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Modal parameters identification of heavy-haul railway RC bridges – experience acquired

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Abstract. Traditionally, it is not easy to carry out tests to identify modal parameters from existing railway bridges because of the testing conditions and complicated nature of civil structures. A six year (2007-2012) research program was conducted to monitor a group of 25 railway bridges. One of the tasks was to devise guidelines for identifying their modal parameters. This paper presents the experience acquired from such identification. The modal analysis of four representative bridges of this group is reported, which include B5, B15, B20 and B58A, crossing the Carajás railway in northern Brazil using three different excitations sources: drop weight, free vibration after train passage, and ambient conditions. To extract the dynamic parameters from the recorded data, Stochastic Subspace Identification and Frequency Domain Decomposition methods were used. Finite-element models were constructed to facilitate the dynamic measurements. The results show good agreement between the measured and computed natural frequencies and mode shapes. The findings provide some guidelines on methods of excitation, record length of time, methods of modal analysis including the use of projected channel and harmonic detection, helping researchers and maintenance teams obtain good dynamic characteristics from measurement data.

Keywords: railway bridges; operational modal analysis; stochastic subspace identification; frequency domain decomposition

1. Introduction

Railway bridges are large and complex structures subjected to dynamic loads and thus need a thorough evaluation to ensure satisfactory use, especially after many years of operation under heavy traffic conditions. Structural health monitoring based on dynamic measurements is a very active field, especially in bridge engineering (Shih *et al.* 2011, Moradipour *et al.* 2015). However, the experimental evaluation of dynamic parameters can be very challenging, particularly in the case of large and heavy structures such as bridges. It may be very difficult and/or inconvenient to excite a structure with a known input force because this procedure usually causes traffic interruption. Thus, a number of papers have been published on output-only modal analysis techniques. In the case of railway bridges, when freight train passages are used to excite the structure, it is clear that the train exerts a great influence on the system modal parameters due to

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