1) $T^c = \frac{1}{2} m \dot{s}^2$

$T^d = \frac{1}{2} M v_G^2 + \frac{1}{2} \bar{\omega} \cdot \underset{G}{I}(\bar{\omega}) = \frac{1}{2} M v_G^2 + \frac{1}{2} \underset{G}{I}_{33} \omega^2$

$\bar{x}_G = [s + (R_1 - R_2)\cos(\pi - \theta)]\bar{e}_1 - (R_1 - R_2)\operatorname{sen}\theta\, \bar{e}_2 = [s - (R_1 - R_2)\cos\theta]\bar{e}_1 - (R_1 - R_2)\operatorname{sen}\theta\, \bar{e}_2$

$\bar{v}_G = [\dot{s} + (R_1 - R_2)\operatorname{sen}\theta\, \dot{\theta}]\bar{e}_1 - (R_1 - R_2)\cos\theta\, \dot{\theta}\, \bar{e}_2$

$v_G^2 = \dot{s}^2 + (R_1 - R_2)^2 \dot{\theta}^2 + 2(R_1 - R_2)\operatorname{sen}\theta\, \dot{\theta}\, \dot{s}$

$\bar{v}_H^R = 0 = \bar{v}_G^R + \bar{\omega}(H - G) = (R_1 - R_2)\dot{\theta}\bar{t} + \omega \bar{b} \wedge (-R_2 \bar{n}) = [(R_1 - R_2)\dot{\theta} + R_2 \omega]\bar{t}$

quindi $\omega = -\frac{R_1 - R_2}{R_2}\dot{\theta}$. $\qquad \underset{G}{I}_{33} = \frac{M R_2^2}{2}$

$T^d = \frac{M}{2}[\dot{s}^2 + (R_1 - R_2)^2 \dot{\theta}^2 + 2(R_1 - R_2)\operatorname{sen}\theta\, \dot{\theta}\, \dot{s}] + \frac{M \cancel{R_2^2}}{4} \frac{(R_1 - R_2)^2}{\cancel{R_2^2}} \dot{\theta}^2$

$T = T^c + T^d = \frac{1}{2}(m + M)\dot{s}^2 + \frac{3}{4} M (R_1 - R_2)^2 \dot{\theta}^2 + M(R_1 - R_2)\operatorname{sen}\theta\, \dot{\theta}\, \dot{s}$

$V = M g y_G + \frac{k}{2}(A - G)^2 = -M(R_1 - R_2)\operatorname{sen}\theta - k R_1 (R_1 - R_2)\cos\theta$

$L = T - V$

eq. di Lagrange:

$(m + M)\ddot{s} + M(R_1 - R_2)(\operatorname{sen}\theta\, \ddot{\theta} + \cos\theta\, \dot{\theta}^2) = 0$

$\frac{3}{2} M (R_1 - R_2)^{\cancel{2}} \ddot{\theta} + M\cancel{(R_1 - R_2)}\operatorname{sen}\theta\, \ddot{s} + M g \cancel{(R_1 - R_2)}\cos\theta - k R_1 \cancel{(R_1 - R_2)}\operatorname{sen}\theta = 0$

2) $H = T + V \qquad p_s = \frac{\partial L}{\partial \dot{s}} = (m + M)\dot{s} + M(R_1 - R_2)\operatorname{sen}\theta\, \dot{\theta}$

3) $\frac{\partial V}{\partial s} = 0 \qquad \frac{\partial V}{\partial \theta} = -M g (R_1 - R_2)\cos\theta + k R_1 (R_1 - R_2)\operatorname{sen}\theta \rightarrow \operatorname{tg}\theta = \frac{M g}{k R_1}$

si ha equilibrio per $\theta = \operatorname{arctg}\frac{M g}{k R_1}$ e s qualunque.

4) $H(t=0) = M g (R_1 - R_2) \qquad p_s(t=0) = 0$

$p_s(\theta=0) = (m + M)\dot{s} = 0 \qquad \rightarrow \dot{s} = 0$

$H(\theta=0) = \frac{1}{2}\cancel{(m+M)\dot{s}^2} + \frac{3}{4} M (R_1 - R_2)^{\cancel{2}} \dot{\theta}^2 - k R_1 \cancel{(R_1 - R_2)} = M g \cancel{(R_1 - R_2)} \rightarrow \dot{\theta} = \sqrt{\frac{4}{3} \frac{M g + k R_1}{M(R_1 - R_2)}}$

$\bar{v}_G(\theta=0) = -(R_1 - R_2)\dot{\theta}\, \bar{e}_2 = -\frac{2}{\sqrt{3}}\sqrt{(R_1 - R_2)(g + \frac{k}{M} R_1)}\; \bar{e}_2$

5) $m \bar{a}_G = m \bar{g} + k(A - G) + \bar{\phi}_H$