

## **SOME STRATEGIES FOR THE REDUCTION OF SEISMIC STRUCTURAL RESPONSES**

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### **Abstract**

The present contribution shall give some ideas to reduce earthquake-induced reactions of structures with the help of special construction elements. Helical steel springs are utilized to provide local elasticity within structures. Earthquake demands cause relatively large deflections in these elements according to plan. For the absorption of seismic energy viscous damping elements can be installed. These dissipation effects induce a reduction of peak displacements and may assure defined states of serviceability after an earthquake. Applied in the right manner, elastic and plastic deformations as well as internal stresses of important members and acceleration amplification can be decreased when seismic actions have to be considered. Hence, the safety of the structure can be increased and/or construction costs can be lowered significantly for buildings in earthquake areas. For the confirmation of the efficiency of these construction elements, numerical analyses are performed utilizing elastic springs and viscous dampers arranged below or within the structural models. A 3-dimensional steel frame is investigated numerically by finite elements and the effects of seismic base isolation as well as of a mass damper are discussed.

### **1. Introduction**

In earthquake engineering two basic ideas have been established within recent decades: the first one requires a maximum strength of the structure to withstand occurring earthquake forces, the second one gains from structural flexibility which generally results in fewer seismic demands. The latter, more commonly implemented strategy, transfers the system to a lower frequency range where the seismic energy acting on the structure may be beyond that of resonance. The well known corresponding key words in common literature are 'ductility' and 'energy dissipation'. In most of the actual codes pertaining to seismic demands the prescribed response spectra indicate a lower amplification of acceleration when the damping of the significant mode is higher and/or the major frequency arises at a low level.

In literature the efficiency of passive control systems is not uniquely discussed. Seismic base isolation systems are broadly accepted for the protection of structures (Naeim and Kelly, 1999). Here, usually a horizontal decoupling is described where the implemented bearings possess a high vertical and a very low horizontal stiffness. Vertical seismic effects remain unchanged but the 1<sup>st</sup> horizontal mode is very low so that the horizontal motion of the building is nearly unaffected by usual seismic ground acceleration. The efficiency of (passive) Tuned Mass Dampers for the reduction of earthquake demands is sometimes neglected. Active or semi-active systems are more frequently discussed and favoured as a seismic protection system (Sakamoto *et al.*, 2000). Single cases of the application of passive mass dampers are described for e.g.