Teach Me Suspension (Part 5): Basic Suspension Damping

When having a conversation about motorcycle suspension, it is as the conversation moves to damping that the idea of suspension tuning being a dark art tends to creep in.

The main reason for this is because when an adjuster is turned, little happens, and the only way to determine what has happened is to get out there and ride.

With the likes of preload or geometry changes, you have solid figures and measurements to aim for. With damping you do not have these same references.

But fear not, the most valuable thing to have in the face of uncertainty is knowledge, and a little knowledge can go a long way to helping you feel more at ease with damping changes.

In this part we'll begin the damping conversation and break things down to make them easier to understand, as well as help you piece together what each type of damping does and what it represents.

What Suspension Damping Does

In many different applications in today's world, mechanical components are put in place to act as a counter force to 'dampen' the effect of certain movements and forces.

The job of the dampers in motorcycle suspension is to tame the oscillating effect of the spring as it stores and releases the energy it builds up as it compresses and extends.

Remember that a spring cannot efficiently dispose of energy and will experience a continuous extending and contracting effect after the initial compression.

It is the suspension dampers that tame this 'bouncing' effect.

Dampers have been implemented in many different ways over the years, and you don't have to look too far back to see things as simple as friction dampers that slow down the compression and rebound simply by using a friction component that presses against a plate to change how the spring behaves.

In today's technology, damping is achieved by using oil flowing through a range of different passages to control how the spring compresses and extends. Typically known as hydraulic dampers.

It is this far more frictionless method that means the end result of your damper tuning efforts are a lot more consistent than say, rubbing two pieces of material together.

This is why we took the friction measurements in Part 4, because we want as little friction as possible in the suspension so we know that when we feel a given change in the suspension, we are sure it was our tuning efforts that caused it, not a change in the materials inside.

In a real simple hydraulic damping arrangement, oil is forced through a hole of a given size. It is the size of the hole that determines a good portion how much resistance (damping) is experienced.

Have you ever seen one of those simple water guns that work by sucking up and pushing out water from the end nozzle?

Because the hole is small you feel a lot of resistance when trying to push the water out. If the hole was a lot bigger it would be much easier to push. The size of the hole is the first part of the damping equation.
What’s also important to note about these water guns is the harder you try to force the water out, the more resistance is felt as a results. Hydraulic suspension dampers have this exact same characteristic.

The speed of the compression is the second thing that determines how much resistance, or damping, is felt when the suspension is compressed.
Said another way, the velocity of the oil being forced through the hole.

The third part of the damping equation is the viscosity of the oil. The more viscous (thick) the oil is, the more resistance that will be felt as it is forced through the hole.

It's Still Not a Perfect Solution

While oil based hydraulic damping provides a lot more consistency for our tuning efforts, a simple fluid and hole arrangement isn't ideal.

To go back to our water gun example, imagine filling up the gun and then gently pushing on the plunger to force the water back out.

Now imagine trying twice as hard to push the water out. It may well come out about twice as fast.

However, as you continue to push harder and harder to get the water to come out faster, the resistance pushing back at you increases exponentially.

Eventually you get to the point where no matter how hard you push, the water simply will not come out any faster.

Now think of our simple oil and hole suspension damping arrangement. As the velocity of the fluid being pushed through the hole increases, so too does the resistance. Exponentially.

The faster the suspension tries to compress, the more resistance is felt pushing straight back which prevents it from compressing at the desired rate.

This nonlinear relationship between velocity and resistance is a nightmare for everyone from suspension manufacturer, right down to the rider, because it makes it very difficult to find a good setting that works through all conditions and situations.

For example, this simple fluid and hole arrangement would work fine in slower, more gentle suspension compression scenarios.

Even in the braking zone this setup works ok. The harder you get on the brakes the more the suspension wants to compress, but because the resistance against compression only gets higher the harder and faster you squeeze the brakes, this in turn does an excellent job of stopping major front end dive.

But, the issues arise when very fast compression is experienced.

For example, imagine trying to ride over this bad boy at speed!

The suspension would compress so fast that large amounts of resistance (damping) would build up and the suspension simply wouldn't be able to compress quick enough to soak up the bump. If you rode over it fast enough, the suspension could almost lock in place completely!

As a result a large portion of the energy would be transferred into the chassis and then into you, massively upsetting both you and the bike.

To combat this, manufacturers employ what's known as high and low speed damping. Basically meaning that depending on how quickly the suspension compresses or extends, a different level of damping will be called upon to deal with these different scenarios.

This is achieved by creating a hole for the oil to pass through that is variable depending on the velocity of the oil (how hard it's being pushing through).

As you can see in the simple diagram above, the oil passes through a cartridge before arriving at the main orifices (large holes left and right)

Before they make it all the way through the cartridge, the oil has to pass through an opening created by the shims (blue).

Depending on how hard the oil is forced through, these shims will open more to allow a greater opening for the oil to pass through.

The faster the suspension compresses, the harder the oil is forced through and the larger that opening becomes.

What this does is create a lot more linear relationship between damping and suspension velocity, making it A LOT easier to find one setting that works through the different stages of riding.

Hopefully now you have a better idea of the basics of damping and how it works.

In the next part we will continue on the damping theme and talk about the different types of suspension damping; rebound and compression.

We will also start to look at how we make adjustments to damping, and what effect those changes have.