Suspension Workshop 101

Suspension is one of the great mysteries of motorcycling for many riders but is likely one of the most important items on a bike to have set up correctly. This is a worksheet and course list of a 2-day motorcycle suspension care, maintenance and set up workshop I taught for several years. Even though I don't teach this workshop anymore I hope you are able to make good use of the notes and worksheets included in this document. Please visit www.BretTkacs.com often for new resources.

Suspension has two major jobs; first is to isolate the rider from the road, second is to keep the expand your abilities while exploring new limits, and know how to adjust and improve how it works. Learning advanced riding techniques will improve your suspensions ability to maintain traction more than any "upgrade" or adjustment. Often lack of riding technique will cause a bike to lose traction and fall down. When this happens riders frequently blame the tires, the road, or the suspension rather that the true cause... the rider!

THE MOST COMMON SUSPENSION ISSUE IS RELATED TO RIDING TECHNIQUE NOT SUSPENSION!

Common ways to "upgrade" suspension

-rebuild or maintenance existing suspension components
- buy a new bike with better suspension
-match the spring rate to the rider
-match the damping to the spring
-buy higher grade components
-decrease unsprung weight
- **improve riding skill**

Course Topics:

- Basic history of suspension
- Function and history of frame and swing arm design
- Spring function
- Hydraulic shock absorbers
- Open damper
- Cartridge system
- Damping levels
- Damping speed
- Optimizing telescopic forks
- Basic adjustments
- Suspension geometry
- Center of mass
- Chain effects
- Tire Technology
- Lowering suspension

Workshop Topics…		
Springs:	*Damping:*	*Other factors:*
1. Spring rate 2. Multi rate springs 3. Performance springs 4. Preload 5. Spring sag	6. Damping 7. Damper rods 8. Cartridge forks 9. DeCarbon Shocks 10. Knobs and Dials 11. Suspension fluids 12. Shim stack	13. Weight reduction 14. Sprung vs. Unsprung weight 15. Stiction 16. Slick stuff (friction coatings, seals, etc) 17. Suspension braces 18. Bearings 19. Maintenance

THE MOST COMMON SUSPENSION ISSUE IS RELATED TO RIDING TECHNIQUE NOT SUSPENSION SETTINGS !

Start with the basics:

- Confirm correct spring rates with fork and shock **sag** set around 1/3 of its total travel
- Properly **align the chain**. *If this is not correct the bike will corner improperly and sprocket wear will be increased.*
- Ensure the **tires/wheels are balanced***, if the wheels are out of balance, you may experience a vertical vibration and headshake.*
- **Set tire pressure** *(Use the tire manufactures recommendations not the Max sidewall pressure)*
- Check **steering head bearings** and torque specifications (*if too loose, there will be head shake at high speeds.)*
- *Inspect suspension components and **suspension linkage** for wear and condition*

Static Sag = L1 – [(L2 + L3) / 2]

L1= suspension free length

L2= rider, gear & bike, suspension raised and settled gently

L3= rider, gear & bike, suspension compressed and released gently

The answer is the static sag - *you want around 1/3rd of the total travel* (*25-35 mm for most street bikes*) , *if your preload adjustments are near max or minimum then you need a different spring rate*

Fork Adjustments *(common locations)*

Rebound adjustments are located near the top of the forks.

Compression adjustments are located near the bottom of the forks.

Spring preload adjustments are located at the top of the forks.

Shock Adjustment *(common locations)*

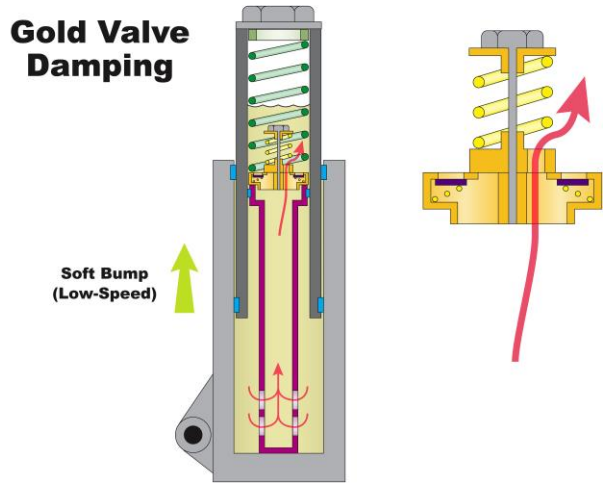
Rebound adjustment is commonly located at the bottom of the shock

