International Congress on
Science & Engineering
Humboldt University of Berlin August 2018
کنگره بین المللی علوم و مهندسی برلین

Increasing of Concrete Endurance in Acidic and Sulfate Environments Using Calcareous Materials

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ABSTRACT

In the present study, replacement of normal concrete aggregates with calcareous and silica aggregates and concrete endurance against acidic corrosion has been investigated. For this purpose, a number of concrete samples were built and placed in sulfate sodium and magnesium solutions. Then, in various time intervals, changes of weight, dimension and strength of samples have been assessed and the obtained results on the samples and solutions were considered as basis of judgment. Regarding the results of performed tests, it is observed that the samples built with calcareous aggregates have higher endurance and strength in acidic and corrosive environments. Regarding the statistical analyses, the calcareous samples showed more than 53% endurance improvement in acidic and corrosive environments. So, using calcareous aggregates is an applied suggestion for raising the concrete endurance.

Keywords: concrete, calcareous aggregates, silica aggregates, compressive strength, endurance.

1. INTRODUCTION

One of the most fundamental and common materials used in construction of civil structures is concrete. In some projects, the subject of concrete endurance against acidic and corrosive environments has created some limitations in using this constructional product. In recent decades, costs due to destructions created by concrete corrosion have urged researchers to study and investigate approaches of increasing concrete endurance against corrosion and reduction of costs due to it. Considering the performed studies, the cost of concrete corrosion in various countries on average includes 1-5% of national gross revenue. Crack accession in the concrete occurs during a process where acid sulfuric and hydroxide calcium reaction at first leads to plaster production and in the following, the produced plaster reacts with hydrate aluminum and forms Ettringite. Plaster and Ettringite have a volume increase of about 7 and 2.2 against their constituting materials and this volume increase creates internal pressures and finally cracking and dissolution of the corroded concrete. Also, the materials produced due to corrosion have less strength comparing their constituting materials and so by progress of corrosion the concrete strength is decreased. On the other hand, sulfate invasion in the mortar or the concrete due to formation of products like Ettringite and plaster has long been known as a destructive phenomenon. In recent decades, regarding the growth of consumption of calcareous Portland cement, another type of sulfate attacks has been created whose product is a material, called Tomasite. Tomasite like plaster and Ettringite leads to expansion of the cement pasture and over time reduces the pasture adherence of the cement pasture. One of the most important required resources for formation of this product is carbonate ion. So, one of important problems of calcareous Portland cement is its endurance against sulfate attacks. Usually, various factors like increasing of sulfate solution density, increasing of carbonate ion, reduction of temperature and moisture lead to intensification of destructions due to formation of Tomasite in the concrete. Several studies have been performed for reinforcing the concrete against corrosive factors. One of approaches of retrofitting against corrosion is using anti-sulfate cements or sulfur as a cohesive material in the concrete structure. Also, in several studies, it has been tried to increase the endurance of cement pasture against corrosion using cement additive materials (SCM). All these studies have been performed for changing the nature of cement pasture and improvement and increasing of its endurance. Regarding the mentioned subjects, in recent years some studies have been performed using alkaline and especially calcareous aggregates for increasing the concrete endurance. For example, by replacing silica aggregates by calcareous ones, some results have been obtained which indicate more consistency and coordination of cement and aggregates against corrosive factors when using calcareous aggregates. This prevents from creation of discontinuity between the cement pasture and aggregates and