patch, but some of it is lost to friction within the tire and is no longer available to drive the bicycle forward.

Optimal tire pressure

For the best performance and comfort, you need a tire that is neither too hard nor too soft. Instead of inflating your tires to the maximum pressure, run them at the optimal pressure, where they deflect enough to keep the bike from vibrating too much yet are not so soft that they slow down due to excessive deformation losses.

Tire drop

Tire drop measures how much the tire deflects under the load of rider and luggage (Figure 1). For example, if your tire is 30 mm tall without a load and 27 mm tall once you sit on the bike, your tire drop is 3 mm or 10 percent.

As part of *Bicycle Quarterly's* tire performance tests, we looked at the influence of tire pressure on the speed of a real rider on an average road surface. As expected, performance increased with higher tire pressures, but only up to the point that corresponded to about 15 percent tire drop. Higher pressures no longer brought meaningful performance improvements. Tubular tires even became slower at higher pressures. This means that if you want the optimal speed and comfort from your bike, you should try to obtain a tire drop of 15 percent. With more tire drop (lower pressure), you will be more comfortable but slower. With less tire drop (higher pressure), you will be less comfortable, but not significantly faster, because your bike bounces so much more. Perhaps not coincidentally, many tire manufacturers recommend a tire drop of 15 percent.

Tire Pressure

Measuring tire drop requires a relatively complex setup. Fortunately, Frank Berto has done the measurements for us (Figure 2). His chart shows the tire pressure that results in a tire drop of 15 percent. Obviously, tire drop depends both on the weight resting on the wheel and the air volume of the tire (which correlates to tire width). For the width, you can either use calipers or, as a rough estimate, the markings on the tire. For the weight, place a scale under the front wheel of your bike and a brick under the rear wheel so the bike is level. Sit on the bike, have a helper hold you upright, and read the scale. Then turn the bike around so that its rear wheel rests on the scale and repeat the measurement. Depending on how you load the bike, the weight distribution may be very unequal. You can use the values in Fig. 3 as starting points for your bike. For example, if you and your racing bike together weigh 200 pounds, your front tire probably carries about 80 pounds. (40%) and the rear tire carries about 120 pounds. (60%).

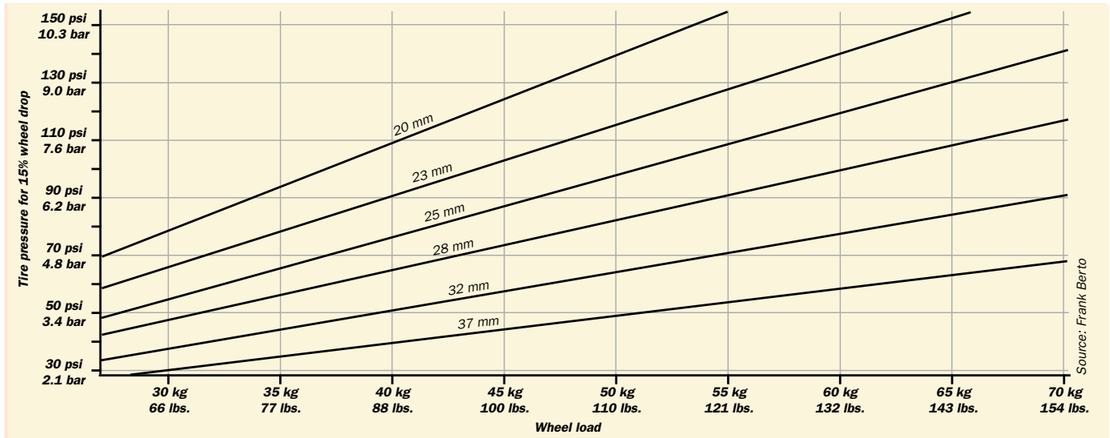

Figure 2. *Tire inflation for 15% tire drop, with various loads and tire widths. The loads are for each wehel not the entire bike.*

To find the ideal tire pressure, follow the line for your tire width until it intersects the weight on that wheel. Now you can read the tire pressure that results in 15 percent tire drop. Round it off to the nearest 5 pounds per square inch (psi). For example, if you use 23-mm tires in the example above, your front tire should be inflated to 80 psi and your rear tire to 125 psi.

Of course, you should not exceed the maximum pressure rating of your tires. If you find that the table suggests a pressure that your tires cannot support, you probably should use wider tires.

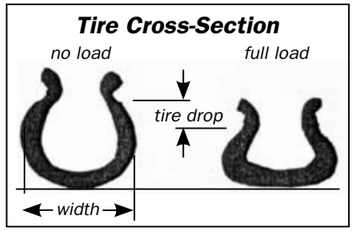

Figure 1.

Wider tires carry loads better

When you look at the slope of the lines in the chart, you will see that the lines for narrow tires are much steeper than those for wide tires. With wider tires, you don't have to increase the tire pressure by much as you load the bike. If you add a 40-pound load (20 pounds each on front and rear racks) to the bike in the above example with its 23-mm tires, your tire pressures should increase by 25 psi to 105 psi (front) and 150 psi (rear). However, if you use 37-mm tires, the tire pressures should increase only from 35 to 45 psi (front) and from 55 to 65 psi (rear).

Bike	Load (8 lbs.)	Weight distribution Front	Rear
Randonneur	front	45%	55%
Racing	-	40%	60%
City	rear	35%	65%

Weight distribution. *Weight distribution for three typical bicycles.*

Properly inflated, wider tires provide much more comfort. When you hit a bump and your tire drop increases from 15 to 18 percent, the 23-mm tire will give you only 0.69 mm suspension, whereas the 37-mm tire deflects 1.11 mm. The added suspension of the wider tire makes it faster and more comfortable on rough roads. This opens up many backroads to enjoyable bicycle touring.

Tire width and speed

But aren't narrower tires faster? Not really. The key to a fast tire is a supple thin casing that requires less energy to deform than a sturdier thicker casing. For a variety of reasons, many wide tires use heavy-duty casings, which are indeed slow. Wide tires with high-performance casings can be very fast. In *Bicycle Quarterly's* tests, the five fastest tires ranged in width from 24 to 37 mm. Many narrow "racing" tires did not make it into the top five.

A thin supple casing is faster because it absorbs less energy as it deforms. Thus, it will deform more for a given bump, making it more comfortable than a sturdier tire with a thicker casing (for the same tire width and pressure). The downside of a thin supple casing is reduced resistance to punctures.

When you plan your tour, it is useful to think about tire sizes and pressures. However, once you're on the road, don't obsess about tire pressures, as long as you have enough air in your tires to avoid pinch flats. Especially with wide tires, a few psi more or less make little difference, and you can focus on enjoying the ride. AC

Jan Heine is editor of Bicycle Quarterly, *a magazine about the culture, technology, and the history of cycling. More information can be found at www.bikequarterly .com.*