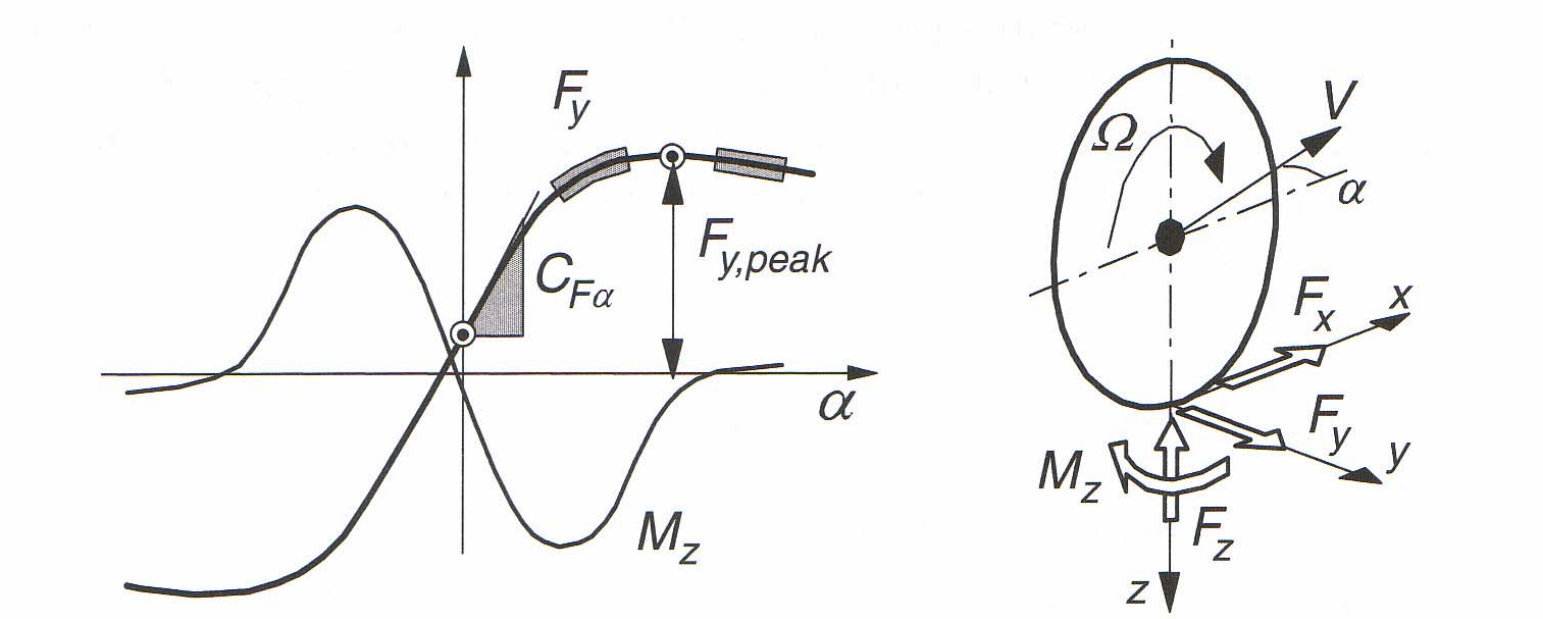
Tyre Characteristics and Vehicle Handling and Stability

