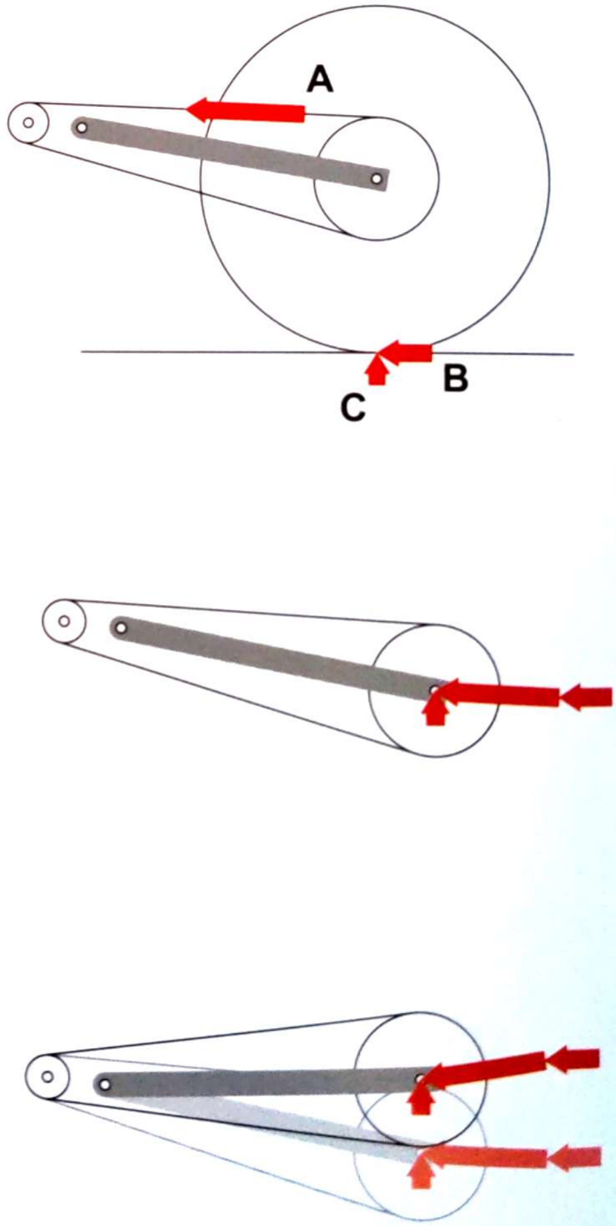
BELOW: The forces involved in rear-end geometry are the driving force (b), which pushes the rear wheel forward, and the chain pulling the wheel in the direction of the top chain run (a). These combine to extend the suspension, hopefully in a way that neatly offsets compression from weight transfer (c) under acceleration. (ANDREW TREVITT)

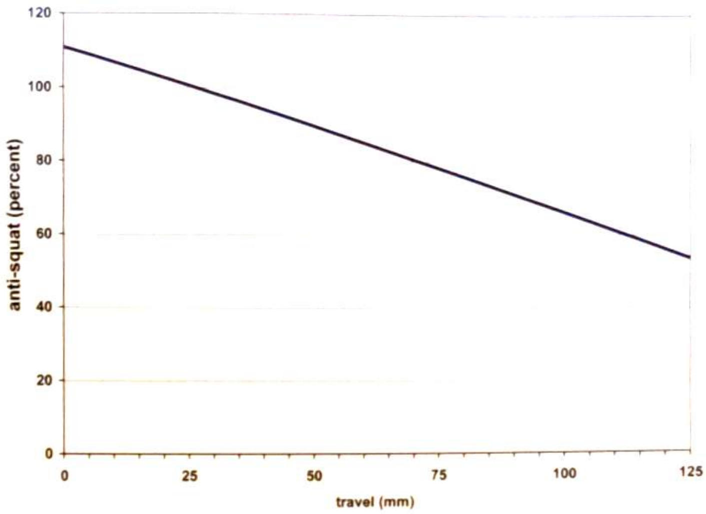


and carefully applying some throttle and gradually releasing the clutch—without making the rear tire spin, mind you. As you apply power to the rear tire, the rear of the bike will rise up, enough so that the suspension can completely top out.

The second force involved is the chain pull. The power of the bike's engine, fed through the chain and sprockets, pulls the rear wheel in the direction of the top chain run—toward the engine. Almost every chain-driven motorcycle has a small front sprocket and larger rear sprocket, and this creates a force that will try to extend the rear suspension. The two forces—driving force and chain pull—can be calculated and combined to find a total force that can be used to offset squat. Bikes with shaft drive have a different set of forces to deal with, which typically result in too much anti-squat. Manufacturers use various methods to decrease or nullify the effect, such as the BMW layout (shown on pages 4 and 5) that employs a parallelogram arrangement. The options for tuning anti-squat in these cases are severely restricted, but on a chain-drive bike the forces can be manipulated by changing sprockets. It all sounds simple enough—simply pick sprockets and swingarm angle so that the resultant forces all cancel each other out, right? Not so fast . . .

