

An engineering approach for evaluating the dynamic response of acceleration-sensitive secondary systems in flexible structures

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Abstract

Secondary systems are nonstructural components that serve important functions within a structure, but are not considered as an integral part of the main structural system. There are many categories of secondary systems addressing architectural aspects, mechanical, electrical, communication, water supply and plumbing functions, as well as being part of the structure's content. The main issue regarding the installation of secondary systems in structures placed in seismically prone regions is preservation of their integrity and functionality during earthquake motions, since failure can have dramatic consequences in terms of property losses and safety concerns. This study introduces a new methodology for approximating the seismic response of acceleration-sensitive secondary systems with a mass lower than 1% of the total mass of the primary structure, and whose seismic excitation derives exclusively from the motion of that structure, that is, interaction phenomena are ignored. The methodology applies to secondary systems installed on regular and flexible primary structures exhibiting floor diaphragm action and quantifies the seismic demand from information based solely on the deflected shape of the structure at the instant it reaches peak seismic response. The methodology can be applied in alternative ways, depending on the required accuracy of the results and on acceptable computational cost, yielding good quality results when compared to those derived from detailed time-history analyses. Thus, the present methodology signifies a departure from the current state-of-design of acceleration-sensitive secondary building components, which does not fully account for the vibrations of the primary structure. Finally, the accuracy of the methodology is gauged through a number of application examples involving different combinations of primary-secondary systems.

KEYWORDS

approximate methods of analysis, flexible structures, nonstructural components, secondary systems, structural dynamics