Reliable Condition Assessment of Structures Using Field Measurements and Uncertainty Analyses

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Abstract

The failure of structural systems has significant societal and human consequences. Therefore, there is a crucial need to assess the structural condition of in-service and aging structures which is a major cost and management consideration, particularly in cases with unknown design validation. However, structural condition assessment, when conducted according to state-of-the-art protocols, produces very subjective and highly variable results. This can be attributed to the presence of uncertainty in structural measurements as well as lack of objective condition assessment tools also capable of considering those uncertainties in their analytical procedures.

In this work, a new method with a hybrid experimental/analytical framework for condition assessment and life prediction of existing structures is developed. This objective hybrid framework combines experimental structural measurements (e.g., results from non-destructive tests or routine performance and/or inspection data for structure's response) and theoretical structural uncertainty analyses (interval finite element method). This method uses the structural measurements, with consideration of uncertainties, in structural uncertainty analyses, for estimating the condition of a structure. Application of structural measurement data, integrated with an enhanced structural analysis scheme, and with consideration of uncertainties provides the necessary information to make decisions regarding inspections, rehabilitation and repairs. As a case study, the method is applied for a failed sign support structure and the damage as well as lifetime of the structure is determined.