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Research

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Simulated C₃A Effects on the Chloride Binding in Portland Cement with NaCl and CaCl₂ Cations

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ABSTRACT

C₃A contents of Portland cement have a significant role in chloride ion binding in chloride-contaminated environments. Cations released due to NaCl and CaCl₂ in chloride environments are the most common and aggressive agents. In this research, various simulated pure C₃A were made using calcium hydroxide and aluminum hydroxide, including 5%, 8%, 10%, and 12%. Moreover, the different concentrations of sodium and calcium cations in NaCl and CaCl₂ in the simulated Portland cement paste were added the bonding performances were investigated. X-ray diffraction (XRD) of prepared C₃A samples identified for major phases of specimens. Thermo-gravimetry analysis (TGA) was used to quantify the simulated C₃A. Standard test methods, including ASTM C1152 and ASTM C1218, were utilized to measure the acid-soluble and water-soluble chloride in prepared specimens, respectively. The results showed that the amount of acid-soluble and water-soluble chloride for NaCl and CaCl₂ cations decreased with an increase of the C₃A, which indicates a better chloride ion binding potential. Moreover, it was concluded that CaCl₂ cations have more chloride binding capacity than NaCl. For calcium cations in CaCl₂, the increase of C₃A is distinguished in water-soluble chloride in comparison with NaCl cations. Then, in areas contaminated with NaCl ions, it is recommendable to use more C₃A content in the Portland cement.

Keywords: C₃A content, CaCl₂ and NaCl cations, Portland cement, Chloride binding.

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1. INTRODUCTION

Chloride-induced steel corrosion is one of the major worldwide deterioration mechanisms for reinforced concrete structures. Concentrations of chloride ions in sufficient amounts are considered essential parameters for inert ferric oxide film around the steel reinforcement, which typically inhibits the steel from corrosion in the alkaline environment of dense concrete [1-2]. Specifications usually express corrosion hazards in terms of total chloride in concrete as a percentage of cement content. However, a significant portion of the total chloride is chemically synthesized or adsorbed by solid cement hydrates [3]. Such chlorides attached to solid hydration products of cement are non-corrosive and do not

pose a risk of corrosion. It is the concentration of the indirect chloride fraction that dissolves in the liquid phase of the concrete and causes it to decompose due to its ability to destroy the protective film and the corrosion process of the steel. Due to this situation, the distribution of chloride ions between the solution phase of aqueous pores and solid hydration products of cement pastes is of great importance from the point of view of starting and spreading the risk of corrosion for reinforcements embedded in chloride concrete [4-5]. The existence of water-soluble chloride in cement mixtures, such as concrete and mortar, can cause corrosion of reinforcements. The chloride ion comes into a chemical reaction with the C₃A phase and produces