$$m\ddot{x}+mg\sin\alpha-\frac{1}{2}mg\cos\alpha\left(1-\cos\theta\right)\left(\frac{\frac{x}{l}+\sin\varphi_{10}}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}}+\frac{\frac{x}{l}+\sin\varphi_{20}}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{20}\right)^2}}\right)$$

$$+\frac{k}{l}\left(\frac{\beta-\arcsin\left(\frac{x}{l}\sin\varphi_{10}\right)}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}}+\frac{\beta-\arcsin\left(\frac{x}{l}\sin\varphi_{20}\right)}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{20}\right)^2}}\right.$$

$$\left.+\frac{\left(-\beta+\arccos\left(\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}\right)+\frac{x}{l}\tan\theta\right)\left(-\frac{\frac{x}{l}\sin\varphi_{10}}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}}+\tan\theta\right)}{\sqrt{1-\left(\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}+\frac{x\tan\theta}{l}\right)^2}}\right)$$

$$-\frac{1}{4}ml\left(\frac{\frac{x}{l}\sin\varphi_{10}}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}}+\frac{\frac{x}{l}\sin\varphi_{20}}{\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{20}\right)^2}}\right)\left(\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{10}\right)^2}+\sqrt{1-\left(\frac{x}{l}+\sin\varphi_{20}\right)^2}\right)$$

$$=\mu m\left(g\cos\alpha\left(\frac{\frac{b}{2}+l\sin\varphi_2}{b+l\left(\sin\varphi_1+\sin\varphi_2\right)}\right)\left(\frac{1}{2}-\frac{l}{a}\sin\theta\right)+\left(\frac{h_C^2}{a}+\frac{a}{4}\right)\ddot{\theta}\right)$$