Long term Behavior of Cementitious Materials in Corrosion Environment

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Abstract

There is an increasing interest in better quantifying the long term durability of construction materials in corrosive environments. The aim of this study is to address the long-term chemical resistance of various cementitious materials. Three cementitious materials were considered with varying cement content from 3% to 20%. They are: controlled low strength materials (CLSM), auger grouts and normal concrete. The parameters that were studied are (1) change in weight (2) pulse velocity (3) pH variation (4) leaching of calcium. Maximum increase in weight was observed in the case of 2% NaCl of CLSM and auger grouts and maximum decrease of weight was observed in the case of H2SO4 at pH 2 in CLSM and auger grouts. Deterioration of the specimens was accelerated by the sulfate ions. There was increased calcium leaching with time. The maximum leaching was observed in H2SO4 pH 2. As of today, the pulse velocity had decreased with time and was maximum in HCl pH 2. Testing has continued for over two years.

Introduction

The need to avoid costly repairs has paved the way for the introduction of maintenance, rehabilitation and restoration works. The reliability, quality, durability, the ease of placing, use of locally available materials and less labor used in construction are some of the important factors. Auger grouts and controlled low strength materials, today, are being used extensively. These materials are popular in trenchless applications, sealing and stopping leakage, backfill material and void filling material for underground facilities.

The chemicals present in the environment could lead to premature degradation of the cementitious materials. In order to simulate the corrosive environment, HCl pH (2 and 4), H2SO4 pH (2 and 4), NaCl 0.5 % and 2% (only for CLSM), Na2SO4 0.5% and 2% were chosen.

Testing program

CLSM, auger grout and normal concrete specimens (3" by 6" cylinders) were immersed in various acidic and salt solutions.

These solutions were changed at the end of each cycle (1 cycle is about a month). At least two specimens are being tested for each condition. The changes of weight, pulse velocity variation, leaching of calcium, pH change were being monitored with time.

Results

CLSM:
Due to the porosity, the water uptake increased the weight of the specimens. While NaCl 2%, Na2SO4 both 0.5% and 2% and HCl exhibited weight gain, H2SO4 suffered weight loss. Specimens in NaCl had the maximum weight gain of 3.55% . Specimens in H2SO4 lost nearly 2.2 % of weight during the period of study.

A decrease in the pulse velocity was observed after 24 months. The pulse velocity of the auger cast grouts was approximately 3454 m/s with COV of 1.7% . This was estimated at 6% lower than the original pulse velocity.

In all cases, calcium leaching increased with time. The maximum value was in H2SO4 (pH 2). A maximum of 1.2% was observed. Compared to NaCl, specimens in Na2SO4 had greater amount of calcium leaching.

Auger grouts:
There was an increase in weight in the case of HCl pH (2 and 4), H2SO4 (pH 4) and 2% NaCl. The maximum increase of 1.62% was recorded in21% NaCl. Decrease in weight occurred in H2SO4 by 1.8%. The samples in of Na2SO4 solutions failed.

Decrease in pulse velocity was observed. The maximum decrease of 7.8% was in HCl (pH 2).

Increase in calcium leaching was observed in all the specimens with time. Specimens in H2SO4 recorded the maximum of 1.7% of the initial weight.

Conclusions

The presence of sulfate ions accelerated the degradation of the specimens. H2S04 pH 4 had the worst effect. Calcium leaching increased with time but pulse velocity decreased.

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Reference

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