

## **Get the Most Out of Your Bike's Suspension**

**(Text reprinted from Motorcyclist, May 1993, author Will Higgs)**

My good friend John had a beautiful GSXR1100, the kind of bike that made me feel self-conscious riding anywhere near it. One day, when we were planning to work on our bikes together, John arrived grumbling about his suspension. He got off the bike and, through a series of frantic hand motions and strange sounds, attempted to explain what was going on.

"Have you ever adjusted your sag." I inquired. From the bewildered look on his face, he obviously hadn't. After a few quick measurements we figured out he needed more pre-load at the rear. We cranked down the collar three or four turns and he rode off more than slightly skeptical. About an hour later John called me up. "It's ten times better," he raved, "I'm still not sure what we did, but it sure worked".

His bike was always in pristine condition. He had carefully modified it, bolting on a Yoshimura Duplex exhaust system, Dynojet carb kit and larger rear wheel wearing the latest in radial technology. But despite all the time and money John had spent improving his bike, he had ignored simple adjustments that could have significantly improved his bike's performance at practically no cost.

John's story is all too common. It's not unusual to find someone who has spent countless hours and an untold fortune to improve a motorcycle without ever sorting out the bike's suspension. These riders don't fiddle with it because they don't understand it, or because they decide it won't make that much of a difference.

To many, there is little difference between the multitude of adjusters on modern sport bikes. If the suspension is soft and mushy, they just click it up or tighten it down without really knowing what they're adjusting, though they reckon they are at least doing something. Many riders don't realize that each adjuster has a specific purpose; it adjusts one particular suspension function. It's important to understand these adjustments and what effect each of them has.

A motorcycle suspension's primary job is to isolate the chassis from obstacles on the pavement. Quality suspension soaks up bumps and ripples, keeps the wheels in constant contact with the ground and makes the chassis feel settled and planted. The adjustments let you control exactly how the suspension reacts to forces that act upon the motorcycle.

The suspension itself can be broken into two parts: spring and damping. Put in simple terms, the spring affects how easily the suspension travels and the damping affects the speed at which it travels. - By tuning these variables anybody can create tailor-made handling manners.

## PRELOAD

The first and most important step in setting your suspension is dialing in the correct preload. Preload is the amount of tension applied to the spring when the suspension is fully extended. Preload sets ride height. Correct preload helps keep the chassis stable in most conditions. Most suspension systems are designed to work best when one-third of the travel is used up by the rider. This gives room for the suspension to load and unload.

Almost all shocks are designed to work best from a given point in the linkage; setting preload correctly puts your spring in that range. Sag is the amount the bike actually hangs (or sags) from the weight of the rider. It reveals whether the spring is properly set to operate under a particular rider's load.

To measure rear-end sag, measure the distance between the rear axle and a specific spot on the tail section without the rider on board. It is important that the suspension is completely extended. This usually means you must lift the rear of the bike because the weight of the bike itself creates some sag in the suspension.

After taking that measurement, take another using the same two reference points, only this time with the rider on the bike. For best results, the rider should put both feet on the pegs and both hands on the bars, so another person should be on hand to hold the bike upright. The difference between the two measurements is the amount of sag in the suspension travel. Usually the ideal amount of sag indifferent sizes of spacers until you find the perfect amount of added preload for you.

**Note:** - when measuring sag, there is a certain amount of stiction, or drag, evident in nearly every shock absorbing system - both front and back. To get a completely accurate measurement, have one of the friends that is helping you pull up on the bike as you are sitting on it and let it gently settle, then measure. Then have the friend compress the spring with you on it, and let gently rise. The difference is the amount of stiction. Take the average of the two measurements with the rider on the bike and this is "actual" sag)

After you've made the adjustments go out riding and try to evaluate any difference in feel. Don't be afraid to change it again, and try to note the differences. A harsher ride and poorer traction are usually indications of too much preload, though a little more preload up front might let the front wheel track bumps more accurately as you're accelerating out of a corner. There's a common misconception that adding preload combats excessive front-end dive, but actually, stiffer springs or extra oil fork oil are the cures for that problem.

If your front suspension has adjustments for preload, measure it also. Secure a zip-tie snugly on the stanchion (sliding) tube flush with the fork seal. Have the rider sit on the bike again. Once the rider dismounts, top out the suspension and measure the distance between the zip-tie and the fork seal. Again, it's very important to make sure the fork is completely topped out to ensure an accurate measurement. When the rider is off and the fork is extended, the zip-tie indicates how much travel has been used just to support the rider's weight. Front sag should be a little lighter than rear and should fall between 1.25 to 1.5 inches, the rear should be between 1 and 1.25 inches.

If there aren't preload adjustments available in your fork, it's not too difficult to create the right amount with simple materials. Most forks have spacers between the springs and the top of the fork tubes. Increasing or decreasing the length of the spacers affects the amount of preload in the fork tube. The longer the spacer, the greater the preload and vice versa. Many roadracers make their own spacers out of PVC tubing because it's light, easy to cut and fits nicely inside most fork tubes. Using PVC, you can cheaply manufacture several

**Quick notes:**

A few turns of the preload adjusters will reduce or increase preload by raising or lowering an adjustable spacer on top of the fork tube. Equally spaced grooves are machined along the tubes as reference points for preload adjustment. A threaded collar on the rear shock can be tightened to add preload or loosened to reduce it. Before you can do this, you must dislodge the locking ring. The ring often locks down tighter with suspension play. If a spanning tool won't budge it, try a few well-placed knocks with a screwdriver and rubber mallet.

