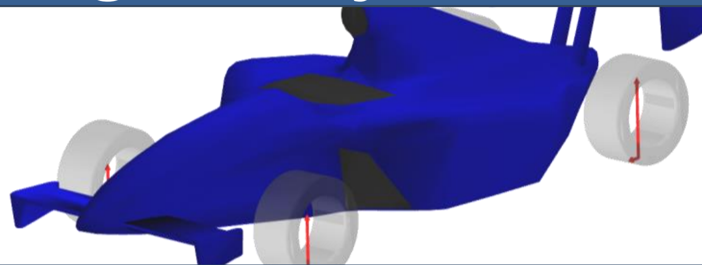
OptimumDynamics - Case Study

Investigating Aerodynamic Distribution



Goals

- Investigate the effect of springs on aerodynamic distribution
- Select bump stop gap

Software

- OptimumDynamics

Benefits

- Ride height sensitive aero map

This case study focuses on utilizing the aero map feature of OptimumDynamics. In this study we demonstrate two different implementations of this feature. We first look at the effect of changing springs on aerodynamic distribution. We then proceed to study the relationship between bump stop gap and vehicle speed.

The case study is broken down into the following two sections:

Section	Description
1	Effect of spring settings on aerodynamic distribution
2	Selecting bump stop gap

Effect of spring settings on aerodynamic distribution

The goal of this study is to investigate the effect of spring stiffness on ride height and aerodynamic distribution. To achieve this we compare three different front spring settings.

The vehicle under consideration is a GT racecar with a top speed of 300km/h. A simple straight line simulation from 50-300km/h is used to isolate the effects of spring changes.

The goal of the study is to investigate the effect of spring stiffness on ride height and aerodynamic balance.

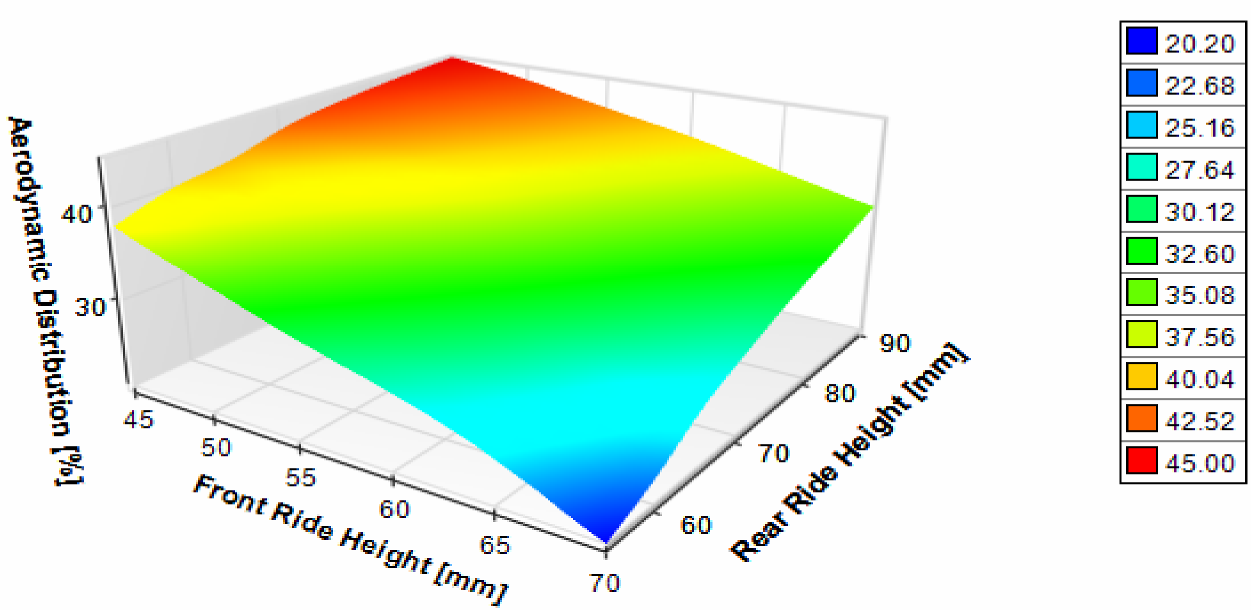
Spring Choices	Stiffness
Soft	Baseline
Medium	+10%
Hard	+20%

Create a database of springs and use OptimumDynamics to analyze the effect of each.

