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Author:	Nithesh Kattathar, Solutions Engineering
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How to set up a Virtual Kick Plate Test in IPG CarMaker

Kick Plate Test [1] is a procedure to train the driver to control and stabilize the car on a low friction test surface by providing an external excitation to the rear axle wheels via a kick plate. This test procedure helps to understand the critical limits of the car, to develop and tune vehicle safety systems.

We are now going to learn how to implement such a functionality in CarMaker.

Technical Background

Using the tire models with Contact Point Interface (CPI), the tire-road contact point position and the road characteristics (for example friction coefficient) at this point can be varied during the simulation. This enables us to impose an external effect from the ground on the tires' contact point. See Reference Manual under the section Tire and General Tire Parameters for more information.

In order to implement such a function, make use of the C-Extension template "MyTireCPMod.c" under the subfolder "ExtraModels" inside the folder "src" of your project directory, where the contact point of the tire during the simulation is modified. See Programmer's Guide under the sections "Integrating C-Code Models" and "The CarMaker Environment" to understand the C-Code extensions in CarMaker. The example TestRun "FourPosterFrequencyTest" under the folder Examples/BasicFunctions/ExtraModels is developed using a similar approach.

A kick plate stimulus is realized via an externally triggered lateral motion of the road patch below the contact point. This external excitation causes yaw by pushing the rear axle of the car to the side (See Fig 2) and puts the car into a skid motion on the adjacent low friction surface (See Fig 1).
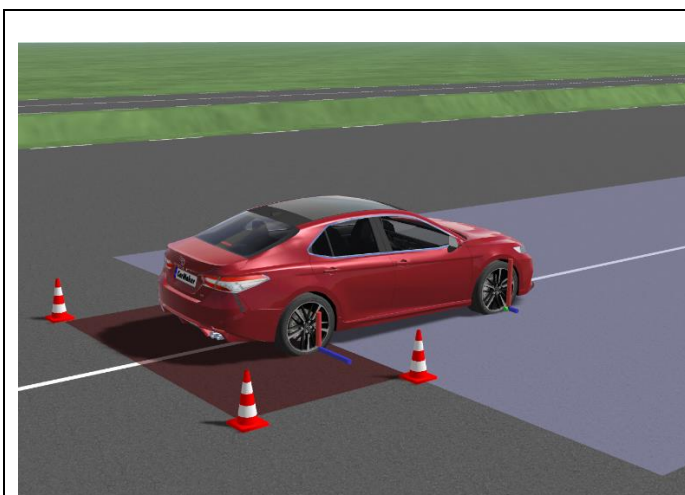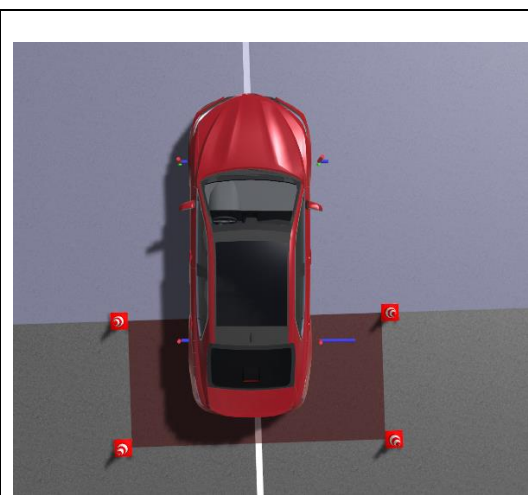

Fig 1: KickPlateTest 3d View

Fig 2: KickPlateTest Top View

[1] https://www.porsche.com/silverstone/en/experience/handlingtracks/tracks

The kick plate has to have a high friction value in order to transfer the motion on the tire. The amplitude of excitation is controlled via Realtime Expressions.

Implementation Details

1. Download the attached files and copy them to your project folder
2. The kick plate is defined in the TestRun as a high-friction patch with the width of 4 m and the length of 2 m starting at road coordinate 106 m
3. In the "User.c" file, the variable "KickPlate_LatVel" is defined to describe the motion of the kick plate
4. View the attached "TireCPMod_KickPlate.c" to understand the implementation of external excitation at the tire-contact point
   - External excitation in terms of lateral velocity of the ground is formulated under the function MyModel_Calc_KP() as below by inducing the lateral movement of the kick plate to the CPMod interface when the corresponding wheels drive over the kick plate

```
1: if (IF->CP 0[0] > 106 && IF->CP 0[0] < 108)
2:     mp->LatVel = KickPlate LatVel;
3:     IF->CP Vel 0[1] += mp->LatVel;
4: }
```

5. Rebuild the CarMaker executable using the included Makefile
6. Select and connect to the new CarMaker executable via "Application Configuration / Status" from CarMaker GUI
7. Use the TestRun "KickPlateTest" where in the maneuver a quantity is defined to detect when the rear axle reaches the kick plate

```
Qu::Sense_RearAxleOnPlate = Vhcl.sRoad > (106.5 + WheelBase)
```

8. The tire model "RT_195_65R15_TireCPMod_KickPlate" activates the kick plate model with the additional parameter mentioned

```
TireCPMod.Kind =     TireCPMod_KickPlate 1
```

9. You can increase or decrease the intensity of an external excitation in the corresponding minimaneuver command

```
Eval KickPlate.LatVel = 4.0
```

10. You can now do virtual testing with several vehicle and driver parameter variations