Long-Term Strength Loss of Concrete in Sulfate and Acidic Environments

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Abstract
A total of 24 concrete specimens were placed in chemical solutions at room temperature. Both dry and wet concrete specimens (75mm x 150mm) were immersed in four chemical solutions. The pH of sulfuric acid and sodium sulfate solutions varied from 2 to 7. The unconfined compressive strength loss of 20% to 80% were observed over a period of 5 years.

1.Introduction

As demand for construction in harsh environments increases so does the concern for long service lives of these structures. Typically, concrete structures are designed to perform, even in aggressive environments, for 50 to 100 years with minimal maintenance. Concrete is susceptible to sulfate attack from either sulfates present in soils, groundwater, seawater, decaying organic matter, and industrial effluent surrounding a concrete structure pose a major threat to long-term durability of the concrete exposed these environments. Although concrete materials are being widely used, there are rising concerns about the changes in strength of concrete materials under long-term exposure to adverse chemical environments. Hence, cement concrete response to chemical environments must be investigated. This study focused on the long-term strength loss of concrete specimen in sulfate and acidic environments.

2.Objective

The overall objective was to quantify the changes in the strength of cement concrete in acidic and sulfate environments over a period of 5 years.

3. Experimental Program

Dry and wet cylindrical concrete specimens (75 x 100 mm) were used in this study. Dry concrete specimens were immersed in selected chemical solutions after 28 days of curing, whereas the wet specimens were first immersed in a water bath for 28 days before testing. At least two specimens were tested under the same testing condition and the solutions were replaced every three months (cycle) or as needed based on the change in the pH of the solution. The solution-to-concrete ratio was approximately 1:1 (by weight). Sulfuric acid (pH of 2 and 4), sodium sulfate (0.5% and 2%) solutions were selected and the tests were performed at a constant pH. The average 28^{th} day compressive strength and the compressive strength after five years of immersion was monitored.

4. Results And Discussions of Test Results

The testing program consisted of monitoring the unconfined compressive strength of dry and wet concrete specimens in sulfuric acid (pH of 2 and 4) and sodium sulfate (0.5% and 2%) solutions.

4.1 Unconfined Compressive Strength: The percentage change in strength of concrete specimens after 1850 days of immersion was studied. The average 28th day unconfined compressive strength was 5000 psi. The maximum strength loss of 84% was observed in the case of dry specimens immersed in H_2SO_4 pH=2 solution. H_2SO_4 attack combines the effect of acid attack and sulfate attack hence was more severe when compared to salt attack. As shown in Fig 1 the least loss of strength was observed in the case of H_2SO_4 pH=4 solution.

5. Conclusions

(1) Similar changes in strength were observed in dry and wet concrete after 5 years of exposure to sulfuric acid and sodium sulfate solutions.

(2) The percentage strength loss in case of sodium sulfate solution of concentration 0.5% and 2% were 35% and 50% respectively.

(3) Of the solution studied, sulfuric acid with a pH=2 had the maximum percentage strength loss of 83% and sulfuric acid with pH=4 had a minimum percentage strength loss of 24%.

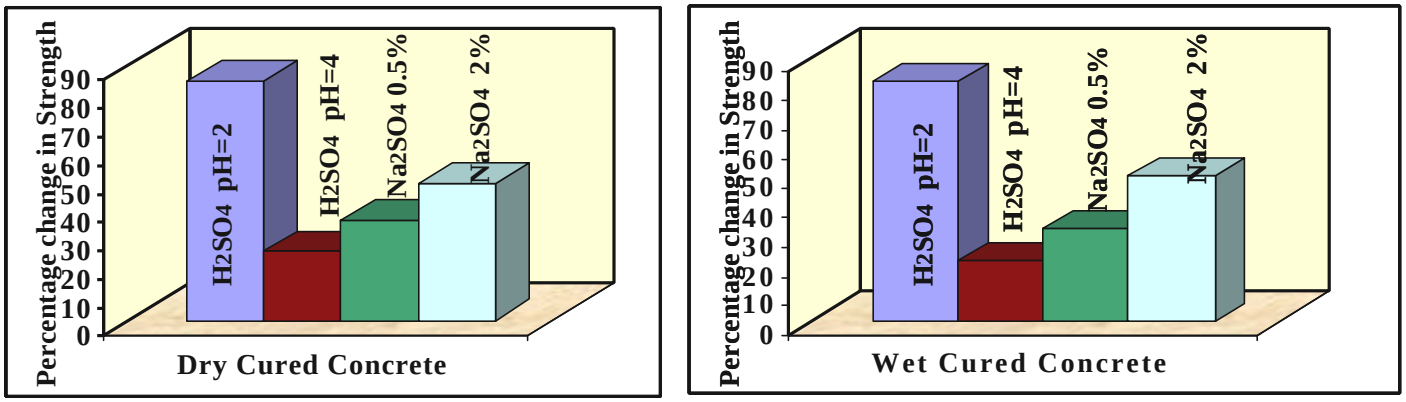

Fig.1: Showing the percentage loss in strength of dry and wet cured concrete immersed in sulfate and acidic solutions

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Reference

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