SPRINGS – We create a database of springs and use OptimumDynamics to analyze the effects of each. The table above shows the spring choices and their stiffness.

WHY – We have purposely selected these springs to influence the operating range of the vehicle in the defined aerodynamic map.

AEROMAP

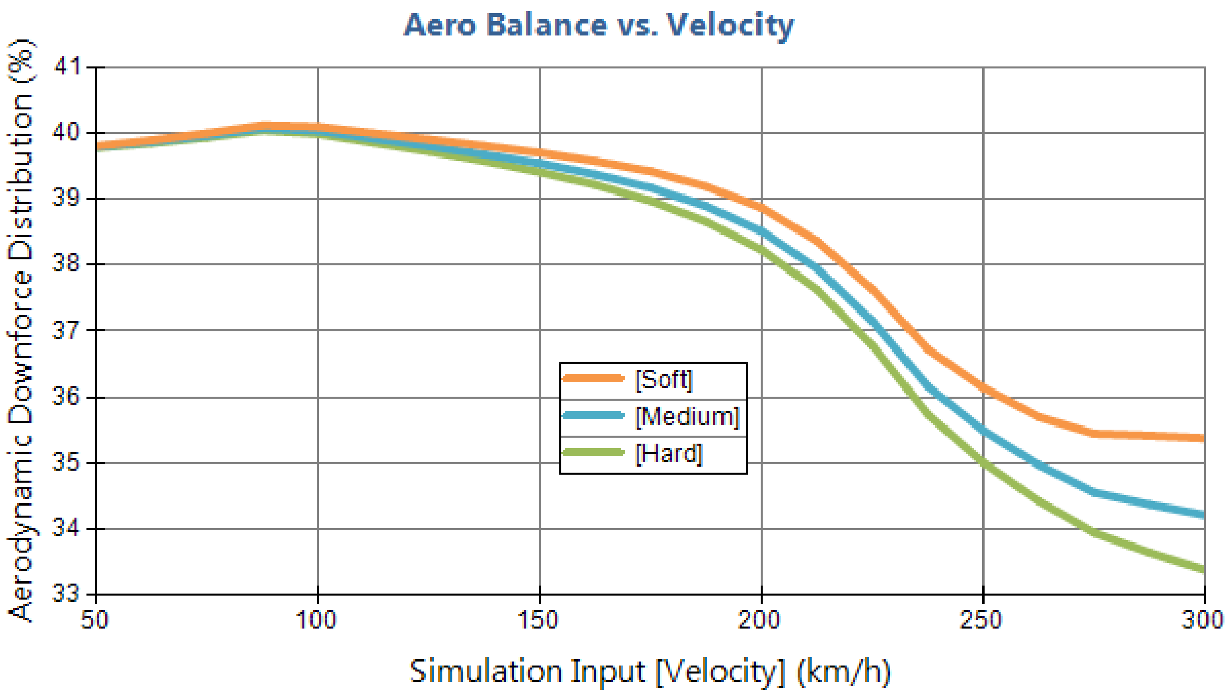


The 3D graphing feature within OptimumDynamics helps visualize the change in aerodynamic distribution

3D - The 3D graphing feature in OptimumDynamics helps us to visualize the change in aerodynamic properties. Shown above is a plot of aerodynamic distribution as a function of both front and rear ride height.

