Long-term monitoring of a progressively deteriorating bridge to support safe operation

Darby Johannessen, Tim Heldt, Neal Lake, Hanson Ngo, Joshua Frew

Australian Road Research Board (ARRB), Fortitude Valley, Queensland, Australia

Contact: darby.johannessen@arrb.com.au

Abstract

Gradual deterioration of concrete structures due to alkali-silica reaction (ASR) and other mechanisms is a worldwide issue which is especially concerning for bridges. Currently, the point at which such deterioration begins to significantly impact structural capacity is not clearly defined. In this study, long-term continuous strain monitoring instrumentation was installed on a deteriorating Queensland bridge in order to monitor structural performance and support ongoing management. Short-term conventional instrumentation was also installed, and a grillage model was developed in order to facilitate benchmarking and validation of the long-term system. This paper describes the rationale, selection of instrumentation and presents initial results.

Keywords: instrumentation; bridge asset management; long-term monitoring; fibre-Bragg grating; alkali-silica reaction; risk assurance; deck unit bridge; Queensland; pre-stressed concrete.

1 Introduction

Gradual deleterious concrete deterioration due to ASR and other mechanisms is a widespread issue which often produces conspicuous, and sometimes severe cracking [1]. ASR is considered irreversible and cannot be eliminated, but its progress can typically be slowed through control of the moisture environment on site [1]. ASR has a detrimental effect on the structural and durability properties of the affected components, but there is insufficient research to quantify its practical effect on structural capacity. The inter-relationship between condition and capacity for these types of structures affected by ASR or other defects is poorly understood [2].

The study bridge (Figure 1) is a critical access link between a central Queensland town and key economic and commercial activity centres. The bridge is a four-span transversely stressed deck unit bridge (prestressed) with a 15° skew which was constructed in the early 1970s. The superstructure consists of 14 deck units per span, including kerb units on each edge which also function as roadway kerbs. The units are transversely stressed using Macalloy bars spaced every 2.0 m. This particular structure is also highly utilised by oversize and overmass (OSOM) permit vehicles which are known to represent a significant live load risk to bridges. These vehicles utilise available structure capacity to very high levels and their actual impact on infrastructure is poorly understood [3]. Thus, the structure has the most demanding combination of load and condition issues in the asset portfolio managed by the local road agency.

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