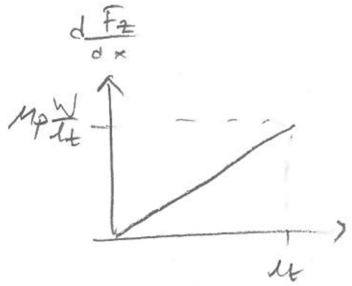
1) a) Där däcket inte glider gäller

$$\frac{dF_x}{dx} = k_t \cdot i \cdot x$$

Kritiskt värde på slippet nås då $k_t \cdot i_c \cdot l_t = \mu_p \frac{W}{l_t}$



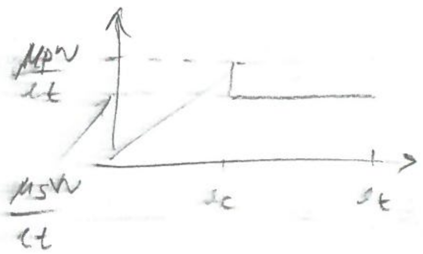
$$\Longrightarrow i_c = \frac{\mu_p W}{k_t \cdot l_t^2} = 1{,}09\%$$

Det är känt att $i = 5\% > i_c$ vilket innebär att vi har en glidzon

Det kritiska värdet där däcket går från vila till att glida nås då

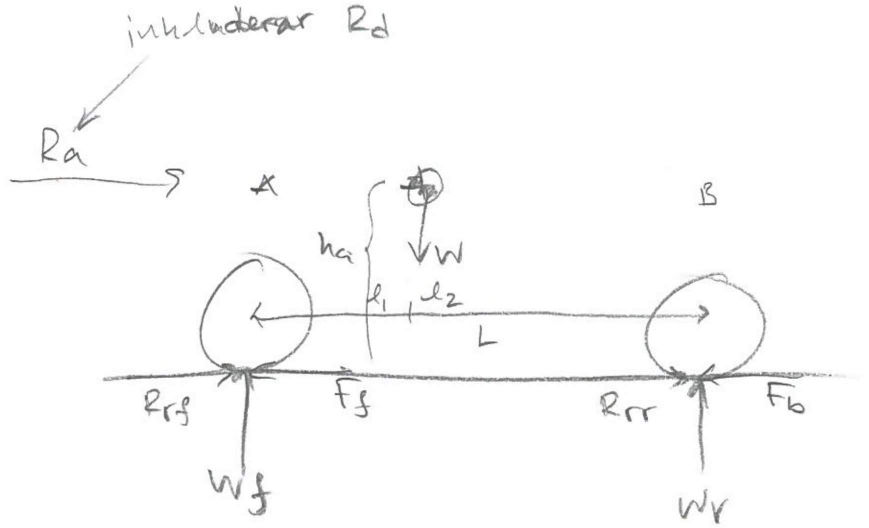
$$k_t \cdot i \cdot l_c = \frac{\mu_p W}{l_t} \Longrightarrow l_c = \frac{\mu_p W}{k_t l_t i} \approx 3\text{ cm}$$

$$\frac{dF_x}{dx} = \begin{cases} k_t \cdot i \cdot x, & 0 \leq x \leq l_c \\ \frac{\mu_s W}{l_t}, & l_c < x \leq l_t \end{cases}$$



b) $F_x = \frac{1}{2} l_c \frac{\mu_p W}{l_t} + (l_t - l_c) \frac{\mu_s W}{l_t} \approx 2{,}2$ kN

2



a) $h_a = h_d = h$, dett gör att momentpunkterna A, B väljs.

Momentjämvikt ger:

A: $W l_1 - W_r L + (F - R_r) h = 0$, $F = F_f + F_b$, $R_r = R_{rf} + R_{rr}$

B: $-W l_2 + W_f L + (F - R_r) h = 0$

Ekvationerna ger

$$W_r = W\frac{l_1}{L} + (F - R_r)\frac{h}{L} = /R_r = 0/ = W\frac{l_1}{L} + F\frac{h}{L}$$

$$W_f = W\frac{l_2}{L} - (F - R_r)\frac{h}{L} = /R_r = 0/ = W\frac{l_2}{L} - F\frac{h}{L}$$

