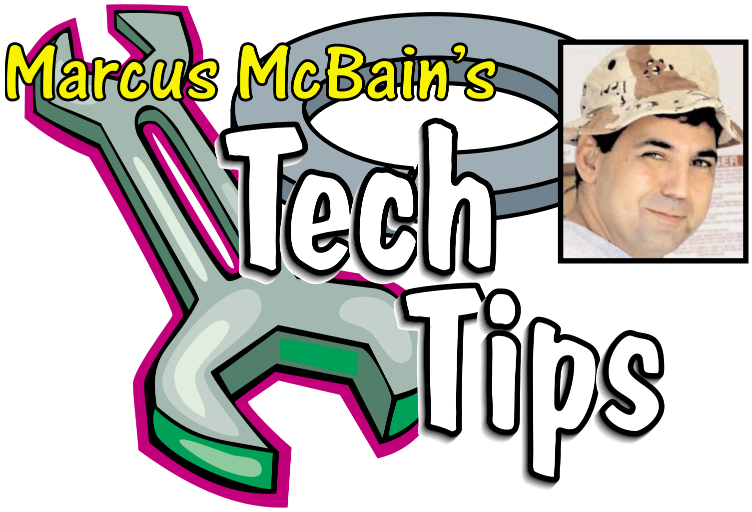
Marcus McBain's Tech Tips



The following article is part one of a three part series by Marcus McBain of Racing Performance Services which will cover the basics of bike set up for Road Racing.

SUSPENSION - Even the most inexperienced racers realize that dollar for dollar there is not a more effective manner to decrease lap times while improving the comfort and safety threshold while riding on the racetrack. Geometry, Spring Rates, and Compression & Rebound settings define your overall effectiveness of your suspension. In this article, we will discuss the basic components of suspension and define terms relative to the affect they have on your race bike.

GEOMETRY - Geometry is a greatly misunderstood term that is both overrated and underrated at the same time. Geometry of your motorcycle for racing purposes entails the following:

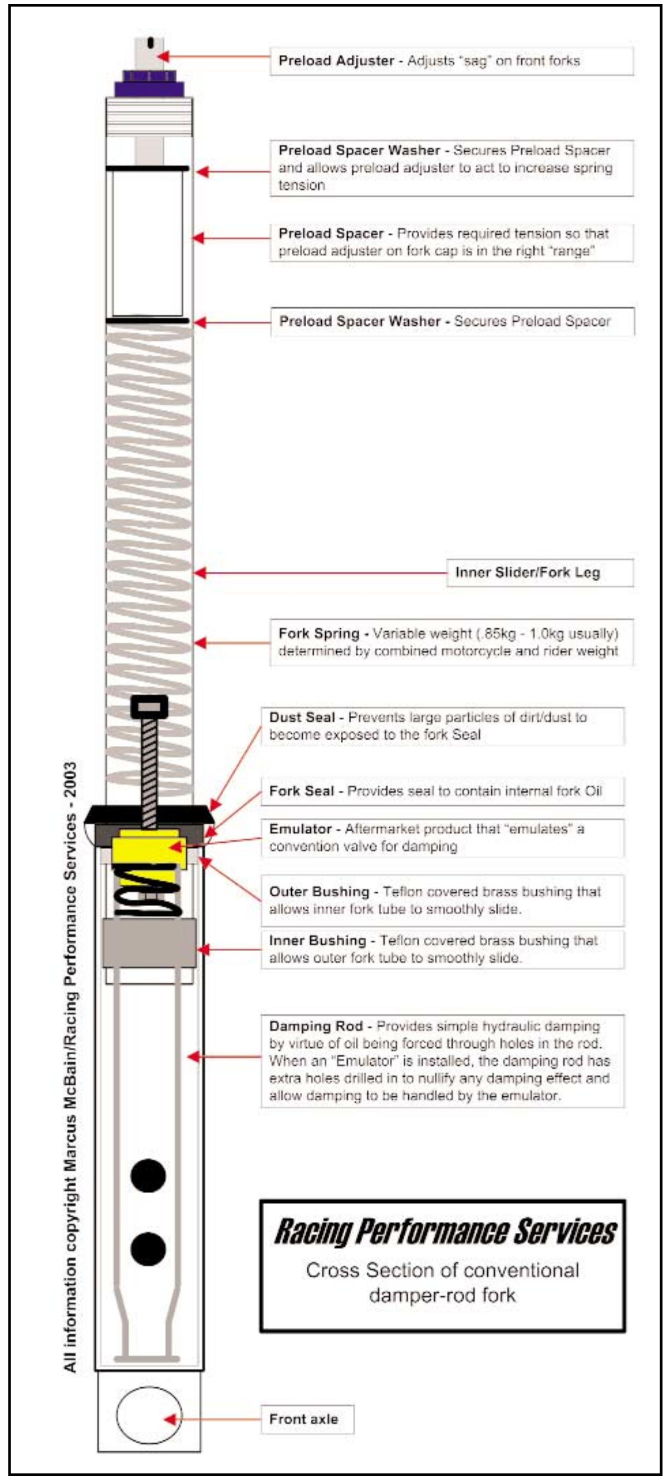
- Rake - This is measured in degrees. It is the angle at which your steering head is positioned. Since most forks are parallel to the steering head, Rake is measured off of the forks by most racers, BUT remember, it is should actually be measured off the steering head angle. It is good to know that when you change front ride height, you modify the rake (and trail) of your motorcycle.