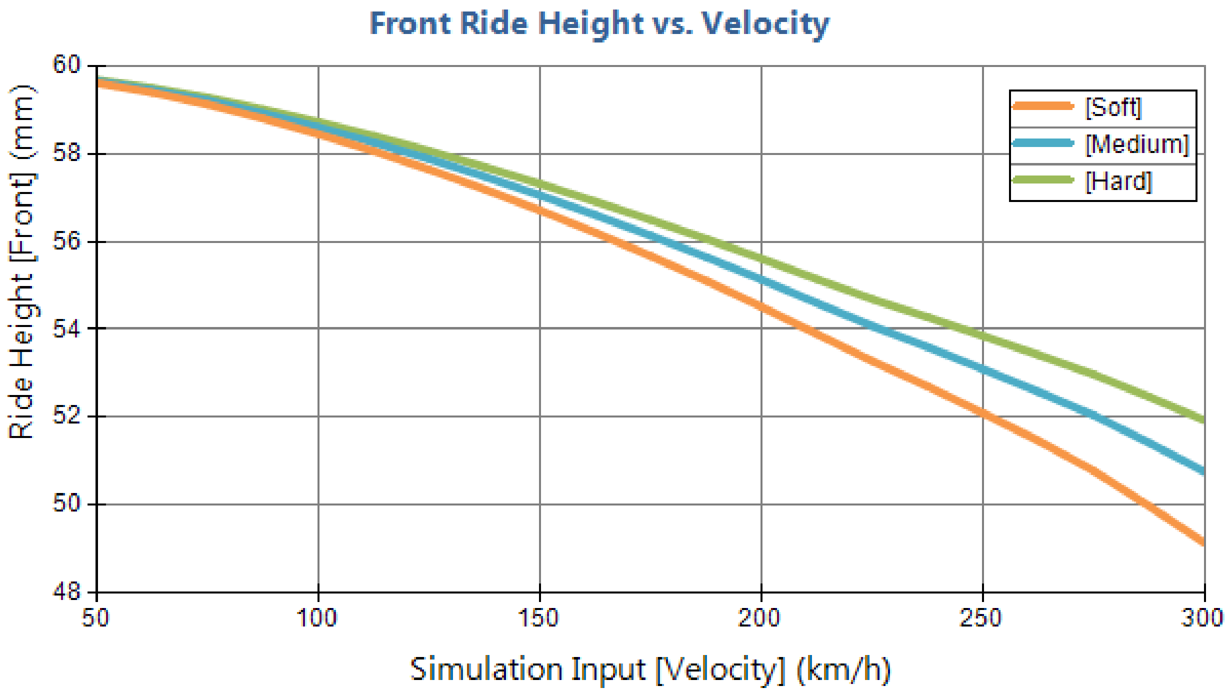
PLOT - The 2D charting feature of OptimumDynamics helps us to post-process the results. The charting feature allows easy overlay of multiple results for visual comparison.

BELOW – Shown below is a plot of aerodynamic distribution against vehicle speed for the three different spring settings investigated.



ANALYSIS – One of key findings from the plot is the non-linearity in the aerodynamic distribution with speed. We are able to see this effect thanks to the full vehicle kinematics model and the ride height sensitive aero maps used in OptimumDynamics. In our case the aerodynamic distribution varies due to changes in front ride height. In the following page, we plot the change in front ride height with speed for the three different spring settings.

Full vehicle kinematics models and ride height sensitive aero maps are used in OptimumDynamics.



Using these results we can determine the influence of spring changes on aerodynamic distribution at different speeds. At one of the tracks, the average cornering speed of this GT racecar is between 160 and 200km/h with a top speed of 240km/h. Presented below is a table summarizing the simulation results at these vehicle speeds.

We can see from the table that a spring change at 160km/h only has a small impact on aerodynamic distribution. Compare this to the same change at 200km/h or 240km/h and we can see a much larger change. In this case, we would look at an alternative option to affect aerodynamic distribution at low speed.

