A finite element model updated by artificial neural networks to explain the behaviour of the Z24 Swiss bridge in different temperature states.

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Abstract

A Finite Element (FE) model of bridge Z24 was developed to reflect its dynamic response and investigate the physical reasons behind the large variations observed on its natural modal properties during a 7-month continuous monitoring campaign conducted before its demolition in 1997. A significant increase in natural frequencies was observed especially during the winter period, something which was explained as a consequence of deck stiffness increase and boundary conditions change, due to the formation of ice layers on the deck and supports.

The paper concentrates on the procedure of developing a FE model update process, which employs Artificial Neural Networks (ANNs), which are trained using data generated through the Monte Carlo process and analysed within the FE model of the bridge. The aim of this procedure is to calibrate the FE update sensitivity parameters in such a way as to replicate the dynamic behaviour of the bridge based on real-time measured eigenvalues obtained during monitoring for five different temperature states at -10 °C, -5 °C, 0 °C, 5 °C and 10°C.

Keywords: Structural Health Monitoring; Finite Element Model Update; Reinforced Concrete; Bridges; Artificial Neural Networks (ANNs); Monte Carlo Analysis

1 Introduction

One of the key aspects of structural health monitoring (SHM) in Bridges is to understand and evaluate the response of a bridge using the measured data coming from monitoring campaigns. SHM can provide a wide variety of measured data. In literature, these can be referred to as “features” or “damage sensitive features” (DSFs) because the majority of them can demonstrate great sensitivity to changes inferred by damage [1-3].

DSFs can be categorised into vibrational-based features, such as natural frequencies, mode shapes, modal strain energy, frequency response functions (FRFs) and component-based features, which are displacements, tensions, strains, moments, deflections and others [1-3]. These

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