An evaluation of damage scenarios and detection methods in mid and high-rise buildings densely instrumented by The Community Seismic Network (CSN)

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Abstract

The Community Seismic Network (CSN) works to deploy dense strong motion instrumentation in buildings throughout the Los Angeles basin. To date, we have 15 mid to high-rise buildings monitored, which range from 9 to 52 stories densely instrumented (every floor with at least one seismometer) recording continuously. Dense instrumentation is made practical by tying together low-cost, 3-component, class-C, MEMS accelerometers with a small onboard computer. This implementation, when coupled with cloud-based processing, facilitates a low-cost deployment and network that makes dense structural health monitoring arrays feasible in the field.

For buildings in the network where we are able to obtain structural drawings, we have developed finite element models for computational study. Each model is vetted against collected data, and both frequency and time domain comparisons are performed to determine model accuracy. We then use these models to execute computational damage detection experiments.

This poster focuses on 3 specific array deployments; a 52-story building in downtown Los Angeles and two 9-story buildings on NASA’s Jet Propulsion Laboratory campus. We use data from these structures, both recorded and simulated, to visualize and isolate damage.

Working with collaborators at Computers and Structures Inc., we have developed an interface with the finite-element software ETABS which allows us to rapidly generate damage simulations and obtain results. With this unique set of synthetic data, we are able to test diverse damage scenarios (varying magnitudes, locations, and forms) with several detection strategies.

Simulating our dense instrumentation field, we extract responses from every floor of the computational models that are equivalent to what our deployed array measures. We supplement noise into the results directly and work to determine thresholds for noise, damage, and signal needed for detection strategies. Strategies implemented for detection are influenced from structural engineering, geophysics, and medical imaging techniques. With a dense array of accelerometers, we can quantify wave propagation over the height of the structure, and are able to highlight certain characteristics in the waveform and ascertain whether there exists a unique impedance in the system.

This poster will showcase the various strategies implemented in our analysis, and the effectiveness of each. These methods include, but are not limited to linear move-out, frequency shift, and several transform methods, each of which gives a unique profile and/or visualization of damage. We will also demonstrate work on visualization for owners and building representatives to show how this work would be useful in practice.