Experimental Damage Diagnosis of a Model Three-Story Spatial Frame

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Abstract:

In order to evaluate the effectiveness of potential damage indicators, an experimental study of a three-story spatial frame structure model was conducted in the Multi-Function Dynamics Laboratory at the University of Mississippi. The steel and aluminum test structure measured approximately 4" square at the base and 24" in height. Referencing an as-built baseline configuration, ten separate and unique damage scenarios were applied to the model by removing various cross bracing members. Single and multiple story damage as well as various forms of symmetric and asymmetric damage were simulated. An impact hammer was used to modally excite the structure while output signals were captured by a tri-axial accelerometer. Modal decomposition was carried out by Star Modal utilizing response data and model geometry.

Several damage detection techniques were then employed by mathematically manipulating the experimentally obtained mode shapes and natural frequencies for each damage case. Two broad categories of damage indicators were analyzed: structural stiffness based algorithms and mode shape based methods. In order to evaluate their effectiveness, detection techniques from literature were utilized to locate damaged elements of the test structure as well as determine the relative severity of damage. The accuracy of each method is established, and in general it was demonstrated that vibration-based experiments can be used for system identification and damage diagnosis.

Keywords: damage detection, damage indication, modal testing, laboratory testing, structural health

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