DESIGN AND IMPLEMENTATION OF AN AMD SLIDING MODE CONTROLLER BASED ON A REDUCED MODEL

Mehdi SOLEYMANI
Assistant Professor, Arak University, Arak, Iran
m-soleymani@araku.ac.ir

Hasan Ali BAHRAMI
Graduate Student, Arak University, Arak, Iran
habahramii@gmail.com

Keywords: Sliding Mode Control, Active Mass Damper, Reduced Model, Image Processing, Shake Table Test

Active structural control has attracted considerable interest in recent years, as structures are getting taller yet more flexible (Soong, 1998). Active mass dampers (ADMs) are one of the efficient solutions presented for mitigating destructive effects of seismic and wind loads. However, design of model-based active structural control systems is such a hardship, as the available models for the control design are contaminated with parametric uncertainties and modeled dynamics. Robust control is an efficient approach for control design of uncertain systems such structures to be controlled via AMD system (Zhao et al., 2000). In this research design and implementation of a new robust sliding mode controller for tackling seismic excitation in the presence of parametric uncertainty in a high-rise building is considered. For this purpose, a reduced model of the tall building is developed. The modal parameters of the reduced model are then measured, using a modal analysis, and compared with simulation results. Table below shows the measured and estimated natural frequencies for the reduced model.

Table 1. Comparison of simulated and measured natural frequencies for the 2 DOF model

Experiment	Simulation	
5.8922	5.6992	First NF
11.833	14.4628	Second NF

A sliding mode controller is then designed based on the reduced model. The controller is then implemented the developed reduced model. Figure 1 depicts the structure and implemented control system. As it is seen in this picture, the AMD is a rack and pinion gear system derived via a DC motor. The feed-back signal is displacement of the top story measured via an online image processing approach.

Performance of the controller is evaluated via a shake table test. Figure 2 compares the top story displacement with and without control (Figure (2-a)). Moreover, robustness of the controller, in case mass of the second floor is increased up to 20 percent, is examined in this figure (Figure (2-b)). As it is clear in this figure, the proposed controller can successfully attenuate the transmitted displacements even in the presence of uncertainty. Figure 3 also presents the maximum drift of the structure (Figure (3-a)) and the base shear (Figure (3-b)) with and without the control system. The measured results prove effectiveness of the proposed controller in improving structural response variables.

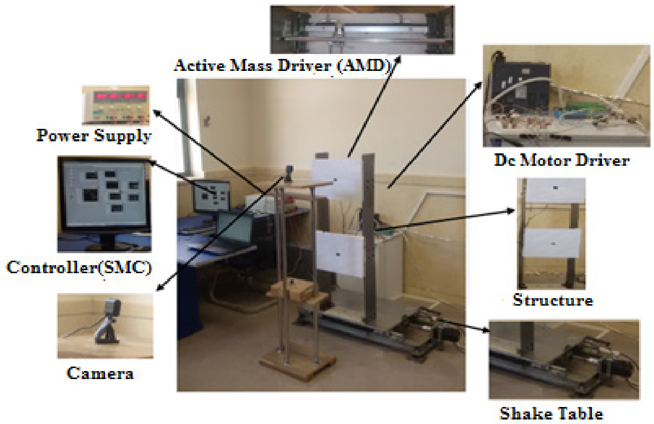

Figure 1. Schematic overview of the test setup

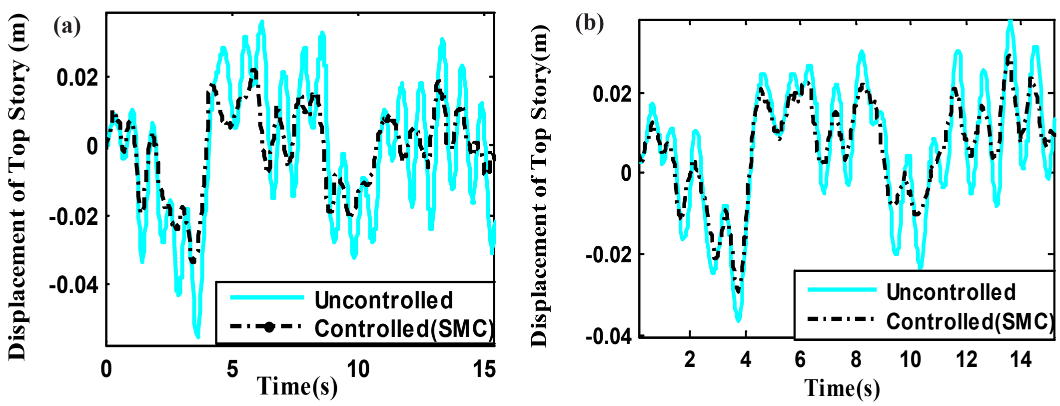

Figure 2. Displacement of the second floor for Chalfant earthquakes (a) without uncertainty (b) with uncertainty

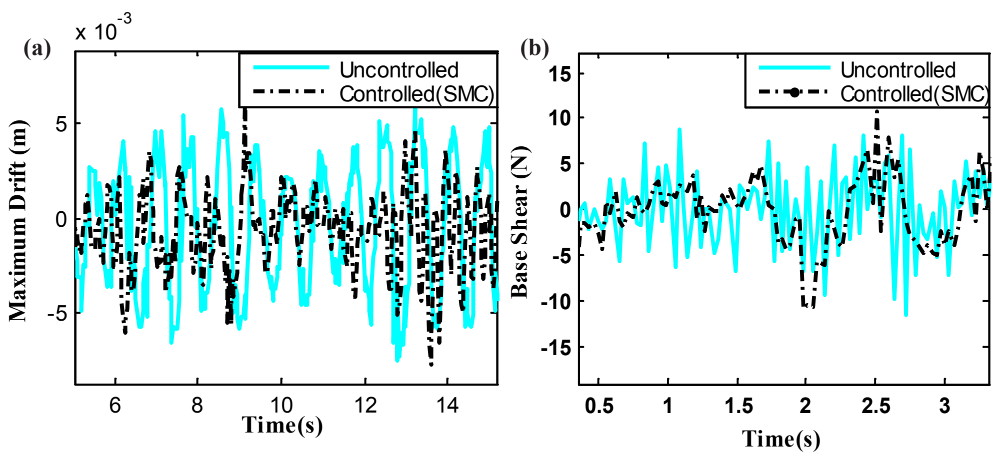

Figure 3. Maximum drift and base shear for Chalfant earthquake (a) Drift (b) Base shear

REFERENCES

Soong TT (1998) State-of-the-art review: *Active Structural Control in Civil Engineering Structures,* 10(2): 74-84

Zhao B, Xilin L, Minzhe W and Zhauxin M (2000) Sliding-mode control of buildings with base-isolation hybrid protective system, *Earthq. Engrg. Struct. Dyn.,* 29: 315-326