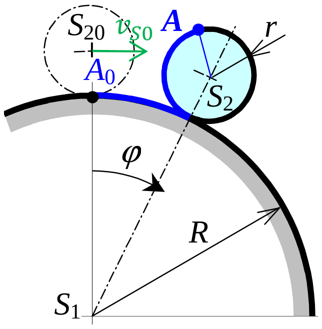

Válec o středu S_2 se valí po pevném válci o středu S_1.

Dáno: R, r, m, v_{S0} (počáteční rychlost)

Určete závislost $v_S = v_S(\varphi)$ a místo odpoutání.

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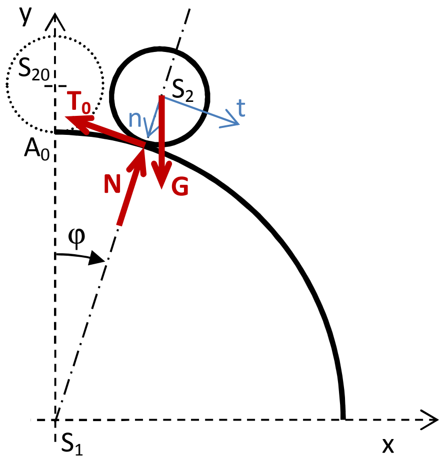
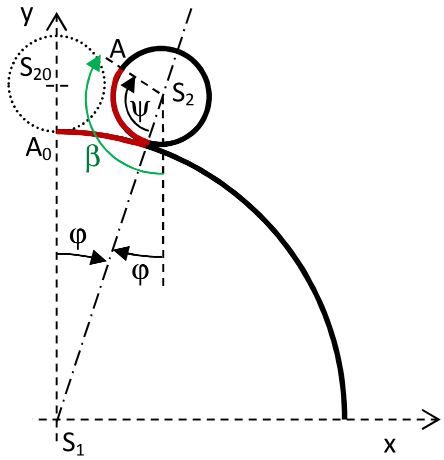
Uvolnění:



Kinematika:



$ma_t = m(R+r)\ddot{\varphi} = G \cdot sin\varphi - T_0$

$ma_n = m(R+r)\dot{\varphi}^2 = G \cdot cos\varphi - N$

$I_S\ddot{\beta} = \frac{1}{2}mr^2\ddot{\beta} = \frac{1}{2}mr^2\frac{R+r}{r}\ddot{\varphi} = T_0 r$

$\beta = \varphi + \psi \qquad R\varphi = r\psi \longrightarrow \psi = \frac{R\varphi}{r}$

$\beta = \varphi + \frac{R\varphi}{r} = \frac{R+r}{r}\varphi$

$\dot{\beta} = \frac{R+r}{r}\dot{\varphi}, \ \ddot{\beta} = \frac{R+r}{r}\ddot{\varphi}$

$$\frac{1}{2}mr(R+r)\ddot{\varphi} = T_0 r = (G \cdot sin\varphi - m(R+r)\ddot{\varphi})r \rightarrow \frac{1}{2}m(R+r)\ddot{\varphi} = m \cdot g \cdot sin\varphi - m(R+r)\ddot{\varphi}$$

$$\frac{3}{2}(R+r)\ddot{\varphi} = g \cdot sin\varphi$$

$$\ddot{\varphi} = \frac{2g}{3(R+r)} \cdot sin\varphi$$

$$\frac{d(\dot{\varphi}^2)}{2d\varphi} = \frac{2g}{3(R+r)} \cdot sin\varphi \rightarrow \dot{\varphi}^2 - \dot{\varphi}_0^2 = 2 \cdot \frac{2g}{3(R+r)} \cdot (1 - cos\varphi)$$

$$\omega^2 = \omega_0^2 + \frac{4g}{3(R+r)} \cdot (1 - cos\varphi) = \left(\frac{v_{S0}}{R+r}\right)^2 + \frac{4g}{3(R+r)} \cdot (1 - cos\varphi)$$

$$\omega(\varphi) = \sqrt{\left(\frac{v_{S0}}{R+r}\right)^2 + \frac{4g}{3(R+r)} \cdot (1 - cos\varphi)} \rightarrow v(\varphi) = \omega(\varphi) \cdot (R+r)$$

Místo odpoutání: $N \stackrel{\text{def}}{=} 0$

$$N \stackrel{\text{def}}{=} 0 = G \cdot cos\varphi - ma_n$$

$$0 = G \cdot cos\varphi - m(R+r)\omega^2$$

$$0 = mg \cdot cos\varphi - m(R+r)\left(\left(\frac{v_{S0}}{R+r}\right)^2 + \frac{4g}{3(R+r)} \cdot (1 - cos\varphi)\right)$$

$$(R+r)\left(\left(\frac{v_{S0}}{R+r}\right)^2 + \frac{4g}{3(R+r)}\right) = g \cdot cos\varphi + (R+r)\frac{4g}{3(R+r)}cos\varphi$$

$$\frac{v_{S0}^2}{R+r} + \frac{4g}{3} = \frac{7g}{3}cos\varphi$$

$$cos\varphi = \frac{3v_{S0}^2 + 4g(R+r)}{7g(R+r)}$$