

# Tech Tip: Spring & Dampers, Episode Five

## The Damping Ratio Strikes Back

By Matt Giaraffa  
[matt.giaraffa@optimumpg.com](mailto:matt.giaraffa@optimumpg.com)

### Roll Damping

Often an overlooked aspect on racecars is the damping in roll. Most of the time, cars have a damper for each single-wheel spring, but not a damper for the anti-roll bars. The goal of this tech tip is to explain the benefits of using a roll damper. Where this setup is not allowed in the rules, the knowledge will help in understanding the setup and compromises in the lack of a roll damper.

As with ride and single wheel motion, roll can be seen as a mass oscillating on a damped spring. In this case, however, instead of linear motion derived from  $\mathbf{F} = m\mathbf{a}$  and the ride frequency, roll is rotation around an axis derived from  $\mathbf{T} = I\mathbf{a}$  (Torque = Moment of inertia \* Angular acceleration) and the natural roll frequency.. Applied to the roll of a racecar, “T” is the roll torque, “I” is the roll inertia of the sprung mass, and “α” is the roll acceleration.

Similar to ride and single wheel damping, you want to start off by choosing a damping ratio. The same compromise of response time and overshoot applies here- making 0.65 – 0.7 a good baseline damping ratio in roll for mechanical grip. Shown below in Figure 12 is developing a baseline roll damping plot for damping torque versus vehicle roll velocity.

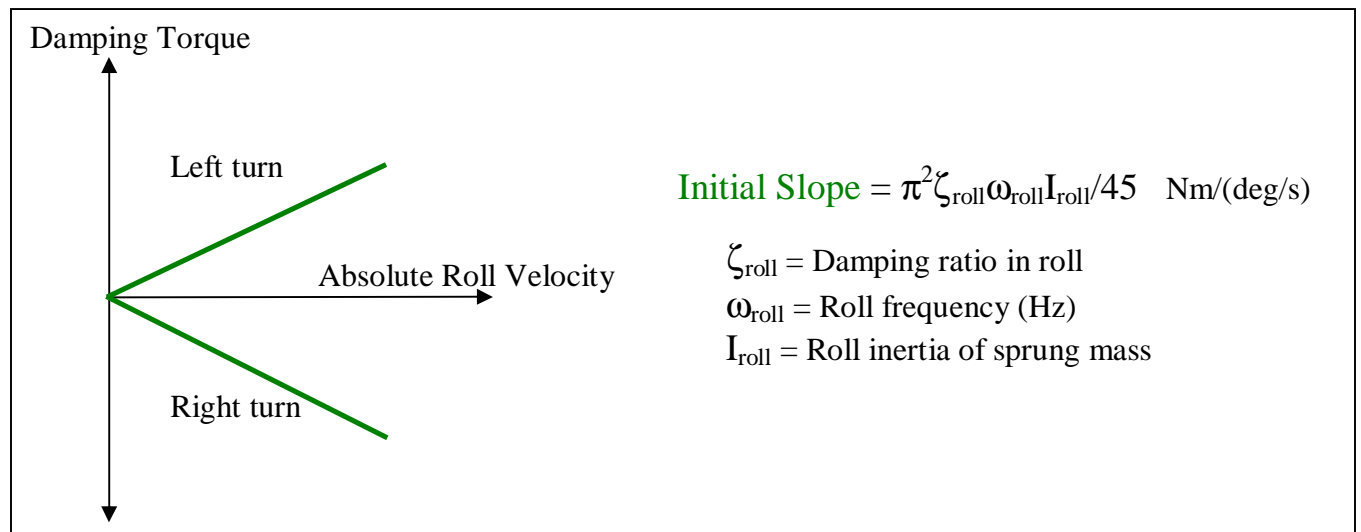


Figure 12. Initial Roll Damping Curve

Unlike ride and single wheel damping where you next modify the slopes to make rebound damping higher, roll damping should start off symmetrical. The only modification necessary is similar to high speed roll-off used for ride and single wheel damping. Since the car has higher frequency roll vibration happening as the body rolls at a much lower frequency into a corner, the lower damping ratio at higher roll velocity tends to even the load on the tires as the car rolls.

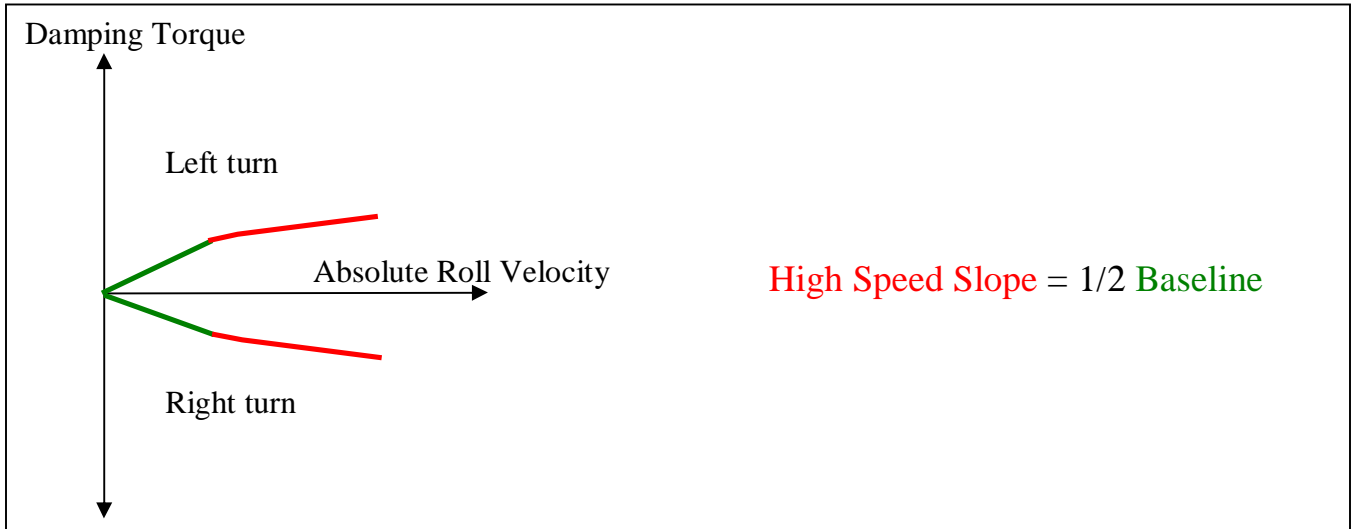


Figure 13. Modified roll damper curve

The damping curve calculated above is a good baseline for most cars- in some situations the roll damping can deviate significantly, such as Indy cars that run extremely high damping coefficients in roll for improved stability. However, for most racecars the above baseline is a good place to begin. Once you calculate the baseline for damping torque vs vehicle roll velocity, use the below equation to calculate the damper curve for the roll damper itself.

$$F_{\text{roll damper}} = F_{\text{wheel}} / MR^2$$

$F_{\text{roll damper}}$  = Damping force of roll damper (Nm)

$F_{\text{wheel}}$  = Roll damping force at the wheel from Figure 13. (Nm)

$MR$  = Motion ratio of roll damper- body roll/roll damper angular displacement

Most cars do not use a dedicated roll damper, necessitating a compromise in damping between ride and roll. However, for complete control of the car handling one roll damper is needed for the front and rear suspension, adding in the previously counted six dampers, brings the count so far to eight dampers on the car for complete control.

Next month for the final episode of the Spring & Damper tech tip series, damping in pitch will be explained.

As always, for more in-depth knowledge, OptimumG offers 3-Day seminars around the world, in-house seminars, a 12-Day Workshop, simulation, track support, and consulting services.