Indirect estimate of concrete compression strength framework with FE model updating and operational modal analysis

Marco Martino Rosso, Raffaele Cucuzza, Giuseppe Carlo Marano

DISEG, Dipartimento di Ingegneria Strutturale, Edile e Geotecnica, Politecnico di Torino, Corso Duca Degli Abruzzi, 24, Turin, 10128, Italy

Angelo Aloisio

Civil Environmental and Architectural Engineering Department, Università degli Studi dell'Aquila, via Giovanni Gronchi n.18, L'Aquila, 67100, Italy

Dag Pasquale Pasca

Norsk Treteknisk Institutt, Børrestuveien 3, Oslo, 0373, Norway

Contact: marco.rosso@polito.it

Abstract

The aging of existing concrete structures requires the development of economical and non-destructive (ND) methods to estimate their structural capacity. The practice of operational modal analysis (OMA) in civil structures is actually widespread, but there are a few applications that relate the estimate of the modal parameters to the ultimate resistance of concrete: accurately, the elastic modulus of concrete is a mechanical parameter correlated to the conservation state of concrete. The modal parameters can return reliable estimates of the elastic modulus, by assuming the geometrical characteristics of the beam and the mass density. In this paper, the authors estimate the elastic modulus of a set of seven spans concrete bridge by optimizing the finite element (FE) model of the bridges using the outcomes of OMA. Thereafter, the value of the elastic modulus has been compared with the compressive resistance of concrete obtained by using existing literature formulations and in-situ destructive tests on concrete specimens. It is assessed the reliability in the estimate of the compression resistance of concrete using OMA, by propagating the uncertainties of the estimates from the modal parameters to the resistance of concrete.

Keywords: structural health monitoring; operational modal analysis; model updating; Young's modulus; concrete strength.

1 Introduction

Due to ageing of existing concrete structures, the scientific community is increasingly concerned to search for ND reliable methods to assess actual material properties from experimental vibration data [1-2]. In concrete structures, the Young's modulus can be a global representative of the health of the whole structural system [3] giving a significant insight into the conservation state of a