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A Novel Damage Indicator Evolved from Poincare Map for Detection and Localization of Seismic Damage in Structures with Nonlinear Breathing Crack

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Abstract

The proposed damage indices are formulated with an intention to utilize the computational advantages of time-domain analysis as well as to minimize the time-dependent fluctuations. To demonstrate efficiency of these damage indicators, a vibration analysis with harmonic excitation is performed on a structure considering nonlinear behavior of crack. The complexity in analyzing the state of a system under nonlinear vibration has been addressed by the graphical Poincaré map-based method. The difference in the estimated value of Poincaré index derived from the state variables of the system is considered as the fault signature. The novelty of this work lies in the combination of distribution of three state variables in phase space. Seismic damage is simulated considering failure of all bracings of a specific floor in the event of an earthquake and the same is incorporated in the experimental model with damaged bracing at the corresponding story. To achieve contact nonlinearity, damaged bracing is modeled with opening-closing mechanism. The present method evaluated in this work facilitates in minimizing the false identification of damage in time-domain by lowering time-dependent fluctuations.

Keywords: Structural health monitoring, Forced vibration, Poincaré map, Breathing mechanism, Damage localization