α – slip angle

M_z – aligning torque



Tyre Characteristics and Vehicle Handling and Stability

α – slip angle

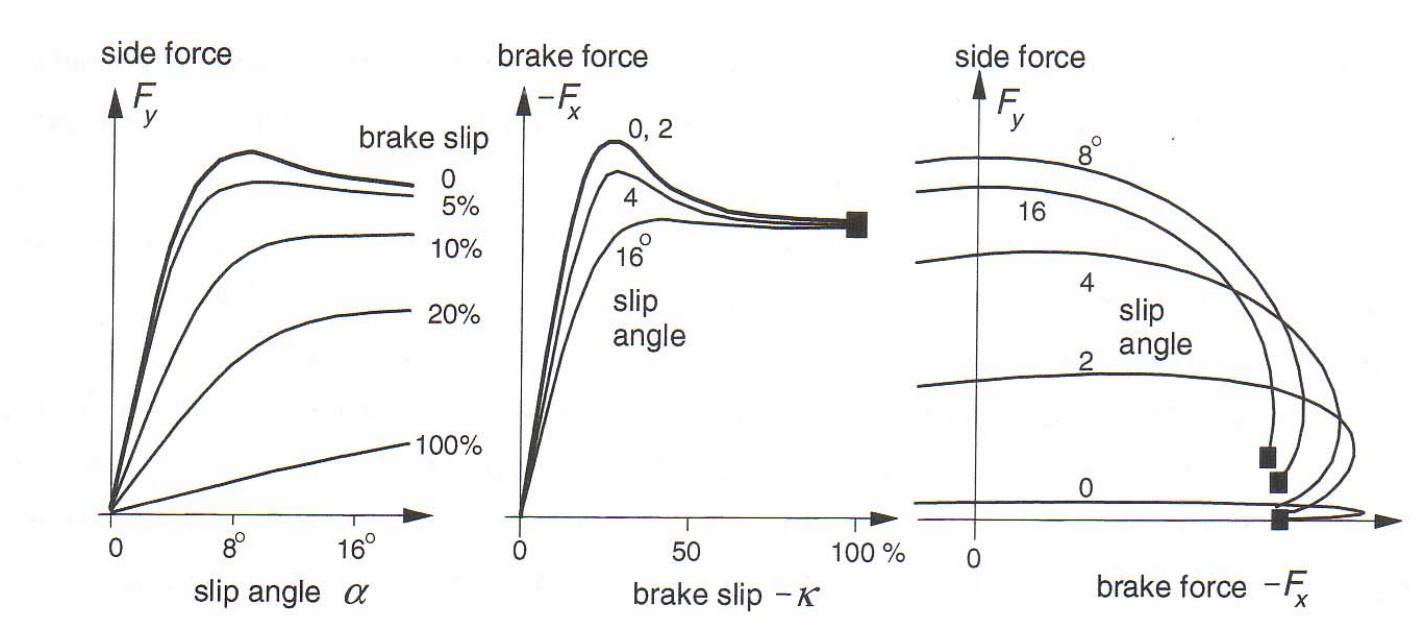
M_z – aligning torque

ω_0 – effective wheel speed

ω_w – actual wheel speed ($\omega_w > \omega_0$ in driving wheel, $\omega_w < \omega_0$ in braking)

