Characterization of operational vibrations of highway bridges Via Lidar

Adriana Trias

Rowan University, Glassboro, NJ, USA

Contact: trias@rowan.edu

Abstract

During the examination of data obtained from scanning an operational steel girder bridge, local ripples were noted in horizontal elements that were expected to be planar in nature (such as girder flanges). It was hypothesized that these ripples are a result of the bridge vibrating under truck traffic. The objective of this paper is to examine this hypothesis through the use of data obtained from an operating highway bridge together with the use of numerical and physical models. After analyzing the data, by estimating the distance between the peak of these ripples (and translating this into time using the data acquisition metrics) the frequency of the vibrating object can be estimated. For the operating bridge and physical model employed in this research, the natural frequencies were estimated within 2% to 10% and 0,22% to 5%, respectively.

Keywords: Bridge; Bridge Dynamics; Structural Health Monitoring; SHM; Vibration; LiDAR.

1 Introduction

During the examination of data obtained from scanning an operational steel girder bridge, local ripples were noted in horizontal elements that were expected to be planar in nature (such as girder flanges). It was hypothesized that these ripples are a result of the bridge vibrating under truck traffic. If true, given the broadband nature of traffic excitation (1-5 Hz for typical highway bridges) [1][2][3], analysing these ripples should be able to provide information about the dynamic properties of the test structure. That is, their frequency is likely more related to the dynamic properties of the structure than the frequency of the loading. The objective of this paper is to examine this hypothesis through the use of data obtained from an operating highway bridge together with the use of numerical and physical models.

2 Observation from an Operational Highway Bridge

This ripple phenomenon was easily observed throughout the point cloud data, as shown in Figure 1, indicating this was not a one-time event. When faced with such a situation, there are two primary concerns related to (1) ensuring that the ripples do not pollute the estimation of geometry from the LiDAR data, and (2) the potential extraction of modal frequencies as a means of characterizing the dynamic performance of the bridge. This paper presents the discussion on how these concerns were addressed for the test bridge following a description of the relevant data acquisition parameters.

https://doi.org/10.2749/ghent.2021.0412
Distributed by structurae