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Development and Experimental Evaluation of a Semiactive Friction Damper

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Abstract : Seismic events may result in discomfort on occupants of the buildings, structural damage or even buildings collapse. Traditional design aims to reduce dynamic response of structures by increasing stiffness, thus increasing the construction costs and the design forces. Structural control systems arise as an alternative to reduce these dynamic responses. A commonly used control systems in buildings are the passive friction dampers, which adds energy dissipation through damping mechanisms induced by sliding friction between their surfaces. Passive friction dampers are usually implemented on the diagonal of braced buildings, but such devices have the disadvantage that are optimal for a range of sliding force and out of that range its efficiency decreases. The above implies that each passive friction damper is designed, built and commercialized for a specific sliding/clamping force, in which the damper shift from a locked state to a slip state, where dissipates energy through friction. The risk of having a variation in the efficiency of the device according to the sliding force is that the dynamic properties of the building can change as result of many factor, even damage caused by a seismic event. In this case the expected forces in the building can change and thus considerably reduce the efficiency of the damper (that is designed for a specific sliding force). It is also evident than when a seismic event occurs the forces in each floor varies in the time what means that the damper's efficiency is not the best at all times. Semi-Active Friction devices adapt its sliding force trying to maintain its motion in the slipping phase as much as possible, because of this, the effectiveness of the device depends on the control strategy used. This paper deals with the development and performance evaluation of a low cost Semiactive Variable Friction Damper (SAVFD) in reduced scale to reduce vibrations of structures subject to earthquakes. The SAVFD consist in a (1) hydraulic brake adapted to (2) a servomotor which is controlled with an (3) Arduino board and acquires accelerations or displacement from (4) sensors in the immediately upper and lower floors and a (5) power supply that can be a pair of common batteries. A test structure, based on a Benchmark structure for structural control, was design and constructed. The SAVFD and the structure are experimentally characterized. A numerical model of the structure and the SAVFD is developed based on the dynamic characterization. Decentralized control algorithms were modeled and later tested experimentally using shaking table test using earthquake and frequency chirp signals. The controlled structure with the SAVFD achieved reductions greater than 80% in relative displacements and accelerations in comparison to the uncontrolled structure.

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