

Effect of Alkali-Silica Reaction on Chloride-Induced Corrosion in Reinforced Concrete

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, *Ata Aminfar* declare that this thesis, is submitted in fulfilment of the requirements for the award of Master's by Research, in the School of civil and environmental engineering, faculty of engineering and information technology (FEIT) at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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To my lovely family

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Abstract

Alkali-silica reaction (ASR) and reinforced concrete (RC) corrosion are two of the major concrete deterioration phenomena that can affect concrete structures such as jetties, bridges, and dams, causing harm to the structure lowering the lifespan and the structural integrity, which eventually results in billions of dollars of rehabilitation cost. Although ASR and RC corrosion mechanisms are well-known and have been studied significantly in the past years individually, there have been small amounts of research regarding ASR and RC corrosion combined effects and how ASR can affect the corrosion of steel in RC structures. This study aims to determine how ASR can impact chloride-induced corrosion in RC structures utilizing accelerated laboratory test methods. ASR generates an expansive gel that causes concrete to expand and crack over time. These cracks may open the way to other deteriorating effects, such as chloride ions. Previous research on ASR speculates that ASR cracks could accelerate chloride ions ingress leading to faster corrosion of the reinforcement embedded in concrete. However, recent research show otherwise and suggest that ASR can cause higher tortuosity in concrete that tributes to the lowering of diffusion/migration coefficient of concrete which causes concrete affected by ASR to resist the ingress of chloride ions. The investigation in this study is planned to be carried out using experimental approaches. The experimental study is based on a “Comparative Method” and will compare the time to corrosion-induced cracking and migration coefficient in concrete specimens utilizing accelerated methods for concrete with highly reactive dacite and non-reactive aggregate with 1.25% alkali boosting. The chloride migration coefficient of reactive specimens decreased over the 150-day test duration compared to specimens prepared with non-reactive aggregate. Furthermore, accelerated chloride-induced corrosion (ACIC) tests on reactive specimens show a higher time to cover crack due to corrosion than non-reactive specimens over the 150-day testing. Additionally, the mechanical properties of the specimens prepared with a reactive and non-reactive aggregate such as compressive strength, tensile strength and modulus of elasticity were measured. The compressive and tensile strength of the reactive specimens, which expanded by 0.12%, shows little change while the modulus of elasticity decreased over the 150-

day testing period compared to non-reactive specimens. The results of this experiment indicate that ASR within the concrete environment can lower the chloride migration of the concrete and increase the time to chloride-induced corrosion crack of the concrete cover.