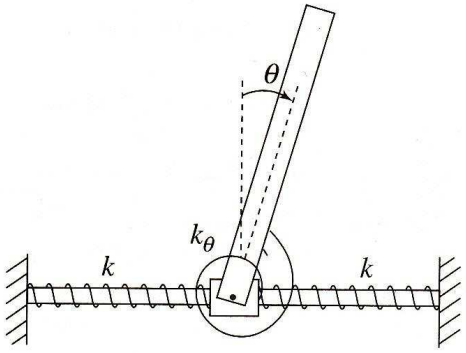
Lab-Project 3 Earthquake

Some buildings can be analyzed as rigid bodies with flexible ground constraints when subjected to loadings due to earthquakes. The sketch illustrates such a model.



Assume that the horizontal earthquake excitation of the ground is given by $x_g = \hat{x}_g \sin(\Omega t)$. Treat the structure as a uniform bar (mass m_b, length ℓ) connected via link joint to the foundation (mass m_f, torsion stiffness k_θ, translation stiffness k).

a) Derive the equations governing the structure's response in generalized form.

b) Find the linearized equations for the non excited case ($\hat{x}_g = 0$).

c) Calculate the eigen-values and visualize the eigen-modes.

d) Plot the amplitude-frequency diagrams of the excited motion.

e) Explain the special case: $k_\theta \to m_b g \ell/2$.

Given:

m_b	=	1000	$[kg]$	k_θ	=	100000	$[Nm]$
m_f	=	20000	$[kg]$	k	=	10000	$[N/m]$
ℓ	=	10	$[m]$	$\hat{x}_g$	=	0.1	$[m]$
Ω	=	$0, \ldots, 2.5$	$[1/s]$				