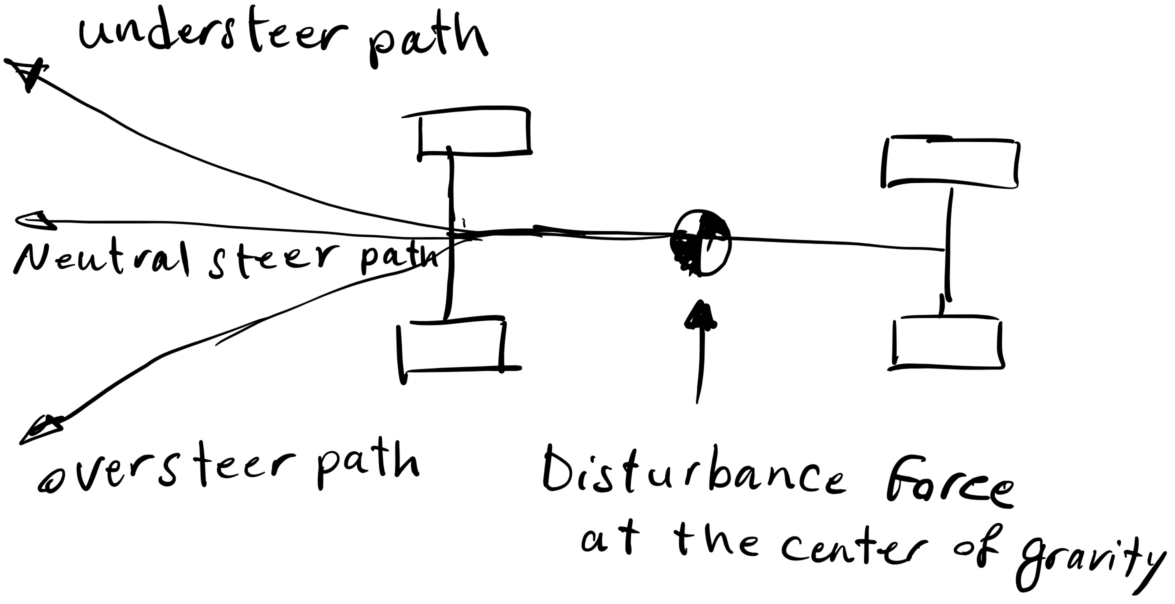
Module 12 - Suspension Effects on Cornering



$$\frac{W_f}{C_{\alpha f}} - \frac{W_r}{C_{\alpha r}}$$

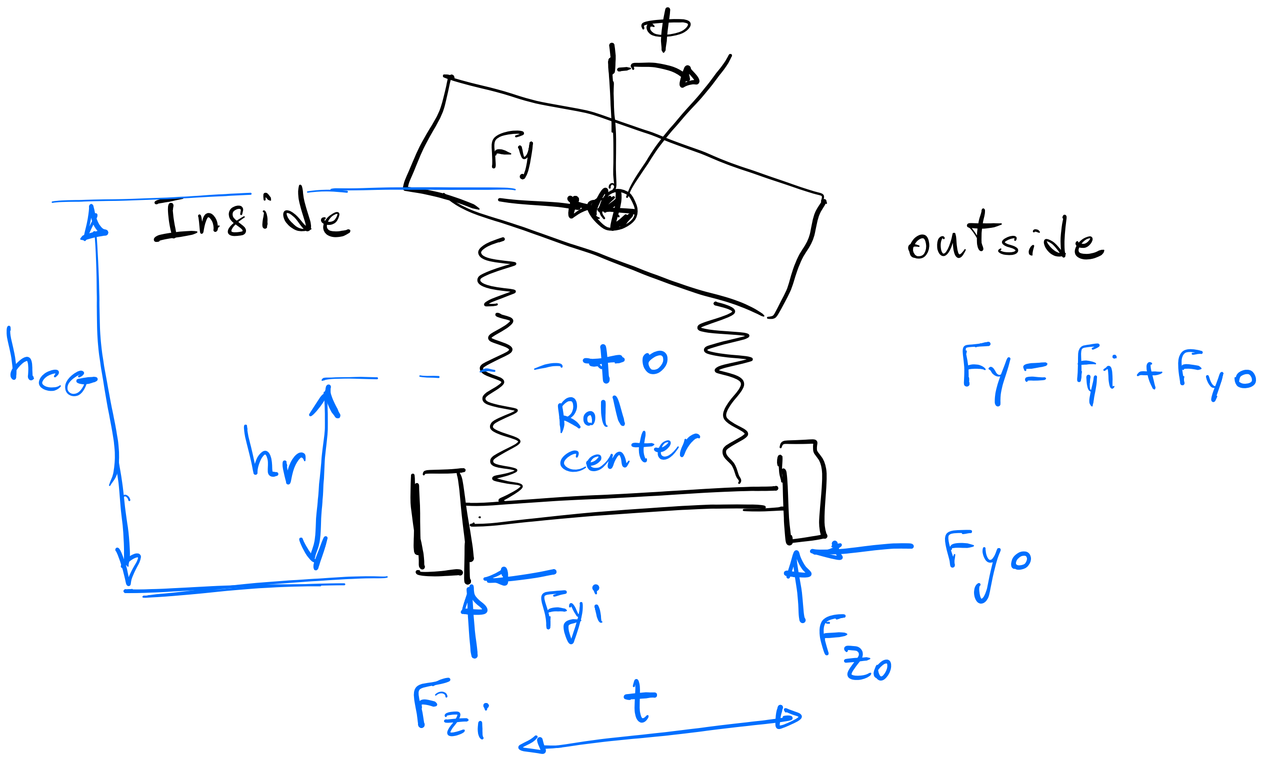
The ratio have the engineering unit of deg/g, and called "cornering compliance."

understeer: The front axel is more compliant than the rear
→ A lateral disturbance produces more sideslip at the front axel.

oversteer : The rear of the vehicle drifts out, There axle exhibits more cornering compliance.