To obtain rear-end sag, measure the distance from the rear axle to a fixed point straight above it on the frame. As with the front, it's important to make sure the suspension is COMPLETELY topped out. Then have the rider mount the bike and measure this distance again making sure you use the same two exact points.

**DAMPING**

With all the technological advances incorporated in today's motorcycles it's amazing that suspension is still built around that simple age-old spring. A spring works by absorbing, storing and then releasing energy, and a steel coil spring is perfect for suspension applications because it does this in a very fluid manner. Since the spring used for suspension duties is preloaded, it does not work in the fully extended or compressed portions of its range but somewhere in the middle.

The point from which a laden spring operates is its "sag point". - If the spring was the lone component of the suspension and the bike hit a bump, the spring would compress as quickly as its coils would allow. Unless the spring is wound progressively, its resistance grows linearly in relation to the amount it's compressed. The energy that compresses the spring is met with resistance from the spring, but if the compression force is released, that stored energy is released in the opposite direction. Unhampered, the release of this energy is quick and forceful, and if enough energy has been stored, it can throw the chassis back up past the spring's sag point. The weight of the bike (which now contains stored energy because it was pushed above the spring's sag point) then pushes the spring down again and this continues, slowly tapering off until all of the energy has been released. This means the bike bounces up and down until it settles. The end result can be witnessed in a '76 Coupe DeVille with worn out shocks. A bouncing chassis is not a stable chassis.

Damping dissipates some of the energy that the spring is absorbing. This energy converts to heat. Damping can be used to control how quickly the spring bounces (compresses) from a bump and how quickly it returns (rebounds) after that bump. - Not only can it hamper bouncing, but damping allows a rider to tune the suspension to handle an array of different conditions. - Most stock motorcycles are under damped to provide a gentler ride and broader range of use.

**Quick note:**

It is important not to have too much spring preload in suspension components. An oversprung shock overpowers the damping system and does not allow it to work at an optimum level.

## **REBOUND DAMPING**

Front rebound-damping adjustments are usually made through screw adjusters on top of the fork and through an adjuster found on the bottom of the rear shock.

If your suspension has only one damping adjustment, it's a safe bet that it's for rebound. Damping consists of low-speed and high-speed (speed of damper) adjustments. Generally, only low-speed components are adjustable with external adjustments; high-speed damping is changed by adding or subtracting washers inside the shock. Without damping there is no pressure other than the weight of the bike acting on the spring during extension.

This means substantial damping is needed to keep the suspension settled. There should be enough damping to keep the spring from rebounding past the sag point or snapping back too quickly after compression. You want a smooth return to the spring's sag point, but it must be quick so the suspension can set up for the next disruption.

If you are adjusting rebound damping, it's a good idea to get a feel for how different adjustments affect your suspension. Try turning the rebound all the way out then quickly compress and release the suspension several times. Then try it with the damping on its maximum setting. This gives you a good idea of how the damping works. The slower the suspension returns, the greater the damping resistance.

When you begin adjusting, start with rebound damping set in the middle of its range and work from there. An underdamped bike feels loose and imprecise. Without enough rebound damping resistance the bike tends to pogo. This is especially evident in transitions between quick turns as the bike rises excessively.

Too much rebound damping and the bike chatters over ripples. This tells you the suspension is packing down; in other words, the suspension cannot return to its sag point quickly enough between bumps. Each new bump the suspension encounters takes up more and more of the travel. Enough of these rapid-fire bumps cause the motorcycle to use up all of its travel. With no travel left, the chassis takes the brunt of the bumps.

## **COMPRESSION DAMPING**

Compression adjustments are usually found on the bottom of most forks and on the top of, or on a remote reservoir protruding from the top of the rear shock.

Much less compression damping is needed because the spring itself offers resistance to compression. Without compression damping a bike might bottom out quickly, leaving no travel for the next bump. Too much compression and the bike stops soaking up bumps and transmits them right through the chassis. Compression damping is set much lower than rebound because you want the suspension to absorb bumps as quickly as possible.

When dialing in compression damping, start on the conservative side. - Then feed a click at a time until the ride gets harsh. Once it gets harsh, back it out a couple of clicks and that should be about right. Too much compression damping creates a harsh ride because the suspension can't compress rapidly enough to absorb large bumps or jolts. Not enough compression damping and the bike wallows, especially in transitions.

Before you make any changes, learn exactly how your bike feels. This gives you a good base to work from. Then head out to your favorite stretch of deserted road with a notebook, heightened senses and quite a bit of free time. Work carefully, documenting each change and making only one change at a time. Try to distinguish how each change affects your bike's handling. If something doesn't feel quite right, try to pinpoint the problem. Ask yourself, "Why would the bike be doing that?"

If your rear suspension does not have adjustments for preload or damping, it may not be a bad idea to replace it with an aftermarket shock that does. If your front suspension does not come with adjustments, there are easy ways to modify it yourself with alternate fork-oil weights and springs. If you work on one section at a time, one adjustment at a time, you can systematically tune your suspension to suit your needs.