World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:12, No:04, 2018

Generation of Roof Design Spectra Directly from Uniform Hazard Spectra

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Abstract : Proper seismic evaluation of Non-Structural Components (NSCs) mandates an accurate estimation of floor seismic demands (i.e. acceleration and displacement demands). Most of the current international codes incorporate empirical equations to calculate equivalent static seismic force for which NSCs and their anchorage system must be designed. These equations, in general, are functions of component mass and peak seismic acceleration to which NSCs are subjected to during the earthquake. However, recent studies have shown that these recommendations are suffered from several shortcomings such as neglecting the higher mode effect, tuning effect, NSCs damping effect, etc. which cause underestimation of the component seismic acceleration demand. This work is aimed to circumvent the aforementioned shortcomings of code provisions as well as improving them by proposing a simplified, practical, and yet accurate approach to generate acceleration Floor Design Spectra (FDS) directly from corresponding Uniform Hazard Spectra (UHS) (i.e. design spectra for structural components). A database of 27 Reinforced Concrete (RC) buildings in which Ambient Vibration Measurements (AVM) have been conducted. The database comprises 12 low-rise, 10 medium-rise, and 5 high-rise buildings all located in Montréal, Canada and designated as post-disaster buildings or emergency shelters. The buildings are subjected to a set of 20 compatible seismic records and Floor Response Spectra (FRS) in terms of pseudo acceleration are derived using the proposed approach for every floor of the building in both horizontal directions considering 4 different damping ratios of NSCs (i.e. 2, 5, 10, and 20% viscous damping). Several effective parameters on NSCs response are evaluated statistically. These parameters comprise NSCs damping ratios, tuning of NSCs natural period with one of the natural periods of supporting structure, higher modes of supporting structures, and location of NSCs. The entire spectral region is divided into three distinct segments namely short-period, fundamental period, and long period region. The derived roof floor response spectra for NSCs with 5% damping are compared with the 5% damping UHS and procedure are proposed to generate roof FDS for NSCs with 5% damping directly from 5% damped UHS in each spectral region. The generated FDS is a powerful, practical, and accurate tool for seismic design and assessment of acceleration-sensitive NSCs particularly in existing post-critical buildings which have to remain functional even after the earthquake and cannot tolerate any damage to NSCs.

Keywords : earthquake engineering, operational and functional components (OFCs), operational modal analysis (OMA), seismic assessment and design
Conference Title : ICEESSD 2018 : International Conference on Earthquake Engineering, Seismology and Seismic Design
Conference Location : London, United Kingdom
Conference Dates : April 24-25, 2018