Operational modal analysis for scour monitoring of bridge piers

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Abstract

Scour is the erosive process of removing sediment and soil around bridge piers in rivers, which can pose significant risks to bridge failures. Therefore, it is essential to monitor this phenomenon, which is difficult because of the various structural, geotechnical and hydraulic actions that are involved. An innovative and effective way to do it seems to take advantage of the structural behavior of bridge piers, which is linked to the scour depth. Indeed, modal characteristics of bridge piers, are very sensitive to change of their boundary conditions including those due to the scour. This study presents some results obtained from vibration-based monitoring of bridge piers subject to scour. As most civil engineering structures, the real-time monitoring concerns output-only systems under environmental and traffic loads. This work aims to propose a method for the operational modal analysis (OMA) of a bridge pier. In this study, the OMA is applied to a real case study in a French motorway bridge. Sensors are placed under the bridge deck and on the top of its pier. The method mixes a frequency domain decomposition (FDD) of the power spectral density matrix with algorithms from unsupervised machine learning (clustering). Natural frequencies of the bridge pier for a period of more than one year are identified and their sensitivities to the water level and the temperature are evaluated in a statistical way. Based on changes of natural frequencies, features which are potentially due to scour are detected.

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