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Abstract

This report shows examples of the scale factors used in a previously published semi-empirical tire-model, developed at the Department of Automatic Control in Lund. The scale factors are plotted as 3d surface diagrams depending on the longitudinal and lateral slip for a few different camber angles and velocities.

Key words
Brush model; Camber; Combined slip; Scale factors; Tire model

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1. Contents

List of Figures

2. Introduction

This report is written as a complement and refers to a semi-empirical tire model previously described in [2, 5, 7, 6, 4, 3, 8, 9, 10]. The combined slip forces and torque are, in the model, formed from the pure slip forces and torque as

$$\hat{F}_x(\lambda,\alpha,\gamma) = G_{ax}(\lambda,\alpha,\gamma)\hat{F}_{0x}(\lambda_{0a}) + G_{sx}(\lambda,\alpha,\gamma,v)\hat{F}_{0x}(\lambda_{0s}) \tag{1a}$$

$$\hat{F}_y(\lambda,\alpha,\gamma) = G_{ay}(\lambda,\alpha,\gamma)\hat{F}_{0y}(\alpha_{0a}) + G_{sy}(\lambda,\alpha,\gamma,v)\hat{F}_{0y}(\alpha_{0s}) + G_{\mathrm{cam}y}(\lambda,\alpha,\gamma)\hat{F}_{0\mathrm{cam}}(\gamma) \tag{1b}$$

$$M_z(\lambda,\alpha,\gamma) = G_{fz}(\lambda,\alpha,\gamma)\hat{F}_{0y}(\alpha_{0r}) + G_{mz}(\lambda,\alpha,\gamma)\hat{M}_{0z}(\alpha_{0r}) + G_{\mathrm{cam}z}(\lambda,\alpha,\gamma)\hat{F}_{0\mathrm{cam}}(\gamma) \tag{2}$$

The aim of report is to visualize how the scale factors G from (1) – (2), further explained in [3, 8, 9, 10], depend on different input signals.

Respective scale factor is shown for sweeps of the longitudinal slip λ and sweeps of the slip angle α and for $\gamma = [0\,5\,10]$ [deg]. The sliding force scale factors, G_{sx} and G_{sy} are also shown for $v = [0.5\,1\,2]\cdot v_0$. The pure slip tire models used for the computation of the limit slips, λ° and α° and the sliding force angle β' are Magic formula parameterizations presented with parameters in [1] for $f_z = 4$ kN.

3. Plots of Scale Factors

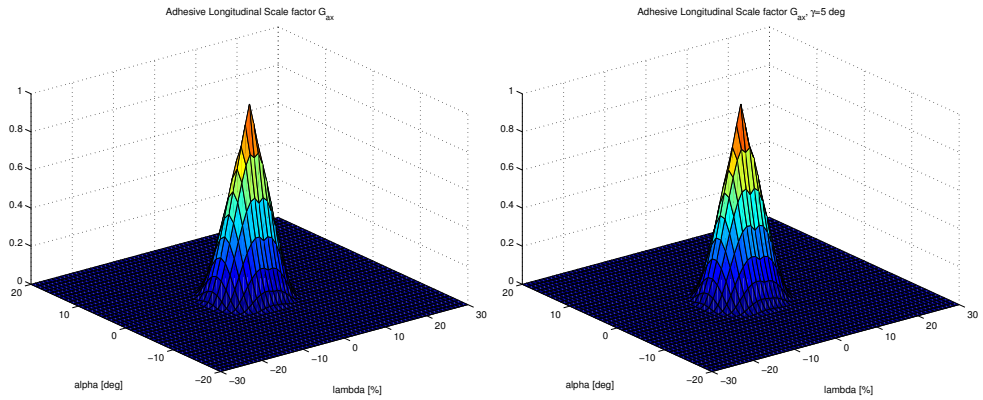

Figure 1 Longitudinal adhesive scale factors. To the right with camber, γ=5 [deg].

