Equations for footstrike
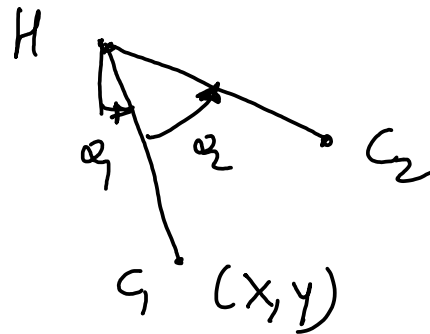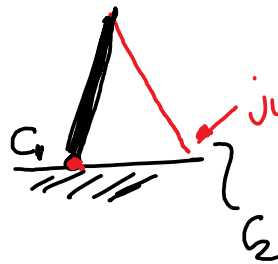
$$M\ddot{z} = B(\theta, \dot{\theta}) + J_{C_1}^T F_{C_1} + J_{C_2}^T F_{C_2}$$

$$\theta = \{\theta_1, \theta_2\}$$
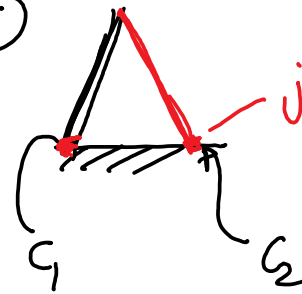
H

C_2

q_1 q_2

C_1 (x, y)

t^- (−)

t^+ (+)

just before collision

just after collision

C_1

C_2

C_1 C_2

$$V_{C_1}^- = 0$$

$$V_{C_2}^+ = 0$$

− denotes before collision

+ denotes after collision

P_{C_2}

$$\int_{t^-}^{t^+} M\ddot{z}\, dt = \int_{t^-}^{t^+} B(\theta, \dot{\theta})\, dt + \int_{t^-}^{t^+} J_{C_1}^T F_{C_1}\, dt + \int_{t^-}^{t^+} J_{C_2}^T F_{C_2}\, dt$$

coriolis, centripetal

0

impulse

impulse

P_{C_2}

$$M\left(\dot{z}^+ - \dot{z}^-\right) = J_{C_2}^T P_{C_2}$$

t^+ t^-

$$V_{C_2}^+ = \underline{\underline{J_{C_2}}} \, \dot{z}^{\,+}_{\underline{}} = 0 \qquad —② $$

$$M(\dot{z}^+ - \dot{z}^-) = J_{C_2}^T \, P_{C_2} \qquad —① \quad \text{(from previous page)}$$

$$\underline{\underline{M}} \, \dot{z}^+ - \underline{\underline{J_{C_2}^T}} \, P_{C_2} = M\dot{z}^- \qquad —①a$$
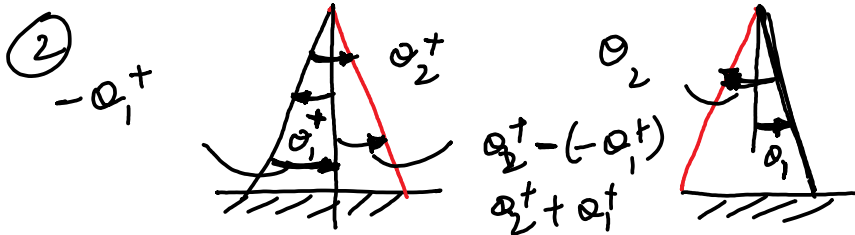
From ①a & ②

$$\boxed{\begin{bmatrix} \underline{M} & -J_{C_2}^T \\ J_{C_2} & 0 \end{bmatrix} \begin{bmatrix} \dot{z}^+ \\ P_{C_2} \end{bmatrix} = \begin{bmatrix} M\dot{z}^- \\ 0 \end{bmatrix}} \qquad —①a$$

---

① Detect collision

$$\theta_2 = -2\theta_1 \quad \Rightarrow \quad \boxed{\theta_2 + 2\theta_1 = 0}$$

②

$$\theta_2^+ - (-\theta_1^+)$$
$$\theta_2^+ + \theta_1^+$$
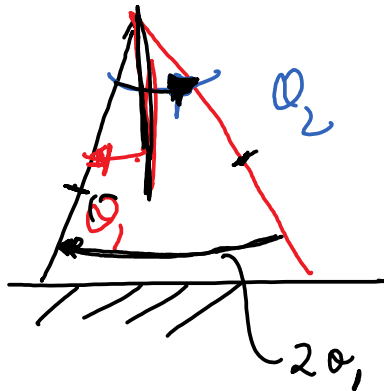
Just after footstrike   swap.

$$\boxed{\theta_2 = -\theta_2^+ \quad ; \quad \theta_1 = \theta_1^+ + \theta_2^+}$$