$r_{eff} = \dfrac{V_x}{\omega_0}$ – effective radius

$\kappa = -\dfrac{V_x - r_{eff}\omega_w}{V_x} = -\dfrac{\omega_0 - \omega_w}{\omega_0}$ – (longitudinal) brake slip. For wheel lock $\omega_w = 0$, $\kappa = -1$.



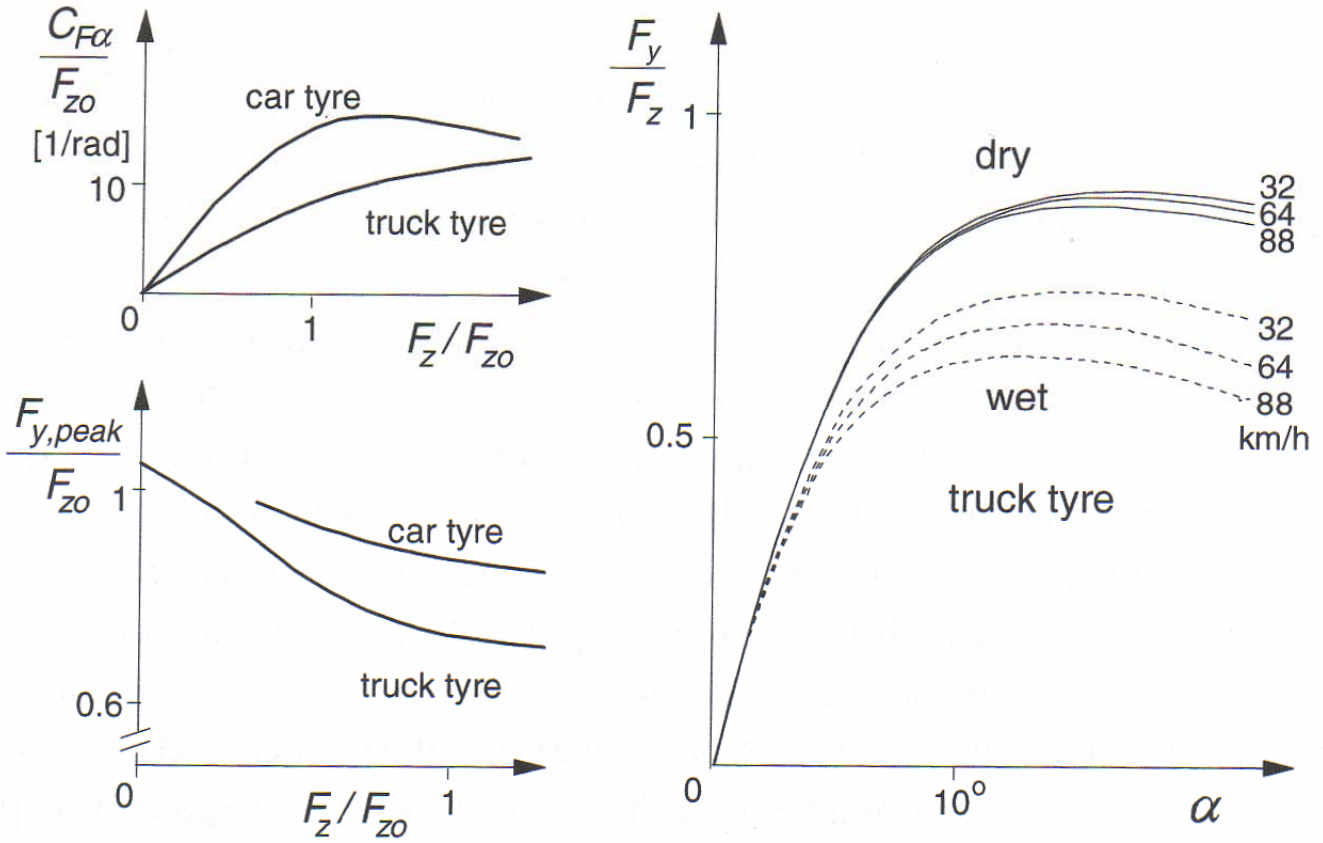
Tyre Characteristics and Vehicle Handling and Stability