- Trail - The value of this is measured by extending a straight line down from your axle as well as a line that would extend from the steering head (angle). The distance between where the two would meet on the ground is your trail.

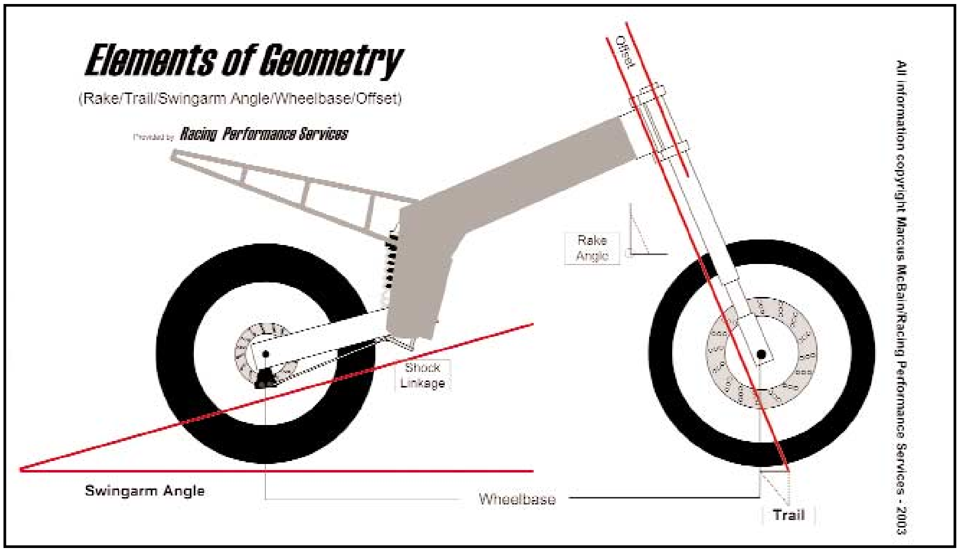
- Offset - This value is the measured distance between the steering head stem and the actual forks. All motorcycles have a degree of offset, but since the "offset" is designed at the factory, you as a rider are not aware of the amount or the need to change it. Factory superbikes and top-level privateer racebikes will have offset adjustability to independently decrease/increase the wheelbase or change the rake/trail without negatively affecting other attributes of your motorcycles geometry.

- Swingarm Angle - This is the measured angle of the swingarm relative to level ground. Swingarm angle is important from the perspective that your singwarm is a giant lever that pushes against the shock utilizing a linkage system. Swing arm angle is important, as different degrees of tune will provide more/less squat as the rider accelerates as well as the fact that overall performance is affected by changes.

- Wheelbase - The distance from the front axle to the rear axle. Tuners will evaluate chassis rigidity in combination with Rake/Trail to determine the most appropriate wheelbase.



PRELOAD/RACING SPRINGS/SAG - This is actually the simplest component of tuning and yet still severely abused. Before we begin, let's think about a couple of things. Your motorcycle forks cost approximately $500.00 - $800.00 a set. If you upgrade to a top of the line valve solution such as a Traxxion Dynamics kit, then your total investment in your forks is over $1000.00. The same can be said if you buy a top of the line triple adjustable shock such as a Penske. The cheapest component in both of these scenarios is the spring. That is right, that 100.00 set of springs are the cheapest individual component on your suspension. Quite honestly, when installed and used properly, it is a dumb mechanical device that offers little dynamic tuning. There are some exceptions to this rule, which we will discuss in a moment, but it is good to remember the best strategy



with springs is to "set them and forget them".

