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Frame Flex

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I'd like to share my thoughts about frame flex with you, as I believe this is a widely misunderstood topic. I'll point out at the onset that this is not an engineering study and that I have no hard data to support my conclusions. Rather, these are thoughts and conclusions that I have come to after 15 years of being a professional builder and 25 years as a serious cyclist.

I'll start off by defining a few terms. As I see it there are 3 basic types of frame flex. They are:

- Vertical
- Lateral/torsional
- Bottom bracket/ drivetrain

We'll get deeper into these definitions in a moment. But first I think it's important to understand that these different types of frame flex are more or less related to each other. That is, given traditional construction techniques and materials, it is not likely that a frame would be very soft in one direction and very firm in another. For example, making a frame stiffer torsionally usually makes it somewhat stiffer vertically and in the bottom bracket area. So it is difficult to separate the three flexes. That said, a builder can consider the tubing material, diameter and butt lengths, as well as each tube's placement in the frame. Each of these factors will allow the builder to reach the best solution and make the most of a design.

Let's have a look at how the three types of flex influence what you feel out on the road.

Vertical Flex

A frame with the proper amount of vertical flex will have a very smooth ride. More importantly, it also offers better control and handling. A frame that is too stiff for its rider will tend to have its tires lose contact with the road surface. When the tire skips off the road the rider has no control of the direction or speed of the bike. Even though the tire might lose contact with the road for only a brief instant, it is significant in the handling of the bike. A rider feels this most often during high speed cornering or descending. You might feel as if you need to use the brakes to maintain control while others just carve through the turn… then you get to chase back onto the group.

In my opinion it's hard to design and build a bike that is too soft vertically. Long before that happens the excessive lateral and drivetrain flex will rule out the design.

Lateral/Torsional Flex

For the sake of simplicity I'll refer to this as torsional flex. Torsional flex is when the head tube and seat tube are twisted relative to each other, and thus are no longer in the same plane. All frames, regardless of material or quality have a good deal of torsional flex. Try this sometime – sit on your bike with it pointed straight at a mirror. With your butt on the saddle and your hands on the brake hoods, push your hands to the left and your butt to the right. Watch the frame twist. Fun, isn't it?

Is torsional flex good? No, not really, but it is nearly unavoidable. If a frame has too much torsional flex for the size and weight of the rider, then it will feel vague and unstable at most speeds. A builder could, if he wanted to, all but eliminate torsional flex from a frame. But because the three flexes are intimately linked, the bike would ride very poorly due to inadequate vertical and bottom bracket flex.

Bottom Bracket / Drivetrain

I believe that this is the most talked about and least understood of the three flexes. You often hear people say that the stiffer the better and that any bottom bracket flex results in a loss of energy. I firmly believe that to be untrue. Let's look at what causes bottom bracket flex and what it leads to.

When a rider pushes down on the pedal he also, for better or worse, pushes sideways. This is because the pedal is off to the side of the bike and is not in the bike's centerline. When the rider pushes down with the right foot the bottom bracket flexes to the left. The common belief is that the energy used to push the bottom bracket sideways is lost forever. I contend that it's not lost, but stored to be returned later. Our physics friends will remind us that energy cannot be created or destroyed. It can be converted to different forms such as heat

or light, or it can be stored. In this case the majority of the energy that goes into flexing the frame is stored in the frame itself.

When the bottom bracket is pushed to the side, it stays there until the force that was holding it there is released. So at the top of the pedal stroke the bottom bracket starts its sideways move and at the bottom of the stroke it returns to neutral. In returning to neutral it applies that returned energy to the drive train and then to the road. This flex and return smoothes out our power transmission to the ground, making acceleration smoother and optimizing traction.

So what happens if a frame is too soft or too stiff in the bottom bracket for a given rider?

If the bottom bracket is too soft, it will deflect so far that it doesn't have time to return back to its neutral position before the next pedal stroke on the other side. This will feel inefficient as well as unstable… not a rewarding experience.

If the bottom bracket is too stiff for the rider something very interesting happens. We've all ridden with someone whose rear tire makes lots of scuffing noise when they are out of the saddle. What does that noise come from? When the rider pushes down (and unavoidably sideways) and the frame can't flex and store the energy, something has to give. So the tire loses hold of the pavement, resulting in a sideways scrub. In this case energy from the pedal stroke is lost as the tire slides sideways on the road, neither propelling the bike forward, nor returning energy into the next pedal stroke. So it's easy to see why a frame that is too stiff would be slower.

So what are the ways the designer and builder can control and determine the amount of each flex a frame will have? This is done by choosing the proper tubes. The best tubing is available in a variety of diameters, wall thicknesses, and butt lengths. Let's take a look at these things separately.

Tube diameter has the largest effect on frame stiffness. The bigger the tube the harder it is to bend or twist it.

Wall thickness has a larger effect on bending that it does on twisting. Therefore changing wall thickness has less effect than changing diameter and is used to fine tune ride quality.

Butt length and placement is an area that few builders explore. Outside the one man shop, almost no one considers it. Each end of the tube has a butt, or a thicker section of tube. By carefully choosing how much of the tube to cut off each end to get the correct tube length, a builder can fine tune the ride and road feel.

Now, for the wrap-up.

What does all this mean to the rider? In my opinion it means a given rider needs a frame with the right combination of the three flexes. And because all riders are unique their bikes should be too. Take the time to really communicate with your builder and he'll take it all in and put together a dream bike. A bike with the proper amount of flex will help you ride faster, more comfortably, and will create that sweet feeling of a finely tuned machine.

You've been reading too long now… it's time for a ride.

Thanks for reading.