

Axle Ratio And 6-speeds

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Vinyl blow-up sex dolls/beaus are all the rage these days. The anonymity of ordering one online takes the shame out of the acquisition. They offer white ones, black ones, male, female, and she-male. Hell, there's even a vinyl blow-up cow that moos during the opportune moments—something for everyone. Compared to the flesh-and-bone-equivalent, there are many advantages of going vinyl. They are a cheap date, never get tired, good at keeping those naughty secrets, and don't complain when you come home late. On the flip side, they can't cook or hold a job, and they aren't very "streetable" as arm candy out in public. So to get one thing, you must give up another. Engineering, too, is riddled with its own give-and-take compromises. Such is the case with motorcycle gearing. Playing around with primary and secondary reduction ratios can yield performance gains but can also put more stress and strain on components in the drivetrain.

In my July column I defined a motorcycle's *axle ratio* as the product of multiplying the primary and secondary drive ratios. There are advantages of having a high numerical primary drive ratio. There are also advantages of having a low numerical primary drive ratio.

A popular and easy-to-install performance upgrade for Big Twins is to replace the stock 25-tooth compensating sprocket with a 21-tooth sprocket. This change increases the primary reduction from 1.44 to 1.71 (a 19% increase), which in turn, increases the *axle ratio* from 3.15 to 3.74 (also a 19% increase). In other words, torque multiplication increases by 19% to the clutch, transmission, and rear wheel. In this example, if your motor puts 100 ft.-lbs. of torque to the rear wheel, the change to a 21-tooth sprocket results in 119 ft.-lbs. of torque to the rear wheel. This is an easy and cheap way to increase performance; but there is a price to pay for this 19% increase in torque:

1) Cruising RPM on the highway will increase by the same 19%. So if the stock bike cruised at 3000 RPM at 75 MPH, it will cruise at 3570 with the 21-tooth sprocket at that same 75 MPH. This yields increased wear and tear on the engine with extended distance riding.

1a) Fuel economy will go in the crapper.

2) 19% more torque passing through the clutch will tax the clutch carrying capacity. The clutch carrying capacity would most likely not be an issue if the clutch is in reasonably good condition, but friction plate wear will be accelerated.

3) 19% more torque passing through the transmission



shortens the life of the transmission by that amount, but transmissions for American bikes are usually over designed so this isn't a huge deal (but could be if a poorly made overseas transmission is used).

4) The starter system is geared through the primary reduction. By going to a 21-tooth comp sprocket the mechanical advantage of the starter is decreased by 19% thereby making the starter work harder to get those heavy flywheels in motion.

Of the four resultant compromises listed above, the first one is probably the biggest deal. A 570 RPM increase on the highway is very noticeable. Engine wear and tear, fuel economy degradation, foot and hand buzzing, and monkey butt will all head in the wrong direction. For those reasons 6-speeds are popular these days because they reduce cruising RPM on the highway. A 6-speed transmission offers real help. Most 6-speeds offer a 6th gear ratio that is close to .86, so let's plug that into the example above. A 6th gear ratio of .86 reduces the cruising RPM by $1 - .86 = 0.14 = 14\%$. To look at it another way, it effectively reduces the axle ratio 14% and takes that 3.74 down to 3.22 (effectively).

The moral to the story is this: Some of the negative consequences of increasing the axle ratio (for performance gains) can be offset by utilizing a 6-speed overdrive transmission. It is a genuine no-tricks way to cheat the evil face of engineering compromise. Performance axle ratios used in conjunction with a 6-speed yields the best of both worlds. Think of it this way; it's like melding the advantages of a vinyl doll/beau with the advantages of your flesh and bone spouse. **IW**