Teach Me Suspension (Part 9): Rear End Squat

If there's one thing that seems to be repeated year on year with the development of production motorcycles, it's that they increasingly get more and more powerful.

Ultimately, these increases put more strain on the rear suspension through the application of power, which transfers weight to the rear. This means that squat and anti-squat are becoming more important factors to look at in the realm of suspension tuning.

Just like getting hard on the brakes going into a corner sends the vast majority of the weight to the front and compresses the front suspension, getting hard on the power sends weight to the rear and in turn tries to compress the rear suspension.

However, this *doesn't* necessarily mean the rear of the bike squats down, like many would have you believe.
At the rear of the bike there is actually something else going on that can be used to counter act this natural attempt for the rear of the bike to squat.

It's known as anti-squat, and what it refers to is the suspension extending force that is generated when getting hard on the power, as a result of the geometry of the swingarm, sprocket and chain.
The ideal scenario is that while getting hard on the power sends the weight to the back and tries to compress the rear, the anti-squat will offset that to prevent the rear from squatting down.

This would then create the ideal scenario of enough grip at the rear so that the bike can put the power down, while still having enough weight on the front for steering.

It's pretty common knowledge that the weight moves to the back when you apply the power, but how anti-squat counter acts that isn't as well known.

Let's take a look at just where this trait comes from and how we can use it to our advantage.

What Determines Anti-Squat

There are three components that come together to determine anti-squat which I touched on above (geometry of the swingarm, sprocket and chain), but to understand how each affect anti-squat, we need to go over a little bit of physics to discover why the rear suspension wants to extend under power.

For this, I need to once again state Newton's Third Law of Motion:

"For every action, there is an equal and opposite reaction."
When you apply power with the throttle, this turns the wheel and the sticky rubber in contact with the asphalt tries to push the pavement away.

And as per Newton's Third Law, the asphalt pushes right back on the tyre and the bike begins to move forward.

Now, being that on your bike (and pretty much all bikes) the swingarm slopes downward from the pivot point, as the tyre is forced forward the swingarm angle becomes even steeper and the suspension extends.

This can easily be proved by resting your front wheel up against a wall and then trying to apply some power. The rear wheel will move forward and your rear suspension will actually extend.

The other part of the equation comes from chain pull.

As you apply power and the front sprocket begins to pull on the top run of the chain, that pulling force wants to pull the rear wheel closer to the engine.

And once again due to the angle of the swingarm, this (coupled with the driving force at the contact patch) will also serve to extend the suspension.

The Hard Job for Tuners

You may think that this squat vs anti-squat stuff works out pretty nicely.

As more power is applied, more weight goes to the rear but more anti-squat comes into play, nicely cancelling each other out.

But it doesn’t always work like that.

If the relationship isn’t already nicely set, as the weight moves to the back and the suspension compresses, for example, this alters the swingarm angle and the direction of which the chain is pulling on the sprocket, ultimately changing the sum of how much anti-squat you have.

What this effectively means is that the more the rear compresses, the LESS anti-squat you are getting from the bike’s rear end geometry as a result, when what we really want is to have equalling amounts of squat and anti-squat to prevent too much compression.

There is a sweet spot in the suspension’s range where this does happen, giving the rider maximum rear end traction, but if you fall outside that sweet spot things can get difficult.

If you experience too much anti-squat and the suspension continues to extend, the suspension won’t be as compliant and traction will be reduced.

Too little and you once again have suspension that isn’t as compliant, but also reduces weight on the front, adversely affecting steering.

For experienced riders, they should be able to immediately feel too much either way as they physically feel the bike squatting or extending too much.

It becomes more obvious the more power your bike has.

Outside of these big movements, poor traction at corner exits will be a symptom predominantly associated with too much anti-squat, because there’s not enough weight on the rear.

At the other end of the scale (too little anti-squat) with less weight on the front it will feel very light and skittish over bumps and the bike won’t steer as well.

Also, depending on how early they get on the power, it can cause the rider to run wide at corner exits.

Like with many suspension settings, there often comes a point where compromises have to be made, and working to change squat is no exception.

Changing Squat Characteristics

There are a few things you can do to change how much anti-squat you have. Here's how to generate more anti-squat:

First you can increase chain angle by changing both the front and rear sprockets. A smaller front sprocket and a larger rear sprocket increase the angle of the top chain run to the swingarm, increasing anti-squat.

Likewise, increasing swingarm angle by increasing ride height or preload will have the same effect.

Lastly, you can raise the swingarm pivot so that it is closer to the chain run.

If you wish to decrease anti-squat, then you simply do the opposite of the above to increase the angle between the top chain run and the swingarm and/or increase the distance of the chain to the swingarm.

Potential Consequences From Squat Alterations

It's important to realise that when you start making changes like those listed above, that could begin to have an effect on other areas too.

For example, raising the ride height to combat squat will send more weight to the front and also affect trail, changing your handling characteristics.

As well as that, depending on how far you go with the gearing to alter squat, you could ultimately be hurting yourself at a given track.

If you do have to raise rear ride height, consider raising the front too as not to upset the settings you worked hard to find.

It's also worth noting that if you change the gearing but the ratio remains the same, this will have very little effect on anti-squat.

The new gearing may move the chain away from the swingarm, but the new angle of the top chain run relative to the swingarm will cancel out the effect.

Lastly, damping can be used to affect squat, meaning less anti-squat is needed.

More compression damping on the rear is going to prevent too much weight transferring to the rear, ultimately meaning you don’t need as much anti-squat to combat the squat.

Or if you’re finding too much anti-squat coming into play, taking a couple of clicks off compression damping could be the order of the day.

Like with any settings it’s important not to go wild and change everything, but rather pin point the exact issue you’re having and make small changes to anti-squat so that it least affects your overall setup.