CRITICAL DAMPING DEMYSTIFIED

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A Real World Example of Critical Damping

Introduction

The other day I was experimenting with the Evo's spring rates and setups. While I had the fronts off, I decided to dyno the fronts and do several PVP plots on the dyno to demonstrate the true force the damper creates at the various velocities. While I was at it, I decided to drive a basic test loop around our industrial park that consists of some rough concrete roads. There isn't a flat, smooth piece of concrete on the route and several sharp upheavals of concrete are always waiting around the corner. Welcome to Plano, Texas. This write up shows how an adjustable shock can achieve 0.5 to 1.2+ critical damping ratios with a turn of a rebound knob.

Critical Damping: Internet Folklore or True Science?

We always talk about what is optimal for your car based on several parameters. One common parameter used by more advanced consumers is critical damping. While we are in no way trying to debunk science, we thought about applying science to the real world. I'm a big fan of talking about what really happens when science meets the pavement. Science is great at explaining how we **begin** to achieve the results we want, but it is rarely as cut and dry as plugging in a formula, putting the results on the car, and feeling what the formula said we would feel. Sometimes you get lucky, but that's not usually the case.

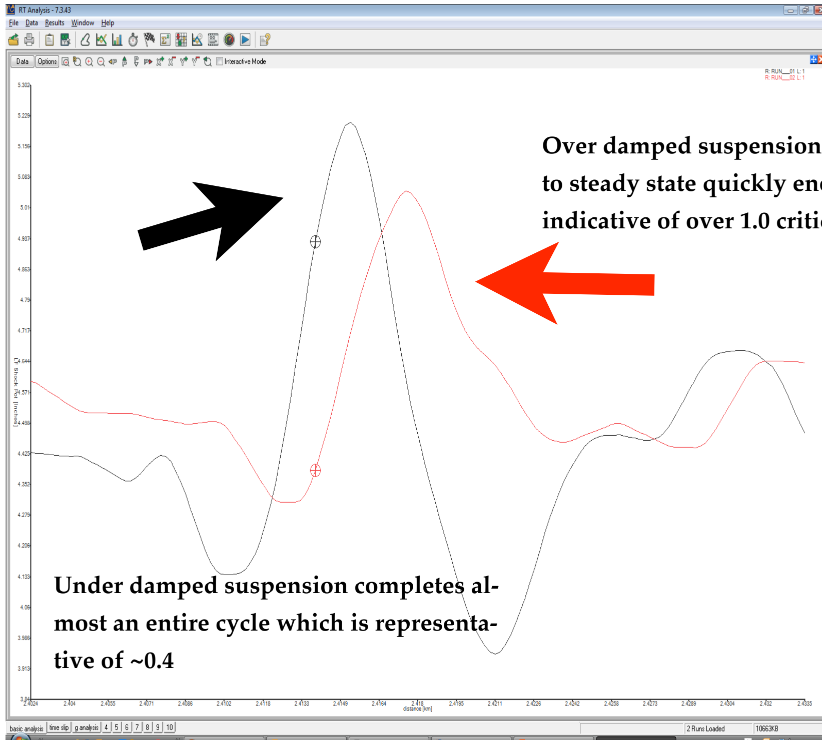
While our test is not necessarily representative of every real world scenario, take this as a quick example of how you can feel changes with your adjustable shocks and what is happening in your suspension. Again, we drove a quick loop where speeds reached 45 mph on rough concrete roads. We drove one lap with the front shocks on full soft (rebound) and one lap with the front shocks on full stiff (rebound). Speeds were consistent on each lap, tires and other settings remained unchanged. Compression adjustment was fixed and was not changed in order to simplify the test.

While we do not operate in the perfect world with perfect tools, we do have a "prosumer" Race Technology DL-1 capable of taking inputs from a shock potentiometer (aka shock pot). We began using the shock pot for testing on the Evo earlier this year and continue to use it as we develop new pistons, valving and other technologies. The Evo offers a great test bed since it uses AST 5200s in the front and AST 4200s in the rear we can therefore try many new upgrades on one vehicle, our very large test mule if you will. The DL-1 does a good job of keeping consistency, but we can not expect it to track distance close enough to lay each plot identically on top of each other. They are slightly displaced from each other. Also, the shock displacement varies within 0.06" from each other and it shows on the graph as well.

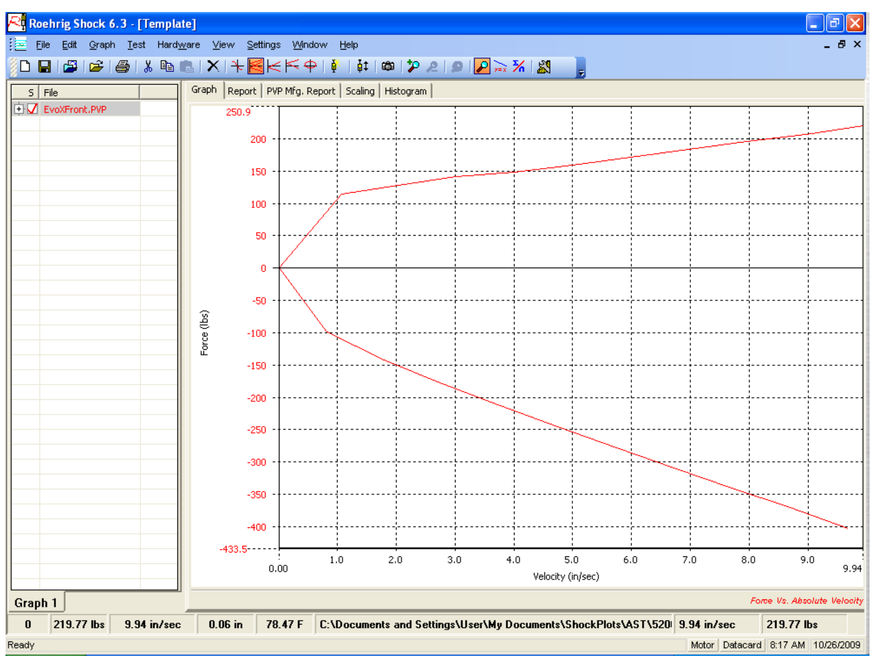
Again, seeing as we're not in a test lab, this test does not include removing interactions inherent to a street vehicle. Things like pitch resultant from the rear axle interacting with the same bump (or different bumps) or the effects of sway bars, etc are all assumed to be negligible for our example.

Test Results

The following is a bump the vehicle hit on the test loop. The black line is the damper at full soft. The red line shows the damper at full stiff. Positive vertical displacement is actually the shock compressing therefore moving upward is hitting the bump. Notice how the open rebound setting allows the suspension to complete an entire cycle then settle back to the resting state. The fully closed rebound setting (red line) not only keeps the suspension from making a full cycle, but it extends the cycle longer. This is representative of an "over damped" shock. As you can see, with this vehicle, tire, shock, and spring combination, we were able to go from under damped to over damped with 12 clicks of a knob. This represents a range of adjustment greater than required for most applications.



Obviously this is one bump with one certain scenario that can not fully describe the complete vehicle dynamics either on the street or track. Use this as one example where science and the real world meet and work together!



Dyno plot of the Evo's damper prior to the test. For reference only.