$$Ek := \frac{m_k \cdot vx^2}{2} + \frac{m_k \cdot vy^2}{2} + \frac{J_c \cdot \omega\alpha^2}{2} + \frac{\left(J_{c1} + J_{w1} + J_{s1}\right)\cdot\left(\omega\phi_1\right)^2}{2} + \frac{\left(J_{c1} + J_{w1} + J_{s1}\right)\cdot\left(\omega\phi_2\right)^2}{2} + \ldots$$
$$+ m_1 \cdot \frac{\left(vx_{c1}\right)^2}{2} + m_1 \cdot \frac{\left(vy_{c1}\right)^2}{2} + m_1 \cdot \frac{\left(vx_{c2}\right)^2}{2} + m_1 \cdot \frac{\left(vy_{c2}\right)^2}{2}$$

$$U := m_k \cdot g \cdot y + m_1 \cdot g \cdot yc_1 + m_1 \cdot g \cdot y_{c2} \ldots$$
$$+ \frac{k_y \cdot (y + l\cdot\alpha)^2}{2} + \frac{k_y \cdot (y - l\cdot\alpha)^2}{2} + \frac{k_x \cdot (x + H\cdot\alpha)^2}{2} + \frac{k_x \cdot (-x - H\cdot\alpha)^2}{2}$$

$$L := \frac{m_k \cdot vx^2}{2} + \frac{m_k \cdot vy^2}{2} + \frac{J_c \cdot \omega\alpha^2}{2} + \frac{\left(J_{c1} + J_{w1} + J_{s1}\right)\cdot\left(\omega\phi_1\right)^2}{2} + \frac{\left(J_{c1} + J_{w1} + J_{s1}\right)\cdot\left(\omega\phi_2\right)^2}{2} + \ldots$$
$$+ m_1 \cdot \frac{\left(vx_{c1}\right)^2}{2} + m_1 \cdot \frac{\left(vy_{c1}\right)^2}{2} + m_1 \cdot \frac{\left(vx_{c2}\right)^2}{2} + m1 \cdot \frac{\left(vy_{c2}\right)^2}{2} - mk\cdot g\cdot y - m1\cdot g\cdot y_{c1} - m1\cdot g\cdot y_{c2} \ldots$$
$$- \frac{k_y \cdot (y + l\cdot\alpha)^2}{2} - \frac{k_y \cdot (y - l\cdot\alpha)^2}{2} - \frac{k_x \cdot (x + H\cdot\alpha)^2}{2} - \frac{k_x \cdot (-x - H\cdot\alpha)^2}{2}$$

$$D := \frac{b_y \cdot (vy + l\cdot\omega\alpha)^2}{2} + \frac{b_y \cdot (vy - l\cdot\omega\alpha)^2}{2} + \frac{b_x \cdot (-vx - H\cdot\omega\alpha)^2}{2} + \frac{b_x \cdot (vx + H\cdot\omega\alpha)^2}{2}$$

$$x_{c1} := -a\cdot\cos(\beta - \alpha) - e\cdot\cos\left(\phi_1\right) + x$$
$$y_{c1} := a\cdot\sin(\beta - \alpha) + e\cdot\sin\left(\phi_1\right) + y$$
$$x_{c2} := a\cdot\cos(\beta - \alpha) + e\cdot\cos\left(\phi_2\right) + x$$
$$y_{c2} := -a\cdot\sin(\beta - \alpha) + e\cdot\sin\left(\phi_2\right) + y$$

$$vx_{c1} := vx - a\cdot\omega\alpha\cdot\sin(\beta - \alpha) + \omega\phi_1\cdot e\cdot\sin\left(\phi_1\right)$$

$$vy_{c1} := vy - a\cdot\omega\alpha\cdot\cos(\beta - \alpha) + \omega\phi_1\cdot e\cdot\cos\left(\phi_1\right)$$

$$vx_{c2} := vx + a\cdot\omega\alpha\cdot\sin(\beta - \alpha) - \omega\phi_2\cdot e\cdot\sin\left(\phi_2\right)$$

$$vy_{c2} := vy + a\cdot\omega\alpha\cdot\cos(\beta - \alpha) + \omega\phi_2\cdot e\cdot\cos\left(\phi_2\right)$$

Rownanie Alfa

$$rown1 := J_c\cdot\omega\omega\alpha + 2\cdot H\cdot b_x\cdot vx + 2\cdot H\cdot k_x\cdot x + 2\cdot H^2\cdot\alpha\cdot k_x + 2\cdot H^2\cdot b_x\cdot\omega\alpha + 2\cdot\alpha\cdot k_y\cdot l^2 + 2\cdot b_y\cdot l^2\cdot\omega\alpha + \ldots$$
$$+ 2\cdot a^2\cdot m_1\cdot\omega\omega\alpha - a\cdot m_1\cdot\left(\omega\phi_1\right)^2\cdot\sin\left(\beta - \alpha - \phi_1\right)\cdot e + a\cdot m_1\cdot\omega\omega\phi_2\cdot e\cdot\cos\left(\beta - \alpha + \phi_2\right) - \ldots$$
$$+ a\cdot m_1\cdot\omega\omega\phi_1\cdot\cos\left(\beta - \alpha - \phi_1\right)\cdot e - a\cdot m_1\cdot\left(\omega\phi_2\right)^2\cdot e\cdot\sin\left(\beta - \alpha + \phi_2\right)$$