It is really important to understand the core function of your springs on your motorcycle. They are for all intents and purposes "suspenders" for your motorcycle. When selected properly, a spring is designed to hold the bike up and promote the racebike to move "up ad down" at optimal rate(s). Most racing springs for motorcycles today are "straight rate" springs. This is to say that if you have a .90kg spring, it will provide .90kg of resistance per mm initially and after the spring starts to compress. Many engineering types have theorized that because of this, a straight rate spring is not affected by preload. This is absolutely untrue. A straight rate spring is indeed linear in its forces, but there are two factors that affect this. The first factor is free sag (also called static sag).

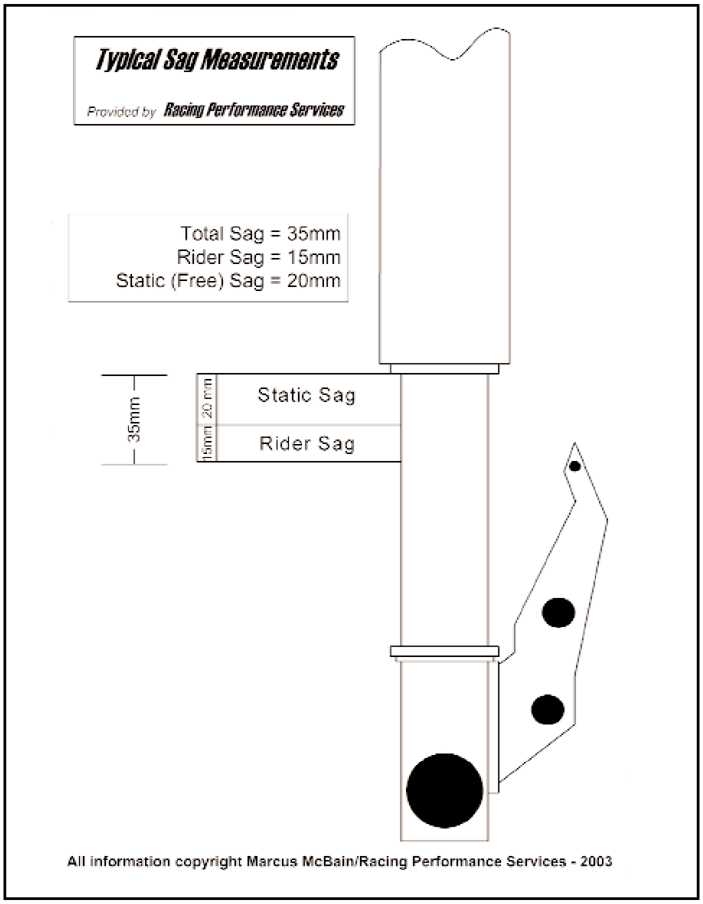
FREE SAG - This is the measured amount of travel your motorcycle uses under its own weight. To measure free sag, the tuner lifts up the motorcycle to "top it out" and measures the difference in the top out position and at rest. Free sag is provided in today's motorcycles primarily because today's racebikes have a chassis that offer very minimal flex. It was only a decade ago where tuners knew there would be considerable flex in the chassis and this provided a state of tune that kept the racebike from being "abrupt" handling in transitional states. Additionally, the updates in tires and suspension has allowed acceleration and braking at angles and in situations that if the suspension/chassis did not have a certain amount of travel to "soak up" chassis movement without disturbing the motorcycle dramatically, a crash would surely follow closely. Free sag is derived by "understanding how much is enough". Too much free sag causes a motorcycle to excessively move up and down, while too little free sag causes the racebike to feel "busy" and somewhat "nervous". The common question I am asked is, "If the spring is a constant rate spring, why don't you just put in a bunch of free sag?" The answer to this question is part physics and part common sense. If you take into account that you accelerate out of a turn, the bike tends to squat and take the weight bias off the front. Many racers then accelerate until the point of braking. Instantly, the front end is slammed down. Now, if you had put in a bunch of free sag (say 35mm), you just created a very extreme situation. As the weight is transferred from the rear to the front, it had to move 35mm before the front springs began to actively provide tension against the forks compressing. By putting 35mm of static sag in when maybe 20mm is the correct amount, the tuner just allowed the weight transfer to accelerate without resistance for an extra 15mm. The extra velocity of the front end coming down creates an extreme where more energy must me absorbed by the front forks. Most tuners use guidelines of 15mm-30mm of static sag for the front forks and 5mm-15mm of free sag for the rear/shock. The desired total sag (Free Sag + Rider Sag) is about 35mm-40mm. Remembering rider sag is the amount of travel used up when the rider sits on the racebike from bike subtracted from the racebike at rest, you can deduce that an idea rider sag is 20mm-30mm for the rear and 10mm-25mm on the front. Total sag is the amount of sag measured from the racebike totally topped out to where the bike rests with a rider on it.

