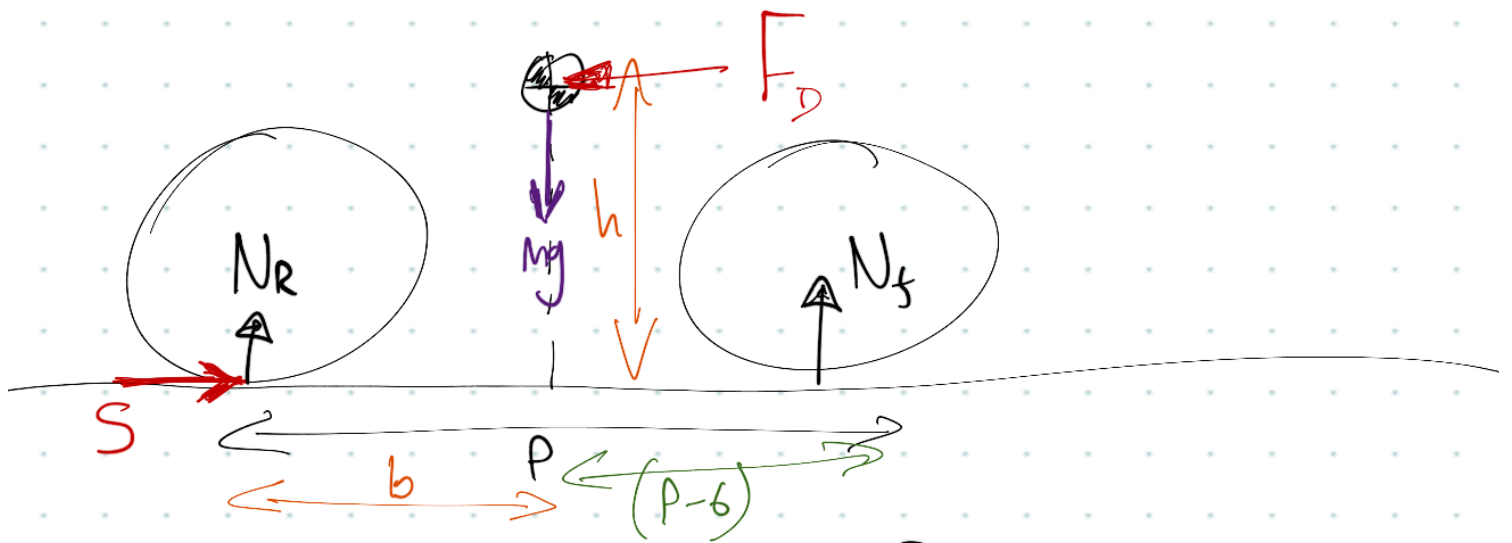


Calculating wheel loads ----



Resolve Horizontally $\Rightarrow F_D = S$ (1)

Resolve Vertically $\Rightarrow mg - N_f - N_r = 0$ (2)

Moments around Centre of gravity?

$$Sh - N_r b + N_f (P - b) = 0 \quad (3)$$

So from (2) $N_f = mg - N_r$ into (3)

$$Sh - N_r b + (mg - N_r)(P - b) = 0$$

$$Sh - \cancel{N_r b} + mgP - N_r P - mgb + \cancel{N_r b} = 0$$

$$S_h - N_R P + M_g(P-b) = 0$$

$$N_R P = S_h + M_g(P-b)$$

$$N_R = S_h/P + M_g \frac{(P-b)}{P}$$

$$N_R = M_g \frac{(P-b)}{P} + S_h/P$$

Now for N_f :

from (2) again $N_R = M_g - N_f \rightarrow (3)$

$$S_h - (M_g - N_f)b + N_f(P-b) = 0$$

$$S_h - M_g b + \cancel{N_f b} + N_f P - \cancel{N_f b} = 0$$

$$S_h - M_g b + N_f P = 0$$

$$N_f P = M_g b - S_h$$

So we have:

$$N_f = mg \frac{b}{p} - S^h/p$$

and

$$N_R = mg \frac{(p-b)}{p} + S^h/p$$

Let's look at some examples:

Consider a bike:

$$m_{\text{mass}} = 200 \text{ kg}$$

$$C_D A = 0.305 \text{ m}^2$$

$$b = 0.7 \text{ m}$$

$$p = 1.4 \text{ m}$$

$$h = 0.7 \text{ m}$$

Find maximum velocity?

$$N_R = mg \frac{(p-b)}{p} + S^h/p$$

$N_R = 200g$? Front totally unloaded.

$$200g = 200g \left(\frac{1.4 - 0.7}{1.4} \right) + S \left(\frac{0.7}{1.4} \right)$$

$$200g = 100g + \frac{1}{2} S$$

$$\frac{1}{2} S = 100g$$

$$S = 200g = \underline{\underline{1962 \text{ N}}}$$

So we have the driving force

$$S = F_D + F_w \quad (\text{Drag} + \text{Rotational friction})$$

We need F_D ... why? Need velocity.

$$F_D = S - F_w$$

$$F_D = 1962 - 0.02mg$$

$$F_D = \underline{\underline{1922.76 \text{ N}}}$$

2% of weight force

So Now ~

$$F_D = \frac{1}{2} \rho C_D A V^2$$

So

$$V^2 = \frac{F_D}{\frac{1}{2} \rho C_D A}$$

$$V^2 = \frac{1922.76}{0.5 \times 1.167 \times 0.305} = 10803.995$$

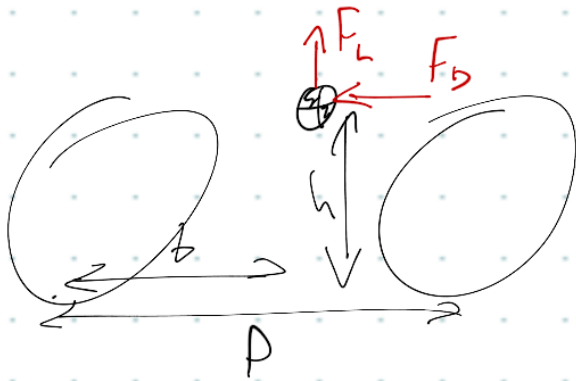
$$\text{So } V = 104 \text{ ms}^{-1} \sim 374 \text{ km/h}$$

Power needed?

$$\begin{aligned} \text{Power} &= \text{force} \times \text{Velocity} \\ &= 1922.76 \times 104 \\ &= \underline{200 \text{ kW}} \end{aligned}$$

$$(\text{Power} = \frac{1}{2} \rho C_D A V^3)$$

How about max velocity including Aerodynamic lift



Moments about rear contact patch

$$F_D h + F_L b = mgb$$

$$F_D = \frac{1}{2} \rho C_D A V^2$$

$$F_L = \frac{1}{2} \rho C_L A V^2$$

So $\frac{1}{2} \rho C_D A V^2 h + \frac{1}{2} \rho C_L A V^2 b = mgb$

$$V^2 \left(\frac{1}{2} \rho C_D A h + \frac{1}{2} \rho C_L A b \right) = mgb$$

$$V = \sqrt{\frac{mgb}{\left(\frac{1}{2} \rho C_D A h + \frac{1}{2} \rho C_L A b \right)}}$$

$$V = \sqrt{\frac{200g \times 0.7}{\left(\frac{1}{2} \times 1.167 \times 0.3 \times 0.65 + \frac{1}{2} \times 1.167 \times 0.1 \times \right)}}$$

$$V = 94.2 \text{ ms}^{-1} = \underline{\underline{339 \text{ km/h}}}$$