ADVANCED SHM SYSTEM FOR U.S. DEPARTMENT OF VETERANS AFFAIRS HOSPITAL BUILDINGS

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ABSTRACT

Major earthquakes near urban centers can cause significant loss of life and catastrophic property damage. Most of this loss will be from damage to buildings and other structures. For instance, the 1971 magnitude 6.6 (Intensity XI) San Fernando earthquake in Southern California resulted in losses of 46 lives due to the collapse of several hospital buildings including four buildings at the San Fernando U.S. Department of Veterans Affairs (VA) medical center and significant damage to VA’s Olive View hospital. In order to minimize or eliminate future losses, it is imperative to manage hospitals condition periodically, and assess their structural integrity before, during and after an earthquake. For condition or serviceability assessment, structural health monitoring (SHM) has been a powerful tool for measuring structural response to effectively diagnosis damage produced by severe loading events and by progressive deterioration to promote comprehensive and efficient inspection service.

In collaboration with the VA, the U.S. Geological Survey has developed a vibration-based SHM software to analyze and archive the building’s vibration in near real-time. The SHM software is built on the Earthworm (EW) system (Johnson et al., 1995), which is an open data processing system that allows any waveform data to be collected from a digitizer into ring buffers and then processed further (http://www.isti2.com/ew). The SHM software develops a baseline for the structural parameters, and continuously examines the response for changes. The structural parameters monitored are interstory drift ratios, shear-wave travel time throughout the building,

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and base-shear capacity-demand ratio. The SHM software is integrated with a web-enabled SHM data management framework to support aggregation, storage, and reporting of SHM data obtained and analyzed from the hospital buildings instrumented to record strong shaking from earthquakes. By analyzing and characterizing the threshold values for building-specific engineering demand parameters, the SHM software can determine inspection priority as low, moderate, high or very high—estimated from the measured vibration data—to assist efforts to evaluate the safety and integrity of building(s) in the aftermath of an earthquake. The SHM software is scalable—able to support an arbitrary number of sensors, and it is extensible—able to accommodate new data streams without the need to rewrite storage and display logic. The SHM software works on site or remotely. The validation of the software is achieved by using ambient as well as low- and high-intensity shaking data from a full-scale seven-story reinforced concrete building section tested on the UCSD shake table.