$$M_{el1} := 2 \cdot M_{ut} \cdot (\omega_s - \omega_{ut}) \cdot \frac{(\omega_s - \omega\phi_1)}{(\omega_s - \omega_{ut})^2 + (\omega_s - \omega\phi_1)^2}$$

$$M_{el2} := 2 \cdot M_{ut} \cdot (\omega_s - \omega_{ut}) \cdot \frac{(\omega_s - \omega\phi_2)}{(\omega_s - \omega_{ut})^2 + (\omega_s - \omega\phi_2)^2}$$

$$Q_\alpha := M_{el1} - M_{el2}$$

$$Q_x := -T_{r,1}$$

$$Q_y := -F_{r,1}$$

$$Q_{\phi 1} := M_{el1}$$

$$Q_{\phi 2} := M_{el2}$$

Rownianie X

$$m_1 \cdot e \cdot \cos(\phi_1) \cdot (\omega\phi_1)^2 - m_1 \cdot e \cdot \cos(\phi_2) \cdot (\omega\phi_2)^2 + 2 \cdot b_x \cdot vx + 2 \cdot k_x \cdot x + 2 \cdot m_1 \cdot vvx + m_k \cdot vvx + 2 \cdot H \cdot \alpha \cdot k_x \;. \\ + \blacksquare + 2 \cdot H \cdot b_x \cdot \omega\alpha + m_1 \cdot \omega\omega\phi_1 \cdot e \cdot \sin(\phi_1) - m_1 \cdot \omega\omega\phi_2 \cdot e \cdot \sin(\phi_2)$$

$$2 \cdot g \cdot m_1 - m_1 \cdot e \cdot \sin(\phi_2) \cdot (\omega\phi_2)^2 - m_1 \cdot e \cdot \sin(\phi_1) \cdot (\omega\phi_1)^2 + g \cdot m_k + 2 \cdot b_y \cdot vy + 2 \cdot m_1 \cdot vvy \ldots \\ + \blacksquare + m_k \cdot vvy + 2 \cdot k_y \cdot y + m_1 \cdot \omega\omega\phi_1 \cdot e \cdot \cos(\phi_1) + m_1 \cdot \omega\omega\phi_2 \cdot e \cdot \cos(\phi_2)$$

Rownanie Y

Rowanie fi 1

$$J_{c1} \cdot \omega\omega\phi_1 + J_{s1} \cdot \omega\omega\phi_1 + J_{w1} \cdot \omega\omega\phi_1 + m_1 \cdot \omega\omega\phi_1 \cdot e^2 + g \cdot m_1 \cdot e \cdot \cos(\phi_1) + m_1 \cdot vvy \cdot e \cdot \cos(\phi_1) + \blacksquare \ldots \\ + m_1 \cdot vvx \cdot e \cdot \sin(\phi_1) - a \cdot m_1 \cdot \omega\alpha \cdot \cos(\beta - \alpha - \phi_1) \cdot e - a \cdot \alpha \cdot m_1 \cdot \omega\alpha \cdot \sin(\beta - \alpha - \phi_1) \cdot e - \blacksquare \ldots \\ + a \cdot \alpha \cdot m_1 \cdot \omega\phi_1 \cdot \sin(\beta - \alpha - \phi_1) \cdot e + a \cdot m_1 \cdot \omega\alpha \cdot \omega\phi_1 \cdot \sin(\beta - \alpha - \phi_1) \cdot e$$

$$J_{c1} \cdot \omega\omega\phi_2 + J_{s1} \cdot \omega\omega\phi_2 + J_{w1} \cdot \omega\omega\phi_2 + m_1 \cdot \omega\omega\phi_2 \cdot e^2 + g \cdot m_1 \cdot e \cdot \cos(\phi_2) + m_1 \cdot vvy \cdot e \cdot \cos(\phi_2) - \blacksquare \ldots \\ + m_1 \cdot vvx \cdot e \cdot \sin(\phi_2) + a \cdot m_1 \cdot \omega\alpha \cdot e \cdot \cos(\beta - \alpha + \phi_2) + a \cdot \alpha \cdot m_1 \cdot \omega\alpha \cdot e \cdot \sin(\beta - \alpha + \phi_2) - \blacksquare \ldots \\ + a \cdot \alpha \cdot m_1 \cdot \omega\phi_2 \cdot e \cdot \sin(\beta - \alpha + \phi_2) + a \cdot m_1 \cdot \omega\alpha \cdot \omega\phi_2 \cdot e \cdot \sin(\beta - \alpha + \phi_2)$$

Rownanie fi 2

$$m_{n1} \cdot vvx_1 = \blacksquare \cdot T_{r,1} - T_{1,2}$$

$$m_{n1} \cdot vvy_1 = \blacksquare \cdot F_{r,1} - F_{1,2} - m_{n1} \cdot g$$

$$m_{n2} \cdot vvx_2 = \blacksquare \cdot T_{1,2}$$

$$m_{n2} \cdot vvy_2 = \blacksquare \cdot F_{1,2} - m_{n2} \cdot g$$

$$F_{j,(j-1,k)} = \blacksquare \cdot (y_{j-1,k} - y_{j,k})^p \cdot k \cdot \left[1 - \frac{(1 - R^2)}{2} \cdot \left(1 - \operatorname{sgn}(y_{j-1,k} - y_{j,k}) \cdot \operatorname{sgn}(vx_{j-1,k} - vx_{j,k})\right)\right]$$

$$F_{t(j,j-1,k)} = \blacksquare \cdot -\mu \cdot F_{j(j-1,k)} \cdot \mathrm{sgn}\left(vx_{j,k} - vx_{j-1,k}\right)$$