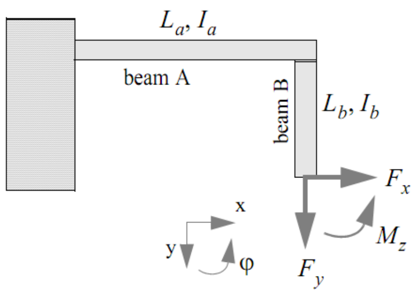
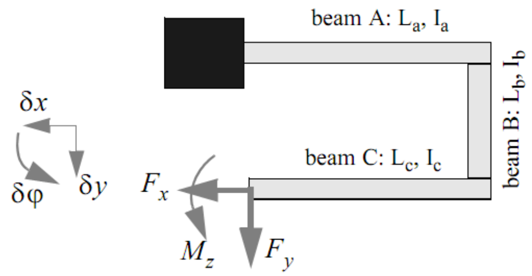
ECE491E/571E- Microsystems Design

Homework

The following two types of elastic flexures are considered to be used as springs for a micro-accelerometer structure. They are to be fabricated in a Si structural layer having a height $H = 10\mu m$, modulus of elasticity E=160GPa and density $\rho = 2330 kg/m^3$.The in-plane geometrical parameters are:$L_a = L_c = 100\mu m$, $L_b = 50\mu m$, $W = 4\mu m$ (L=length, W=width)



crab-leg suspension



folded beam suspension

1. Use finite element analyses (in Comsol Multiphysics) to determine

   1a.the equivalent spring constants for the two cases in the linear regime:

   $$k_{xx} = \frac{F_x}{\delta x}, k_{yy} = \frac{F_y}{\delta y}, k_{zz} = \frac{F_z}{\delta z}, k_{\varphi} = \frac{M_z}{\delta \varphi}$$

   1b.the equivalent spring constants corresponding to cross-sensitivities:

   $$k_{xy} = \frac{F_y}{\delta x}, k_{yx} = \frac{F_x}{\delta y}, k_{x\varphi} = \frac{M_z}{\varphi}$$

2. Plot the force-displacement characteristics, and determine the maximum allowed displacement such that the nonlinearity of the characteristics is less than 10%.
3. Build an equivalent macromodel of the suspensions (using the results from the previous analyses) to be used in a system-level simulation. The model will use equivalent across-through representations.
4. Determine (using finite element analyses) the first 5 vibration modes (eigenmodes) and their corresponding eigenfrequencies. Comment how should their relation be with the resonant mode of the accelerometer, and with respect to the frequency of the electronic read-out circuit.