

## **PARTNER Project post-documentation study – condition assessment of field exposure site cubes (Part I – results of physical and chemical testing)**

**Jan Lindgård<sup>(1)</sup>, Ingmar Borchers<sup>(2)</sup>, João Custódio<sup>(3)</sup>, Esperanza M. Menéndez<sup>(4)</sup>,  
Benoit Fournier<sup>(5)</sup>, Børge J. Wigum<sup>(6)</sup>**

*(1) SINTEF, Trondheim, Norway, [jan.lindgard@sintef.no](mailto:jan.lindgard@sintef.no)*

*(2) VDZ gGmbH, Düsseldorf, Germany, [ingmar.borchers@vdz-online.de](mailto:ingmar.borchers@vdz-online.de)*

*(3) National Laboratory for Civil Engineering (LNEC), Lisbon, Portugal, [jcustodio@lnec.pt](mailto:jcustodio@lnec.pt)*

*(4) IETcc-CSIC, Madrid, Spain, [emm@ietcc.csic.es](mailto:emm@ietcc.csic.es)*

*(5) Laval University, Québec City, Canada, [benoit.fournier@ggl.ulaval.ca](mailto:benoit.fournier@ggl.ulaval.ca)*

*(6) HeidelbergCement NE, Reykjavik, Iceland, [BorgeJohannes.Wigum@heidelbergcement.com](mailto:BorgeJohannes.Wigum@heidelbergcement.com)*

### **Abstract**

The “PARTNER” project (2002-2006) aimed at establishing unified test procedures for evaluating the potential alkali-reactivity of aggregates across different European economic and geological regions. The suitability of RILEM ASR aggregate tests and four regional tests was evaluated with a variety of European aggregates, and their reliability was calibrated against the behaviour of those aggregates in real concrete structures and in field site tests. For the latter, a total of 100 concrete cubes, 300×300×300 mm<sup>3</sup> (two from each mixture), from 13 aggregate combinations were produced at five laboratories in 2004 and placed on eight different field sites representing different European climatic conditions. Measurements of expansion and maximum crack widths were carried out over a period of 15 years [1, 2].

As part of the activities of RILEM TC 258-AAA (2014-2019), focusing on ASR field-lab correlations, the condition of 21 selected PARTNER cubes incorporating 11 (of the 13) aggregate combinations was assessed. In 2017, these 21 cubes were collected from five (of the eight) field sites across Europe. The results will be used as part of the assessment of the laboratory and field results from the PARTNER study [3]. Focus has been to assess the influence of different European climatic conditions on the development of ASR for various European aggregate types.

Originally, the plan was to send all the 21 cubes to LNEC for visual examination, non-destructive testing prior to coring, coring and distribution of samples to the following laboratories (institutions) taking part in the post-documentation program: LNEC (Lisbon, Portugal), University of Laval (Quebec, Canada), Norwegian University of Science and Technology (NTNU, Trondheim, Norway), SINTEF (Trondheim, Norway), EMPA (Dübendorf, Switzerland), University of Lisbon (Portugal) and IETcc-CSIC (Madrid, Spain). However, at the time of starting the post-documentation program, all the 16 cubes stored at AIDICO in Valencia (Spain) had already been transported to IETcc-CSIC (Madrid, Spain) (the cubes were collected from Valencia during the summer 2016, because AIDICO had to close down their field exposure site). Visual examination, non-destructive testing prior to coring and the coring of the seven Valencia cubes were thus performed by IETcc-CSIC. Three cores from each of these cubes were subsequently packed and sent to LNEC for further handling together with the cores drilled by LNEC.

This paper presents main results of the many post-documentation tests performed: (a) Non-destructive tests (UPV) performed on the cubes prior to core extraction, and tests performed on cores extracted from the field cubes: (b) Physical tests: carbonation depth, moisture condition (relative humidity (RH) and degree of capillary saturation (DCS)) and porosity (PF-method); and (c) Chemical tests (alkali content).

A second paper at this ICAAR 2020-2022 by Fernandes et al. [4] presents results from the microstructural analyses performed on one of the four cores drilled from each of the 21 PARTNER cubes selected for post-documentation. The characteristics of the microstructure are compared with the measured field expansion. Additionally, it investigates possible effects of aggregate type and exposure conditions on the composition of the ASR products formed.

The following main conclusions can be drawn from the post-documentation of the cubes (in total, 7 laboratories took part in the post-documentation; see also [3] and [4]):

- Even though different concrete compositions were assessed, overall, as expected, a decreasing trend of the UPV with increasing expansion was observed.
- The cubes exposed in Valencia had much higher carbonation depths than the cubes exposed on the four other exposure sites. This corresponds well with the drier climate in Valencia and with a general lower internal moisture state measured on the Valencia cubes compared with the cubes from the other exposure; the mean Degree of Capillary Saturation (DCS) for the 14 cubes exposed at the four other exposure sites (equal to 86.5 %) was about 13 % higher than the mean for the seven Valencia cubes.
- As expected, there seems to be a tendency that high ASR induced expansion correlates with a relative high moisture state (when excluding the Valencia cubes), due to absorption of water by the ASR-gel developed.
- The alkali content in the concrete pore water measured by CWE is far less than the alkali content in the cement clinker at the time of mixing ( $5.5 \text{ kg/m}^3 \text{ Na}_2\text{O}_{\text{eq}}$ ). The alkalis are most likely bound in the CSH in the cement paste and in the ASR-gel, and partly in anhydrous cement clinker.
- It seems that a majority of the concretes that expand the most have the lowest alkali contents in the concrete pore water, most likely due to more alkalis bound in the ASR-gel developed.
- The alkali content in the lower 50 mm of the cubes is lower than in the interior of the cubes. This is due to alkali leaching through the bottom face.

**Keywords:** *chemical and physical tests; concrete condition assessment; field site tests; PARTNER study; RILEM.*

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