



Advanced modelling of concrete bridges

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Abstract

The combination of non-linear finite element analysis with structural monitoring can considerably improve the prognosis of bridge behaviour, deterioration, and damage. Recently, a digital twin concept is utilized in which a digital replica of a real structure is developed. Based on the data obtained from the monitoring system installed on the Wonka bridge, Czech Republic, a computational model was calibrated. Then, advanced deterioration models accounting for chloride-induced reinforcement corrosion were applied to assess the long-term development of the structure's load-bearing capacity. It is shown that the proposed integrated system can be used as a tool for the ageing management of concrete structures ensuring their long-term safe operation.

Keywords: ageing management, bridge monitoring, finite element method (FEM), non-linear analysis, durability assessment

1 Introduction

The functional transport infrastructure is one of the key aspects of an efficient modern economy both in developed and developing countries. In the case of the European Union, the road and railway system plays an important role in the transport of goods and passengers. This infrastructure was mainly built during the economic growth after World War II implying that the average age of the structures well-exceeds 50 years. Nowadays, the ageing infrastructure represents a significant financial burden for the public authorities. Based on the data from 22 selected OECD countries [1], the cost of infrastructure maintenance increased by 1.78 billion euros each year between 1997 and 2016 as shown in Figure 1.

The early diagnosis and prediction of the structural deterioration not only reduces the repair cost but may prevent limitation in serviceability of the structure and prevent the worst-case scenarios such as was the case of the pedestrian Trója bridge

in Prague or the Morandi Bridge in Genoa. Except for regular inspections confirming the integrity of the structure, online monitoring systems can be used to monitor the structural performance characteristics. Furthermore, these systems provide valuable data for the validation of numerical models.

Recently, a concept of a digital twin has been introduced to many engineering fields, including structural design [2]. The concept relies on the

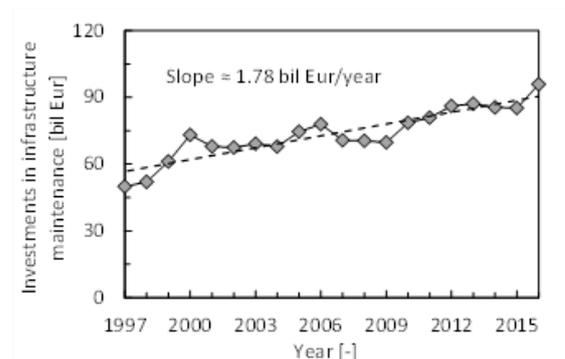


Figure 1. Cost of infrastructure maintenance for selected OECD countries between 1997 and 2016