Evaluation of Residual Prestress Force in a Concrete Girder Bridge

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Abstract

When assessing the structural behaviour of prestressed concrete bridges, understanding the level of prestressing is crucial. However, for existing structures, this is usually an unknown parameter and the literature only describes a few methods of experimentally determining the residual prestress forces. For this paper, a non-destructive testing approach has been evaluated based on testing of a multi-span continuous girder bridge. The method, consisting of in-situ measurements in combination with finite element (FE) simulations, revealed prestress levels in the range 25 % to 82 % of the reinforcement steel yield strength, depending on the section tested. A comparison with theoretically calculated residual prestress forces, taking into account friction and time-dependent losses, indicated values of the same order but with some inconsistencies.

Keywords: Assessment, bridges, finite element modelling, non-destructive test, prestressed concrete, residual prestress force.

1 Introduction

When assessing existing prestressed concrete bridges, an accurate determination of the residual prestress force is essential. This parameter is crucial for estimating the bridge response and capacity at both the serviceability and ultimate limit states. From a durability perspective, the prestress force is relevant for bridges in aggressive environments, as it relates to the prevention of cracks and the limitation of crack widths.

Despite the importance of having an accurate measurement of the residual prestress force, there are only a few evaluation methods available, with several studies showing appreciable deviations between values seen experimentally and those predicted using theoretical models e.g. [1]. There are two categories of methods, destructive and non-destructive, but only the non-destructive methods are suitable for use with bridges in service. Uncertainties in the theoretical models predicting the prestress losses mean that these testing procedures are necessary. Moreover, the initial prestress force applied to the structure is sometimes unknown, making experimental determination even more important.

In order to improve on the limited knowledge of the on-site application of existing non-destructive approaches on bridges, an experimental study has been carried out and evaluated. The bridge investigated also required further development of the approach to handle the complexity of the structure. Within the research project, the ultimate goal was to assess the structural behaviour and load-carrying capacity where information about the residual prestress force was needed. In this particular case, the initial prestress force was not documented in construction drawings and, thus, experimental evaluation was necessary.

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