Simulation of a Dual Axis MEMS Seismometer for a Building Monitoring System

M. A. Shah[1], F. Iqbal[1], and B. L. Lee[1]

1. Korea University of Technology and Education, Cheonan, Chungcheong, South Korea

Introduction: Accelerometer that is used to measure the ground motion during earthquake is called a seismometer. This study describes a dual axis MEMS seismometer which has the ability to sense the building vibration induced by the earthquake. The design is capable of accommodating extra capacitive finger structures. Figure 1 is the proposed dual axis microelectromechanical-system (MEMS) seismometer.

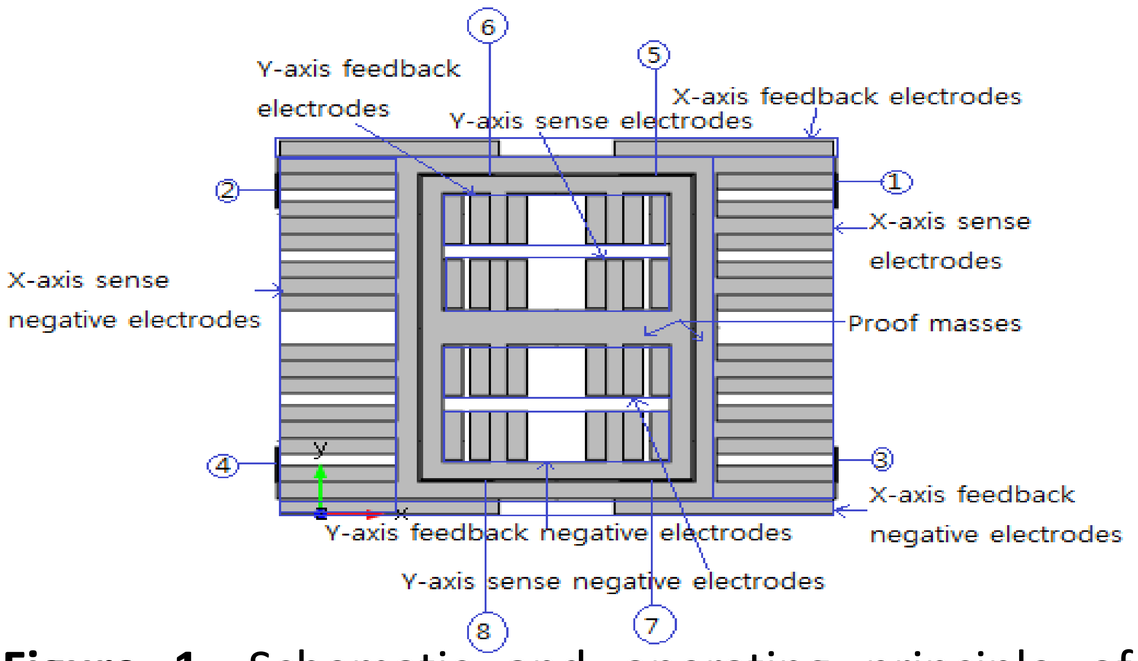


Figure 1. Schematic and operating principle of the proposed dual axis MEMS seismometer. Spring#01-04=X-axis springs and Spring#05-08=Y-axis springs.

Simulated Results: Folded spring was selected for the X-direction of final design due to its low deformation towards Y-direction. The proposed design has a very low cross axis sensitivity (almost negligible) as shown in figure 5 .