Roll moment Distribution

- Load is transfered laterally in cornering due to the elevation of the vehicle c.g..
- This causes "roll moment." More roll moment on the front axle contributes to understeer, wheres more roll moment on the rear axle contributes to oversteer.



The stiffness is given by:

$$K_\Phi = 0.5 \; K_s S^2$$

K_Φ = roll stiffness of the suspension

K_s = vertical rate of each of the left and right spring.

S = lateral seperation between the springs.

$M_o \overset{+}{\circlearrowleft}$

$$F_{z_o}(t/2) - F_{y_o}(h_r) - F_{z_i}(t/2)$$

$$- F_{yi}(h_r) - F_y(h_{cg} - h_r) = 0$$

$$\underbrace{(F_{zo} - F_{zi})}_{\Delta F_z}(t/2) = F_{yo}(h_r) + F_{yi}(h_r) + F_y(h_{cg} - h_r)$$

$$= F_y h_r + F_y(h_{cg} - h_r)$$

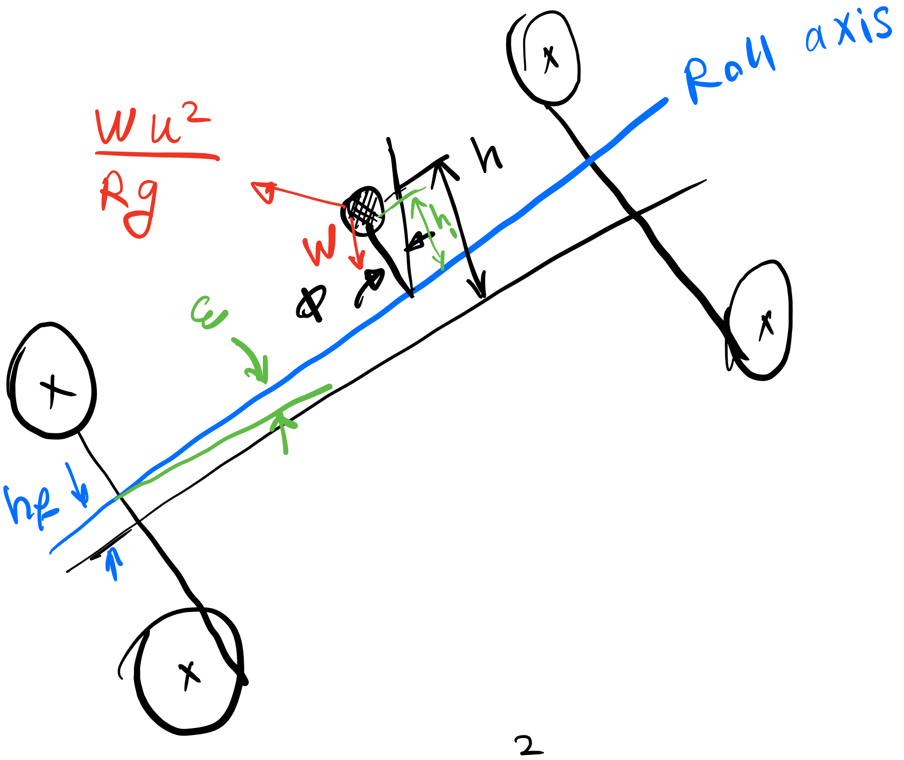
$(F_y = F_{yi} + F_{yo})$

$$\Delta F_z = 2F_y \frac{h_r}{t} + \frac{2}{t}\Big[F_y \underbrace{(h_{cg} - h_r)\Big]}_{K_\phi \phi}$$

$$\Delta F_z = 2F_y \frac{h_r}{t} + 2K_\phi \frac{\phi}{t}$$

Lateral load due to cornering forces independant of roll angle & roll moment distribution

Lateral Load due to vehicle roll.



$$M_\Phi = \left[W h_1 \sin\Phi + \frac{W u^2}{Rg} h_1 \cos\Phi \right] \cos\varepsilon$$

Small angles : $\cos\Phi = \cos\varepsilon = 1$ $\sin\Phi = \Phi$

$$M_\Phi = W h_1 \left[\frac{u^2}{Rg} + \Phi \right]$$ ①

$$M_\Phi = M_{\Phi f} + M_{\Phi r} = (K_{\Phi f} + K_{\Phi r}) \Phi$$ ②

$$\Rightarrow \Phi = \frac{W h_1 u^2 / Rg}{K_{\Phi f} + K_{\Phi r} - W h_1}$$ ③

Derivative with respect to the lateral acceleration.

Roll rate: $R_\phi = \frac{d\phi}{da_y} = \frac{Wh_1}{K_{\phi f} + K_{\phi r} - Wh_1}$

Force analysis: ① & ③

$$M'_{\phi f} = \underset{\underset{W_f h_f}{\swarrow}}{K_{\phi f}} \frac{Wh_1 u^2/Rg}{K_{\phi f} + K_{\phi r} - Wh_1} + W_f h_f \frac{u^2}{Rg}$$

$$M'_{\phi r} = \underset{\underset{W_r h_r}{\swarrow}}{K_{\phi r}} \frac{Wh_1 u^2/Rg}{K_{\phi f} + K_{\phi r} - Wh_1} + W_r h_r \frac{u^2}{Rg}$$