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Optimal Active Control of Structural Vibration by Classic and Adabtive Fuzzy Smart Algorithms

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Abstract

Erecting tall buildings especially in big cities where space limitation for developing residential areas is a prevailing problem has become a growing concern for many governments in recent years. What is important to consider about these buildings is the fact that they are mostly made up of light and highly flexible materials. The low ratio of damping to energy absorption of these structures leads to creation of a vast altitude of vibration even with occurrence of mid-level earthquakes. Thus, considering large investment in erecting such buildings and considerable revenue earned by such investment, using control systems with relatively lower costs would be justifiable. The present study aims at evaluating classic (LQR, Pole Assignment) and fuzzy logic control (FLC) models regarding their control capabilities against earthquake (Elcentro) in an eleven-stored building and then determining an appropriate control system for this structure in two different conditions.

Keywords: Fuzzy Logic Controllers (FLC), Quadratic Optimal Controller (LQR), Pole Assignment Controller, Control System, Structure.

1. INTRODUCTION

Secure design of a structure is ensured when three substantial conditions are met. First condition: having real information about applied forces to the structure; second condition: having real and correct information about behavior and strength of structural materials; third condition: taking reliable methods in design and analysis of the structure. In practice, these three conditions are rarely provided simultaneously. Therefore, in order to remove the influence of these unknowns in the conditions different amounts are taken into accounts as safety factors in design of structures. Recent achievements in developing new materials having more strength and predefined behavior (such as high-strength steel or prestressed concrete) have brought improvements to structure analysis methods, hence have provided structural engineers with more confidence in erecting huge flexible structures such as skyscrapers, large-span bridges, telecommunication towers, and maritime structures. However, flexibility and low damping ratio of these structures may lead to emergence of some problems including:

a) Probability of structural failure due to natural external loads like wind and earthquake.

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