Vibration Control of Structures through Structure-Soil-Structure-Interaction

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The problem of reducing vibrations in structures, generally known as vibration control, arises in various branches of engineering: civil, aeronautical and mechanical. Unpredicted vibrations can lead to the deterioration or collapse of structures. In the framework of Earthquake Engineering, modern passive control systems for the seismic design involve the use of tuned mass dampers, dampers and isolation systems. The introduction of these control devices in existing structures is invasive, costly and requires the demolishing of some structural and/or non-structural components. This is clearly prohibitive for developing countries and for historical buildings. Furthermore up to now there are no strategies available to reduce vibrations of more than one structure. Remarkably, early studies on Structure-Soil-Structure Interaction and site-city interaction [1-3] have highlighted that the presence of a structure will alter the dynamic behaviour of neighbourhood structures by reducing and in some case increasing their maximum response.

In this work a novel passive control device called Vibrating Barrier (ViBa) [4] developed for reducing the seismic response of structures to earthquake excitation is scrutinized. The device is a massive structure, hosted in the soil, calibrated for protecting structures by absorbing portion of the ground motion input energy. The work aims to investigate the possibility to exploit Structure-Soil-Structure Interaction in order to protect one or more structures. Firstly, simplified models are analysed in order to have a better comprehension of the phenomenology and lastly, an industrial building is examined. The interaction between the ViBa and a simple reactor building model [5] is investigated through parametric studies by considering several spacing and soil profiles. Steady state analyses and Monte Carlo Simulations are carried out for both cases of single structure and structure protected by the ViBa showing the reduction affected by the novel device to the structure in terms of maximum acceleration. Moreover, the sensitivity of the stochastic response of the model of the Reactor Building to a zero mean Gaussian random process is analysed by extending the procedure proposed by Cacciola et al. [6]. Experimental tests are carried out for supporting the results obtained by the numerical analyses.

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