Application of Tuned Mass Control Systems for Earthquake Protection

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Summary

The following paper introduces the practical application of Tuned Mass Control Systems (TMCS) for earthquake protection. Optimization approaches for these passive control systems will be discussed as well as practical considerations regarding the resulting specification of the TMCS such as stiffness loss during an earthquake and wide-band effectiveness. For the discussion, theoretical approaches will be introduced and results of additional numerical calculations will be presented to verify the reduction due to the control systems. The contribution also introduces the practical application of TMCS at an elevated bridge structure and presents design solutions for these systems.

Keywords: Tuned Mass Control Systems, Seismic Loading, Optimization for Passive Systems

1. Introduction

The application of passive energy absorbing devices such as Tuned Mass Control Systems (TMCS) to reduce the response of earthquake loading is still in the controversial stage. While some researchers have figured a noticeable reduction of the structural response to earthquake loads, the effectiveness has been abolished by others. Considering the evidence that passive appendages can cause a reduction of the structural seismic response, the effectiveness of these systems is strongly dependent on the specification of the guiding TMCS parameters such as effective mass, tuning frequency and internal damping ratio. Since the commonly known optimization criteria formulated by Den Hartog are only applicable for a harmonic excitation, these resulting conventional specifications are not leading to the desired reduction effects for earthquake loads.
To successfully apply Tuned Mass Control Systems, their specification has to be optimized by applying load characteristics that reflect those of seismic loading. In the following several methods to estimate an optimum specification of TMCS will be discussed. The introduced methods will be compared with numerical calculation of an example Multi Degree of Freedom (MDOF) - structure to verify the numerical optimization approach. Additionally the resulting specification shall be discussed under practical considerations. The objective of this theoretical analysis is the optimum design of the TMCS equipment for an elevated bridge structure by using the generalized results. Supplementary a FE-model of the bridge structure has been used to verify the effectiveness of the

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