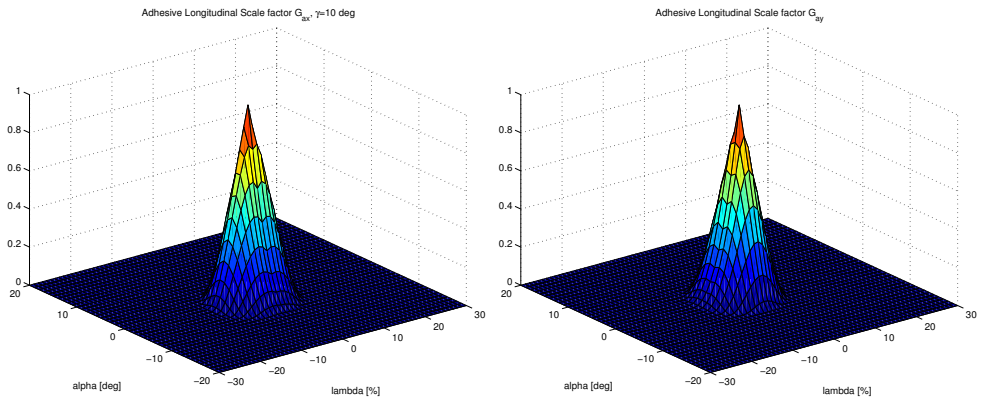

Figure 2 To the left: Longitudinal adhesive scale factor with camber, γ=10 [deg]. To the right: Lateral adhesive scale factor.

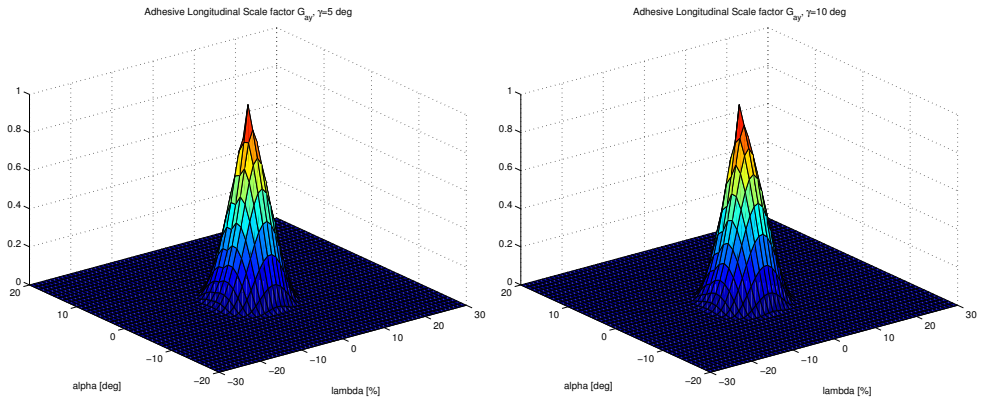

Figure 3 Lateral adhesive scale factors with camber. To the left: γ=5 [deg] and to the right: γ=10 [deg].

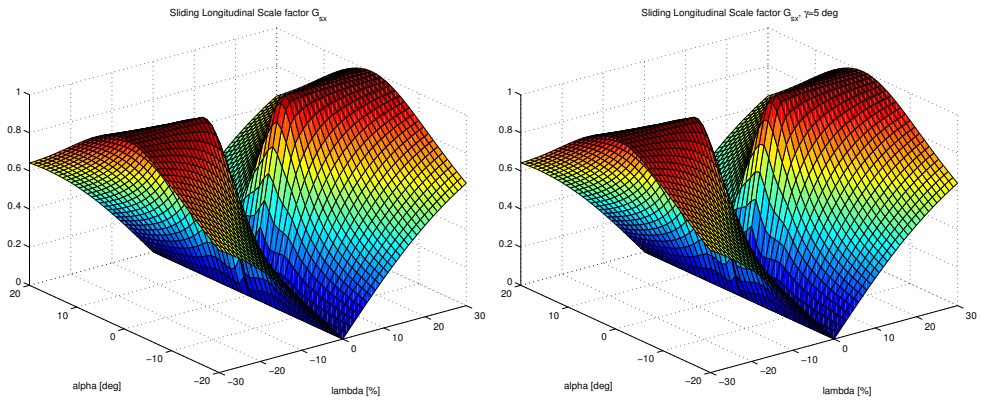

Figure 4 Longitudinal sliding scale factors. To the right with camber, γ=5 [deg].

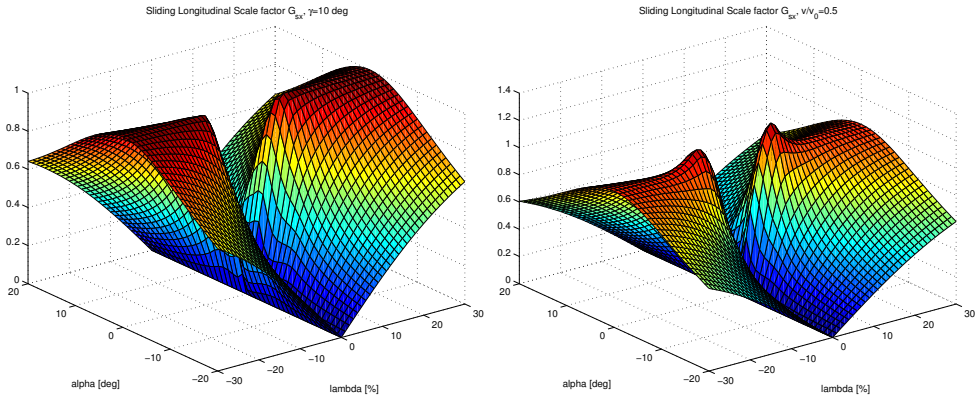

Figure 5 Longitudinal sliding scale factors. To the left with camber, γ=10 [deg] and to the right, $v/v_0 = 0.5$.