$F_x = F_x(\kappa, \alpha, \gamma, F_z)$

$F_y = F_y(\kappa, \alpha, \gamma, F_z)$

$M_z = M_z(\kappa, \alpha, \gamma, F_z)$ – aligning torque

γ - camber angle F_{z0} – rated load : when $\gamma = 0 + \kappa = 0$ or $\alpha = 0$



Tyre Characteristics and Vehicle Handling and Stability

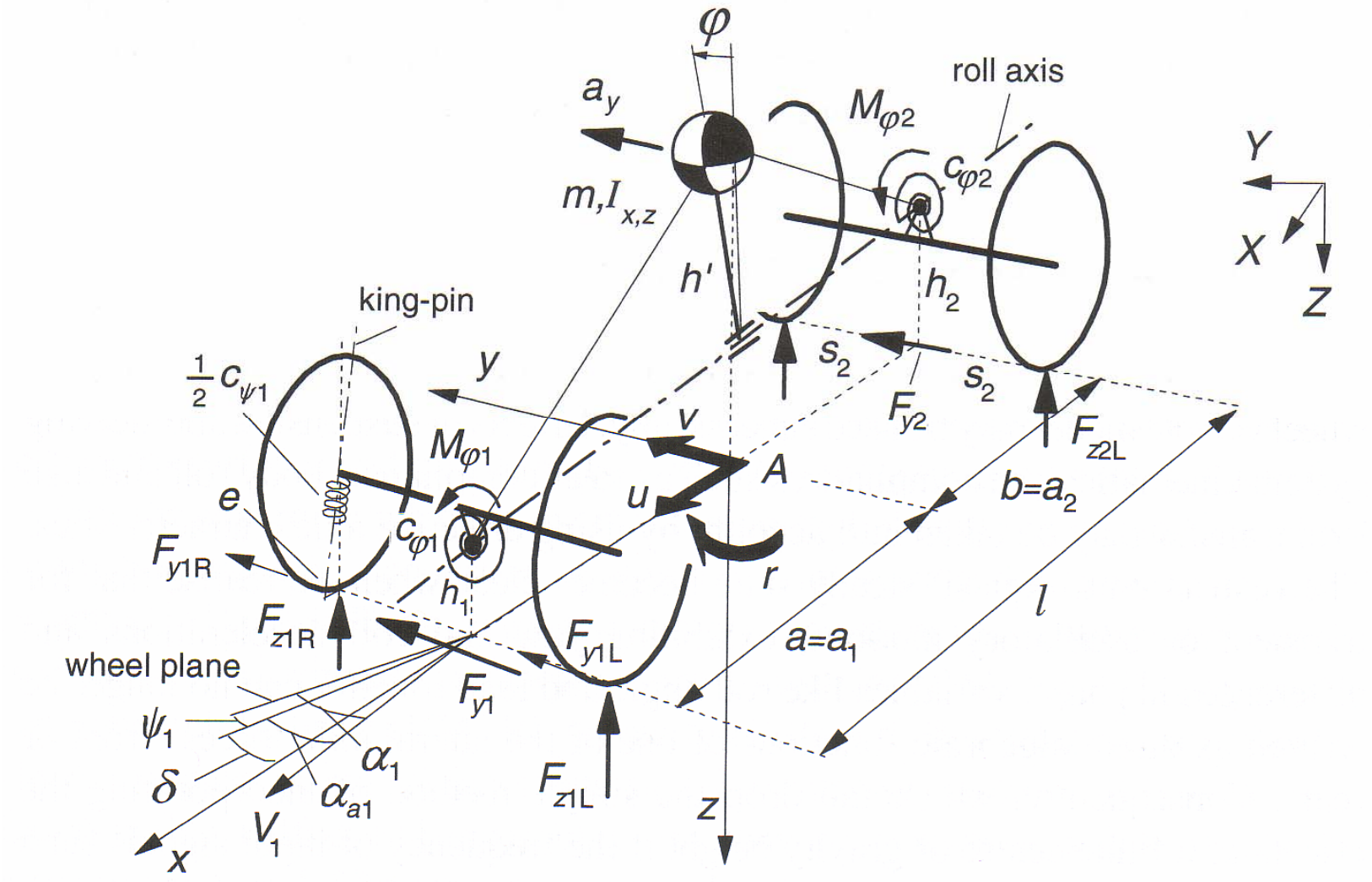
Forces and torque

$$F_x = F_x(\kappa, \alpha, \gamma, F_z)$$
$$F_y = F_y(\kappa, \alpha, \gamma, F_z)$$
$$M_z = M_z(\kappa, \alpha, \gamma, F_z)$$

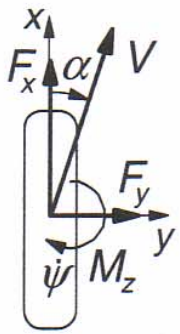
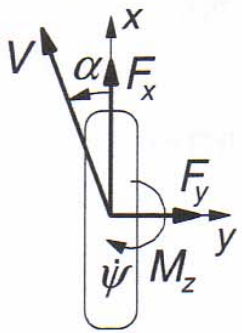
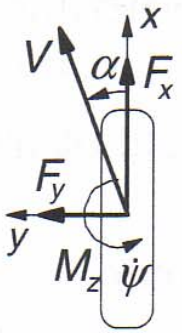
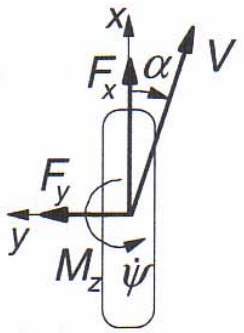
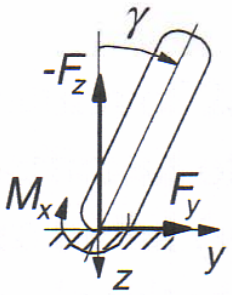
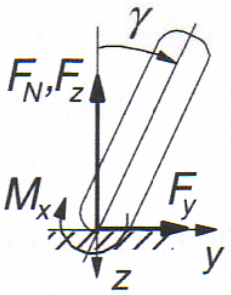
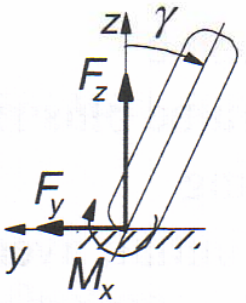
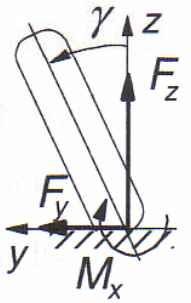
Linearised forces and torque