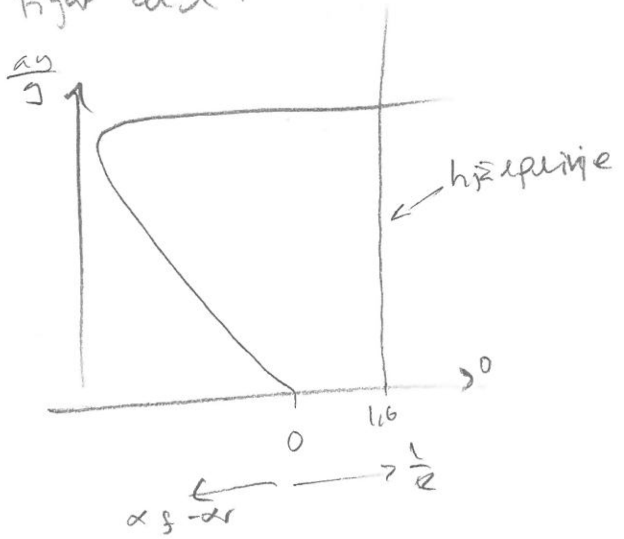
b) För en bakhjulsdriven bil gäller $F = F_b$

Maximal acceleration $\Longrightarrow$ $F_b = F_{b,max} = \mu W_r = W\frac{l_1 \mu}{L} + F_{b,max}\frac{h\mu}{L} \Longrightarrow$

$$F_{b,max}\left(\frac{L - h\mu}{L}\right) = W\frac{l_1\mu}{L} \Longrightarrow F_{b,max} = W\frac{l_1\mu}{L - h\mu} = 8681\ N$$

$$a = \frac{1}{m}\left(F_{b,max} - R_a\right) \approx 4{,}9\ m/s^2$$

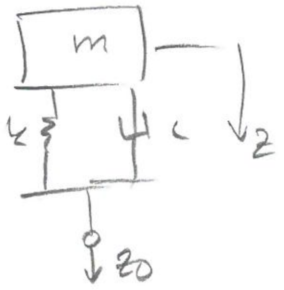
3a) $\frac{L}{R}\cdot\frac{180}{\pi} \approx 1{,}6^{\circ}$, rita in i figur med:



b) $\frac{a_y}{g} = \frac{v^2}{gR} \approx 0{,}46$

Avläst vid detta värde fås $\delta \approx 2{,}7^{\circ}$

4



$$m\ddot{z} = -k(z - z_0) - c(\dot{z} - \dot{z}_0) \xrightarrow{\mathcal{L}} ms^2 z = -kz + kz_0 - csz + csz_0$$

$$\Longrightarrow \quad (ms^2 + cs + k)z = (cs + k)z_0 \quad \Longrightarrow$$

$$G(s) = \frac{z}{z_0} = \frac{cs + k}{ms^2 + cs + k}$$

$$|G(i\omega)| = \left| \frac{ci\omega + k}{m(i\omega)^2 + ci\omega + k} \right| = \frac{\sqrt{(c\omega)^2 + k^2}}{\sqrt{(k - m\omega^2)^2 + (c\omega)^2}}$$

$$\omega = \frac{v}{\lambda} \cdot 2 \cdot \pi$$

$$z = |G(i\omega)| z_0 \approx 4{,}7 \text{ mm}$$

5

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

c)

Momentjämvikt ger:

$$W_f = \frac{l_2}{L}\frac{W}{2}$$

$$W_r = \frac{l_1}{L}\frac{W}{2}$$

$$K_{us} = 0.07$$

b) $$\delta = \frac{L}{R} + K_{us}\frac{V^2}{gR} = \Big/ R = \frac{V}{\omega} \Big/ = \frac{\omega}{V}\left(L + K_{us}\frac{V^2}{g}\right)$$

$$\Longrightarrow \omega = \frac{\delta \cdot V}{L + K_{us}\frac{V^2}{g}} \approx 0.26$$

Uppgift 6

$$m\frac{dv}{dt} = m\frac{dv}{dx}\frac{dx}{dt} = m\frac{dv}{dx}v = \frac{m}{2}\frac{dv^2}{dx} =$$

$$= F - R_a - R_r - R_g = /\text{Frikopplat}/ = -(a+bv^2) - w\sin\alpha$$

$$= /2^0 = 2\cdot\frac{\pi}{180} = \frac{\pi}{90}, \text{ liten vinkel approximation}/ = -(a+bv^2+w\alpha)$$

$$\Rightarrow /\text{Separabel diff}/ \to \frac{m}{2}\int_{v_i^2}^{v_f^2}\frac{1}{a+w\alpha+bv^2}dv^2 =$$

$$= /\text{Standardintegral: } \int\frac{1}{zx+c}dx = \frac{1}{z}\ln|zx+c|/ =$$

$$= \frac{m}{2b}\left[\ln(a+w\alpha+bv^2)\right]_{v_i^2}^{v_f^2} = \frac{m}{2b}\left(\ln(a+w\alpha+bv_f^2)-\ln(a+w\alpha+bv_i^2)\right)$$