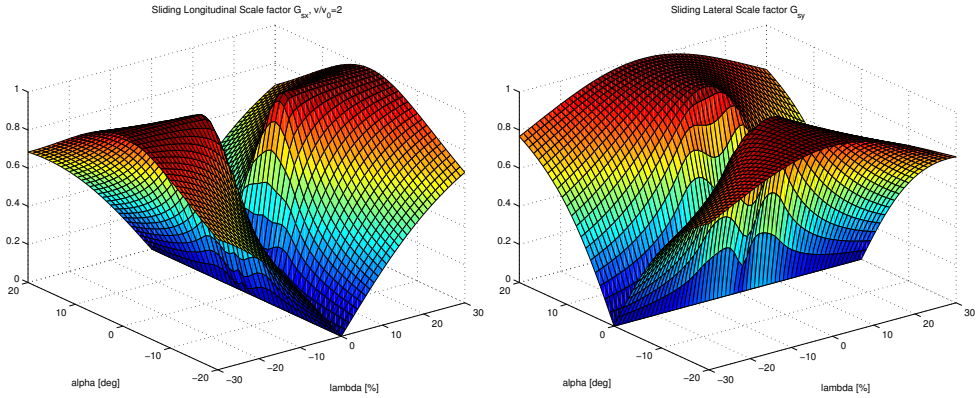

Figure 6 To the left: Longitudinal sliding scale factor, $v/v_0 = 2$. To the right: Lateral sliding scale factor.

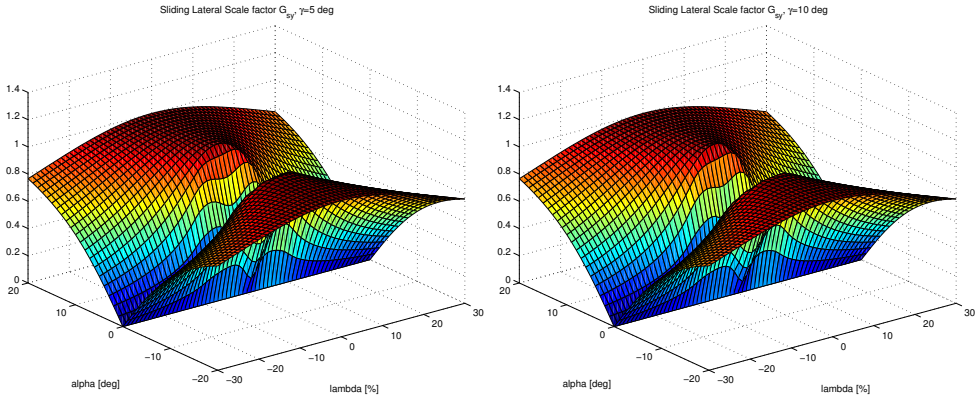

Figure 7 Lateral sliding scale factors with camber. To the left: γ=5 [deg] and to the right: γ=10 [deg].

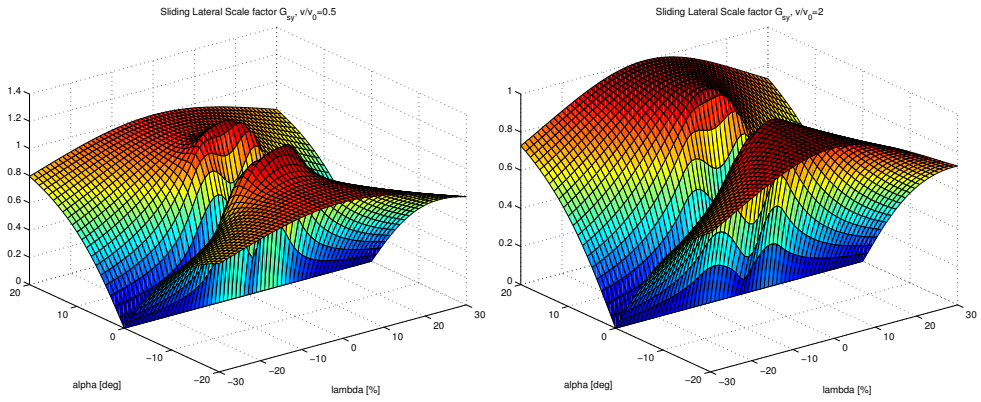

Figure 8 Lateral sliding scale factors with velocity dependence. To the left:$v/v_0 = 0.5$ and to the right: $v/v_0 = 2$.

