Modelling the non-linear behaviour of the pot bearings of railway bridge KW51

Menno Van de Velde, Kristof Maes, Geert Lombaert

Department of Civil Engineering, KU Leuven, Leuven, Belgium

Contact: menno.vandevelde@kuleuven.be

Abstract

Railway bridge KW51 in Leuven, Belgium, has been monitored since October 2018 with the aim of constructing a digital twin, i.e. a virtual representation that mimics the behaviour of the actual structure. A linear finite element model of the bridge was updated using measurements carried out on the bridge. The pot bearings of the bridge, however, are found to behave in a non-linear way. This paper describes a methodology to account for this non-linear behaviour in the model, where friction in the bearings is accounted for by means of non-linear Bouc-Wen elements. The first results are presented, showing that the overall non-linear behaviour of the bearings during a train passage is well captured but that further research is needed to calibrate the model parameters.

Keywords: Digital twin, pot bearings, Bouw-Wen friction force, railway bridge KW51

1 Introduction

In both industry and research, the popularity of digital twins is increasing steadily. A digital twin is a virtual representation of a physical product or system (the physical twin) during its life cycle. They are used to represent small products and machines as well as large infrastructures and even cities. Digital twins try to be an almost exact real-time duplicate of the physical twin and are constantly updated using measurements carried out on the physical twin. In bridge engineering, these measurements may for example consist of deflection measurements, counting the numbers of vehicles crossing the bridge, vibration measurements etc. During the lifespan of the product, the digital twin can assist with the inspection and the maintenance of the virtual twin. By doing so, the costs for tactile and visual inspections and maintenance can be significantly reduced [1].

Railway bridge KW51 (Figure 1) in Leuven, Belgium, has been monitored since October 2018 with the aim of constructing a digital twin. A detailed finite element model has been constructed, which is updated using acceleration measurements carried out on the bridge. When constructing a digital twin, it is desirable to represent the actual behaviour of the structure as accurately as possible. An important aspect of bridge modelling lies in the representation of the support conditions. The behaviour of bearings is typically assumed to be perfectly linear elastic. For railway bridge KW51, however, it was found that the pot bearings behave non-linearly [2].

Figure 1: Railway bridge KW51

https://doi.org/10.2749/ghent.2021.0404
Distributed by structurae