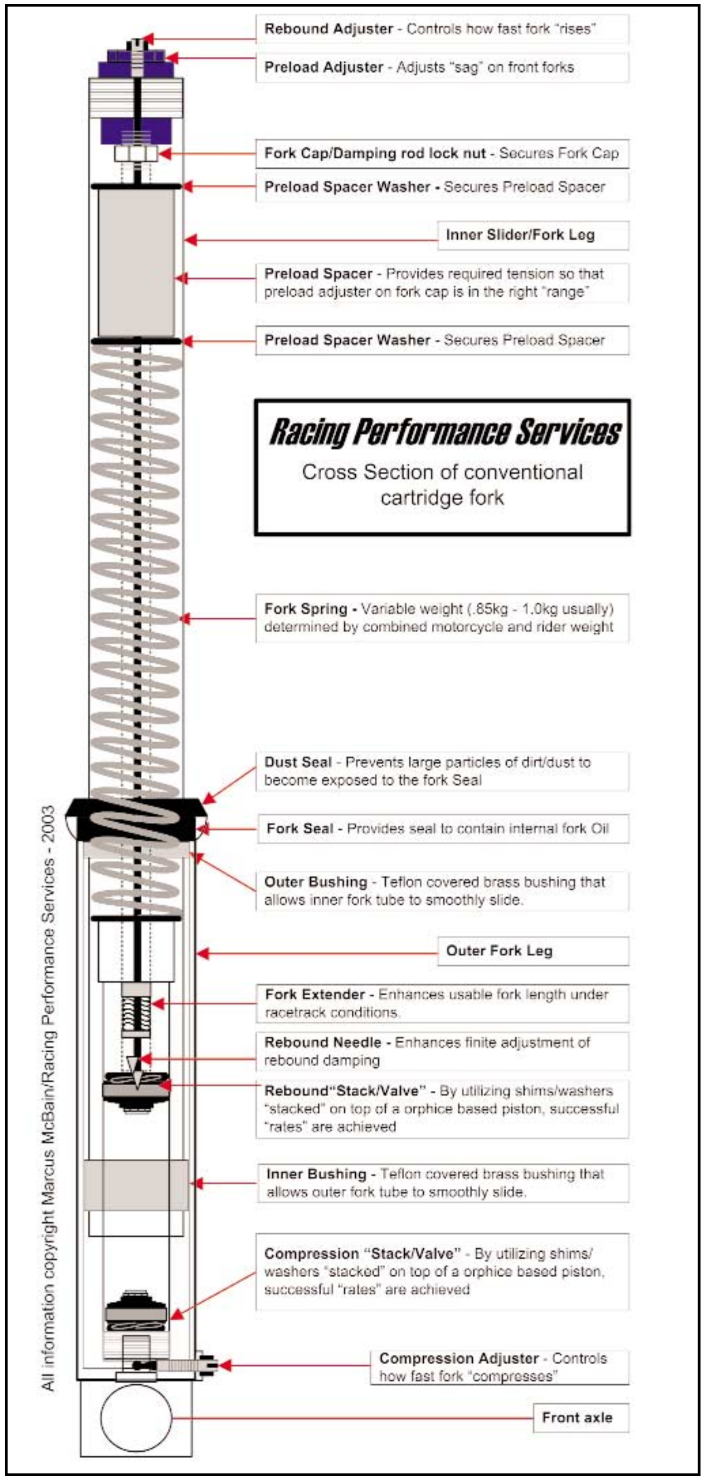
The second factor that affects spring performance that is not definitively measurable and that is the damping effect created when a fork compresses. The decrease in volume/area provides for a progressive affect relative to your forks. This is important and tuners will use fork oil level at times to enhance or negate this. Ultimately, it is up to your suspension builder to provide you with a fork that works appropriately and allows the rider to not be affected by this tendency.