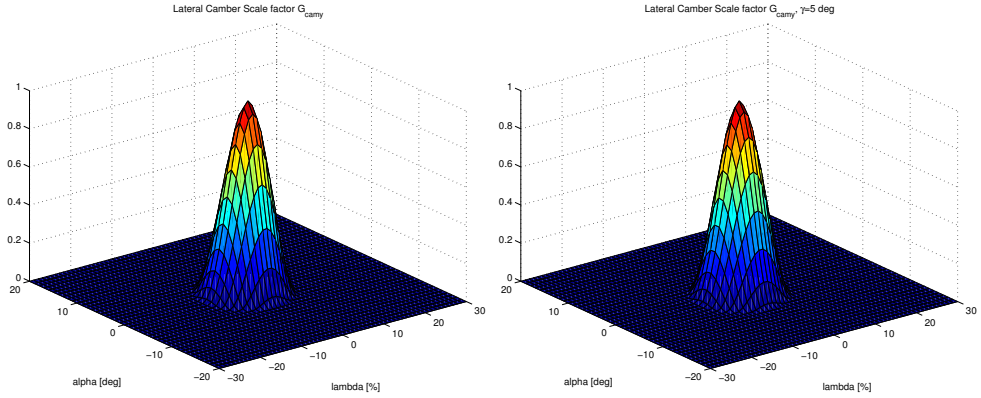

Figure 9 Camber scale factors. To the right with camber, γ=5 [deg].

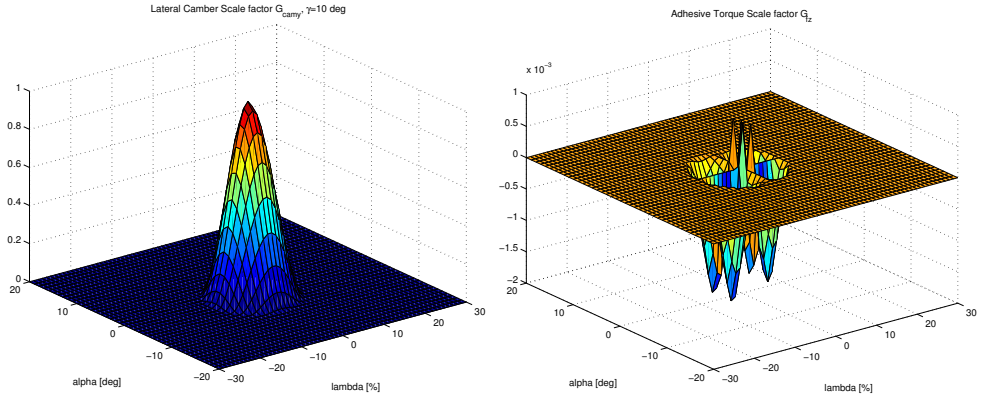

Figure 10 To the left: Camber scale factor with camber, γ=10 [deg]. To the right: Self-aligning torque force scale-factor.

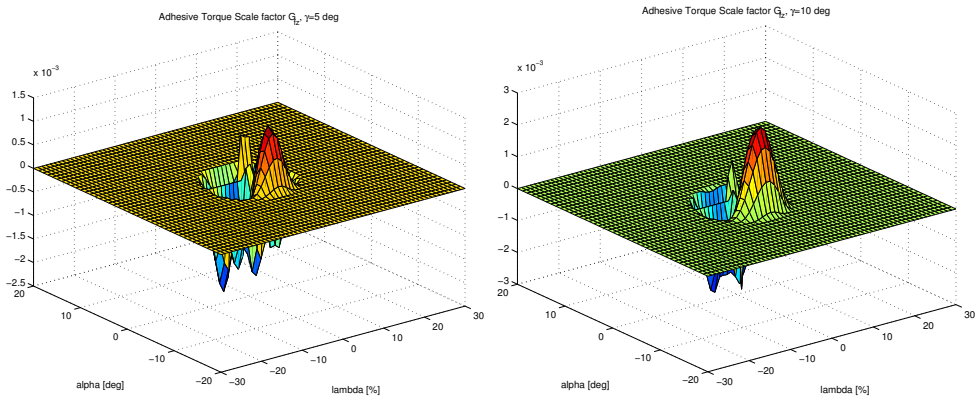

Figure 11 Self-aligning torque force scale-factors with camber. To the left: γ=5 [deg] and to the right: γ=10 [deg].

