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Investigation into the characteristics of dampers and their effect on vehicle handling

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Introduction

This project investigates the handling of two different vehicles by implementing different high and low speed damping coefficients into the vehicles. The tests conducted for this project will be at the Silverstone International Circuit and the ISO Double Lane Change Manoeuvre.

The first test is done on the Sports 2000 Prototype Race car where a real-life data set has been recorded. The damping coefficients will then be matched from the real-life data onto the simulator. Then, the GP car will be tested on the simulator using the double-lane change manoeuvre.

Project Aims

- Validate the simulator accuracy by comparing real-life data with data obtained from the simulator.
- Compare different damping coefficients across a whole lap and their effect on cornering ability and lap times.
- Understand the effect of low speed damping on the vehicle's balance and handling using a BSI ISO test.

Methodology

The vehicle's characteristics were physically measured in the workshop along with un-sprung and sprung masses. Using the equation below clarified that the vehicle is critically damped and has a stiff suspension setup overall (Milliken, 1995).

$$\text{Ccrit} = 2\sqrt{Spring\ rate\ x\ Mass}$$

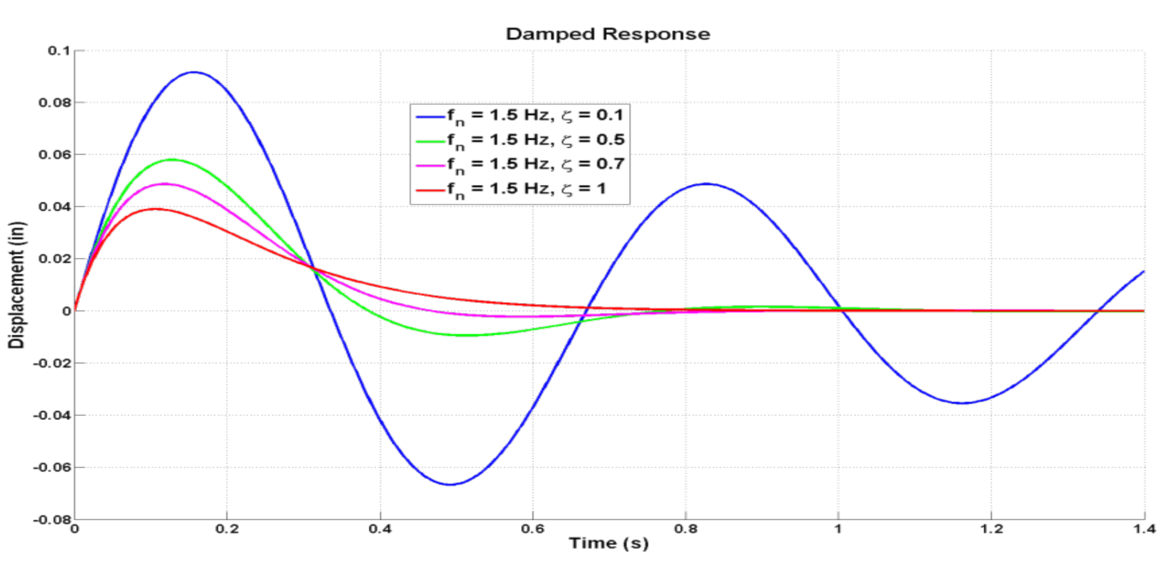

Figure 1 - Displacement vs Time graph where marked red is critically damped (Kasprzak, 2014)

$$T\ St\ Pct = A\ Angle\ x\ (\frac{-28.46}{0.0994})$$

The equations put into Motec as math channels to assess the behaviour of each damping coefficient;

