

System Identification of Building Structures with Continuous Modeling

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Abstract : This paper introduces a wave-based approach for system identification of high-rise building structures with a pair of seismic recordings, which can be used to evaluate structural integrity and detect damage in post-earthquake structural condition assessment. The fundamental of the approach is based on wave features of generalized impulse and frequency response functions (GIRF and GFRF), i.e., wave responses at one structural location to an impulsive motion at another reference location in time and frequency domains respectively. With a pair of seismic recordings at the two locations, GFRF is obtainable as Fourier spectral ratio of the two recordings, and GIRF is then found with the inverse Fourier transformation of GFRF. With an appropriate continuous model for the structure, a closed-form solution of GFRF, and subsequent GIRF, can also be found in terms of wave transmission and reflection coefficients, which are related to structural physical properties above the impulse location. Matching the two sets of GFRF and/or GIRF from recordings and the model helps identify structural parameters such as wave velocity or shear modulus. For illustration, this study examines ten-story Millikan Library in Pasadena, California with recordings of Yorba Linda earthquake of September 3, 2002. The building is modelled as piecewise continuous layers, with which GFRF is derived as function of such building parameters as impedance, cross-sectional area, and damping. GIRF can then be found in closed form for some special cases and numerically in general. Not only does this study reveal the influential factors of building parameters in wave features of GIRF and GRFR, it also shows some system-identification results, which are consistent with other vibration- and wave-based results. Finally, this paper discusses the effectiveness of the proposed model in system identification.

Keywords : wave-based approach, seismic responses of buildings, wave propagation in structures, construction

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