Abstract

In order to develop seismic codes that can effectively mitigate damage to wood-frame construction under seismic activity, the dynamic characteristics of wood-frame buildings must be well understood. Funding of full-scale structure experimental tests can be costly and may not be a true replica of real life scenarios. Therefore, data interpretation projects focusing on dynamic behavior of low-rise wooden shearwall buildings under large seismic motions have become increasingly important. Procedures include determining the modal parameters and extracting hysteretic characteristics from the available records. The results help extend the understanding of wood-frame structures and update building codes. Furthermore, the amount of information extracted can help evaluate the effectiveness of the current instrumentation program.

This work focuses on the seismic records from wood-frame structures during the 2004 Parkfield Earthquake. Studies involve verifying the amplitude dependence of modal parameters and retrieving pinching hysteresis curves that are common in wood-frame structures. Modal parameters are identified with a robust routine called MODE-ID. Equivalent viscous damping estimates in wood-frame buildings can range from 5% - 10% in largely linear behavior and 10% - 20% in significant nonlinear behavior. The discrepancies of damping estimates reported in the past are a result of inappropriate comparisons without understanding 1) the degree of nonlinear response and 2) the system identification methods used for the studies. By studying the hysteretic curves, insights can

be obtained to reveal and to resolve the damping estimate discrepancies. Since displacement time histories of structures are not typically measured, the hysteretic curves are extracted from acceleration time histories. The proposed process accounts for inherent double integration errors and phase delay through filtering. It is still being debated that if the double integration can provide meaningful structural relative displacement time histories. In a laboratory setting with unilateral ground motion, the extraction process provides accurate hysteretic curves. However, this dissertation demonstrates that if the building experiences bi-directional ground motions, the nonlinear behavior of the diaphragm tampers with this process.

The results from modal identification and hysteresis curves serve as a basis for creating numerical models. Direct and gradient search methods were used for model updating. Bayesian updating and model selection provided the best results for dealing with hysteretic structural models. This probabilistic framework demonstrates potential benefits in a seamless integration with a seismic database. The selected hysteretic model showed great resemblance to the measured responses and had evidence of pinching hysteresis. Insights on the structure's deformations and dissipation of energy can be inferred from the model.