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Realization and Testing of an In-Service Vibration Analysis System for Structural Health Monitoring

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Large lightweight structures like bridges are susceptible to vibrations due to operational and environmental loads. Since the excitation of structural resonances can effect in high vibration levels and in turn to fatigue damages, structural analyses are conducted which serve as a basis for the improvement of the design or the implementation of vibration control devices like tuned mass dampers. By regularly repeating those analyses, also structural damages can be detected in an early state in order to support condition based maintenance processes. In this paper, a system is introduced for the permanent instrumentation of structures in order to realize unattended long-term vibration analyses for structural health monitoring. Robust units are used for data acquisition on the structure under in-service conditions. Those units are distributed over the structure to collect vibration signals from a number of adjacently mounted sensors. Also, a first signal analysis for data compression to enable efficient communication of data via a protocol based network is performed on those units. To keep computational efforts moderate, the Random Decrement (RD) method is used to estimate auto- and cross correlation functions of vibration time signals from ambient excitation due to traffic or wind. The Random Decrement signatures are transmitted to a central processing unit, which performs the derivation of modal parameters, i.e. resonance frequencies and mode shapes of the structure, which can serve as input for damage detection algorithms. The developed system is tested on a pedestrian bridge. To this end, first an experimental modal analysis is performed with impulse hammer excitation. The results serve as a reference for assessment of the resonances and mode shapes identified by the operational modal analysis performed with the in-service vibration analysis system.

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Ключевые слова:

Содержание