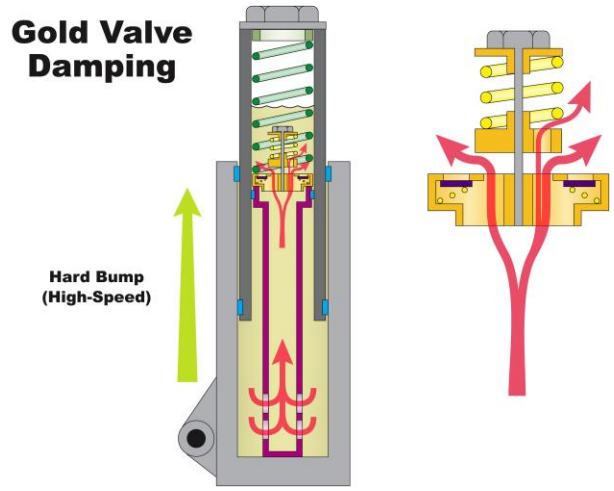
Compression adjustment is located near the top or on a remote reservoir

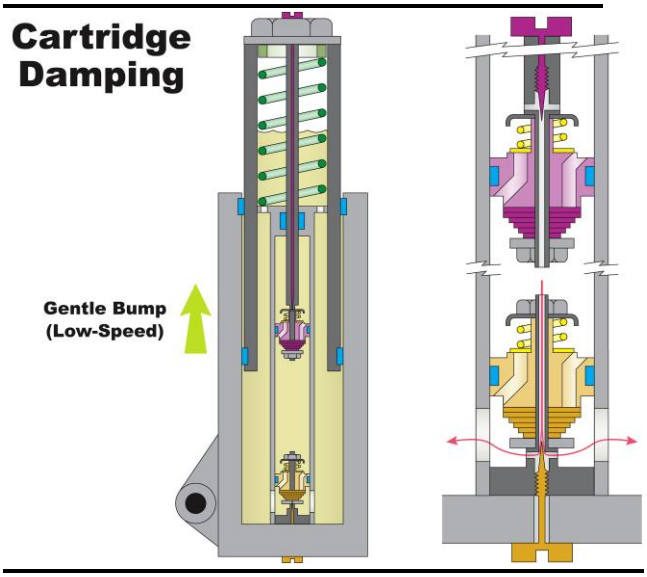
Spring preload is located on a ramp adjuster or double collar and thread at the top or bottom of the shock spring

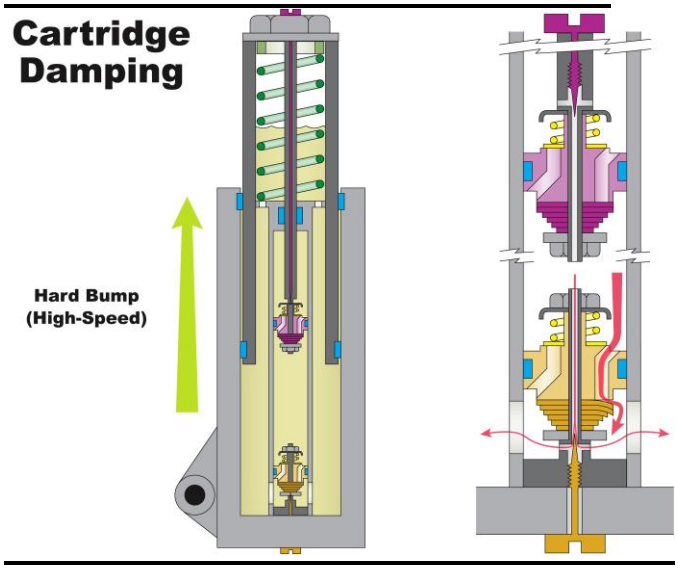
Initial set-up

1. Set Static sag 33% of total travel (average 25-35 mm) and check for free sag (front 5-10 mm, rear 1-5mm)
2. Check for excess stiction (Front <10 mm good, >20mm bad, rear should be near 0)
3. Set rebound and compression settings on forks and shock to manufacture recommendations or to the middle of their adjustment range
4. Tune fork rebound
    - *Front end should rebound and settle only a few mm, less for heavy rider, more for light riders (up to 15 mm)*
    - *For sport riding set as describe and then slowly tune out settling to 0mm*
5. Tune fork compression (this is difficult to do static and is best done during test rides)
    - *Softer = comfort*
    - *Harder = sport (Too much compression = headshake and reduced traction on bad roads or high speeds)*
6. Tune shock rebound
    - *Press down hard, bike should return to full ride height in less that 1 second with a visible delay at the end of its travel (too much rebound = BAD)*
7. Tune shock compression (difficult to tune static… take it for a test ride)
    - *Add more for sport riding or heavy loads*
    - *Less for Touring comfort, rough roads, or light weight riders.*









