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Design and application of anti-seismic active vibration control systems

Max Guendel, Carsten Block

Woelfel Beratende Ingenieure, Hoechberg, Germany

Dominik Schott

Technische Universität Darmstadt, Darmstadt, Germany

Contact: guendel@woelfel.de

Abstract

Building structures subjected to earthquakes undergo deformations, which may damage structural and non-structural elements. Vibration control systems are an interesting solution to reduce the dynamic response of structures. However, even if this technique is on the research agenda for several decades, there is only a limited number of anti-seismic applications in buildings in Europe. In this paper active, passive and hybrid vibration control systems are designed and analysed numerically in 9 case studies to assess their effectiveness to reduce the inter-storey drift. The investigations are carried out by linear time history analysis at damage limitation state. The results show clearly the advantages and limitations of different vibration control systems for anti-seismic purposes. In the next step the effectiveness and robustness of the most favourable solution will be tested experimentally in a full scale shaking table test of a two storey lightweight steel structure.

Keywords: earthquake, inter-storey drift, vibration control system, active, hybrid, passive.

1 Introduction

Buildings in moderate to high seismic regions are designed efficiently against earthquakes by means of dissipative design principles to prevent collapse of major parts or the whole structure; i.e. plastic deformations in primary structural elements are exploited to dissipate seismic energy introduced into the building. Besides collapse prevention of the structure, also damages under more frequent earthquakes with lower amplitudes have to be avoided. This is usually ensured by limiting the inter-storey drift depending on the deformation capacity of non-structural elements in the building (e.g. plasterboards, facades). For building typologies with low lateral stiffness, e.g. steel moment resisting frames, the verifications for damage limitation control the design and layout of the building and prevent the full exploitation of the dissipative capacity of the structure. For more economic seismic design of such structures the performance at damage limit state has to be improved: either by increasing the deformation capacities of non-structural components or by reducing the inter-storey drift under moderate earthquakes. The latter option is traditionally achieved by increasing the stiffness and strength of the main structure; an economic alternative is the application of vibration control systems.

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