Durability Loss in Concrete Due to ASR-DEF, The Role of Aggregate Reactivity in Deleterious Def

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Durability of concrete and cementitious materials is important to their worldwide usage in housing and infrastructure. Two known causes of durability loss in concrete are the alkali-silica reaction (ASR) and delayed ettringite formation (DEF), which are chemical processes with the potential for expansion, cracking, and strength loss in affected elements. There is significant overlap in the contributing factors for ASR and DEF, in particular pore solution alkalinity. DEF is of most concern for large, precast concrete structures, although in Australia reported cases of deleterious DEF have been in conjunction with mild or moderate ASR. Current guidelines regarding DEF are based on laboratory experiments in mortar specimens, and the role of the aggregate and ASR in concrete has been overlooked. Mitigation strategies for DEF involve temperature thresholds during curing, chemical limits for the binder, and the use of supplementary cementitious materials (SCMs) in the mix design. This study investigates the role of aggregate reactivity, curing temperature, and cement composition in the susceptibility of concrete elements to deleterious DEF, and the efficacy of fly-ash as an SCM in preventing deleterious ASR-DEF. Concrete specimens containing ASR-reactive aggregates were made with different binder and curing conditions, then monitored for expansion and strength loss over two years. Contributions towards the understanding of ASR-DEF mechanisms and the development of industry risk assessments in Australia are presented in this paper.