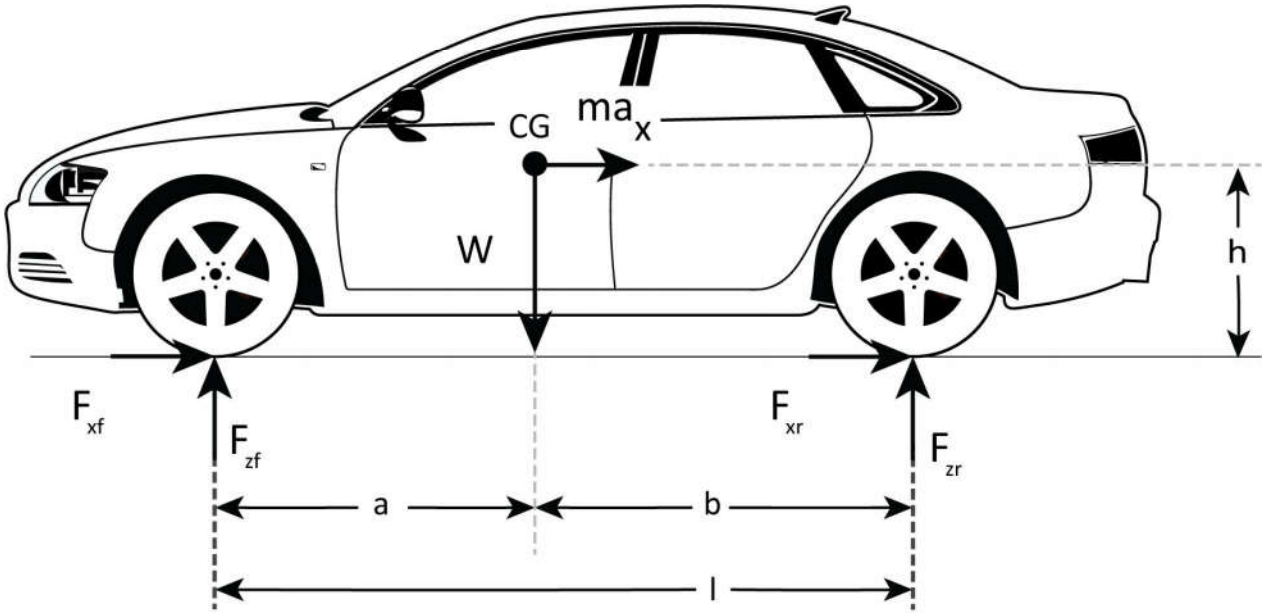
Vehicle Ride and Handling Analysis

Introduction

This tool lets you experiment with the steer- and camber-by-roll coefficients of a 3-DOF vehicle model, and simulate the effect on the yaw gain curve and the understeer coefficient.

- Enter the vehicle mass, inertial, geometric and compliance properties, then the natural-frequency requirements for the suspension
- Click "Compute Parameters" to determine the stiffness and damping coefficients
- Adjust Steer-by-Roll and Camber-by-Roll factors
- Set up simulation properties and click "Run Simulation"



Mass and Inertia

Vehicle curb weight	1000	kg
Total vehicle sprung mass weight	900	kg
Unsprung weight per wheel, front	2*25	kg

Geometry

Wheel base	2.5	m
Track (front and rear)	1.4	m
Distance of CG from front axle (a)	1.2	m

Unsprung weight per wheel, rear	2*25 kg	Distance of CG from rear axle (b)	1.3 m
Vehicle inertia about z axis	2000 $kg \cdot m^2$	Vehicle CG height	0.6 m
Sprung mass inertial about x axis	750 $kg\,m^2$	Sprung mass CG height	0.7 m
		Roll center height (front/rear)	0.2 m

