Vehicle Parameters for a Jaguar X-Type

Andrew Gray, Janick Frasch, Mario Zanon

We state parameters for simulating the driving behavior of a Jaguar X-Type:

- Mass: 2200 kg
- Moment of inertia: 3344 Nm^2
- Front axle to center of gravity: 1.432 m
- Rear axle to center of gravity: 1.472 m
- Wheel base to center of gravity: 0.4 m
- Half car width: 0.8125 m
- Tire radius: 0.333 m
- Tire spinning inertia: 0.5 $\mathrm{N\,m}^2$
- Load transfer time constant: 0.01 s.

For tire-road interaction we use a Pacejka-type tire model of the form

$$
\begin{aligned}
F_l &= \frac{\sigma_l}{\bar{\sigma}_l} \cdot \mu D_l \cdot \sin\left(C_l \operatorname{atan}\left(\frac{1}{\mu} B_l \left(1 - E_l\right) \kappa_0 + E_l \operatorname{atan}\left(\frac{1}{\mu} B_l \, \kappa_0\right)\right)\right) \\
F_c &= -\frac{\sigma_c}{\bar{\sigma}_c} \cdot \mu D_c \cdot \sin\left(C_c \operatorname{atan}\left(\frac{1}{\mu} B_c \left(1 - E_c\right) \alpha_0 + E_c \operatorname{atan}\left(\frac{1}{\mu} B_c \, \alpha_0\right)\right)\right)
\end{aligned}
$$

where

$$
\begin{aligned}
\sigma_l &= \frac{\kappa}{\sqrt{\kappa^2 + (e_d \cdot \tan\alpha)^2}} \\
\sigma_c &= \frac{e_d \tan\alpha}{\sqrt{\kappa^2 + (e_d \cdot \tan\alpha)^2}}.
\end{aligned}
$$

Inputs to the tire model are the slip angle α, the slip ratio κ, and the road friction factor μ. It holds

$$
\begin{aligned}
\kappa^0 &= 100 \cdot \frac{\sigma_s \, \bar{\sigma}_l}{1. + \sigma_s \, \bar{\sigma}_l} \\
\alpha^0 &= \operatorname{atan}\left(\frac{1}{1 - \kappa} \sqrt{\kappa^2 + (\tan\alpha)^2}\right),
\end{aligned}
$$

and further

$$
\begin{aligned}
e_d &= e_{d0} - \frac{e_{d0} - 1}{1 + \sigma_s^{2.5}} \\
\sigma_s &= \frac{1}{1 - \kappa} \sqrt{\left(\frac{\kappa}{\bar{\sigma}_l}\right)^2 + \left(\frac{\tan\alpha}{\bar{\sigma}_c}\right)^2}.
\end{aligned}
$$

For front and rear tires e_{d0} is given by 1.764 and 1.725, respectively. Under normal load distribution, the remaining tire parameters are

Parameter	*front*	*rear*
$\bar{\sigma}_l$	0.105	0.106
B_l	0.201	0.200
C_l	1.65	1.65
D_l	5620.199	5484.323
E_l	0.613	0.614

Parameter	*front*	*rear*
$\bar{\sigma}_c$	0.185	0.182
B_c	0.201	0.174
C_c	1.3	1.3
D_c	4868.778	4753.954
E_c	-1.229	-1.177