

Degradation of Concrete Bridges by Internal Expansive Reactions – Portuguese Case Studies

António Santos Silva, Arlindo Gonçalves, Manuela Salta

Materials Department, Laboratório Nacional de Engenharia Civil, Av. Brasil 101, 1700-066 Lisboa, Portugal

Abstract

In the last years some concrete bridges in Portugal have shown premature deterioration due to intensive concrete cracking development mainly attributed to internal expansive reactions. An important experimental program was conducted by Laboratório Nacional de Engenharia Civil (LNEC), a public institution of the Portuguese Ministry for Public Works, Transports and Housing, in order to diagnose the causes and also prognostic the long-term behaviour of the deteriorated concrete bridges.

The research conducted has pointeded that the concrete cracking was mainly due to the occurrence of internal expansive reactions: alkali-silica reaction (ASR) and/ or delayed ettringite formation (DEF).

The ASR was caused by the use of alkali reactive aggregates and the DEF by the high heat-curing temperature obtained during the setting and hardening in combination with the high portland cement content used in the concrete mix designs.

Residual expansion tests were done in order to access the residual ASR and DEF reactivity. Measurements have been carried out with the methods normally used for ASR and DEF concrete testing: $38^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 95% HR in the first case and $20^{\circ}\pm 2^{\circ}\text{C}$ and 100% HR for the second. Mostly of the bridges show residual capacity to continue the expansion due to ASR or DEF, which forced remedial measures against these expansive reactions, mainly associated with control of the ingress of water into concrete.

This situation in Portugal led to conclude that new deterioration cases can occur. To avoid these causes of damage the design and construction of new structures must follow the new Portuguese preventive methodologies (developed by LNEC).

Keywords: Alkali-silica reaction, delayed ettringite formation, concrete, bridges, recommendations