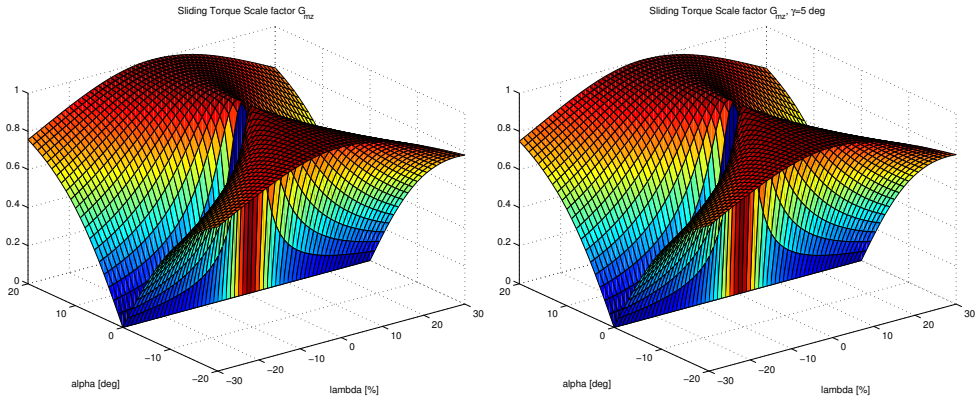

Figure 12 Self-aligning torque sliding scale-factors. To the right with camber, γ=5 [deg].

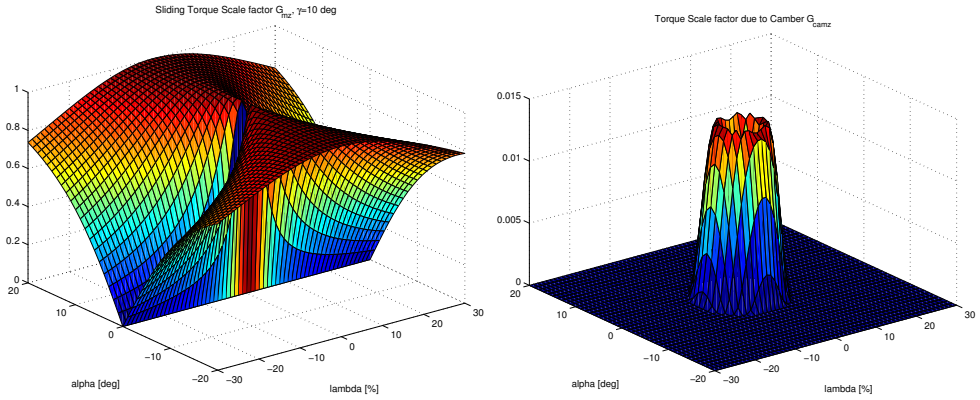

Figure 13 To the left: Self-aligning torque sliding scale-factor with camber, γ=10. To the right: Self-aligning torque camber scale-factor.

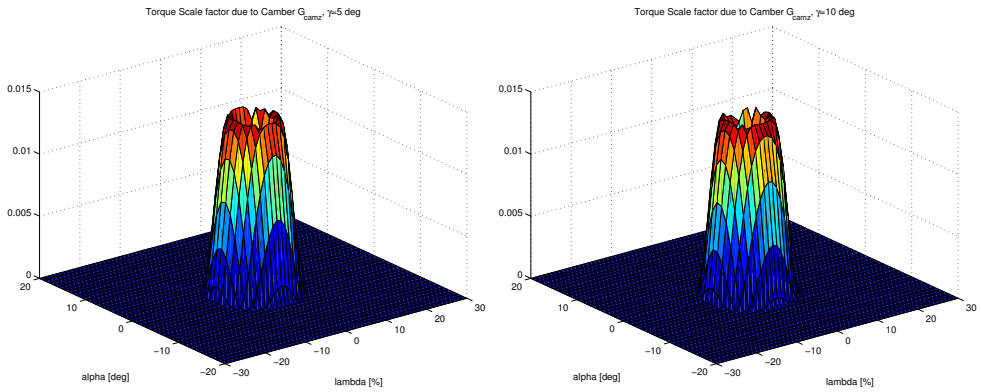

Figure 14 Self-aligning torque camber scale-factors with camber. To the left: γ=5 [deg] and to the right: γ=10 [deg].

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