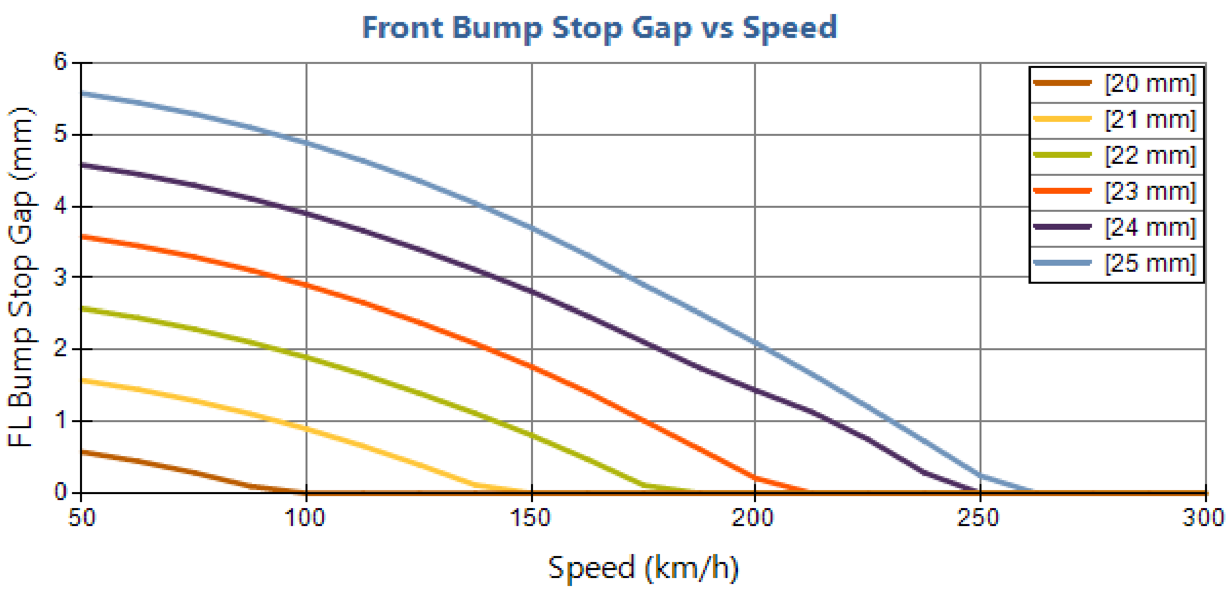
Aerodynamic Balance			
Spring Setting	Speed (km/h)		
	160	200	240
Soft	39.5%	39.0%	36.5%
Medium	39.4%	38.5%	36.0%
Hard	39.2%	38.1%	35.5%

Change in Aerodynamic Balance			
Spring Setting	Speed (km/h)		
	160	200	240
Soft	0.0%	-0.5%	-3.0%
Medium	-0.1%	-1.0%	-3.5%
Hard	-0.3%	-1.4%	-4.0%

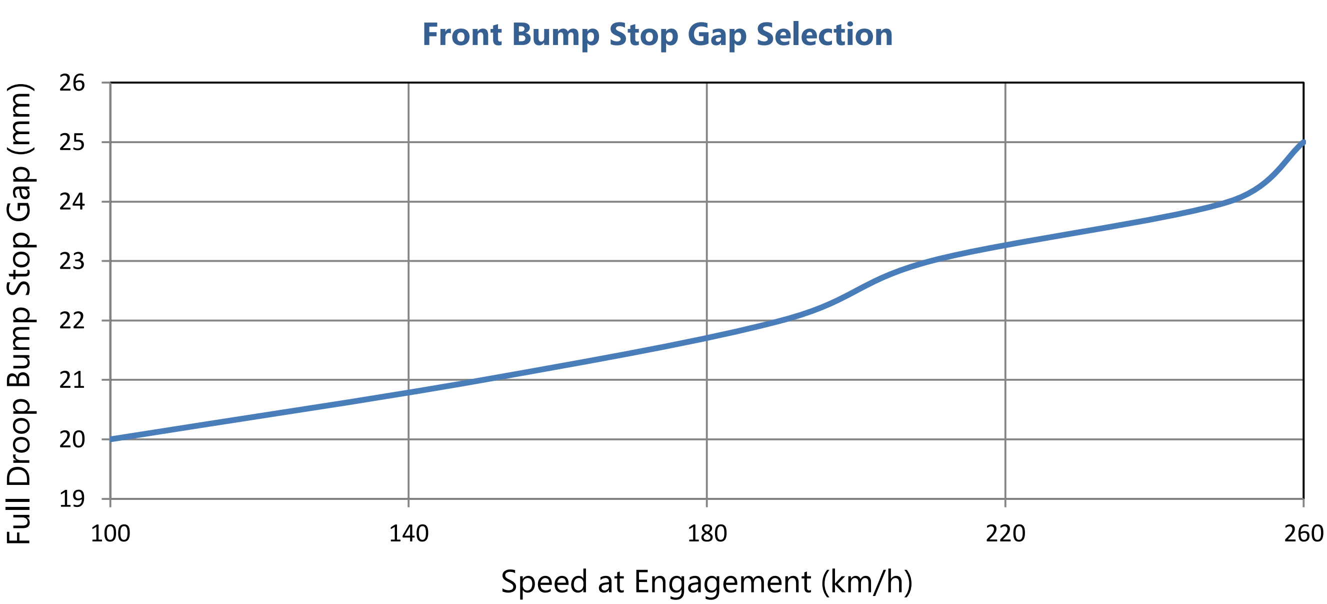
We can determine the influence of spring changes on aerodynamic distribution at different speeds.

