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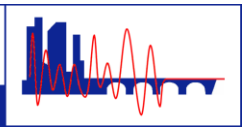

STRUCTURAL STRONG-MOTION INSTRUMENTATION IMPLEMENTED AS A REAL-TIME BUILDING SAFETY DECISION-MAKING TOOL FOR OWNERS

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ABSTRACT

Introduction: Structures worldwide have been instrumented with instrumentation systems (including vibration accelerometers, strong-motion accelerometers, strain gauges, etc.) for the primary purpose of recording structural response data. Researchers, structural engineers, and seismologists use these data to further our understanding of actual building dynamic behavior, validate theories, and ultimately lead to building code improvements. However, these structural health monitoring (SHM) and instrumentation systems are rarely implemented directly on real-world building projects for the benefit of the building owner capturing the rich building-specific measured data and incorporating them into design. In addition to the value to researchers and engineers, there is a tremendous opportunity for the public to benefit directly from the advancements in instrumentation and real-time processing capabilities. Developments in commercial, client-driven applications of SHM technologies has led to a new direct benefit for owners and building occupants, as well as engineers and researchers.

The Problem: Occupants in essential facilities such as hospitals, emergency operations centers, strategic military installations, critical financial institutions/centers, nuclear power plants, and ultra-tall buildings, cannot easily evacuate immediately after an earthquake or wait for a detailed safety assessment to reoccupy and resume operations. Our first-hand experience from post-earthquake response efforts has indicated that the decision to evacuate and reoccupy is difficult, especially under a state of emergency, and poor decisions have had serious consequences (e.g. panic-related injuries, economic loss due to unnecessary evacuations/downtime, etc.).

The Solution: - Although the concept of using strong-motion instrumentation to directly benefit the building owner has been exercised in the SHM community, this paper presents a real, marketable solution built upon strong-motion monitoring, performance-based earthquake engineering principles, and standards of care for post-disaster assessment. The real-time SHM systems of strong-motion accelerometers measure the acceleration at several levels/locations in a building, perform real-time double integration to calculate building displacements and drifts, and compare building drifts with pre-defined drift thresholds based on Performance-Based Earthquake Engineering (PBEE) analysis procedures. The system utilizes intuitive onsite display, alerting, reporting, and remote notification tools to communicate results to building owners and facility managers throughout all phases of the post-earthquake response, inspection, and recovery process. The objective of this tool is provide building owners and facility managers with the real-time information to make knowledgeable decisions regarding the condition of the building in order to help avoid/minimize down-time, increase resiliency, improve disaster preparedness, and ultimately improve the safety of building occupants.

Case Studies – Several case studies will be presented describing how this strong-motion instrumentation system has been deployed in commercial applications for essential facilities, including several hospitals and industrial facilities in the United States, as well as several iconic high-rise buildings in the United Arab Emirates.

Keywords: Business Continuity; Structural Health Monitoring; Earthquake Preparedness; Strong-Motion