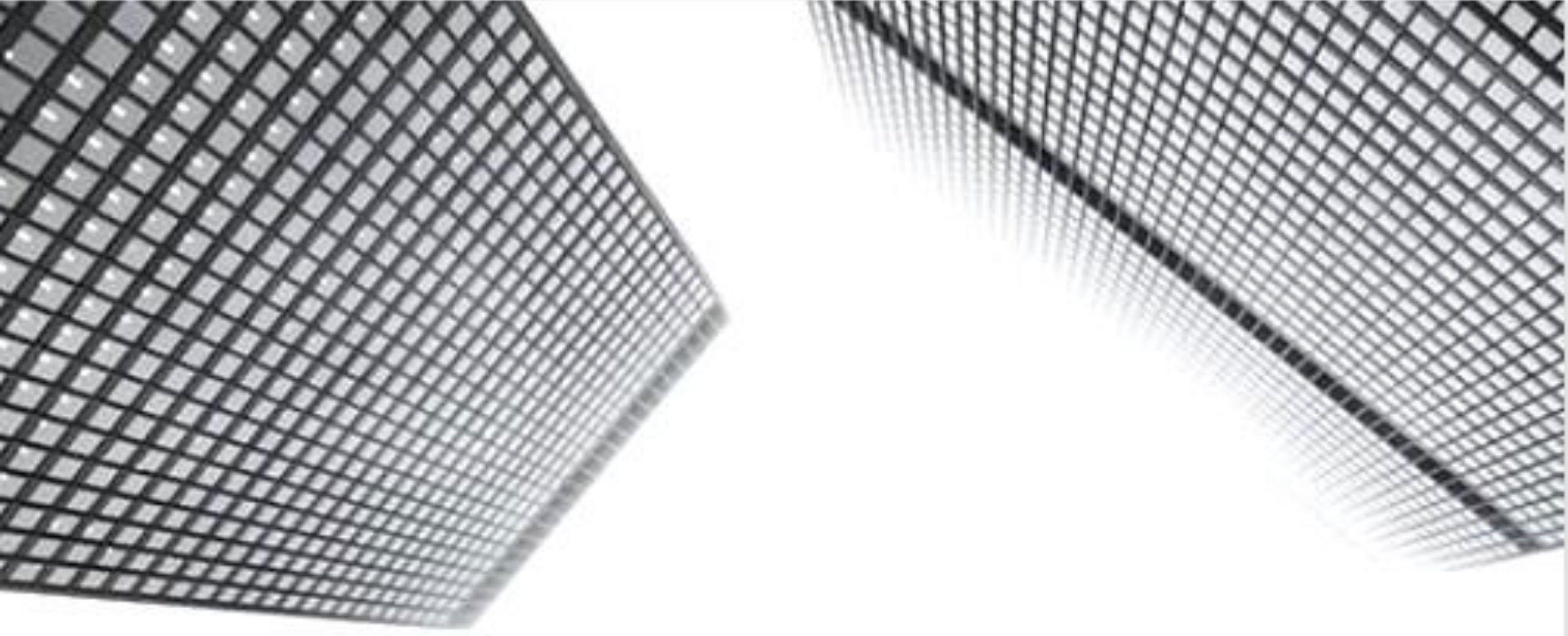

CIVIL ENGINEERING, SCIENCE AND TECHNOLOGY CHALLENGES: STRUCTURAL ENGINEERING AND CONSTRUCTION MATERIALS

EDITED BY

Wan Hashim Wan Ibrahim
Siti Noor Linda Taib
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The book is based on scientific and technological advances in various Structural Engineering and Construction Materials areas of Civil Engineering. It nurtures therefore the exchange of discoveries among research workforces worldwide including those focusing on the vast variety of facets of the fundamentals and applications within the Structural Engineering and Construction Materials arena. To offer novel and rapid developments, this book contains original contributions covering theoretical, physical experimental, and/or field works that incite and promote new understandings while elevating advancement in the Structural Engineering and Construction Materials fields. Works in closing the gap between the theories and applications, which are beneficial to both academicians and practicing engineers, are mainly of interest to this book that paves the intellectual route to navigate new areas and frontiers of scholarly studies in Structural Engineering and Construction Materials.

