Effectiveness of Negative Stiffness Devices at Resisting Seismic Force in Buildings

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The purpose of this project was to design and construct a Negative Stiffness Device (NSD) that could be used in buildings to aid with seismic protection. A device such as this offers an alternative for seismic protection over simply constructing stiffer columns. A model NSD was fabricated using steel beams arranged in a diamond formation and attached using nuts and threaded bolts allowing its shape to change vertically and horizontally. A spring was then attached to the vertical ends of the device. Equations based on the device's scissor-jack geometry were derived to determine the forces and displacements acting upon the device and the building. The NSD was then recreated virtually using a SolidWorks™ motion study to determine its force versus displacement profile. The data for this project are the horizontal and vertical force versus displacement values predicted for the model from the equations and the virtual simulation. When compared side by side, the data from the virtual simulation validated the derived equations for the device's force vs. displacement profile. Results from the simulation showed that the NSD behaved close to what was predicted from the equations by initially exhibiting negative stiffness. The fact that the Solidworks™ force vs. displacement profile exhibited slightly less negative stiffness in comparison to the equations suggests that some unknown torsional force is acting on the device during movement.

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