Selecting Bump Stop Gap

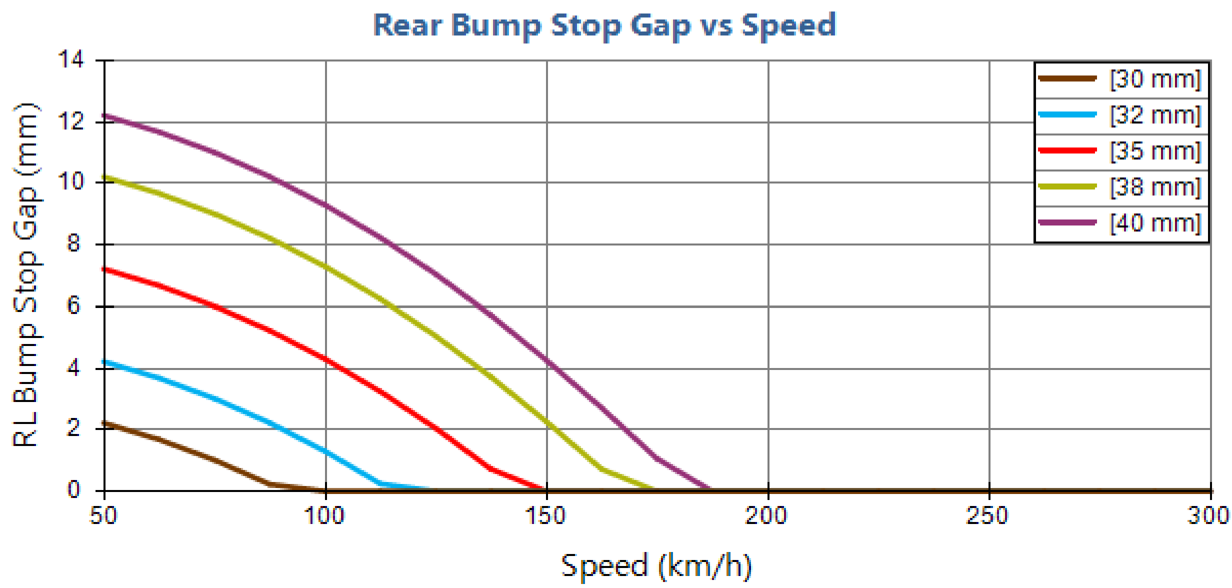
Similar to selecting spring stiffness, we can also decide on a full droop bump stop gap for the GT racecar. We investigated different bump stop gap combinations for a straight line speed simulation of 50 to 300km/h. The plot below shows the vehicle speed required for the bump stop to become engaged. A bump stop gap of zero on this plot indicates that the bump stop has been engaged.



