Sensitivity-based Optimal Design of Linear Damper System for Enhanced Seismic Performance of Coupled Structural System

Dong-Seok Kim
Ph. D. Student
Seoul National University
Seoul, Korea
kimds@sel.snu.ac.kr

Hyun-Moo Koh
Professor
Seoul National University
Seoul, Korea
hmkoh@snu.ac.kr

Seung-Yong Ok
Postdoctoral researcher
University of Illinois at Urbana-Champaign IL, US
syok@uiuc.edu

Kwan-Soon Park
Professor
Dongguk University
Seoul, Korea
kpark@dongguk.edu

Chang-Yeol Choi
Master Course Student
Seoul National University
Seoul, Korea
cychoi@sel.snu.ac.kr

Summary

This paper describes a sensitivity-based optimal design method of linear damper system for connected structures. In order to determine the optimal distribution of the linear dampers, a measure based on the sensitivity of target modal damping ratio to damper distribution is introduced. In order to demonstrate the effectiveness of the proposed method, two numerical examples of seismically excited coupled systems are considered; the first one is for the adjacent buildings interconnected with dampers, and the second is for the parallel bridges transversely connected with dampers. The simulated results show that the sensitivity-based optimal damping system can save the damper cost more efficiently than the uniformly distributed optimal damping system without any loss of seismic performance of the coupled structures.

Keywords: coupled structural system, damper system, sensitivity-based optimal design, seismic performance

1. Introduction

Many structures are built closely to each other due to limited land available. When such adjacent structures carry different dynamic characteristics, pounding problem can occur due to the out-of-phase vibration motion. Accordingly, coupling two adjacent structures with passive, active or semi-active control devices has been of great interest for the past decades. Since Klein et al. [1] first proposed the concept of coupling two tall buildings, subsequent studies have been carried out extensively on dissipative links, active and semi-active devices for mitigating the wind-induced or seismically-excited responses of the neighboring structures. In particular, passive control strategies have drawn much attention due to their reliability and economic benefits.

Zhang and Xu [2] evaluated seismic performance of viscous damping system for connecting adjacent buildings, and Zhu and Iemura [3] analyzed dynamic characteristics of adjacent buildings connected by visco-elastic damper. Optimal design method of various damping systems has been studied as well [4-5]. However, most of the previous studies adopted an assumption on uniform damper distribution to optimize the overall damping capacity. These methods are simple but can be costly due to lack of knowledge about optimal distribution of the dampers. Therefore, a sensitivity-based optimal design method of linear damper system for connected structures is proposed in this paper.

In order to determine the optimal distribution of the damping capacities, a measure based on the sensitivity of modal damping ratio with respect to damper distribution is introduced. As numerical examples, adjacent buildings interconnected with dampers and two parallel bridges transversely connected with dampers are considered respectively. The effectiveness of proposed sensitivity-based design method is verified through comparison with the uniformly distributed optimal damping system.

https://doi.org/10.2749/222137807796158453