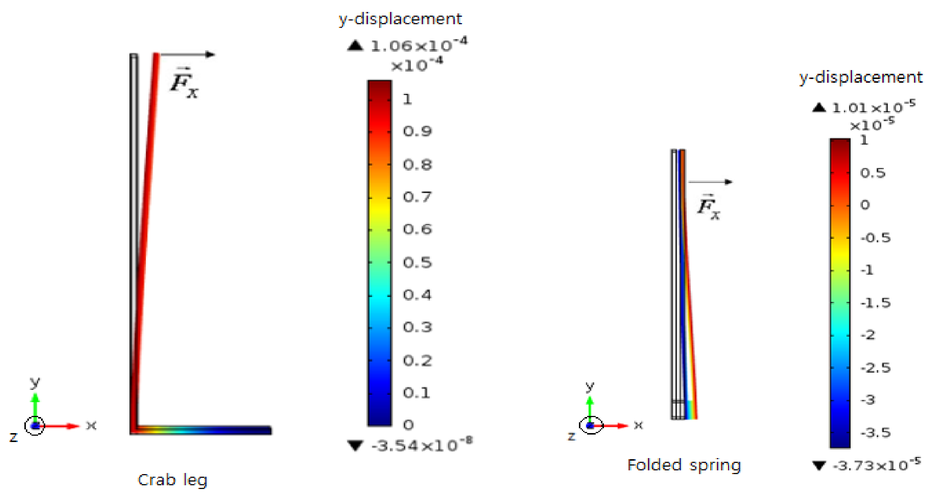
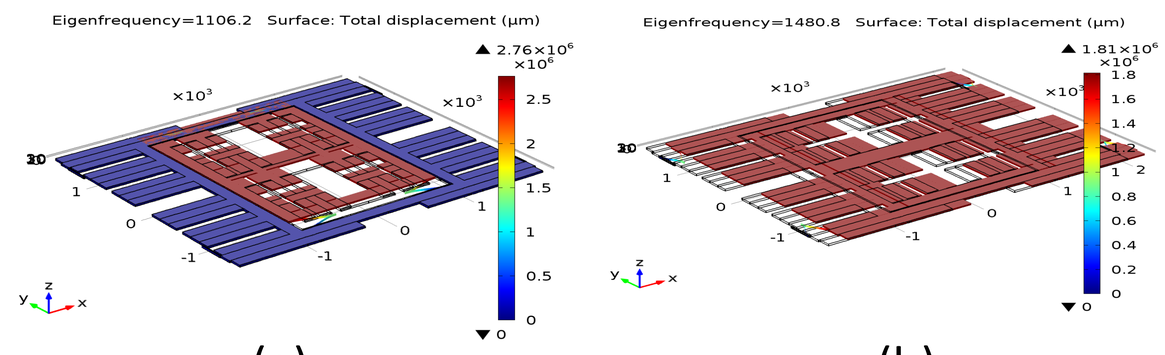


Figure 2. Springs submitted to a force in X-direction; colors show the deformation in Y-direction.

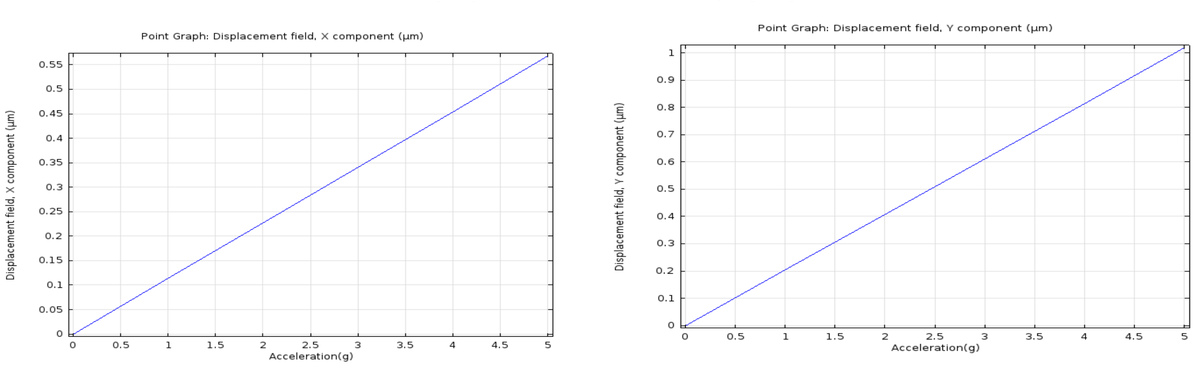
Type of spring	Cross-axis sensitivities of X-axis towards Y-axis. (%)
Crab leg	0.01
Folded	0.001

Table 1: Cross Axis Errors of the Design with Two Different Types of springs.



