$$
\begin{aligned}
k_x\left(v_x - X\right) &= l_0 m_y \phi^2 \sin\left(\varphi\right) - l_0 m_y \cos\left(\varphi\right)\dot{\phi} + m_x \dot{X} - 2 m_y L \phi \cos\left(\varphi\right) + m_y \phi^2 l \sin\left(\varphi\right) - m_y l \cos\left(\varphi\right)\dot{\phi} - m_y \sin\left(\varphi\right)\dot{L} + 2 m_y \dot{X} \\
\dot{x} &= X \\
k_l\left(v_l - L\right) &= m_y \left(-l_0 \phi^2 - \phi^2 l - \sin\left(\varphi\right)\dot{X} + \dot{L}\right) \\
\dot{l} &= L \\
c_\varphi \phi + g m_y \left(l_0 + l\right) \sin\left(\varphi\right) &= -m_y \left(l_0^2 \dot{\phi} + 2 l_0 L \phi + 2 l_0 l \dot{\phi} - l_0 \cos\left(\varphi\right)\dot{X} + 2 L \phi l + l^2 \dot{\phi} - l \cos\left(\varphi\right)\dot{X}\right) \\
\dot{\varphi} &= \phi
\end{aligned}
$$