Probabilistic Performance Assessment of Highway Bridges Using Operational Monitoring Data

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Summary

A new probabilistic performance assessment procedure using operational monitoring data is proposed. In the procedure, multiple finite element models are identified from the weighted aggregation formulation for multi-objective optimization problem, each of which can represent uncertainty condition of operational monitoring data. By applying principal component analysis and *K*-means clustering on numerous candidate models, they are grouped according to their similarity and contributions in performance assessment. And then bridge's performance can be assessed in probabilistic approach using the FE models in the classified groups, at which specific types of operational monitoring data uncertainty is represented. Yeondae Bridge, a steel-box girder highway bridge in Korea, is taken as an illustrative example. Load rating factor is evaluated as performance index of the bridge, and compared to rating factors by sophisticated model and baseline mode to verify effectiveness of proposed method.

Keywords: Performance assessment; Operational monitoring data; Structural identification; Principal Component Analysis; *K*-means clustering; Load rating.

1. Introduction

Bridges in use need proper assessment during its lifetime through quantitative evaluations of current performance. Reliable and accurate structural analysis model is required for precise prediction and evaluation of structural performance. However, it has been recognized that there are inevitable uncertainties in the analysis model, which come mainly from hypotheses in modelling stage, fluctuations in manufacturing structural components, and changes in structural characteristics along with deterioration during their lifetime. In general, discrepancies between the model and the targeted structure are expected to be minimized through model updating process by using monitored responses which can reflect the current state of the instrumented bridge.

Recent advances in structural health monitoring technology have enabled us to collect a large amount of data for the behavior of real life, full-scale structures during its operation [1, 2]. Clearly, this plenty of data seems to open the new window to look at the real nature of what we built rather than the expected responses of what we designed. In addition, the operational monitoring data also have the virtue of simplicity as needlessness of bridge closure for instrumentation. For that reasons, operational monitoring data can be essentially utilized model updating for bridge performance assessment.

On the other hand, the referenced operational monitoring data also exhibit considerable variability due to its intrinsic uncertain nature, innumerable influence of environmental conditions and the

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