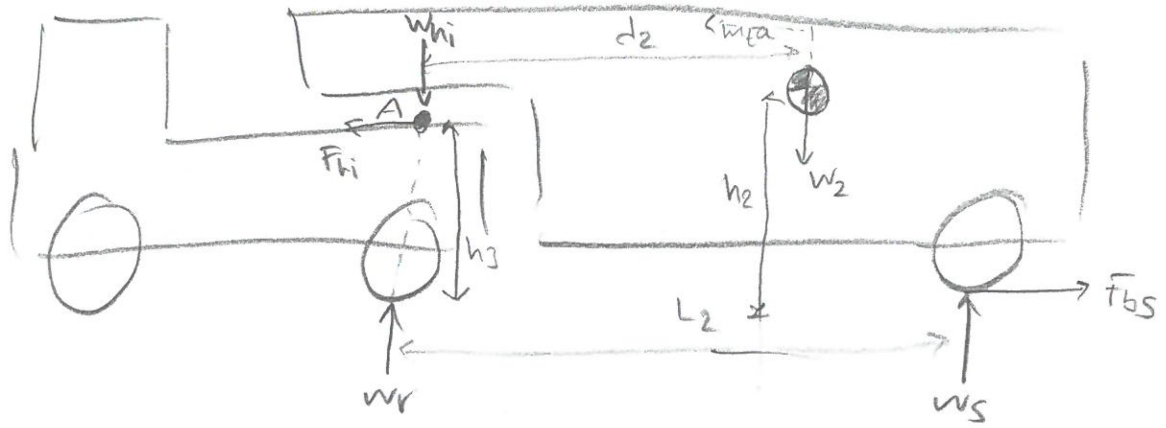
$$= -\int_0^{200}dx = -200 \Longrightarrow$$

$$\ln(a+w\alpha+bv_f^2) = \ln(a+w\alpha+bv_i^2) - \frac{400b}{m} \Longrightarrow$$

$$v_f = \sqrt{\frac{(a+w\alpha+bv_i^2)e^{-\frac{400b}{m}} - a - w\alpha}{b}}$$

$$\Delta v = (v_i - v_f)\cdot 3{,}6 \approx 16{,}7 \text{ km/h}$$

Uppgift 7



Momentjämvikt kring A:

$$\curvearrowleft A: \quad W_2 d_2 - m_s a(h_2 - h_3) - F_{bs} h_3 - W_s L_2 = 0 \Longrightarrow$$

$$W_s = \frac{1}{L_2}\left(W_2 d_2 - m_s a(h_2 - h_3) - F_{bs} h_3\right)$$

Maximal bromsning $\Longrightarrow F_{bs,max} = \mu W_s$

$$F_{bs,max} = \mu W_s = \frac{\mu}{L_2}\left(W_2 d_2 - m_s a(h_2 - h_3) - F_{bs,max} h_3\right) \Longrightarrow$$

$$F_{bs,max} \frac{L_2 + \mu h_3}{L_2} = \frac{\mu}{L_2}\left(W_2 d_2 - m_s a(h_2 - h_3)\right) \Longrightarrow$$

$$F_{bs,max} = \frac{\mu}{L_2 + \mu h_3}\left(W_2 d_2 - m_s a(h_2 - h_3)\right) \qquad (1)$$

Kraftjämvikt horisontellt (hela fordonet)

$$m_{tot} a = F_b + R_a = /\text{maximal bromsning}/ = \mu W_{tot} + R_a = \mu m_{tot} g + R_a$$

$$\Longrightarrow a = \mu g + \frac{R_a}{m_{tot}} \approx 8 \text{ m/s}^2$$

Svar:

$$F_{bs,max} = /\text{Sätt in värden i (1)}/ = 32{,}5 \text{ kN}$$

Uppgift 8

Momentjämvikt:

$F_{yf} l_1 - F_{yr} l_2 = 0$

$l_1 < l_2 \Rightarrow F_{yf} > F_{yr}$

Från figur väljs $F_{yf} = F_{y,max} = 8000 \Rightarrow$

$\alpha_f = 6^\circ$

Momentjämvikten ger

$F_{yr} = F_{yf} \frac{l_1}{l_2} \approx 5867 \Rightarrow$ /Från fig/ $\Rightarrow \alpha_r = 3^\circ$

$m \cdot a_y = m\frac{v^2}{R} = F_{yf} + F_{yr} \longrightarrow$

$v = \sqrt{(F_{yf} + F_{yr})\frac{R}{m}} \approx 73$ km/h

Svar: maximal hastighet 73 km/h m styrvinkel 6°