$$Usteer = Abs(Steer\ Pct) - Abs(T\ St\ Pct)$$

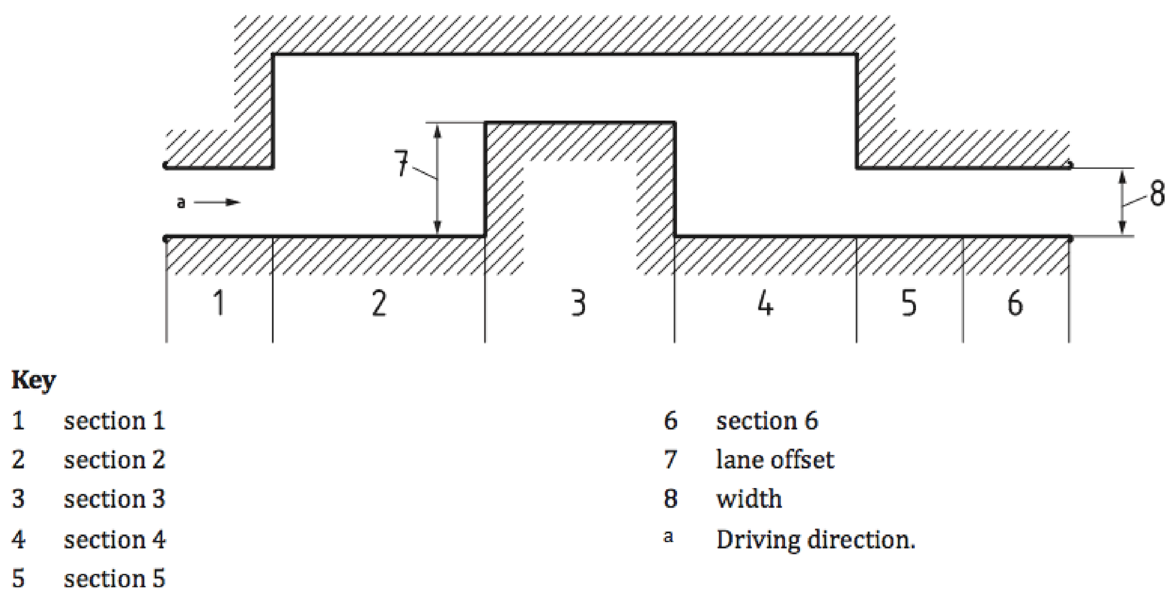

Figure 2 - BSI ISO 3888 standards for severe lane change manoeuvre vehicle test (BSI, 2011)

The double lane change manoeuvre was taken from the BSI ISO 3888 standards where it is used as a dynamic test for vehicle behaviour therefore, a good platform to test low speed damping coefficients (BSI, 2011).

Results

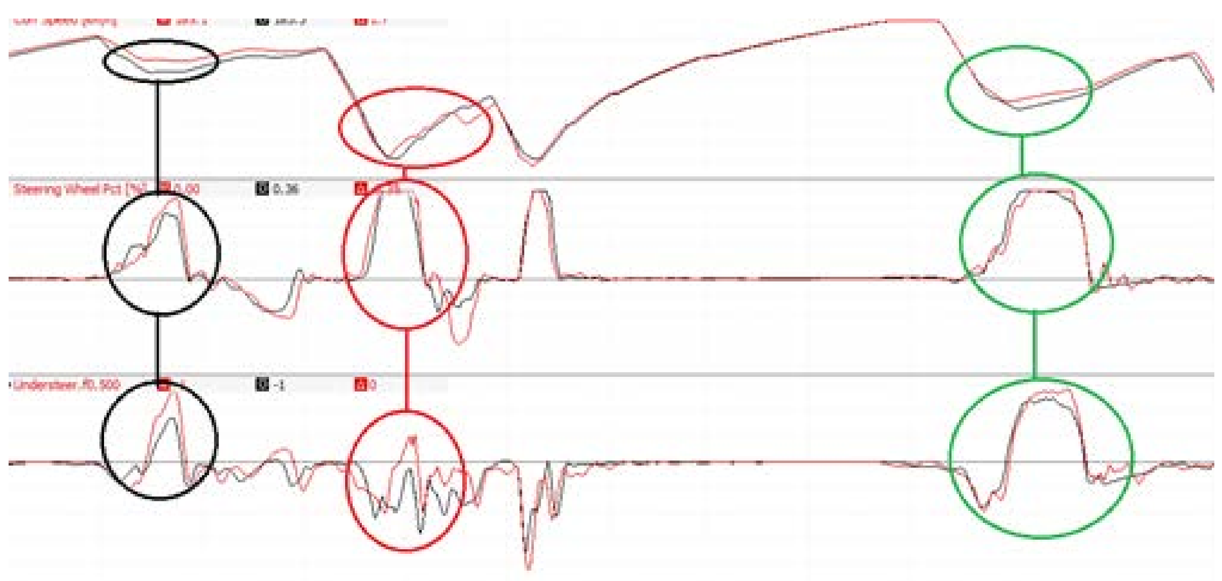

Figure 3 - Simulator test data with speed, understeer and steering percentage channels (Deion Atkinson, 2020)