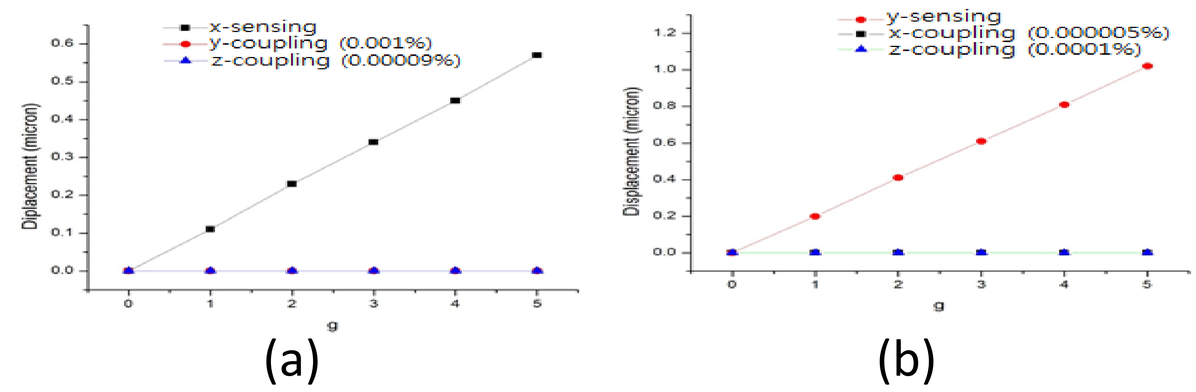
(a) (b)

Figure 3. The Eigenfrequency simulation results for the desired modes (a) Y-axis and, (b) X-axis.



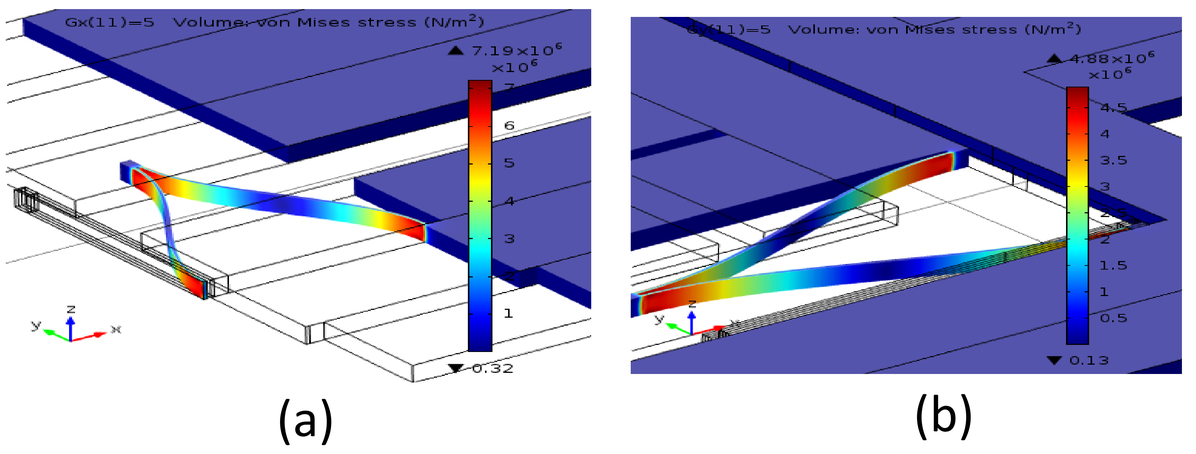
(a) (b)

Figure 4. Displacement vs acceleration. (a) X-axis and, (b) Y-axis.



(a) (b)

Figure 5. Cross-axis sensitivity of, (a) X-axis towards Y- and Z-axes, and (b) Y-axis towards X- and Z-axes.



(a) (b)

Figure 6. Von-mises stresses at the ends of springs, (a) X-axis, and (b) Y-axis. The applied acceleration is 5g.

Conclusions: A very low cross-axis sensitivity dual axis MEMS capacitive seismometer design was proposed for a specific application of sensing building vibration during an earthquake. Two designs with different types of springs and their widths has been simulated for the desired eigenfrequencies and static responses. The design has the ability to accommodate extra capacitive finger structures.