Reliability-Based Analysis and Design of Isolation Systems for Large Scale Building Models

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ABSTRACT

Over the last decades there has been a growing interest in the application of base isolation techniques for a number of structures such as buildings, bridges, nuclear reactors, etc. By means of the flexibility and energy absorption capability, the isolation system partially reflects and absorbs some of the input energy before this energy can be transmitted to the superstructure. The net effect is a reduction of energy dissipation demand on the structural system, resulting in an increase in its survivability. One of the difficulties in the application of isolation systems has been the explicit consideration of the non-linear behavior of the isolators during the design process. Another challenge has been the efficient prediction of the dynamic response under future ground motions considering their potential variability as well as the efficient control of competing objectives related to the protection of the superstructure and the minimization of the base displacement. In particular, the response of this class of systems under near-field ground motions has been recognized to be one of the current challenges for the analysis and design of base-isolated systems. Near-field ground motions may lead to excessive base deformations and superstructure deformations with important implications for the integrity of the combined structural system.

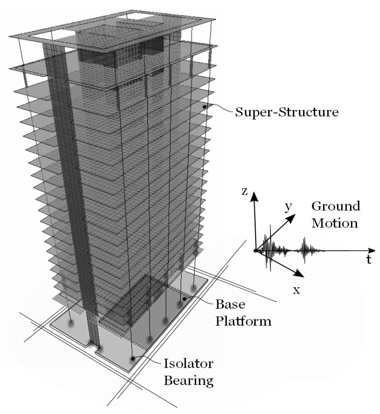

Figure 1: Schematic representation of a base-isolated finite element building model

The objective of this presentation is to introduce a general framework for the analysis and design of isolation systems that addresses the previous challenges. A probabilistic approach is adopted for considering the variability of future excitations. Isolation systems composed by rubber bearings are used in the present study. The non-linear behavior of these devices is characterized by a biaxial hysteretic model which is calibrated with experimental data. In this setting, reliability is quantified as the probability that the response quantities of interest will not exceed acceptable performance bounds within a particular reference period. Such probabilities are estimated by an advance simulation technique. The proposed reliability-based analysis and design of isolation systems is illustrated by means of several examples, including large superstructure finite element models of real base-isolated buildings.