SUMMARY OF Ph.D. DISSERTATION

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Title

Control System Design for Base Isolated Buildings Considering the Characteristics of Structural Response and Earthquake Motion

Abstract

The purpose of this study is to establish a design method of control system for base isolated building considering the characteristics of structural response and earthquake motion. The characteristic of structural response means the nonlinearity and amplitude of the structural response. The characteristic of earthquake motion means the location, magnitude and nonstationary of earthquake. First of all, the design method of control system which considers both the nonlinear characteristic of base isolated building and the nonstationary characteristic of earthquake motion is proposed, and control performance is verified by some numerical simulations. Second, a response evaluator to determine the control input to the system by using structural response is proposed. The control performance of the response evaluator is verified through some numerical simulations. In addition, the control system design considering uncertainty of source region and ground motion of earthquake is proposed by using both the response of base isolated building and the immediate earthquake information such as Earthquake Early Warning. From some numerical simulations, the control performance is verified.

The contents of this dissertation are summarized as follows.

Chapter 1 describes the background and the purpose of this study.

Chapter 2 describes a control design method considering both nonlinear characteristic of a base isolated structure and nonstationary characteristic of earthquake motions to reduce the building response subjected to earthquake. This method is applied to the base isolated building whose rigidity is bilinear hysteresis during nonstationary earthquake. Good control performance is obtained by using the optimal control theory to the equivalent linearization model.

Chapter 3 presents a response evaluator which evaluates the response of the system and determines the control input to the system. The response evaluator is designed by a layered neural network and it is applied to a base isolated building with semi-active oil dampers whose damping coefficient has large or small values. Some computer simulations are carried out using several kinds of earthquake motions and the effectiveness of the response evaluator is verified.

In chapter 4, the response evaluators are designed by using the information of the source region and ground motion of earthquake to improve control performance. Some regions are set according to the earthquake location and the response evaluators are designed to respond to the earthquake in each region. From some numerical simulations, good control effect is obtained when the response evaluator is selected corresponding to the designed region. And the building response is also reduced to the wide range of amplitude of earthquake to use the peak ground velocity as input information to the layered neural network.

Chapter 5 is the conclusion of this dissertation.