In some ways, the squat/anti-squat problem all

RIGHT: This graph shows typical anti-squat forces over the range of suspension travel. On the Y-axis, 100 percent anti-squat is the amount that exactly offsets weight transfer. At this point, the suspension will neither compress nor extend under acceleration due to weight transfer or the chain force, but rather it is free to move and absorb bumps, as it is intended. Because of the swingarm and chain layout, the amount of anti-squat decreases as the suspension is compressed—the opposite of what is desired. Note in this case (calculated from a Kawasaki ZX-6R's measurements and typical of most sportbikes) that 100 percent anti-squat occurs at 25mm of suspension travel, or approximately the measurement for rider sag. (ANDREW TREVITT)



works out nicely. As you feed more power to the rear wheel, there is more weight transfer, which results in more squat. However, more power is also being fed through the chain and to the rear wheel, and chain pull and driving force will increase proportionately. This means that under any amount of acceleration, the anti-squat characteristics are close to the same in relation to the squat characteristics. The problem, though, is that as your suspension compresses, the relationship between the swingarm and chain run changes. The swingarm angle flattens out and may even go negative. And because the front sprocket is in front of the swingarm pivot, the angle between the swingarm and chain also changes. This alters the direction of the forces involved, changing their sum and hence the amount of anti-squat. Not only that, but the traditional layout used on every sportbike causes the anti-squat force to *decrease* as the suspension compresses—exactly the opposite of what you want to counteract squat!

This is what drives tuners and riders, especially those dealing with powerful race bikes such as superbikes or 1000cc superstock machinery, to pull their hair out. The "sweet spot," where the forces all work out and squat is nicely offset with anti-squat, is found in only a small range of the suspension's travel. If the rear suspension is extended beyond that point, there is too much anti-squat, and the suspension will stay extended, not letting weight transfer to the rear tire for good traction. If the rear suspension is compressed too much, decreasing anti-squat will lead the suspension to compress even more, unloading the front end. And the relationships all change depending on how much traction is available at a certain track or in certain conditions.

Too much squat, or too much anti-squat, will manifest itself fairly clearly, especially on a bigger bike. Sometimes you will be able to literally feel the rear of the bike raise or lower as you dial on the power out of a turn, especially at the extreme of one or the other. Most likely, however, you will have to watch for other, more subtle symptoms. One sign of too much anti-squat—not enough weight transfer—is simply poor traction under power. When the rear tire starts to spin even moderately exiting a corner, the squat side of the equation loses its effect and the chain pull forces take over. The swingarm extends, stepping the rear wheel out and worsening an already-bad situation. In an extreme case, this will all happen so suddenly that the wheel can seem to snap sideways as the rear suspension extends suddenly.

At the other end of the spectrum, not enough anti-squat—too much weight transfer—is characterized by a flighty front end on rough corner exits as the fork tops out over the bumps. Even on smooth pavement,

OPPOSITE: Raising or lowering the swingarm pivot will increase or decrease the anti-squat forces respectively. This GSX-R1000 chassis has inserts at the swingarm mount that can be changed to move the pivot. (MARC COOK)

too much squat can cause understeer, giving your bike a tendency to run wide under power.

How can we change anti-squat characteristics? As a rule of thumb, the greater the angle between the top chain run and the swingarm and the closer the chain is to the swingarm, the more anti-squat you will have. To increase anti-squat for less weight transfer, you can:

- Increase swingarm angle by adding rear ride height or increasing rear preload
- Increase chain angle by making the front sprocket smaller or the rear sprocket bigger
- Raise the swingarm pivot, so that it is closer to the chain run

To decrease anti-squat for more weight transfer, you can:

- Decrease swingarm angle by lowering rear ride height or reducing rear preload
- Decrease chain angle by making the front sprocket bigger or the rear sprocket smaller
- Lower the swingarm pivot

Keep in mind two things when juggling these parameters to change anti-squat: First, small front sprockets can rob power by forcing the chain to curl too tightly and can also allow the chain to rub on the swingarm right at the pivot. This can completely nullify any setup changes, as the chain—should it run right on the swingarm—can pull the pivot down under acceleration. Always be sure that you've got some clearance on the top chain run. Second, changing gearing will have little effect on anti-squat if the actual ratio is not changed—for example, changing from a 15/45 setup to a 16/48 combination. Yes, the chain is further away from the pivot and this reduces anti-squat, but the new sprockets put the chain at more of an angle, increasing anti-squat almost exactly enough to offset the increased distance.

Notice that if you raise or lower the rear end to change anti-squat characteristics, you will also change the geometry of the front end, which may create a problem in other areas. One solution when raising or lowering the rear end to change the swingarm angle is to raise or lower the fork tubes in the triple clamps an equal amount, to keep the overall attitude of the bike the same. This will help retain the ideal front-end geometry you worked so hard to attain. Another is to use damping to control weight transfer and the squat characteristics, rather than making a geometry adjustment. More rear compression damping will decrease weight transfer under acceleration, while less compression will increase weight transfer and squat—again, this may have consequences elsewhere. Try to isolate the exact setup problem you are having, and make changes accordingly to least affect other aspects of your setup.