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CHAPTER 1

MODIFIED CEMENT SYSTEM: DURABILITY AND AESTHETICS

Mohamed, J. S. Z. and Mohamed Sutan. N.*

ABSTRACT

Concrete deterioration is one of the most concerning matters in the construction world. Significant decay such as efflorescence should not be ignored. The efflorescence is a deposit of salts, usually white, formed on the surface of the concrete. The efflorescence is not a significant problem that leads to structural defects, but it can build unattractiveness to the structure, such as brick walls and concrete mortar. The way to prevent the efflorescence occurrence is by studying the results of testing such as absorption and efflorescence itself to reduce the efflorescence. The non-modified cement system can reduce efflorescence but cannot avoid it because of the reaction of cement hydration itself. This study proves that using a modified cement system such as Pulverized Fly Ash (PFA) and Polymers (water-based latex grade 29Y46), the efflorescence of the mortar can be prevented. This study proved that the modified mortar, a sample with PFA and Polymers, has higher strength, durability, and minor efflorescence than the non-modified cement system**.**

Keywords: Concrete, Efflorescence, Durability, Pulverized Fly Ash, Polymers

INTRODUCTION

One of the main characteristics influencing the durability of concrete is its permeability. The ingress of water, oxygen, carbon dioxide, chloride and others is the most durability problem in the concrete that can be attributed to the changes in the concrete. Volume changes in the concrete can be caused by many factors such as the hydration process, pozzolanic action, sulphate attack, carbonation, moisture movement, and others. A crack can decrease the durability of the concrete that occurs by interactions involving concrete materials and its surrounding environment. Colours changes of concrete can arise due to a well known yet not well-understood phenomenon called efflorescence. Efflorescence occurs when water percolates through poorly compacted concrete or cracks when evaporation can occur at the concrete's surface. It will form white deposits that can decrease the concrete's aesthetic value. Efflorescence, which used to be ignored due to its negligible structural effect, is now viewed as a significant problem in coloured concrete products. To date, there are no economical and effective methods to guarantee the prevention of efflorescence [11].

EXPERIMENTAL PROGRAM

The preparation of specimens varies with concrete mixes according to the predefined proportions. Concrete samples are tested through a series of test methods. The arrangement of the experimental program can be summarised in the flow chart, as shown in figure 1.

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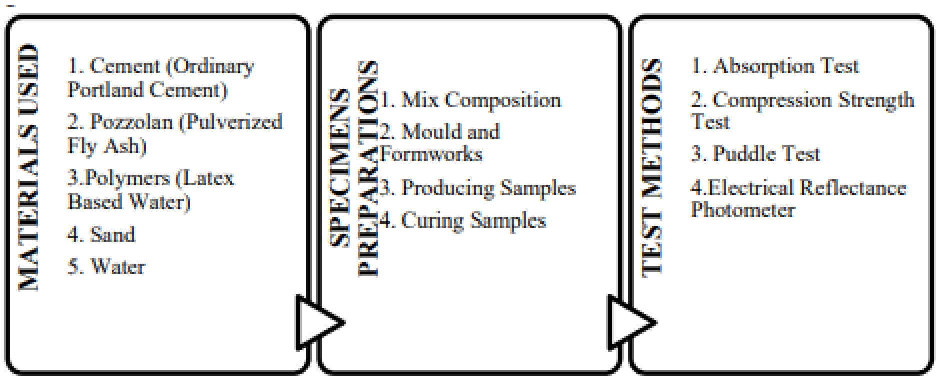


Figure 1: Flow Chart of the Experimental Program

RESULTS AND ANALYSIS

ABSORPTION TEST

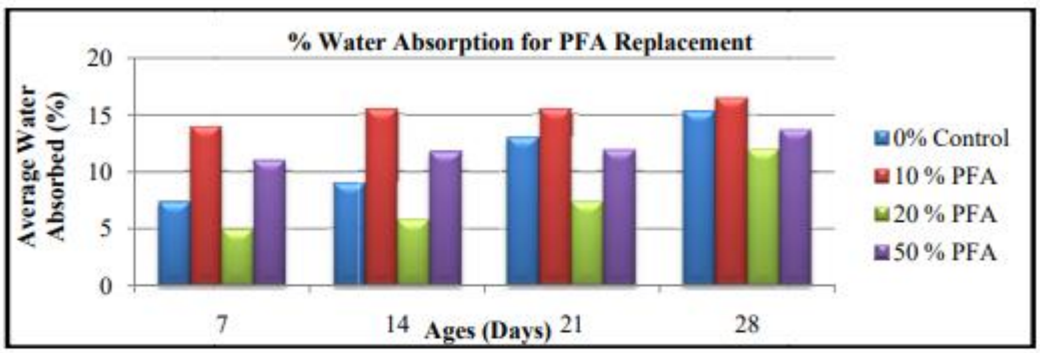


Figure 2: Water Absorption between 0%, 10%, 20% and 50% PFA

Figure 2 shows that the highest water absorption is 10% PFA replacement followed by 5% PFA replacement. At the same time, the 20% PFA replacement t is the lower percentage of water absorption.

