Correlating field and laboratory investigations for preventing ASR in concrete – the LNEC cube study

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Extended Abstract

As part of the large Norwegian R&D project “ASR - Reliable concept for performance testing” (KPN-ASR) and of the RILEM TC 258-AAA activities, a study was launched in 2015 with the aim of correlating the results of field and laboratory investigations for selecting appropriate preventive measures against alkali-silica reaction (ASR) in concrete. Three coarse aggregates, *i.e.* the extremely reactive New Mexico gravel from the USA (NM), the highly reactive Ottersbo aggregate from Norway (Ott), and a non-reactive limestone aggregate from Portugal (L), were used to manufacture 85 concrete cubes (300x300x300 mm^3 in size) at LNEC facilities in Lisbon. The air-entrained concrete mixes consisted of control (high-alkali cement - HA; normal alkali cement - NA) and siliceous/low calcium fly ash, FA (20 and 30 % replacement levels of the HA cement). After demoulding, the cubes were wrapped in wet burlap and cling film and shipped to be placed on the participants outdoor exposure sites, where they were then monitored for long-term expansion and cracking development (Lisbon and Cascais, Portugal; Paris, France; Düsseldorf, Germany; Reykjavik, Iceland; Trondheim and Brevik, Norway; Ottawa, Canada; Treat Island, Maine, USA; Austin, Texas, USA).

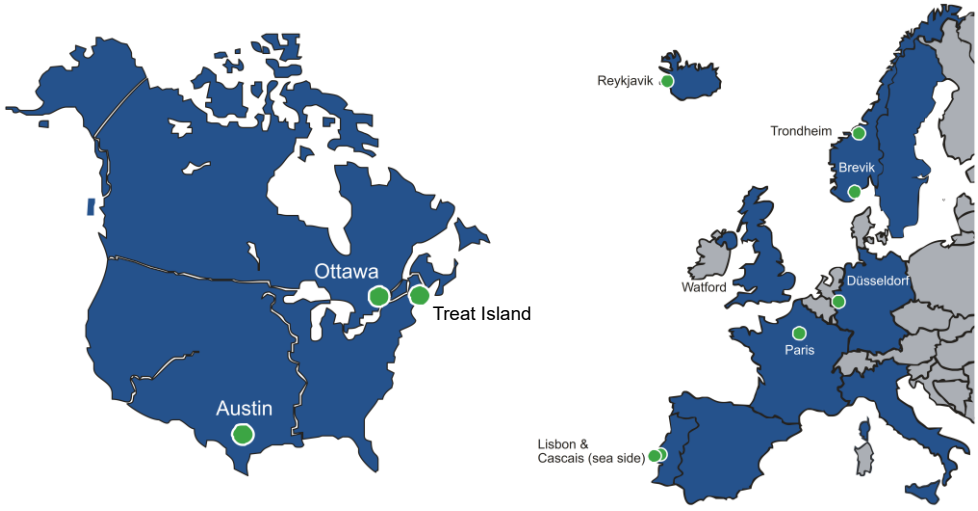

Figure 1.1: Location of outdoor exposure sites of “LNEC cube study”.

Companion laboratory specimens consisting in cubes (compressive strength and air-void spacing factor determination on hardened concrete) and prisms, 75x75x285 mm^3 in size, were cast from the above

mixtures. The prisms were subjected to RILEM AAR-3.1 (38 ºC) and RILEM AAR-4.1 (60 ºC) testing at LNEC's laboratory; their expansion was monitored over 205 and 28 weeks, respectively. Selected control and FA mixtures (*i.e.*, those incorporating the Ottersbo aggregate), without air-entrainment, were repeated at SINTEF following the Norwegian concrete prism test (38 ºC NCPT, prism size 100x100x450 mm^3) and RILEM AAR-4.1 (prism size 70x70x280 mm^3). In addition to the mass change and expansion, the dynamic Young's modulus as a function of time was also measured on those prisms.

This programme, referred to as the "LNEC cube study", aims to provide information on the following issues:

- Effect of fly ash in controlling expansion due to ASR with selected highly reactive aggregates.
- Effect of environmental conditions on the preventive effect of fly ash against ASR expansion.
- Correlation between the results obtained in accelerated concrete prism tests carried out in the laboratory and the "real behaviour" of identical concrete mixes kept outdoors under various natural climatic conditions.

As expected, high expansions were obtained from the control high-alkali concretes with the extreme reactive aggregate from New Mexico and the highly reactive Ottersbo aggregate from Norway. Moreover, also as expected, adding 20 and 30 % fly ash to the mixture with the Ottersbo aggregate reduced the expansion dramatically. Depending on the test method used, the ultimate expansion for the two fly ash mixtures were either just above (RILEM AAR-3.1) or below (the three other CPTs) the acceptance limits normally used in various countries for the different ASR test methods. When using the same test procedure, RILEM AAR-4.1, almost identical results were obtained at LNEC and at SINTEF, despite the use of concrete mixtures with (LNEC) and without (SINTEF) air-entrainment. This indicates that the influence of different air-content on the ASR expansion is not significant for the concretes tested, and furthermore that the variation obtained between the two laboratories for this method is low.

The full details on the results obtained so far in the LNEC cube study, will be published in a journal article.

***Keywords**: ASR; laboratory/field correlation; performance testing; preventive measures against ASR; RILEM.*

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