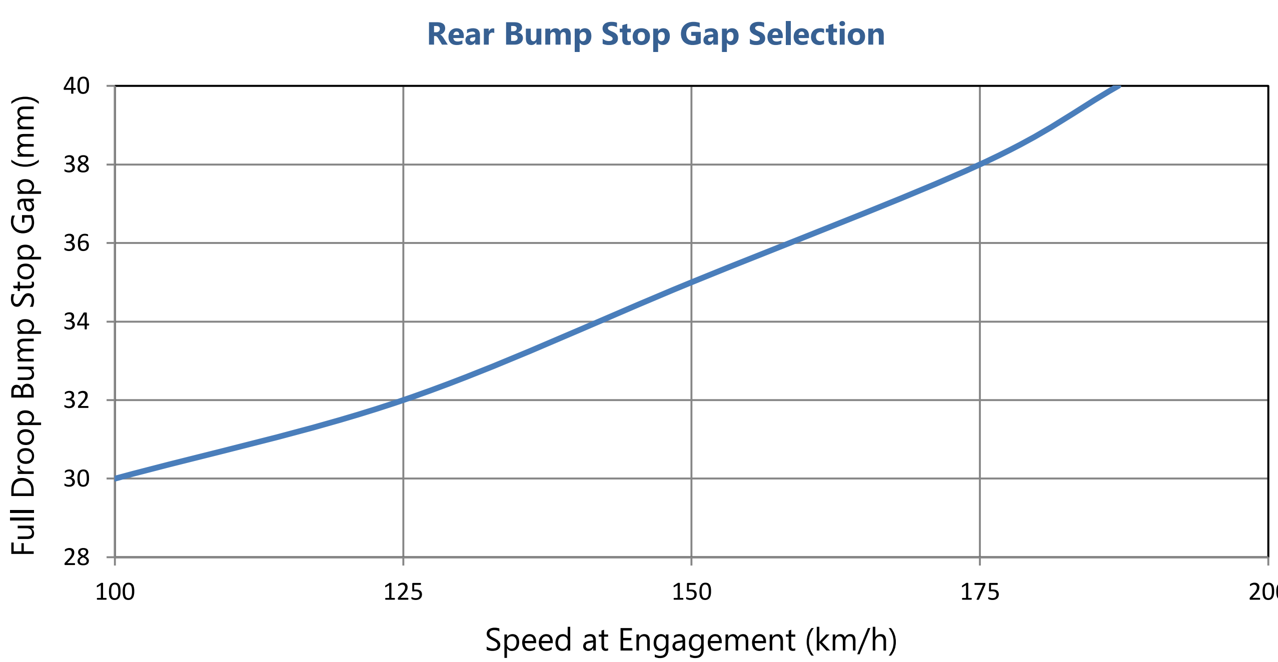
From these results we can create a chart relating the full droop bump stop gap to the vehicle speed at which it engages (*speed at engagement).*



BELOW - In a similar way we can create a plot of rear bump stop gap vs speed. With this plot we can visualize the relationship between bump stop gap and vehicle speed



BELOW - We now proceed to create a plot of full droop bump stop gap and the speed at engagement. In this plot we can see the non-linear relationship between these two variables. This is due to the nonlinear nature of the vehicle kinematics and the ride-height sensitive aerodynamic map used in the vehicle setup.



Using these results we can now determine our full droop bump stop gap depending on the vehicle speed at which they should engage. Let's say that we would like the vehicle to have its rear bump stop engaged at 160km/h and front bump stop engaged at 220km/h. From the results above we should set the front bump stop gap to be 23mm and rear bump stop gap to be 37mm at full droop.

In this study, the effect of springs on the aerodynamic distribution and the selection of bump stop gaps were investigated. By running a simple straight line simulation we were able to isolate the effect of spring selection on aerodynamic distribution.

We were also able to determine the full droop bump stop gap based on simple engagement criteria. The benefits of having a full vehicle kinematics model and a ride height sensitive aerodynamic map were demonstrated.

Analysis

- Results from multiple setups compared
- Simple straight line simulation

Post Processing

- OptimumDynamics
- Results exported to Excel

Conclusion

- Aerodynamic distribution variation calculated
- Bump stop gap selection based

About OptimumG

OptimumG is an international vehicle dynamics consultant group that works with automotive companies and motorsports teams to enhance their understanding of vehicle dynamics through seminars, consulting and software development.

About OptimumDynamics

OptimumDynamics is the newest benchmark in computational vehicle dynamics analysis software. It is a versatile software tool that allows you to investigate the dynamic handling and performance characteristics of any vehicle.

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