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ASR potential of quartz based on expansion values and microscopic characteristics of mortar bars

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The alkali-silica reaction (ASR) is one of the most damaging factors for concrete structures. Different analytical techniques are used to quantify ASR potential of aggregates. The accelerated mortar bar test (ASTM C1260) in combination with the petrographic examination of aggregates by microscopic techniques belongs to the frequently employed methods. Such a methodical approach enables quantification of the ASR potential, based on the expansion values of accelerated mortar bars; and also to identify deleterious components in aggregates.
In this study, the accelerated mortar bar test (ASTM C1260) was modified and combined with the scanning electron microscopy of polished sections prepared from mortar bars. The standard 14-day test period of mortar bars was prolonged to 1-year. ASR potential of aggregates was assessed based on expansion values (both 14-day and 1-year) of mortar bars and microscopic analysis of ASR products (alkali silica gels, microcracks, dissolution gaps) detected in the sections.
Different varieties of quartz-rich rocks including chert, quartz meta-greywacke, three types of quartzite and pegmatite were used as aggregate. Only quartz from pegmatite was assessed to be non reactive (14-day expansion of 0.08%, 1-year expansion of 1.25%). Aggregate sections exhibited minor ASR products even after 1-year of mortar bar immersion in 1 M NaOH. Expansion values of the rest of samples exceeded the limit of 0.10% after 14-day test period indicating aggregates as reactive. The highest ASR potential was detected in mortar bars containing chert (14-day expansion of 0.55%, 1-year expansion of 2.70%) and quartz meta-greywacke (14-day expansion of 0.46%, 1-year expansion of 2.41%). The high ASR potential was explained by presence of cryptocrystalline matrix in significant volumes (24 - 65 vol%). Influence of the lengths of the immersion in the alkaline solution was observed mainly in the microstructure of the cement paste and on the extension of ASR products. The dissolution of the matrix originating on grain boundaries and propagating through the entire volume of the matrix was observed in mortar bars after 14 days of testing. The individual aggregates were almost dissolved after 1 year of mortar bar testing. The quartzite samples exhibited 14-day expansion between 0.19 and 0.25%, and 1-year expansion from 1.27 to 1.78%. The difference in expansion values of quartzites could be caused by the different quartz grain sizes, and the various content of cryptocrystalline matrix. Quartzite exhibiting the highest expansion value indicated the smallest grain size and had the highest content of cryptocrystalline matrix comparing to all quartzites. The reactivity of quartzites was confirmed by frequent microcracks, pores filled with alkali silica gels and complete dissolution of cryptocrystalline matrix in aggregate particles of mortar bar sections.