PROGRESSIVE RATE SPRINGS. - OK, if straight rate springs were definitely the way to go because of the linear feel, why would anyone want to use progressive rate springs? Unfortunately, we still have damping-rod based forks. In a damping rod based fork, damping is provided by crude holes drilled into a rod that seals off the upper and lower fork leg. The problem with damping-rod based forks is that at some point the volume of oil that needs to move through the holes will exceed the available capacity and cause a spike in damping. The solution is to either create bigger holes or as all racers did in the 70's and 80's, get a progressive rate fork spring. The advantage of a progressive weight fork spring is that it can be softer on the first portion of travel (i.e. .90kg) and then as the spring compresses, it can then have more resistance and act like a stiffer spring (i.e. .95kg). This is made possible by variations in the spring wind/thickness and constitutes the make up of a progressive rate spring. With the introduction of emulators, riders of racebikes such as the SV650 and the 1992 and earlier Honda F2 can have more linear damping control that also provides for a more functional use of straight rate springs vs. the progressive rate springs that prevailed before emulators.

REBOUND/COMPRESSION DAMPING - The last ingredient in a great handling motorcycle is the adjustment and fine-tuning of the rebound and compression on the forks and shock. Setting rebound and compression an art more than a science. The critical understanding of how a motorcycle should move up and down is very important. Many times inadequacies in the suspension component build and quality can be remedied to some degree by adjusting/manipulating the compression and rebound settings. In the simplest explanation, compression and rebound settings control how fast the forks and shock move up and down. A quality tuner will provide a setup that is "balanced" and then fine tune to the rider's need(s). An initial setup will allow the front (forks) and rear (shock) to move up and down in unison. This is easier said than done. In a typical modern sport bike it is usually just a matter of modifying the compression and rebound adjusters until the desired results are achieved. On a motorcycle like a SV650, the lack of external compression/rebound adjustment will make the tuner utilize the preload to adjust compression and rebound characteristics. This is the extreme example of suspension being an art and not a science.

Cartridge forks have a rebound adjuster that is on top of the fork. This controls how fast the front end will rise when compressed. The adjuster on the bottom of the fork is the compression adjuster that controls how fast the front end will collapse. On a quality set of forks, you should only need to use the compression/rebound adjusters to remedy performance inadequacies. Using the spring to adjust performance on cartridge forks is a great disservice to the racebike owner. Typically, the tuner will set the rebound just stiff enough so that when the fork





comes up, it does not "bounce" when the fork comes up after being compressed. Once this is set, the tuner will then match the compression action with the rebound action. At this point, the tuner moves to the shock and repeats this strategy for setting shock rebound and compression. On the shock, the rebound adjuster is usually located on the bottom of the shock, while the compression adjuster is located on the top of the shock or on the remote reservoir. Sometimes the shock will have a "high-speed" compression adjuster. This is usually difficult for the privateer racer to setup as they do not have the skill or knowledge of what to do/observe relative to "high-speed" characteristics. There are a handful of tuners in the country that can decipher rider feedback into correct shock "high-speed" adjustment.

It is good to know that the adjusters on the forks and shock are simple needle valves that control how much oil can move through the low speed circuit. It is a very simple hydraulic design. When the rider hits a very abrupt bump at speed that causes the suspension to move very quickly, that is when the "high-speed" damping characteristics are noticed. Typically, when you are on the track and the bike is subtly moving up and down, this action is controlled by "low-speed" damping. When you hit that really ugly bump at speed, then again, that is handled by the "high-speed" damping in your fork and shock. In the forks, the high-speed damping is controlled by the quality of build your suspension tuner provides on the shim stack. In the shock, the same can be said except in the higher performance shocks that have a "high speed compression" adjuster then the high-speed damping is taken care of by a separate shim stack in the reservoir on at the top of the shock.

Closing thoughts - We have just run through the terms as well as corresponding action/performance associated with your motorcycle suspension components. It is not expected that this textbook discussion will allow anyone the independent ability to be a suspension expert by just reading this. Mostly, this article should provide a good basis for a foundation of understanding regarding your suspension. As a rider, it took me about 12 years to really understand all of the intricacies of suspension to the point that I could independently make intelligent decisions. If a rider has a good tuner, the rider will soak in a lot from doing things correctly and this will allow the rider to become proficient at a highly accelerated rate. The "fast expert" that knows about suspension and setup generally did not learn it on his own, rather they more than likely "soaked up" that knowledge from a now unknown tuner. I hope this article has helped you grasp all of the details that are involved in a top level suspension setup as well as allow you create a strategy to optimize your own racebike.

Sincerely,
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