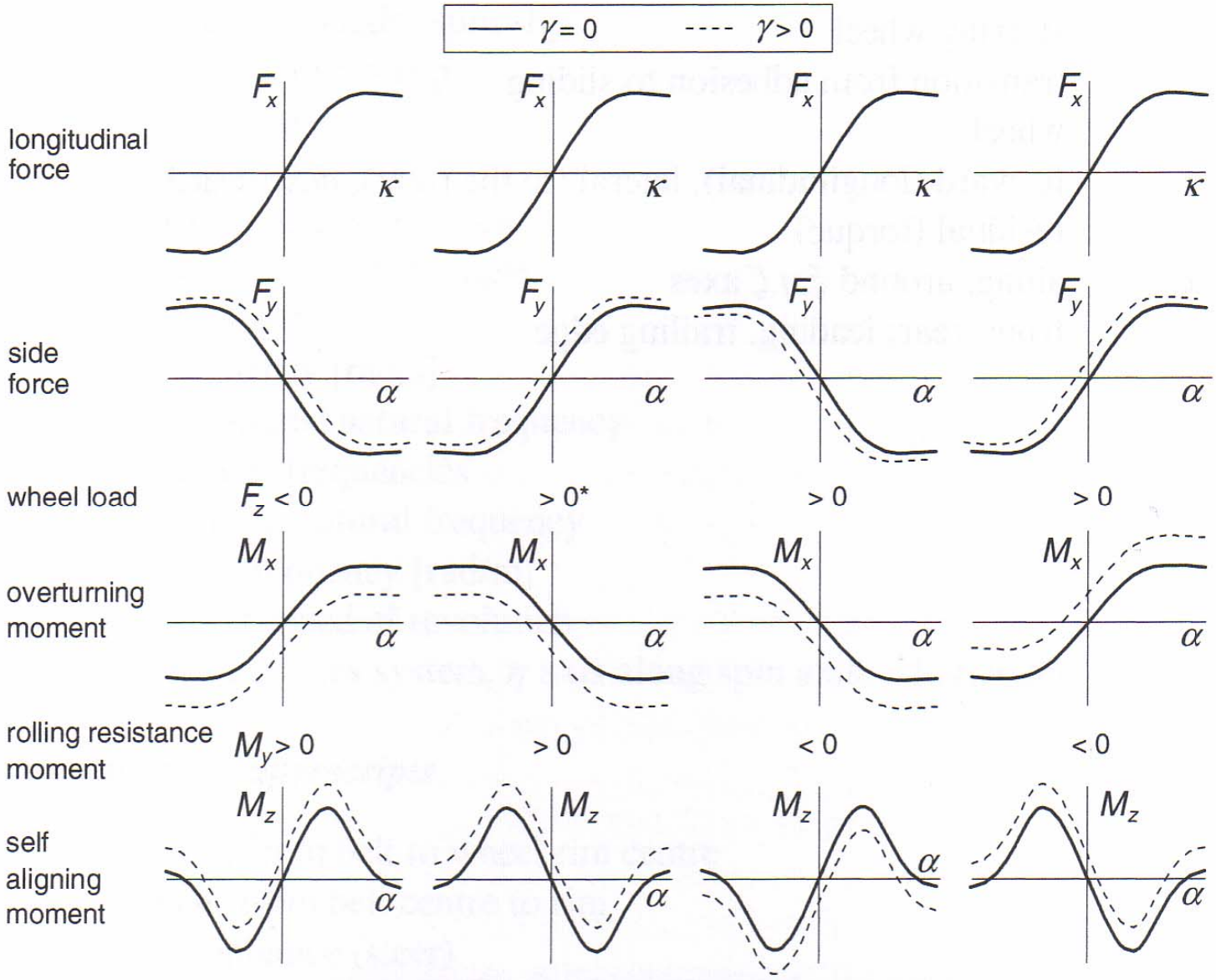
$$F_x = C_{F\kappa}\kappa$$
$$F_y = C_{F\alpha}\alpha + C_{F\gamma}\gamma$$
$$M_z = -C_{M\alpha}\alpha + C_{M\gamma}\gamma$$

where $C_* -$ stiffness


φ
roll axis
a_y
$M_{\varphi 2}$
$c_{\varphi 2}$
$m, I_{x,z}$
Y
X
Z
h'
h_2
king-pin
$\frac{1}{2}c_{\psi 1}$
y
s_2
s_2
F_{y2}
F_{z2L}
v
$M_{\varphi 1}$
A
u
e
$b=a_2$
$c_{\varphi 1}$
F_{y1R}
r
h_1
l
F_{z1R}
F_{y1L}
$a=a_1$
wheel plane
F_{y1}
ψ_1
α_1
δ
α_{a1}
F_{z1L}
z
V_1
x

Sign Conventions for Force and Moment and Wheel Slip

($V_x > 0$)	SAE	adapted SAE (Pacejka, this book)	ISO	adapted ISO (Besselink 2000)
side angle (top view)				
inclination/ camber angle (rear view)				
side slip	$\tan\alpha = \frac{V_{sy}}{V_x}$	$\tan\alpha = -\frac{V_{sy}}{V_x}$	$\tan\alpha = \frac{V_{sy}}{V_x}$	$\tan\alpha = -\frac{V_{sy}}{V_x}$
longitudinal slip	$\kappa = -\frac{V_{sx}}{V_x}$	$\kappa = -\frac{V_{sx}}{V_x}$	$\kappa = -\frac{V_{sx}}{V_x}$	$\kappa = -\frac{V_{sx}}{V_x}$
turn slip	*not defined*	$\varphi = -\frac{\dot{\psi}}{V_x}$	*not defined*	$\varphi = -\frac{\dot{\psi}}{V_x}$



*except for Chapter 9 where $F_N = -F_z > 0$