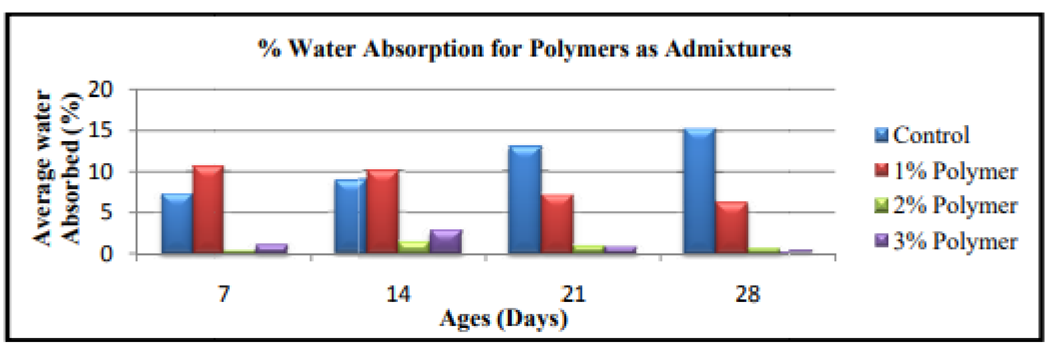


Figure 3: Water Absorption between 0%, 1%, 2% and 3% Polymers

Figure 3 shows the percentage of sample mixes with Polymer and non-non-modified. For non-modified water, absorption constantly increased with curing time. At the same time, the sample with the addition of Polymer water absorption starts to drop off always on day 14. It shows that the more polymers added to the mixtures, the lesser water absorbed into the sample. The result indicates that the sample with PFA has a higher percentage of water absorption than the sample with Polymers. More water can be absorbed when the air content is high in the PFA sample. While the polymer-modified mortar has a structure in which polymers can fill the larger pores. These features are reflected in reduced water absorption. For that reason, it can be concluded that polymerisation of monomers by additives and thermal activation, the hardening of latex takes place by drying or loss of water.

COMPRESSIVE STRENGTH TEST

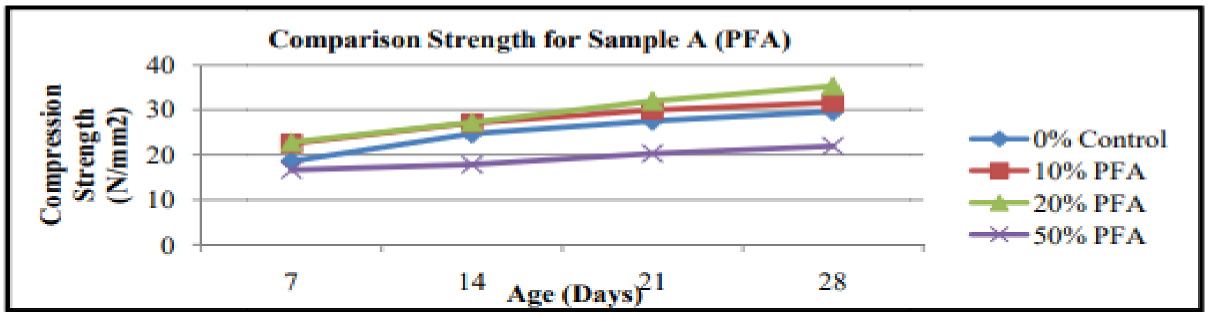


Figure 4: Comparison strength between 0%, 10%, 20% and 50% PFA

Figure 4 shows the relationship between the compressive strength of PFA materials and 100% Portland cement. The 20% replacement of PFA is sufficient to reduce the calcium hydroxide to the minimum level in the sample. It has the highest compressive strength in 28 days compared to 10%, 50% PM-A and non-modified mortar. The 20% replacement of PM-A is suitable for construction, reducing the cost of non-modified cement systems.

