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PASSIVE-DAMPING DESIGN FOR STRUCTURAL VIBRATION CONTROL: A VELOCITY-FEEDBACK ENERGY-TO-PEAK APPROACH

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ABSTRACT

In this work, we present a new methodology to design passive damping systems for structural vibrational control. The method uses recent advances in static output-feedback control to compute fully decentralized velocity-feedback controllers following an energy-to-peak approach. The application of the proposed methodology is illustrated through the design of a passive-damping system for seismic protection of a five-story building with excellent results.

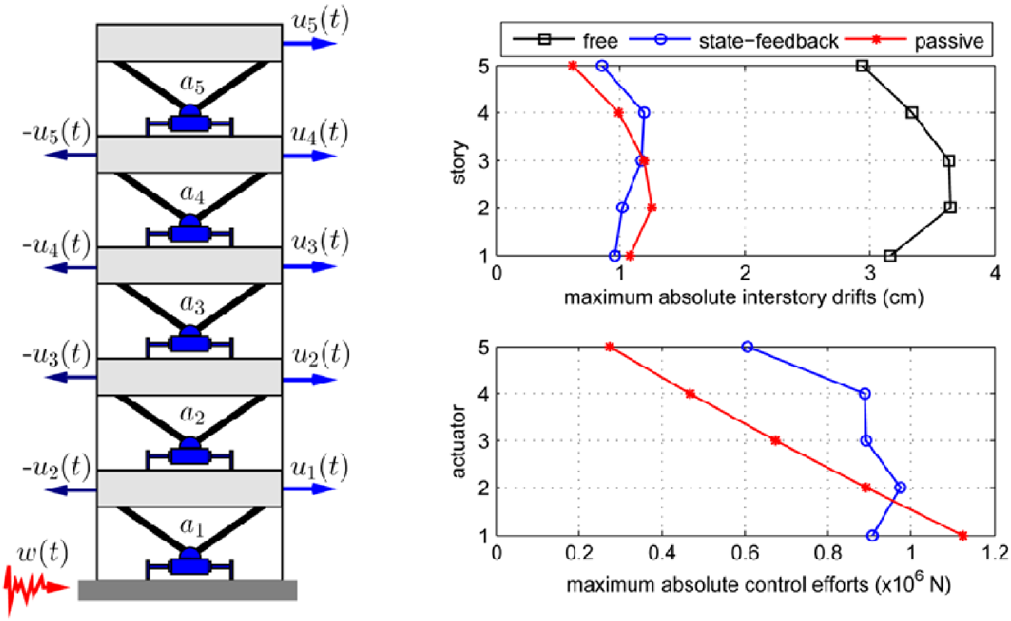
Keywords: decentralized control, passive damping design, static output-feedback, structural vibration control.

INTRODUCTION

Passive damping systems with linear dampers can be seen as fully decentralized static velocity-feedback controllers (Yang et al., 2002). This fact allows using powerful control design tools in designing passive damping systems. To date, however, the practical application of this approach has been seriously limited due to the high computational cost associated to the design of static output-feedback controllers. Using recent advances in static output-feedback control presented by Rubió-Massegú et al. (2013), decentralized velocity-feedback controllers can be efficiently computed. This approach has been successfully applied to design decentralized velocity-feedback H_∞ controllers for structural vibration control of buildings under seismic excitation (Rubió-Massegú et al., 2012), and also to design passive damping systems for structural vibration control (Palacios-Quiñonero et al., 2012). The energy-to-peak control theory is especially suitable for vibration control of structures where the peak values of displacements and accelerations can produce particularly damaging effects (Zhang et al., 2011). In the present article, we present a methodology that allows designing passive damping systems by computing decentralized velocity-feedback energy-to-peak controllers.

RESULTS AND CONCLUSIONS

To illustrate the application and performance of the proposed methodology, a centralized state-feedback controller and a passive damping system have been computed for a five-story building model. Numerical simulations of the building vibrational response have been conducted using the North-South Hachinohe 1968 seismic record as ground acceleration. The maximum absolute interstory drifts and the corresponding control efforts are displayed in Figure 1(b), where it can be clearly appreciated the excellent behavior of the passive control system.



(a) Actuation scheme

(b) Interstory drifts and control efforts

Fig. 1 - Maximum interstory drifts and control efforts for a five-story bulding

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