Compliances

Tire cornering stiffness (front and rear)	25000 $N\,rad^{-1}$
Tire vertical stiffness	150000 $N\,m^{-1}$
Tire camber stiffness (front and rear)	5000 $N\,rad^{-1}$
Front shock absorber rate (per wheel)	800 $N\,m^{-1}\,s^{-1}$
Rear shock absorber rate (per wheel)	1000 $N\,m^{-1}\,s^{-1}$
Distance between installation point of left and right spring/shock absorber (front and rear):	1.3 m
Installation factor for springs and shock absorbers for front and rear wheels	1 m

Requirements

First natural frequency of front suspension	1 Hz 6.283 $rad \cdot s^{-1}$
First natural frequency of rear suspension	1.2 Hz 7.540 $rad \cdot s^{-1}$
Anti-roll-bar on front axle, Roll Gain	4 $deg\,g^{-1}$

Calculated Parameters

Understeer/Oversteer

Compute Parameters

Front Suspension Stiffness, k_{sF}	8487.86
Rear Suspension Stiffness, k_{sR}	13359.50
Overall Torsional Stiffness, K_t	54118.04
Overall Torsional Damping, C_t	1521.00
Anti Roll-Bar Torsional Stiffness, K_{ARB}	35657.03

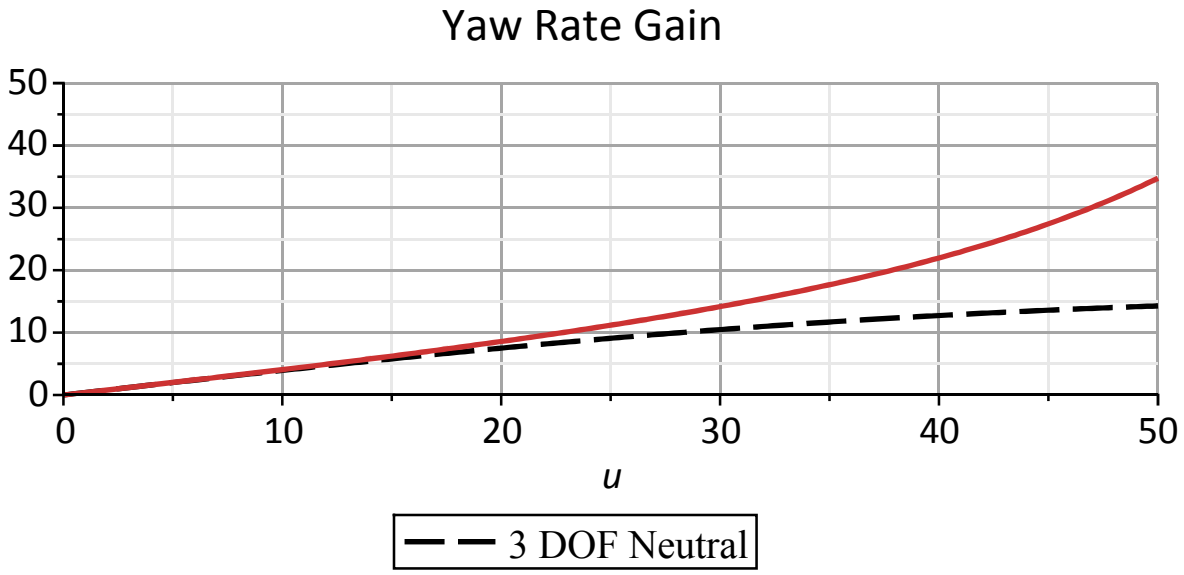
K_{SBRF} -1.0 -0.5 0.0 0.5 1.0 -0...

K_{SBRR} -1.0 -0.5 0.0 0.5 1.0 -0...

K_{CBRF} -1.0 -0.5 0.0 0.5 1.0 -1...

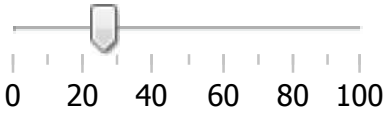
K_{CBRR} -1.0 -0.5 0.0 0.5 1.0 0....

K_{us} Oversteer -0...



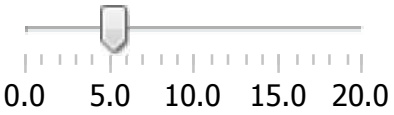
Simulation Setup

Vehicle Speed



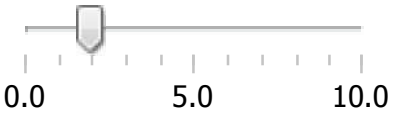
26 $km\,h^{-1}$ = 94 $m\,s^{-1}$

Steering Angle



5.13 deg

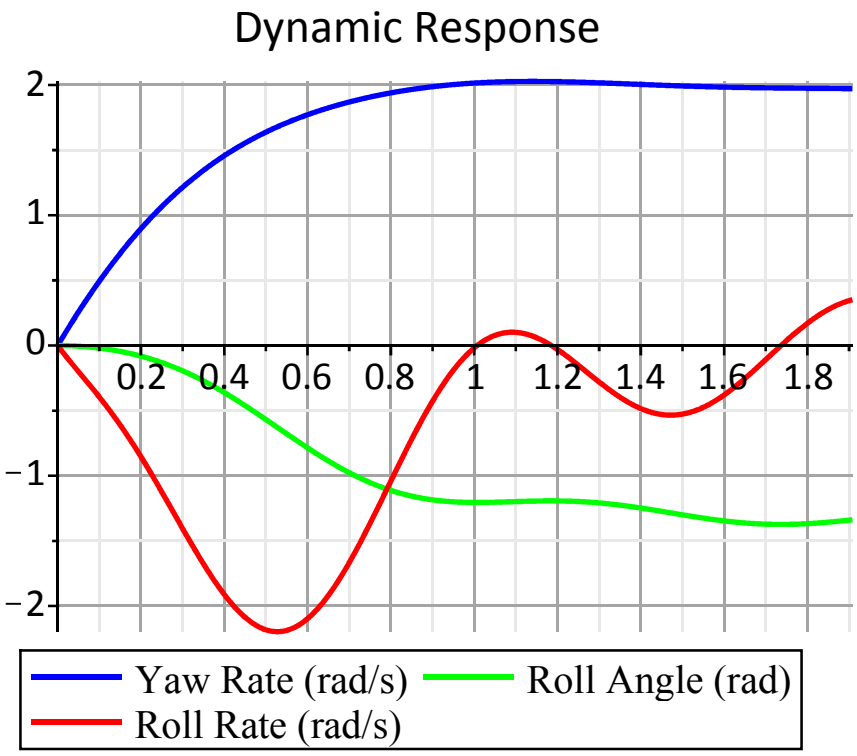
Simulation Duration

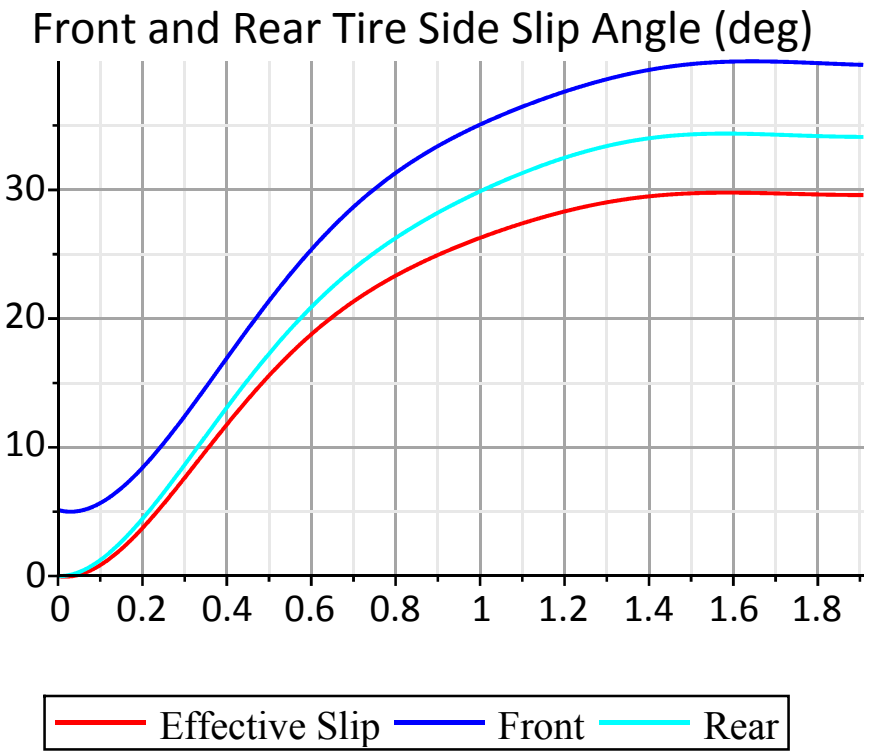


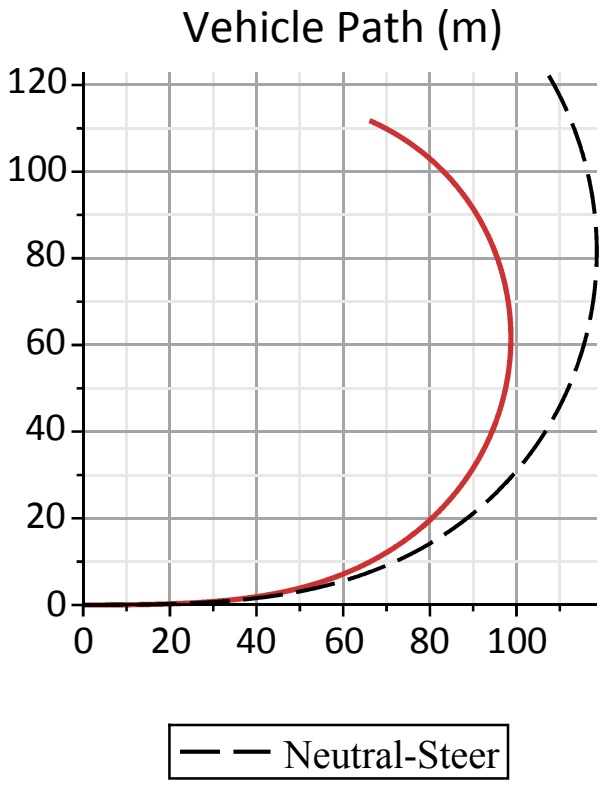
1.91 seconds

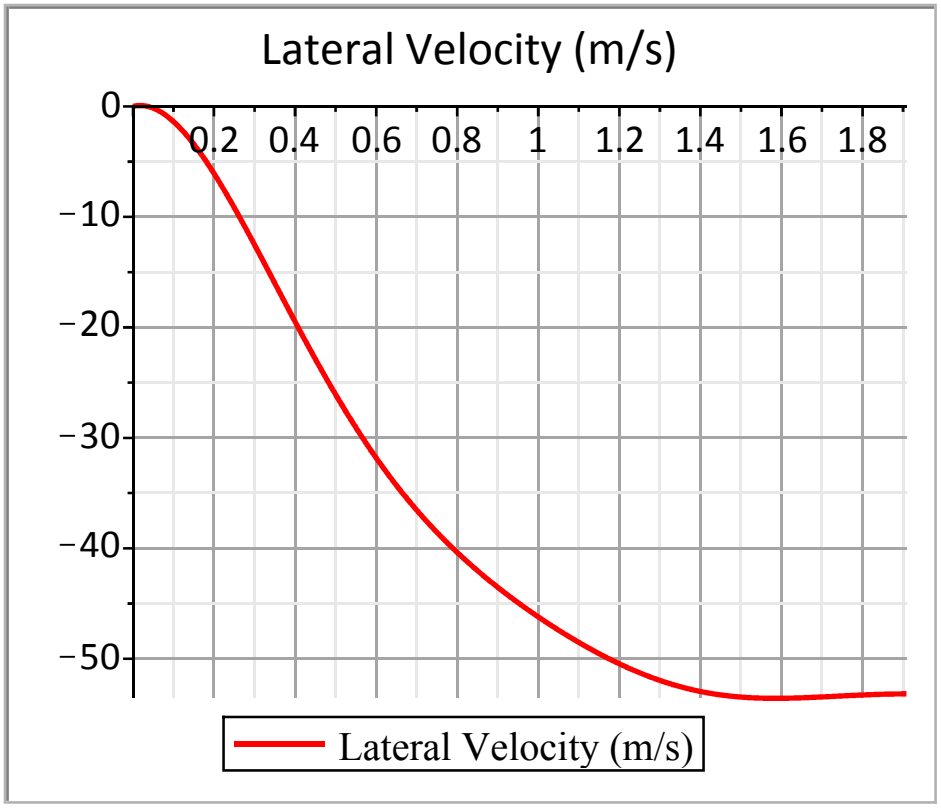
RunSimulation

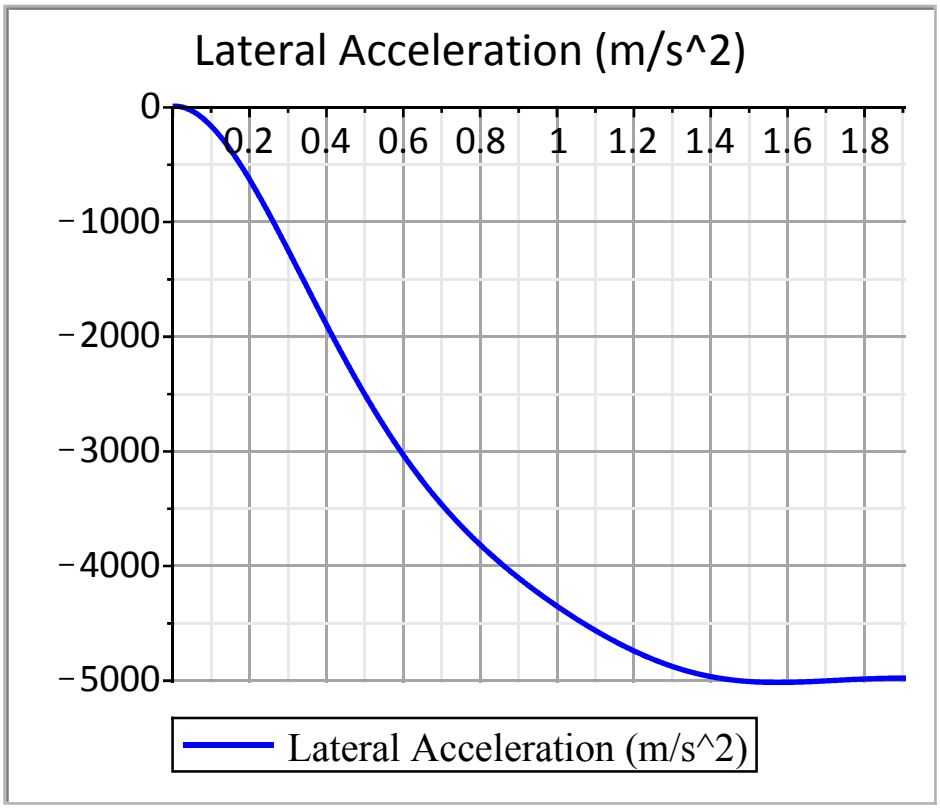
Results




Front and Rear Tire Side Slip Angle (deg)
30
20
10
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Effective Slip
Front
Rear


Vehicle Path (m)
120
100
80
60
40
20
0
0
20
40
60
80
100
Neutral-Steer


Lateral Velocity (m/s)
0
−10
−20
−30
−40
−50
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Lateral Velocity (m/s)


Lateral Acceleration (m/s^2)
0
−1000
−2000
−3000
−4000
−5000
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Lateral Acceleration (m/s^2)