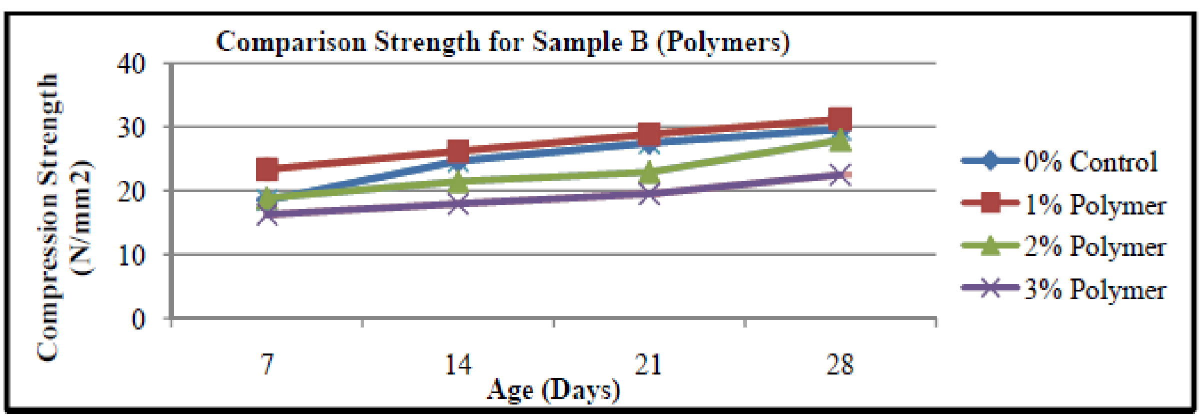
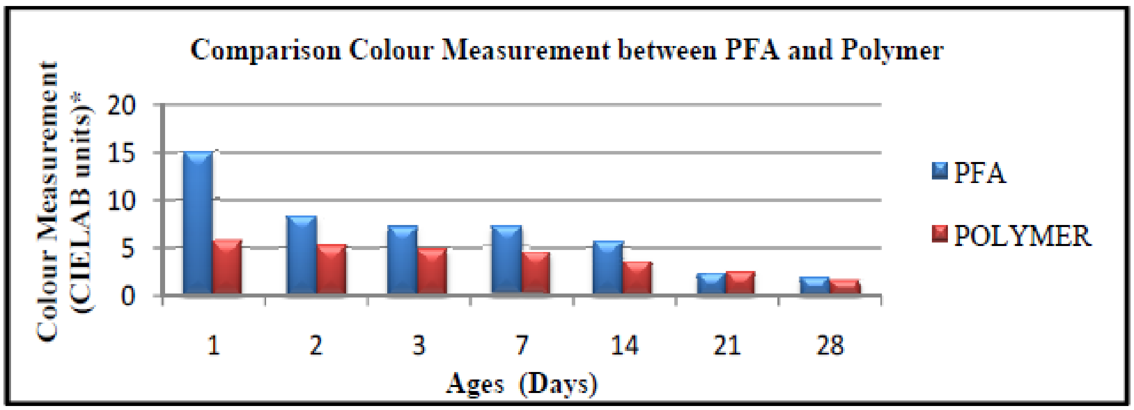


Figure 5: Comparison strength between 1%, 2% and 3% Polymer

From figure 5, it can be concluded that additives with 1% of polymers developed a higher strength than those with 2%,3% and 0% of modified mortar. The polymer molecules are linked together with water and cement to attain a higher power. However, only concrete with additives 1% polymers exhibits higher strength than the control sample at all ages.

PUDDLE TEST & ELECTRICAL REFLECTANCE PHOTOMETER

The puddle tests and electrical reflectance photometer have been done to measure the efflorescence and aesthetic of the concrete cubes. The measure of efflorescence is the different colours between the modified and non-modified cement systems. The humidity during the testing is around 86%, and the temperature is about 27.5°C during curing and absorption testing. High relative humidity around 80'% to 95% provides good protection against efflorescence after one or more days. Low humidity relatively takes a very long time to eliminate the risk of efflorescence. Low curing temperature can reduce the formation of protection against efflorescence. A puddle test is carried out by using mixtures that absorb more water than other samples. For the PFA sample, the percentage that absorbs more water is 10% replacement, while for the Polymer sample, the rate that absorbs more water is 1% addition of Polymers.



*CIELAB: International Commission on Illumination

Figure 5: Comparison color measurement between PFA and Polymer

Figure 5 shows that DE (total colour difference) I for sample PFA on day 1 is the highest or darker than others DE. The colour measurement of both samples constantly increases with ageing. But the sample PP-A shows a higher colour measurement than the sample with Polymers. The water absorption of the cube is the main reason for the colour measurement of change in both samples. The previous subtopic shows that the addition of PFA leads to absorption of more water whilst the addition of polymer gives less water absorption. For that reason, the colour measurement or efflorescence properties may also be affected.

It can be concluded that the mixtures with modified cement systems are better than non-modified cement systems. At the same time, the comparison between PFA and Polymers shows that the sample’s colour measurement with Polymers achieved fewer values or minor efflorescence. The admixtures with more polymers additives are insufficient to develop adequate strength but reduce efflorescence.

CONCLUSIONS

In the conclusions, the concrete additives and concrete replacement with PFA can reduce the calcium efflorescence. It has been proved that replacing fly ash and adding polymer to concrete can prevent efflorescence. The mixtures with modified cement systems are better than non-modified cement systems to determine efflorescence. The comparison between PFA and Polymer shows that the sample's colour measurement with Polymers achieved a lesser value. The admixtures with more additives are insufficient to develop adequate strength but less efflorescence build-up. The high relative humidity around 80% to 95% gives good protection against efflorescence. Low curing temperature can reduce the formation of protection against efflorescence also. The compressive strength test proved that PFA with 20% replacement could reduce the calcium hydroxide to the minimum level. At the same time, the additives with 1% of polymers developed a higher strength at all ages. In conclusion, the additive with 1% Polymers in mixtures can reduce efflorescence, absorb more water and give more strength to the concrete.

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