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Structural Health Monitoring of Buildings–Recorded Data and Wave Method

Authors : Tzong-Ying Hao, Mohammad T. Rahmani

Abstract : This article presents the structural health monitoring (SHM) method based on changes in wave traveling times (wave method) within a layered 1-D shear beam model of structure. The wave method measures the velocity of shear wave propagating in a building from the impulse response functions (IRF) obtained from recorded data at different locations inside the building. If structural damage occurs in a structure, the velocity of wave propagation through it changes. The wave method analysis is performed on the responses of Torre Central building, a 9-story shear wall structure located in Santiago, Chile. Because events of different intensity (ambient vibrations, weak and strong earthquake motions) have been recorded at this building, therefore it can serve as a full-scale benchmark to validate the structural health monitoring method utilized. The analysis of inter-story drifts and the Fourier spectra for the EW and NS motions during 2010 Chile earthquake are presented. The results for the NS motions suggest the coupling of translation and torsion responses. The system frequencies (estimated from the relative displacement response of the 8th-floor with respect to the basement from recorded data) were detected initially decreasing approximately 24% in the EW motion. Near the end of shaking, an increase of about 17% was detected. These analysis and results serve as baseline indicators of the occurrence of structural damage. The detected changes in wave velocities of the shear beam model are consistent with the observed damage. However, the 1-D shear beam model is not sufficient to simulate the coupling of translation and torsion responses in the NS motion. The wave method is proven for actual implementation in structural health monitoring systems based on carefully assessing the resolution and accuracy of the model for its effectiveness on post-earthquake damage detection in buildings.

Keywords : Chile earthquake, damage detection, earthquake response, impulse response function, shear beam model, shear wave velocity, structural health monitoring, torre central building, wave method
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