ABSTRACT

Gauthier, Javier F. Ph. D., Purdue University, August, 2005. A New Methodology for Evaluation and Rating of Bridges. Major Professors: Judy Liu and Timothy M. Whalen.

Highway bridges are susceptible to structural damage over their service lives due to factors such as excessive operating loads, fatigue, and corrosion. Structural assessment programs have been developed in order to detect damage in its early stages and thus avoid a catastrophic situation. These programs have relied largely on visual inspection to provide critical information on the condition of bridges in the United States. It is expected that visual inspections should provide sufficient information about the health of the bridge inventory to permit effective maintenance and repair planning. However, it has been demonstrated that the subjective nature of current inspection practices does not allow for thorough assessment of the functional condition of highway bridges.

To address the limitations of the current assessment practices, a new nondestructive evaluation (NDE) methodology based upon the use of vibration information to obtain a quantitative assessment of the structural condition of bridges is proposed. Experimental information obtained by NDE techniques, in conjunction with visual inspection, will increase the reliability of the results of the condition assessment process, permitting more cost-effective bridge inventory management and rehabilitation. Accordingly, a new global vibration-based damage identification (DI) method is proposed herein based upon fourth derivatives of the mode shapes for the assessment of the structural integrity of bridges.

An important advantage of the novel DI method is that it does not require a priori information of the structure under consideration or complex analytical models. Thus, the structure's integrity can be assessed even if no data from the undamaged state is available. The proposed DI method will not rely on the subjective judgment of the user;

therefore, it will be suitable for automation. Statistical models are incorporated into the DI method in order to provide criteria to discriminate if damage has occurred at a specific location by measuring the statistical significance of the damage detection feature. This comprehensive DI method will be able to detect deterioration in its early age, provide some estimate of the location of the damage, and provide some quantitative estimate of the severity of the damage.