Bridge Scour Detection of the Feather River Bridge in Yuba City, CA Through the Use of Finite Element Modeling and Infrasound

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Abstract

Introduction: Currently a case study of the Feather River Bridge in Yuba City, CA is being conducted by the US Army Engineer Research and Development Center (ERDC), to investigate the use of infrasound, low-frequency acoustics, as a means of scour detection and assessment at bridge piers. The infrasound passband in which large infrastructure, such as bridges, resonates is within the 0.1-20 Hz range. Scour, as it relates to bridges, is defined as the result of the erosive action of flowing water, excavating and carrying away material from the bed and banks of streams and from around the piers and abutments of bridges, and is a common issue for structures. A recent field deployment in Yuba City, CA allowed for characterization of scour on a known scour-critical structure with validation from a comparison of infrasound data and numerical modeling. Through the use of COMSOL Multiphysics® software, finite element models have been developed of the Feather River Bridge to investigate the fundamental frequencies of the bridge superstructure and substructure. The two models of concern are the model of Span 22 of the bridge which is in conjunction with the pier that is scour-critical, and the scour-critical pier itself. The scour critical pier and span 22 can be seen in Figure 1.

Use of COMSOL Multiphysics: The superstructure and substructure were modeled using COMSOL to determine the fundamental modal frequencies of the structure under dead load. For the mode shape associated with the 1.45 Hz resonance, Figure 2, the deck of the bridge appears to be vibrating vertically. For the mode shape associated with the 1.51 Hz resonance, Figure 3, the deck appears to vibrate in torsion. A 9-in concrete deck was added to span 21-22 of the superstructure and the finite element analyses determined fundamental modes of 1.31 Hz resonance, Figure 4, for vertical vibration and 1.65 Hz resonance vibrating in torsion. All superstructure frequencies were found within the first six modes and observed in the infrasound field data. An acoustic model of the bridge, Span 22, was modeled to determine what energy the structure is producing. An initial substructure finite element model analysis was successful, but improvements to the boundary conditions are predicted to affect the resonant frequency of the piers.

Conclusion: The initial field deployment of Feather River Bridge yielded data that corresponded to the Modal frequencies. The frequencies contained in the infrasound data corresponding to the band of frequencies seen in the finite element model. The backazimuth to source was confirmed

to correspond to the infrasound signals identified in the collected field data for the Feather River Bridge. As future research is conducted, using COMSOL Multiphysics, predictions can be made on how the bridge will resonate based on the depth of the scour.