Images from the Total Control Advanced Riding Clinic 2007 – www.totalcontroltraining.net

This Tuning Guide Assumes Correct Spring Rates and Sag

Front Suspension Tuning (Forks)

Lack of Rebound

- Forks are plush, but increasing speed causes loss of control and traction
- The motorcycle wallows and tends to run wide exiting the turn causing fading traction and loss of control.
- When taking a corner at speed, you experience front-end chatter, loss of traction and control.
- Aggressive input at speed lesson control and chassis attitude suffers.
- Front end fails to recover after aggressive input over bumpy surfaces.

Too Much Rebound

- Front end feels harsh.
- Suspension packs causing the bike to skip over subsequent bumps and wants to tuck the front.
- Under hard acceleration, the front end may tank slap or shake violently due to lack of front wheel tire contact.

Lack of Compression

- Front-end dives severely, sometimes bottoming out over heavy bumps or during aggressive breaking.
- Front feels soft or vague similar to lack of rebound.
- When suspension is compressed a clunk is heard due to bottoming the fork travel.

Too Much Compression

- Front end rides high through the corners, causing the bike to steer wide. It should maintain the pre-determined sag, which will allow the steering geometry to remain constant.
- Front end chatters or shakes entering turns. This is due to incorrect oil height and/or too much low speed compression damping.
- Bumps and ripples are felt directly in the triple clamps and through the chassis. This causes the front wheel to bounce over bumps.
- Ride is generally hard, and gets even harder when braking or entering turns.

Rear Suspension Tuning

Lack of Rebound

- The ride will feel soft or vague and as speed increases, the rear end will want to wallow and/or weave over bumpy surfaces and traction suffers.
- Loss of traction will cause rear end to pogo or chatter due to shock returning too fast on exiting a corner.

Too Much Rebound

- Ride is harsh, suspension control is limited and traction is lost.
- Rear end will pack, forcing the bike to run wide in corners due to rear squat. It will slow steer because front end is riding high.
- When chopping throttle, rear end will tend to skip or hop on entries.

Lack of Compression

- The bike will not want to turn in or feels heavy.
- Suspension may bottom causing a loss of control and traction.
- Excessive rear end squat, when accelerating out of corners, the bike will tend to steer wide.

Too Much Compression

- Ride is harsh, but not as bad as too much rebound. As speed increases, so does harshness.
- There is very little rear end squat. This will cause loss of traction/sliding.
- Rear end will want to kick out when going over medium to large bumps.

Common Tuning Terms:

Damping - Damping is how suspension energy is controlled through the process of converting excess energy to heat. This is done by controlling the speed of oil through the suspension by using a series of holes or valves. Damping is speed sensitive not position sensitive.

Preload – This is the amount of load (compression) being applied to the spring in relation to its free-length (non-compressed state). A common misconception is that preload changes spring force… it does not.

Rake – Angle of neck at normal chassis attitude

Sag / Static Sag- is how far the bike compresses between fully extended and how far it compresses with the rider onboard.

Free Sag – This is the amount the bike settles under its own weight with no rider on board.

Stiction – Amount of friction resistance there is to start suspension parts moving. Static + Friction = Stiction

Suspension Travel – Total movement from top to bottom of forks / rear shock(s)

Trail/ Caster – Length made by a line from rake angle to vertical line measured from center of axle spacing in normal motorcycle attitude, this allows the self-righting effect of the front wheel.

My Bike

Full range of adjustments	Front	Rear
Total suspension travel		
Rebound adjustment range		
Low speed Compression adjustment range		
High speed compression adjustment range		
Ride Height adjustment range		

Initial settings	Front	Rear
Static sag		
Rebound adjustment		
Low speed Compression adjustment		
High speed compression adjustment		
Ride Height adjustment		

First adjusted settings	Front	Rear
Static sag		
Rebound adjustment		
Low speed Compression adjustment		
High speed compression adjustment		
Ride Height adjustment		

Final adjusted settings	Front	Rear
Static sag		
Rebound adjustment		
Low speed Compression adjustment		
High speed compression adjustment		
Ride Height adjustment		

Always make small adjustments, more is not always better.
Keep notes. Suspension tuning is an art, be patient.

Tuning NOTES: