VEHICLE DYNAMICS

Assignment 2: Steady-State handling

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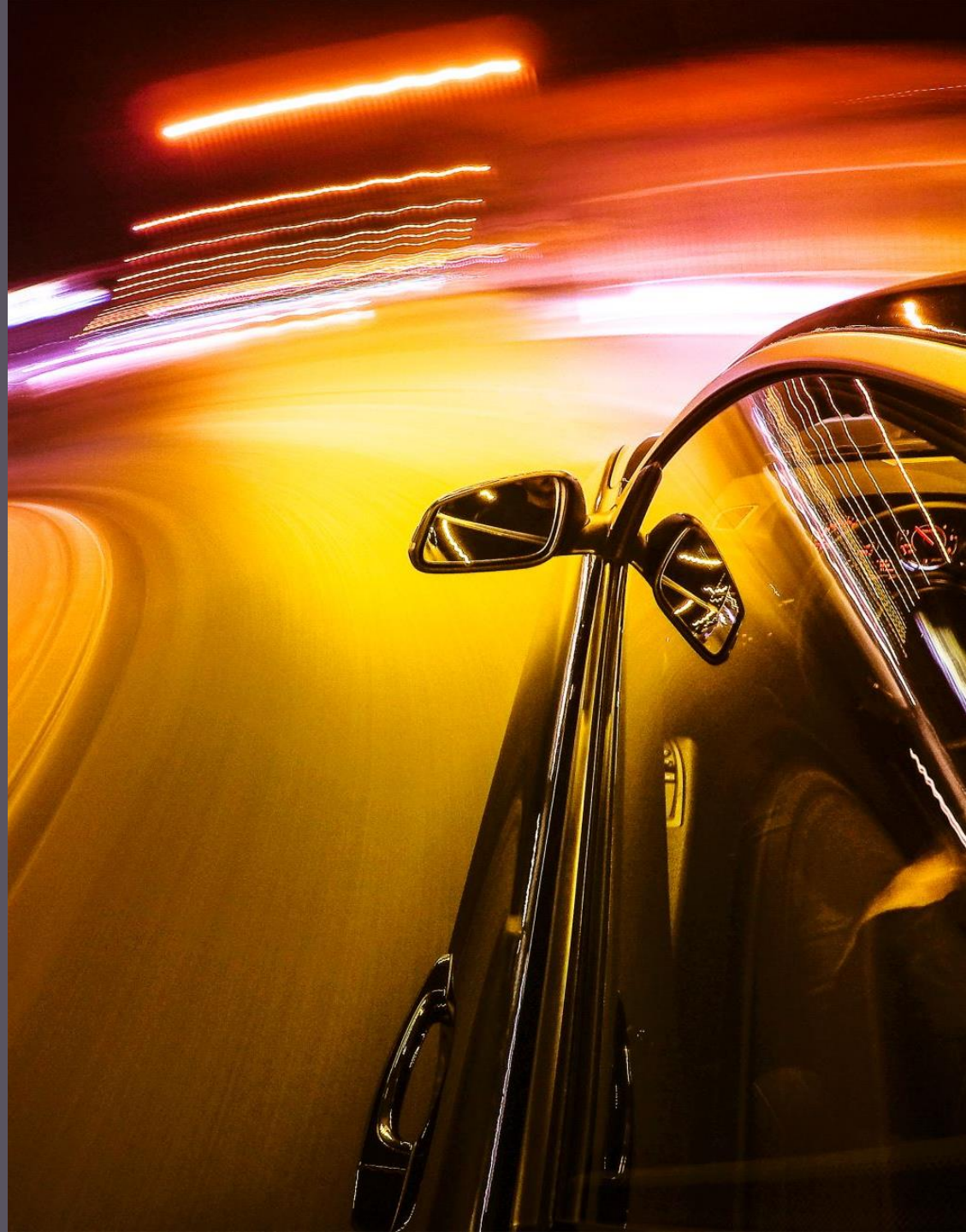


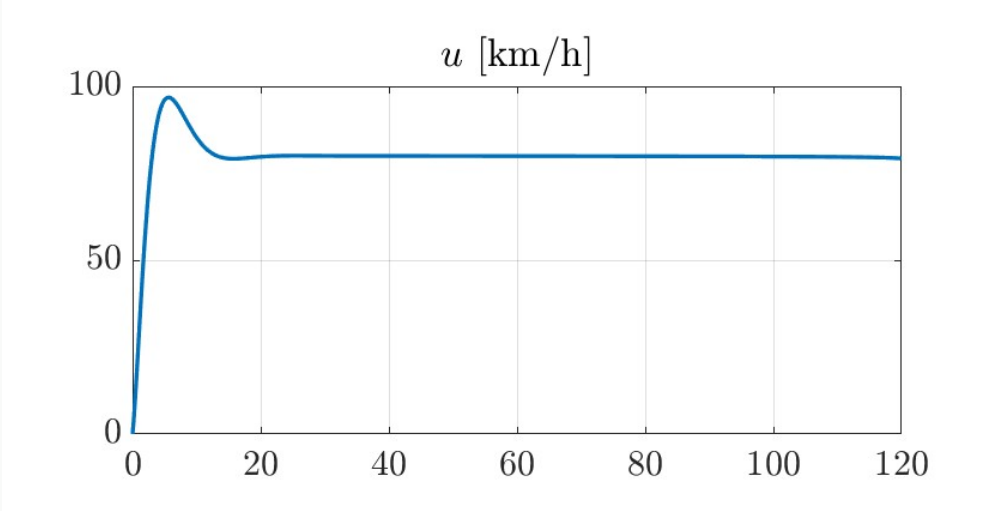
Steady-State Tests

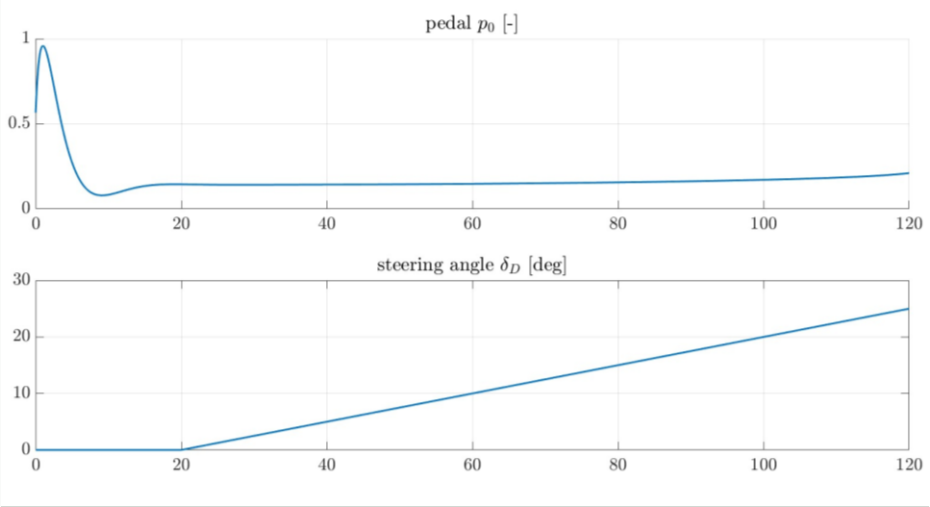
The steady-state tests that we carried on to analyse the behaviour of the car were:

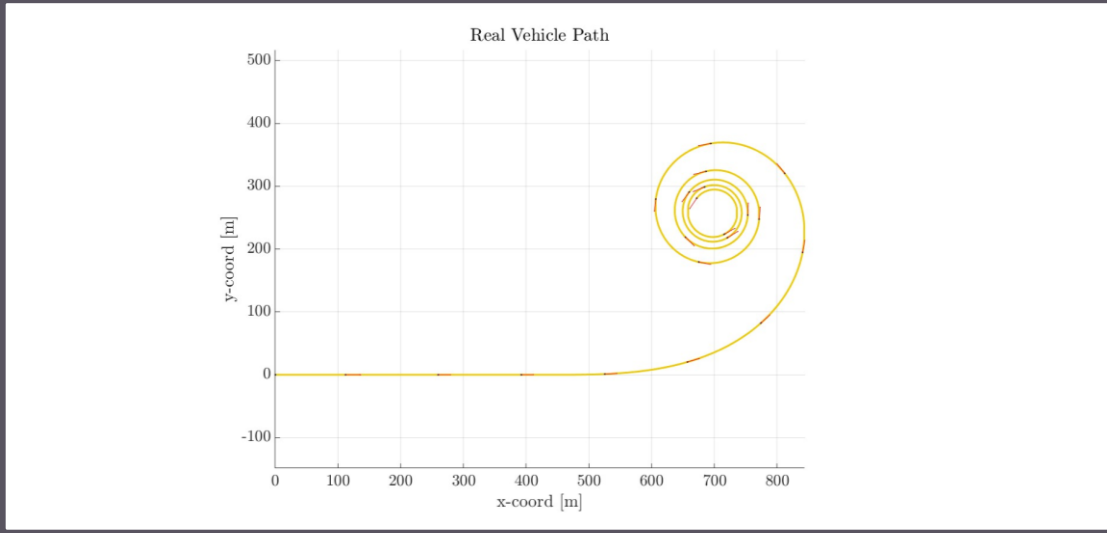
- Steer ramp test with constant velocity
- Speed ramp test with constant steering angle

Steer ramp test

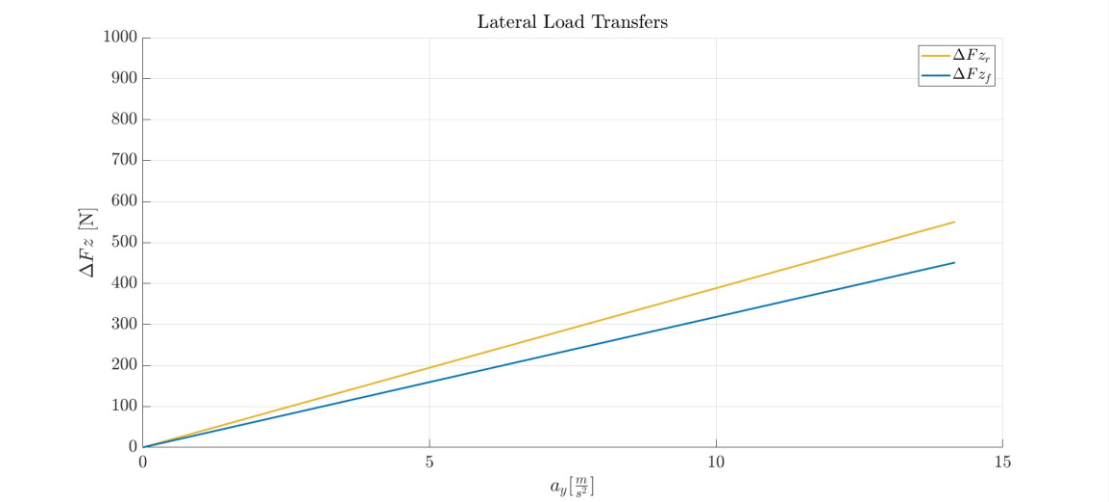
The steering angle increase linearly only from the moment that the steady state condition is achieved

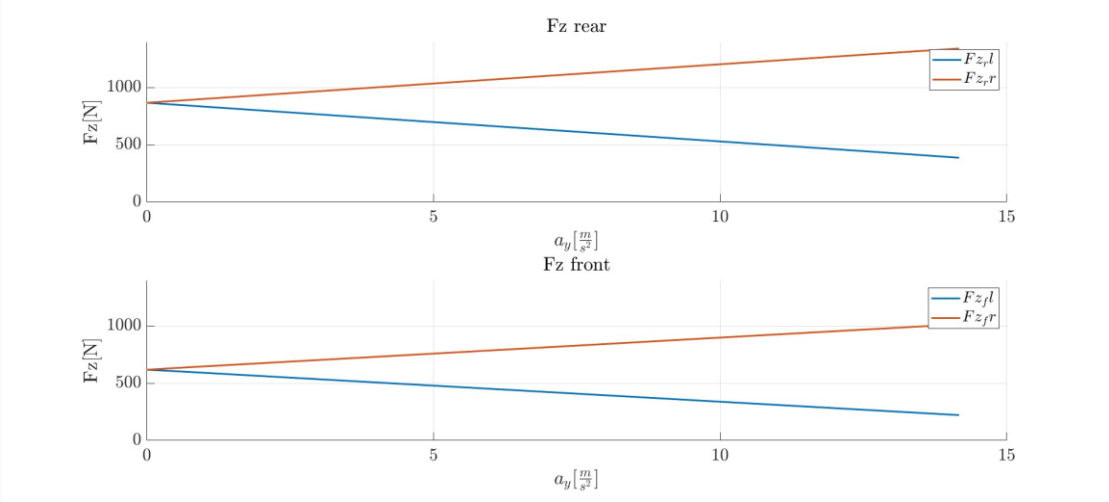






Lateral Load Transfer



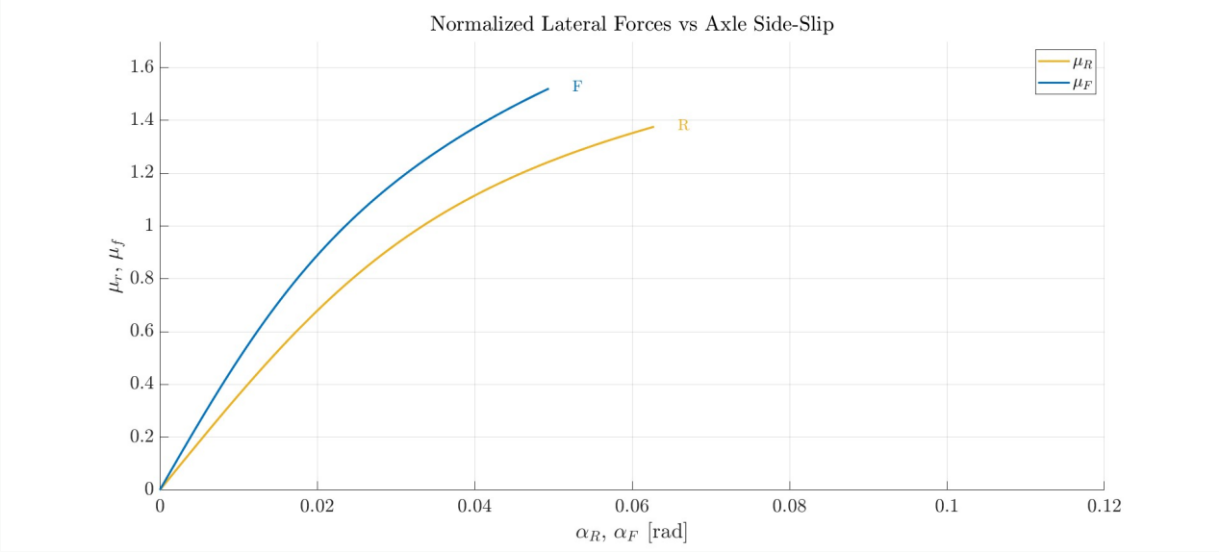


The Lateral Load Transfer increase linearly with the lateral acceleration

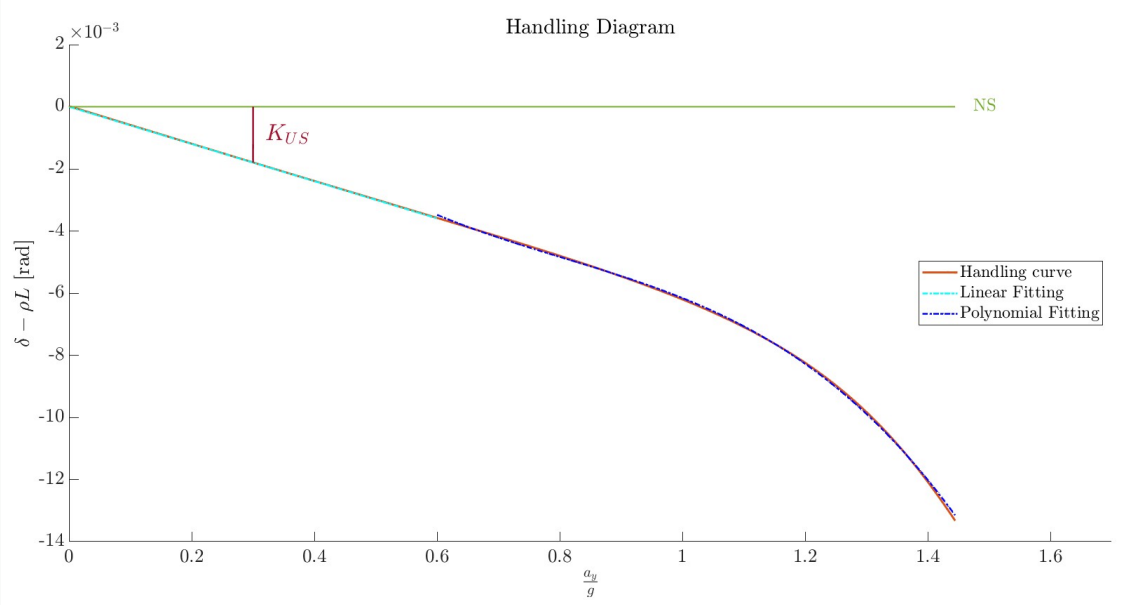
From the plots on the right is easy to see that the outer wheels have to sunstain more load than the inner wheels

Axle Characteristics

The axle characteristics represent the total lateral force of an axle, as a function of the apparent side slip of the axle. In the figure the normalized axle characteristics are showed, which in steady state, at a given acceleration are equal for the two axle and equal to normalized acceleration.



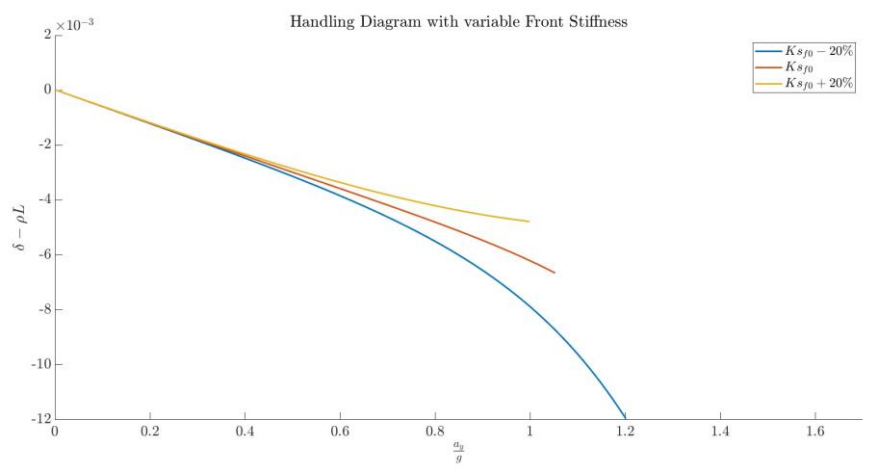
Handling Diagram

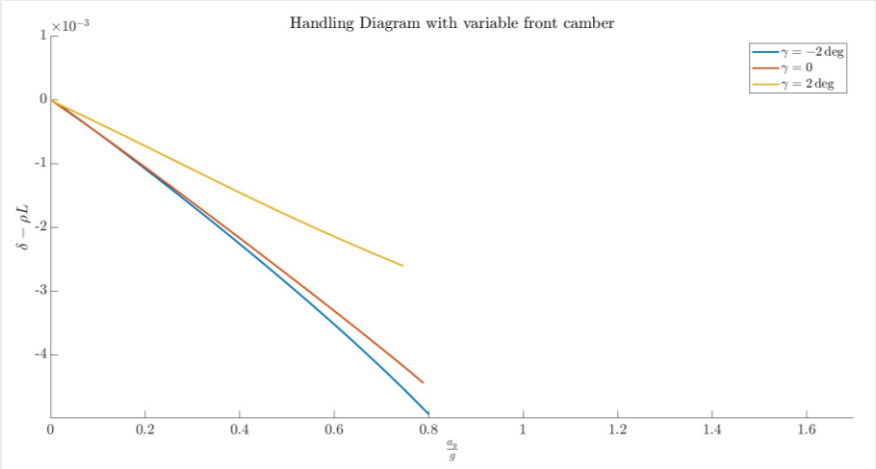


The handling diagram gives us the possibility to clearly recognize the oversteering behaviour of the vehicle we considered

Moreover, we computed the understeering gradient Kus:

- fitting procedure of the linear part of the handling diagram → Kus = -5.99e-03
- theoretically: $Kus = -\frac{1}{L*g*\tau}(\frac{1}{Cyr} - \frac{1}{Cyf})$, with the cornering stiffness computed as the angular coefficient of the normalized lateral forces → Kus = -5.73e-03





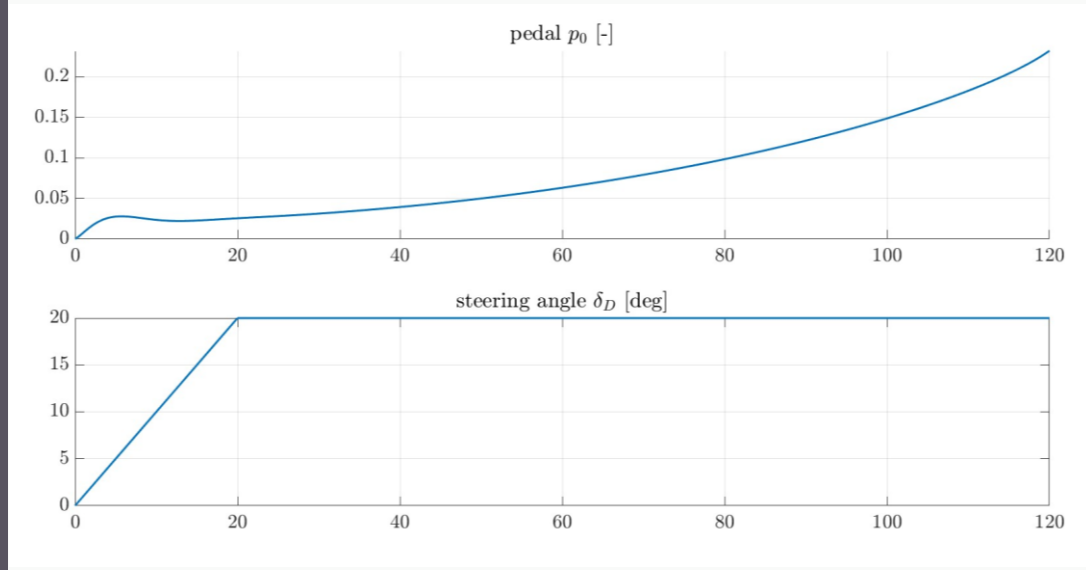
Effect of suspension stiffness and camber on handling

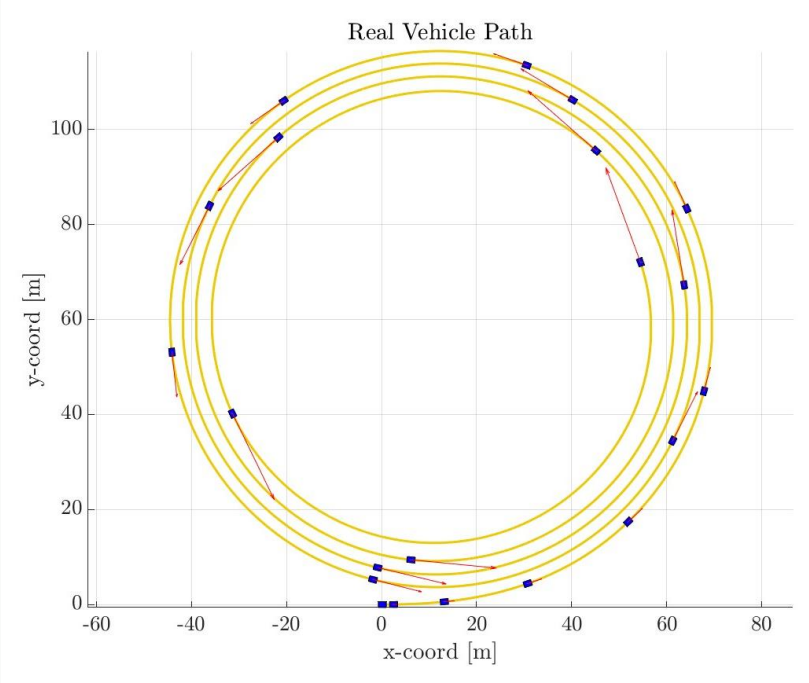
We carried on further analysis on the handling behaviour of the vehicle, changing the suspension stiffness at the front and also using different values of camber for the front wheels.

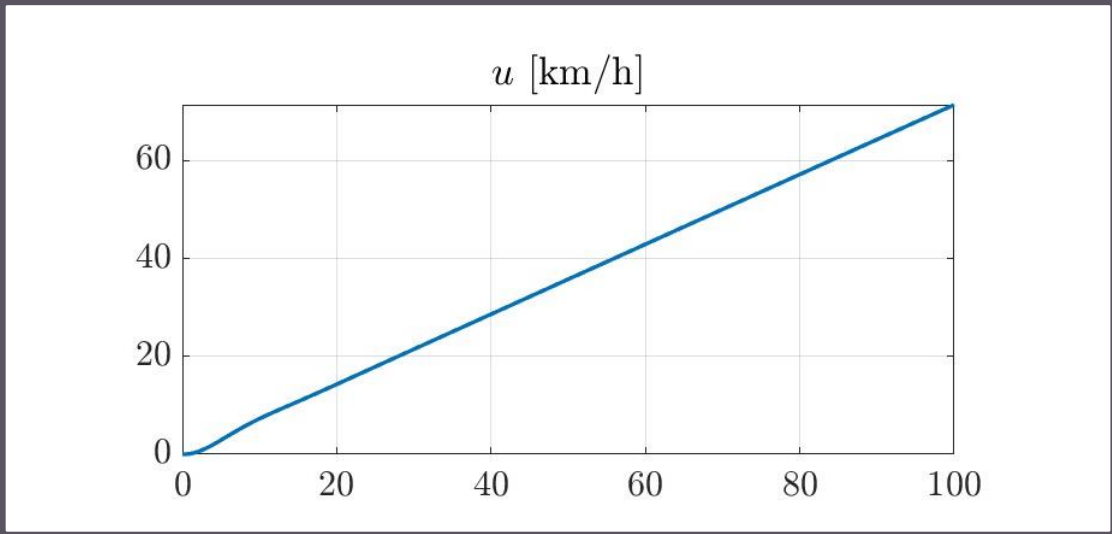
From the figures is possible to understand that this changes affects the behaviour of the vehicle.

Speed ramp test

The velocity increase linearly controlled by a PID. Initially the steering angle increase slowly to reach constant value, in order to avoid sudden change







Results

The simulations carried on with this kind of test leads to equal results as the previous test, with similar plots of lateral load transfer and handling diagram. Also the value of Kus, that result very similar, confirms the validity of the test → Kus= -5.45e-03

Steady-state Gains

- Yaw Rate Gain
- Side-Slip Gain
- Acceleration Gain

Parameters that determine the response of the vehicle to steering inputs of the driver