MAE 2030 Lecture #20: 3/26/21

Today: ① Cars (Recap)

Max acceleration of rear wheel drive car?

Assume: μ, d, h, L, m, g

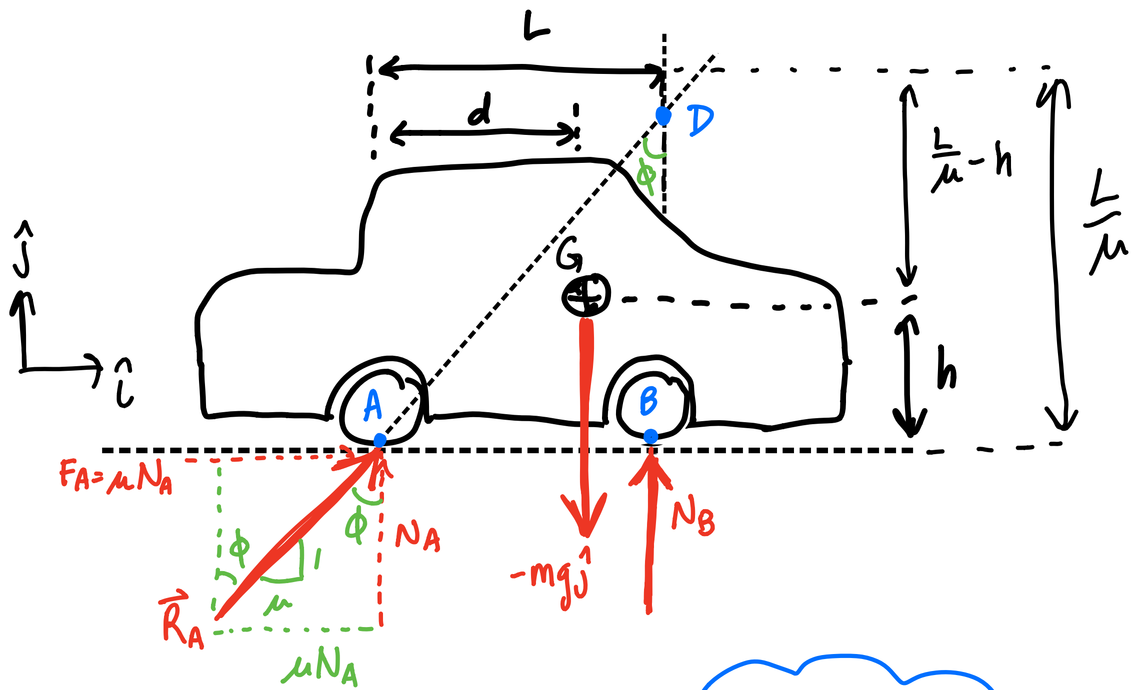
Assume: screeching (skidding) when we get max accel

Assume: car only translates $[\vec{a}_G = a_G \hat{i}]$

Friction angle ϕ

$\tan\phi = \mu$

coefficient of friction



$AMB_{/D}$: $\sum \vec{M}_{/D} = \dot{\vec{H}}_{/D}$

straight line motion "parallel motion"

$$\vec{r}_{G/D} \times -mg\hat{j} = \vec{r}_{G/D} \times m\vec{a}_G$$

→ algebra is skipped

$$\vec{r}_{G/D} = -\left(\frac{L}{\mu} - h\right)\hat{j} - (L-d)\hat{i}$$

$$\Rightarrow \{(L-d)\cancel{m}g\,\hat{k} = \left(\frac{L}{\mu} - h\right) a_G \cancel{m}\,\hat{k}\}$$

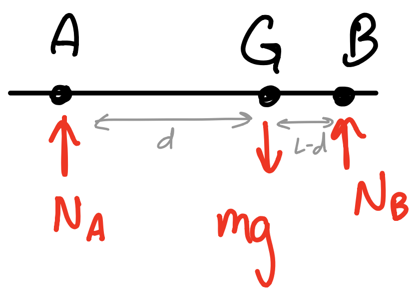
$$\{\ \} \cdot \hat{k} \Rightarrow \qquad a_G = \frac{(L-d)g}{\frac{L}{\mu} - h}$$

$$\boxed{a_G = \left(\frac{1 - d/L}{1 - \mu h/L}\right)\mu g}$$

<u>Check for special cases:</u>

ex) $\mu = 0 \Longrightarrow a_G = 0$ ✓

ex) $h = 0 \Longrightarrow$



✓ no change of N_A and N_B relative to Statics

$(L-d)N_B = d\,N_A$

$N_A + N_B = mg$

$N_A = \left(1 - \frac{d}{L}\right) mg$

→ statics reasoning : $a_G = \frac{\mu N_A}{m} = \left(1 - \frac{d}{L}\right)\mu g$

→ dynamics : $\left(1 - \frac{d}{L}\right)\mu g = a_G$
$h=0$

Calculate N_A & N_B :

LMB : $\sum \vec{F} = m\vec{a}$

$$\{(N_A + N_B - mg)\hat{j} + \mu N_A \hat{i} = m a_G \hat{i}\}$$

$$\{\ \} \cdot \hat{i} \Rightarrow \mu N_A = m a_G = \frac{(1 - \frac{d}{L})}{(1 - \frac{\mu h}{L})} \mu mg$$

$$\boxed{N_A = \frac{1 - d/L}{1 - \mu h/L} mg}$$

$$\{\ \} \cdot \hat{j} \Rightarrow N_A + N_B - mg = 0$$

$$N_B = mg - N_A$$

$$N_B = mg - \frac{1 - d/L}{1 - \mu h/L} mg$$

$$= mg\left(\frac{1 - \mu h/L - (1 - d/L)}{1 - \mu h/L}\right)$$

$$\boxed{N_B = \frac{d/L - \mu h/L}{1 - \mu h/L}}$$

To make sense: $N_B \geq 0$

$\Rightarrow \mu > L/h$ (bottom)

or $\Rightarrow \mu > d/h$ (top)

$d < L \Rightarrow$ problem is first w/ top of fraction

Not tipping $\Longleftrightarrow$ $\boxed{\mu \leq d/h}$

↳ implies that G is below the line from A to D

What does this physically mean?