A Literature Review on Alkali Silica Reactivity of Concrete: Consequences and Challenges

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ABSTRACT

Deterioration of concrete structures with time is well understood. One of the major reasons of deterioration is reaction between cement paste and reactive siliceous aggregates which is known as alkali silica reaction (ASR). This article reviews the studies on ASR in concrete. Although a vast literature is available on mechanisms and preventive measures against ASR, however there are still a lot of deficiencies regarding the test methods to detect the ASR potential in concrete. The aim of this article is to discuss different factors affecting ASR, consequences of ASR and different challenges encountered by researchers in the detection of ASR. The study revealed that alkali content of cement, aggregates grading, mineralogical combinations, testing methods and testing conditions are all the challenges, researchers face during evaluation of ASR potential in concrete.

KEYWORDS

Aggregates, Alkali Silica Reaction, Concrete, Durability, Test Methods

DOI: 10.4018/IJoSE.2018070104

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INTRODUCTION

Alkali silica reaction (ASR) also known as cancer of concrete is a common durability problem for concrete structures. Mechanism of ASR has been under study since 1940. It was first recognized by Stanton (1940) in concrete pavements of California. Early studies (Stanton, 1940; Stanton, Porter, Meder, & Nicol, 1942) revealed that mortar bars comprised of high alkali cement and reactive aggregates showed expansion under specific temperature and high relative humidity. This study was the base for ASTM C227 (standard test method for potential alkali reactivity of cement-aggregate combinations [mortar-bar method]). Based on Stanton (1940), U.S. Bureau of Reclamation studied the abnormal cracking in concrete dams. It was observed that factors like, high alkali content, presence of reactive minerals and specific environmental conditions were responsible for expansion due to ASR in concrete (Stanton et al., 1942). This study was the base for ASTM C289 (standard test method for potential reactivity of aggregates [chemical]) (Mielenz, Greene, & Benton, 1947).

Meanwhile, researchers were focused to understand the mechanism of ASR in concrete. Hanson (1944) reported the formation of gel products (as a result of ASR) responsible for expansion. Alkali silica gel is produced when hydroxyl ions of concrete pore solution react with siliceous minerals of aggregates (Abbas, Kazmi, & Munir, 2017; Gao, Cyr, Multon, & Sellier, 2013; Munir, Kazmi, & Wu, 2017). Owing to water absorbing nature, alkali silica gel exerts pressure on the surrounding concrete (Munir, Qazi, et al., 2016). The presence of higher amount of alkalies in concrete not only increases the amount of hydroxyl ions but also results into a rapid reaction (Ghafoori & Islam, 2013). This reaction generally initiates at the contact surface of cement paste and aggregates (Munir, Abbas, Qazi, Nehdi, & Kazmi, 2017). Sometimes ASR affected concrete shows peripheral cracking (American Concrete Institute, 1998). Amount and size of cracks increase with time (Gillott, Duncan, & Swenson, 1973). ASR in concrete occurs mainly due to reactive aggregates, high alkali and moisture content (Munir, Abbas, et al., 2017; Munir, Qazi, et al., 2016). However, rate of reaction also increases with the increase in temperature (American Concrete Institute, 1998). There are a lot of studies regarding the ASR in concrete. However, the aim of this study is to discuss the factors affecting ASR, consequences of ASR and different challenges encountered by researchers while the detection of ASR. More than 100 studies have been reviewed and a detailed discussion has been provided related to ASR, a major durability issue of concrete in the field of Civil engineering. This study will help the researchers in the field of construction materials to gain the knowledge about the past as well as the state of the art developments related to ASR and its role in durability of concrete structures.
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