



Suitability of alkaline leaching and etching experiments in the quantification of ASR potential of quartz-rich rocks

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Three groups of methods are conventionally applied in the assessment of the susceptibility of aggregates used in concrete to be affected by alkali-silica reaction (ASR). The most frequently employed expansion tests (accelerated mortar bar test and concrete prism test, e.g. ASTM C1260, RILEM AAR2, RILEM AAR4.1) quantify ASR potential of aggregates according to the expansion values of mortar bars (resp. concrete prisms) measured after certain testing time period. Petrographic methods are based on the quantification of alkali-reactive phases by polarizing microscopy (e.g. RILEM AAR1). Chemical methods quantify ASR potential according to the amount of Si⁴⁺ dissolved into alkaline solution combined with the reduction of alkalinity of the solution (e.g. ASTM C289).

The current study focused on the comparison of three approaches: the alkaline etching of polished rock sections and standard chemical method (following ASTM C289) with the measuring of expansion values of mortar bars (following ASTM C1260). Various types of quartz and amorphous SiO₂ used for the experiments were separated from rock samples of orthoquartzite, quartz meta-greywacke, pegmatite, phyllite, chert, and flint. Polished rock sections (resp. crushed fraction 0.125/0.250) were used and subjected to leaching in 1M NaOH solution at 80°C for 14 days (resp. 24 hours). After alkaline etching in alkaline solution, the rock sections were analyzed by scanning electron microscopy combined with energy dispersive spectrometer. Representative areas were documented in back scattered electron images and quantified using fully-automatic petrographic image analysis. ASR potential of the polished rock sections was evaluated by the vol. % of area affected by alkaline etching. ASR potential of crushed aggregate was estimated by measurements of Si⁴⁺ dissolved into the solution versus the reduction of alkalinity of the solution (following ASTM C289).

Classification according to the ASTM C289 indicated three of investigated aggregates to be deleterious (resp. potentially deleterious) to ASR. The rest of aggregates were classified as innocuous. However, alkaline etching indicated presence of alkali-reactive phases in all investigated samples. The size of ASR area varied from 7-9 vol. % for quartz from pegmatite to 84 vol. % for amorphous SiO₂ in flint. Comparing obtained data with standard reference according to ASTM C1260, one can see that more precise correlation was obtained in case of the ASR area values (acquired by alkaline etching of polished rock sections) (correlation coefficient R² of 0.98) than by the amount of Si⁴⁺ dissolved into alkaline solution (following ASTM C289) (correlation coefficient R² of 0.15). Only quartz from pegmatite was assessed to be non reactive (expansion of 0.06%, ASR area of 7-9 vol. %). Expansion values of the rest of samples exceeded the limit of 0.10% (expansion of 0.18-0.53%, ASR area of 15-84 vol. %). The results obtained indicate, that the chemical method does not determine the ASR potential of studied samples sufficiently.