Evaluation of the behavior of old beam-plate bridges

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Abstract

In this paper, the case study of a railway bridge in Antwerp, Belgium will be performed. This bridge is constructed using precambered steel-concrete girders, also known as preflex beams. This was the standard solution for railway bridges at the time of construction, namely the end of the 1960s. Nowadays, bridges of this kind have been in use for more than fifty years and suffer different types of deterioration. For some bridges, longitudinal cracks have been found along the length of the precambered girders, which is also the case for the bridge considered here. To be able to get a better understanding of the state of the bridge using modern guidelines, a detailed 3D finite element model will be made, based on the original design notes dating from the 1960s. With this model, the compliance of the bridge with current guidelines, namely the Eurocode, will be verified. Furthermore, the results will be compared with reality since a detailed site investigation and inspection of the bridge have been carried out. The extremely deteriorated state of the bridge is discussed in detail.

Keywords: existing bridge, concrete beams, preflex, deterioration, monitoring, inspection.

1 Introduction

In Belgium, the standard solution for railway bridges consists of precambered steel-concrete girders, also known as preflex beams. Many of these bridges have been in use for more than fifty years and suffer different types of deterioration. For some railway bridges, longitudinal cracks have been found along the length of the precambered girders. Due to the high number of such bridges and the large impact on overall mobility of the retrofitting of such infrastructure, a better understanding of their state using modern guidelines is needed.

The case study of a railway bridge constructed in 1969 crossing the ringway around Antwerp will be used to conduct this research. In recent years, the state of the bridge has deteriorated, leading to cracks and crumbling concrete in several places. The beginning of the deterioration is not known, but it started between 5 and 15 years ago. Several inspections have taken place which show that the most damage occurs in bridge decks B and C. In 2022, an engineering firm specializing in research and consulting related to existing concrete structures, SANACON, performed an exploratory concrete investigation on the preflex beams of the bridge [1]. The conclusion of this investigation was that the crack formation could not be linked to durability issues but must be linked to a structural deficiency.

In the following of this master's dissertation, bridge deck C will be discussed further, and the cause of the cracks will be investigated. A detailed 3D finite element model will be made, based on the original design notes dating from the 1960s. With this

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