Determination of Optimal Frequency of Tuned Mass Damper for Super-tall Buildings Subjected to Service Level Earthquakes

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Abstract

In recent years, the rapid development of super tall buildings has become a frontier in civil engineering. Subjected to service level earthquakes, all of the plastic energy dissipation components are still in the elastic stage, and will not dissipate energy. In this situation, the story acceleration will be magnified several times, resulting in the comfort problem and causing the damage of contents in the building and other non-structural components. It will not only bring serious economic losses, but also affect the normal function of the building. Therefore, corresponding measures should be proposed to reduce the story acceleration of super tall buildings under service level earthquakes. A simplified analytical model for super tall buildings based on the flexural-shear coupling beam model is developed in this work. Based on the simplified model with a super TMD on the top of the building, the control effect of TMD on the story acceleration is studied by time history analysis. The optimal frequency of TMD is determined through parametric discussion. The outcome of this study can provide some references for the engineering design and vibration reduction of super tall buildings.

Keywords: super-tall building; tuned mass damper; floor acceleration; optimal frequency; flexural-shear coupling beam model.

1 Introduction

The seismic resilience of super-tall buildings has significant impact to the society, which requires the super-tall buildings have enough safety during strong earthquakes, and have minimal economic loss and function interruption after small or moderate earthquakes. Existing researches have proved that super-tall buildings generally have enough safety margins subjected to the maximal considered earthquakes (MCEs) [1-3]. However, when subject to the service level earthquakes (SLEs) or the design basis earthquakes (DBEs), the floor acceleration of the upper part of super-tall buildings may exceed six times of the peak ground acceleration (PGA) due to the acceleration amplification effect [4]. Excessive floor acceleration will lead to the damage of contents

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