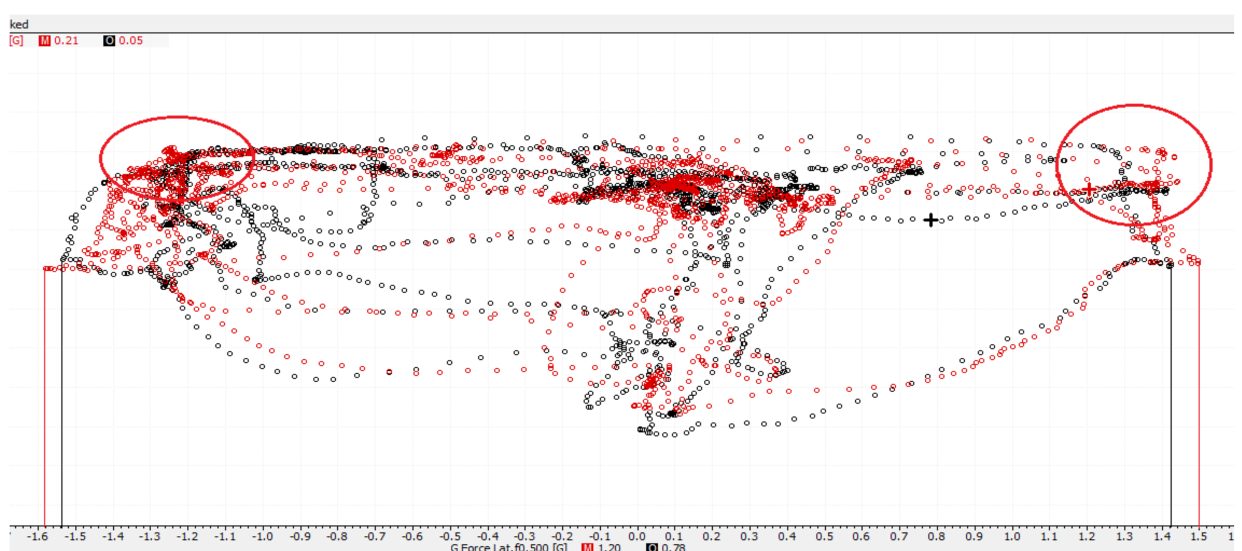

Figure 4 - Real-life data G-G scatter diagram (Deion Atkinson, 2020)

- Both real-life and simulator tests have the same outcome.
- Setup 2 has more understeer but is fastest, due to utilising more of the tyre grip available (Rouelle, 2019).

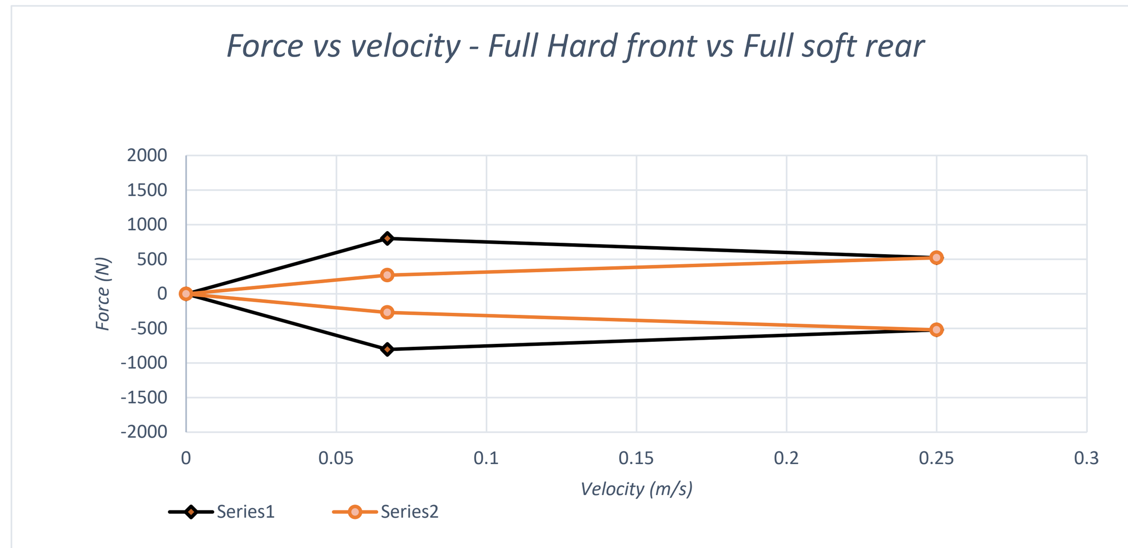

Figure 5 - Force v Velocity graph of a setup used in the double lane change manoeuvre (Deion Atkinson, 2020)

