

$$\mathbf{M} := \begin{pmatrix}
J_c + 2 \cdot m_1 \cdot \mathbf{a}^2 & 0 & 0 & -a \cdot m_1 \cdot e \cdot \cos(\beta - \alpha - \phi_1) & a \cdot m_1 \cdot e \cdot \cos(\beta - \alpha + \phi_2) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 2 \cdot m_1 + m_k & 0 & m_1 \cdot e \cdot \sin(\phi_1) & -m_1 \cdot e \cdot \sin(\phi_2) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 2 \cdot m_1 + m_k & m_1 \cdot e \cdot \cos(\phi_1) & m_1 \cdot e \cdot \cos(\phi_2) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & m_1 \cdot e \cdot \sin(\phi_1) & m_1 \cdot e \cdot \cos(\phi_1) & J_{c1} + J_{s1} + J_{w1} + m_1 \cdot e^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -m_1 \cdot e \cdot \sin(\phi_2) & m_1 \cdot e \cdot \cos(\phi_2) & 0 & J_{c1} + J_{s1} + J_{w1} + m_1 \cdot e^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{pmatrix}$$

$$\mathbf{Q} := \begin{pmatrix}
\omega \alpha \\
v_x \\
v_y \\
\omega \phi_1 \\
\omega \phi_2 \\
\alpha \\
x \\
y \\
\phi_1 \\
\phi_2 \\
v_{x1} \\
v_{y1} \\
v_{x2} \\
v_{y2} \\
x_1 \\
y_1 \\
x_2 \\
y_2
\end{pmatrix}$$

$$\begin{aligned}
& \mathbf{M}_{el1} - \mathbf{M}_{el2} - 2 \cdot \mathbf{H} \cdot \mathbf{b}_x \cdot v_x - 2 \cdot \mathbf{K} \cdot \mathbf{k}_x \cdot x - 2 \cdot \mathbf{H}^2 \mathbf{k}_x \cdot \alpha - 2 \cdot \mathbf{H}^2 \mathbf{b}_x \cdot \omega \alpha - 2 \cdot \mathbf{k}_y \cdot l^2 \cdot \alpha - 2 \cdot \mathbf{b}_y \cdot l^2 \cdot \omega \alpha + m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha - \phi_1) \cdot (\omega \phi_1)^2 + m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha + \phi_2) \cdot (\omega \phi_2)^2 \\
& - \mathbf{T}_{r,1} - m_1 \cdot e \cdot (\omega \phi_1)^2 \cdot \cos(\phi_1) + m_1 \cdot e \cdot (\omega \phi_2)^2 \cdot \cos(\phi_2) - 2 \cdot \mathbf{b}_x \cdot v_x - 2 \cdot \mathbf{k}_x \cdot x - 2 \cdot \mathbf{H} \cdot \mathbf{k}_x \cdot \alpha - 2 \cdot \mathbf{H} \cdot \mathbf{b}_x \cdot \omega \alpha \\
& - \mathbf{F}_{r,1} - g \cdot (2 \cdot m_1 + m_k) + m_1 \cdot e \cdot (\omega \phi_2)^2 \cdot \sin(\phi_2) + m_1 \cdot e \cdot (\omega \phi_1)^2 \cdot \sin(\phi_1) - 2 \cdot \mathbf{b}_y \cdot v_y - 2 \cdot \mathbf{k}_y \cdot y \\
& \mathbf{M}_{el1} - m_1 \cdot e \cdot g \cdot \cos(\phi_1) - m_1 \cdot a \cdot e \cdot \cos(\beta - \alpha - \phi_1) \cdot \omega \alpha - m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha - \phi_1) \cdot \alpha \cdot \omega \alpha + m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha - \phi_1) \cdot \alpha \cdot \omega \phi_1 - m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha - \phi_1) \cdot \omega \alpha \cdot \omega \phi_1 \\
& \mathbf{M}_{el2} - m_1 \cdot e \cdot g \cdot \cos(\phi_2) - m_1 \cdot a \cdot e \cdot \cos(\beta - \alpha + \phi_2) \cdot \omega \alpha - m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha + \phi_2) \cdot \alpha \cdot \omega \alpha + m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha + \phi_2) \cdot \alpha \cdot \omega \phi_2 - m_1 \cdot a \cdot e \cdot \sin(\beta - \alpha + \phi_2) \cdot \omega \alpha \cdot \omega \phi_2 \\
& \omega \alpha \\
& v_x \\
& v_y \\
& \omega \phi_1 \\
& \omega \phi_2 \\
\mathbf{W} := & -\mu \cdot \left[(y - y_1) \cdot k \cdot \left[1 - \frac{(1 - R^2) \cdot [1 - \text{sgn} \cdot (y - y_1) \cdot \text{sgn} \cdot (v_y - v_{y1})]}{2} \right] \right] \cdot \text{sgn}(v_{x1} - v_x) + \mu \cdot \left[(y_1 - y_2) \cdot k \cdot \left[1 - \frac{(1 - R^2) \cdot [1 - \text{sgn} \cdot (y_1 - y_2) \cdot \text{sgn} \cdot (v_{y1} - v_{y2})]}{2} \right] \right] \cdot \text{sgn}(v_{x2} - v_{x1}) \\
& - m_{n1} \cdot g + (y - y_1) \cdot k \cdot \left[1 - \frac{(1 - R^2) \cdot [1 - \text{sgn} \cdot (y - y_1) \cdot \text{sgn} \cdot (v_y - v_{y1})]}{2} \right] - (y_1 - y_2) \cdot k \cdot \left[1 - \frac{(1 - R^2) \cdot [1 - \text{sgn} \cdot (y_1 - y_2) \cdot \text{sgn} \cdot (v_{y1} - v_{y2})]}{2} \right] \\
& - \mu \cdot \left[(y_1 - y_2) \cdot k \cdot \left[1 - \frac{(1 - R^2) \cdot [1 - \text{sgn} \cdot (y_1 - y_2) \cdot \text{sgn} \cdot (v_{y1} - v_{y2})]}{2} \right] \right] \cdot \text{sgn}(v_{x2} - v_{x1}) \\
& - m_{n2} \cdot g + (y_1 - y_2) \cdot k \cdot \left[1 - \frac{(1 - R^2) \cdot [1 - \text{sgn} \cdot (y_1 - y_2) \cdot \text{sgn} \cdot (v_{y1} - v_{y2})]}{2} \right] \\
& v_{x1} \\
& v_{y1} \\
& v_{x2} \\
& v_{y2}
\end{aligned}$$