IABSE Conference – *Structural Engineering: Providing Solutions to Global Challenges*
September 23-25 2015, Geneva, Switzerland

A modified bang-bang control for MR damper and experimental validation using RTHS

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Abstract

Magneto-rheological (MR) damper, an effective semi-active control device has been used for response reduction of structures in civil engineering. This paper presents a modified bang-bang control algorithm for an earthquake excited structure using MR damper. This controller was developed based on linear quadratic Gaussian (LQG) controller and Kalman filter. The performance of the proposed controller was evaluated by comparing with four controllers for the control of a three story structure with one MR damper on the first floor. These four controllers are (1) clipped optimal controller; (2) decentralized Bang-Bang Controller; (3) passive control with a constant 0 volts; (4) passive control with a constant 3 volts. Real-time hybrid simulation (RTHS) tests were given to illustrate the application and effectiveness of the proposed modified bang-bang control strategy. Overall, the proposed controller is quite competitive as compared with above controllers in terms of reduction in the maximum inter-story drifts, displacements, absolute accelerations, and control forces.

Keywords: Magneto-rheological damper; Semi-active control; Real-time hybrid simulation

1 Introduction

Development of seismic response reduction method of the building during earthquakes is necessary in civil engineering. Structural control shows great potential for seismic mitigation in infrastructures. Magneto-rheological (MR) damper known as its environmental robustness, lower operating power requirement and reliability, has been investigated as an effective semi-active control device for seismically excited building structure [1].

Various semi-active control algorithms for MR damper have been proposed, such as a decentralized bang-bang controller by McClamroch and Gavin [2], sliding mode controller by Yang et al [3], clipped-optimal controller by Dyke et al [4], adaptive fuzzy control algorithm by Zhou et al [5] and phase angle control by Chae [6].

Several comparative studies using semi-active devices such as MR dampers have been carried out to evaluate the performance of these proposed control strategies. Jansen and Dyke investigated a variety of control algorithms including the Lyanpunov controller, decentralized bang-bang controller, modulated homogeneous friction algorithm, and a clipped-optimal

https://doi.org/10.2749/222137815818358763