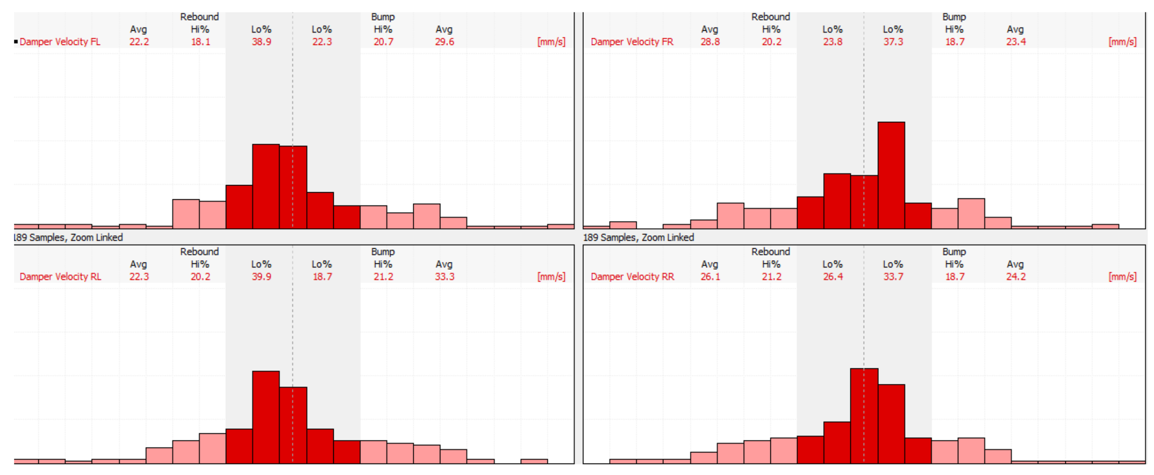

Figure 6 - Damper speed histograms from the double lane change manoeuvre (Deion Atkinson, 2020)

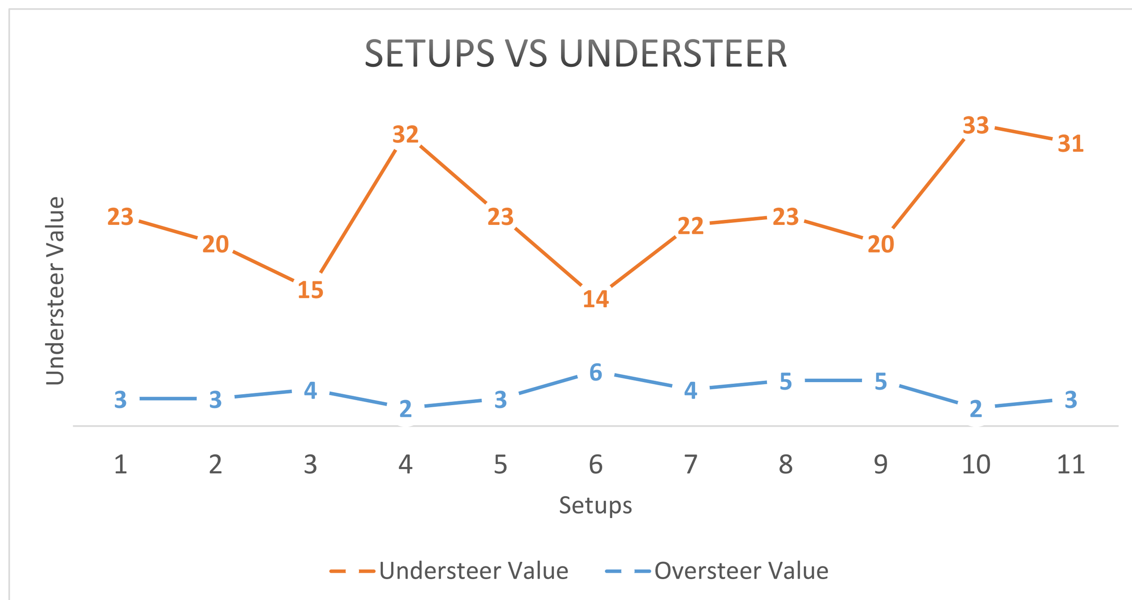

Figure 7 - Understeer vs Oversteer for each setup in the double lane change manoeuvre (Deion Atkinson, 2020)

Conclusions

The simulator is very accurate with results as both data sets have the same outcome. When the front coefficients are raised the lap time decreases by 2 seconds. When the front of the car is stiffer it experiences higher G force values and slightly more understeer but is capable of carrying a lot more speed through the corners. This is evident in both data sets. In the lane change manoeuvre, as the understeer decreases the oversteer increases. This concludes that when the coefficient is raised at the front, the understeer value is higher and vice versa.

References

Rouelle, C., 2019. *Race Car Engineering and Data Analysis on Motec,* Denver: Optimum G

BSI, 2011. *Passenger cars - Test track for a severe lane change manoeuvre,* London: BSI Standards.

Milliken, W. F., 1995. *Race car vehicle dynamics.* 1 ed. Warrendale: SAE International.

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