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Comparative Evaluation of the Effect of Water/Cement Ratio (w/c), Type and Percentage of Fly Ash on Concrete Strength against Chloride Ion Penetration and Its Porosity

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ABSTRACT: In this research, the effect of water-to-cement ratio (w/c), type and percentage of fly ash on concrete permeability, rapid penetration of ion chloride (RCPT), and porosity measurements using mercury (MIP) was performed, which consists of 18 concrete mixing designs (total number of 216 samples). The results show that reduction of water to cement ratio (w/c) decreases porosity and penetration volume, but this results in a rapid reduction of efficiency and new operating problems, and also in comparison with increasing the percentage of Fly ash, Has had a lower impact on the strength of concrete against chloride ion. Also, increasing the percentage of all three types of Fly ash, reduces the penetration of the ion chloride, porosity, and penetration volume, and also increases the efficiency of the concrete. From the results of this study, it can be seen that the water/cement ratio (w/c), the type and percentage of ash in the concrete have a significant effect on the concrete permeability and have increased or decreased the durability and efficiency of the concrete. An interesting point in the ability to release chlorine ions in wind-blown concrete is that even if the specimen containing the industrial A-type industrial ash contains more porosity than the control sample (ash-free), the reduction of chlorine ion release is due to Internal reactions of chlorine ion with alumina phases were observed.

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1. Introduction

Reinforced concrete is one of the most unique compounds in the world. Nevertheless, the embedded steel corrosion in concrete has led to costly repairs, and sometimes structures subject to destruction [1]. This is one of the most important problems of concrete durability [2]; this steel corrosion damages the concrete in two ways: 1-it reduces the cross-section of the rebar.2-it creates corrosion products that are larger in volume than the steel itself [3]. One of the most important contributing factors to the durability of concrete is its permeability. The Capillary pores that remain in the concrete due to excessive evaporation of water are considered the most important cause of porosity and permeability of concrete [4]. The more the pores are connected, the more concrete the penetration is. The excess water also increases the shrinkage cracks. These cracks themselves are the path to penetrate water and chemicals. Deeper cracks lead to faster corrosion of embedded steel in concrete [5-14]. In this study, the effect of fly ash and water/cement ratio on concrete durability is investigated. The penetration and porosity tests were carried out and the results were evaluated.

2. Laboratory process

2.1. Material

Used Cement: Portland cement of type 1-425 of Sufian cement factory, was used according to ASTM C150 standard. Used aggregates: Crushed coarse aggregates with a maximum size of 25 mm and natural fine aggregates were used according to ASTM C33 standard. Also from polycarboxylate super-lubricant, was used according to ASTM C494 standard. Also, three types of fly ash used as ASTM C618 in class C, F, and industrial fly ash brand a produced used.

2.2. Details and testing procedures

Rapid Chloride ion Permeability Test (RCPT): The rapid permeability of chloride ions according to the ASTM C1202 standard has been widely used in the world. In this research, experiments were carried out on specimens at 91 days of age. Mercury Intrusion Porosimetry Theory (MIP): The determination of concrete porosity test was conducted at the age of 91 days. In this study, porosimeter PASCAL 140 and 440 © Thermo Finnigan Italia were used on this sample.

3. Results and Discussion

3.1. Effect of water/cement ratio (w/c) on concrete strength against chloride ion penetration and its porosity

As shown in Fig. 1, the results of the test indicate that there is a relationship between the ratio of water to cement and rapid chloride ion permeability. Also, by decreasing the ratio of water to cement (w/c), the rapid diffusion of chloride ions from the sample decreased from 0.46 to 0.3 by about 45%. Based on the results obtained from Fig. 1, it can be said that the amount of chloride ion penetration in the test specimens

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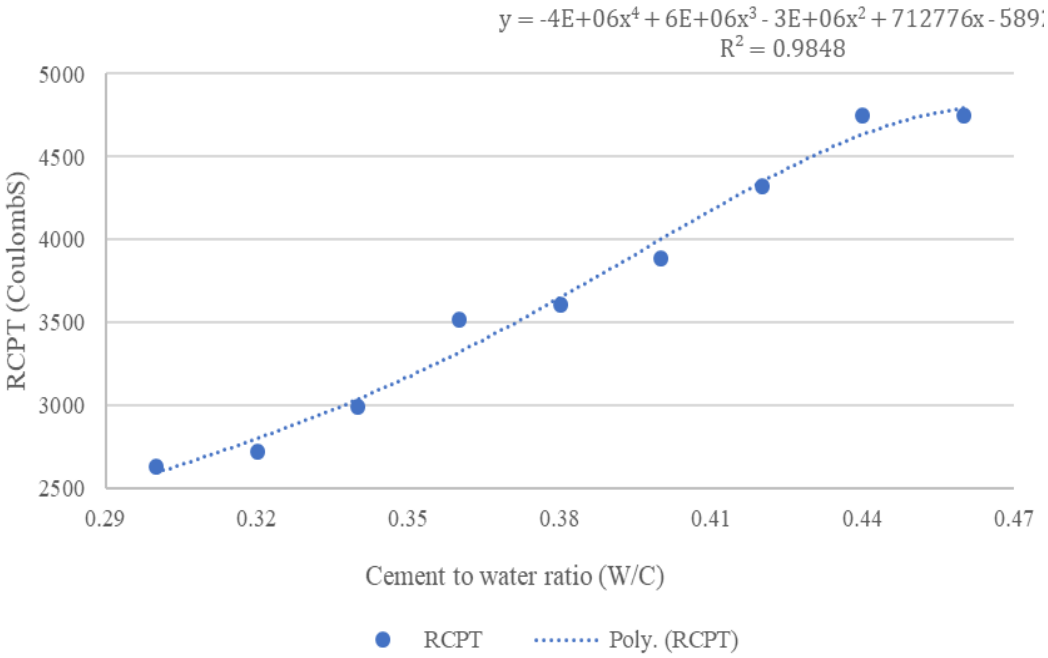

Fig. 1. Effect of water to cement ratio on concrete strength against chloride ion penetration

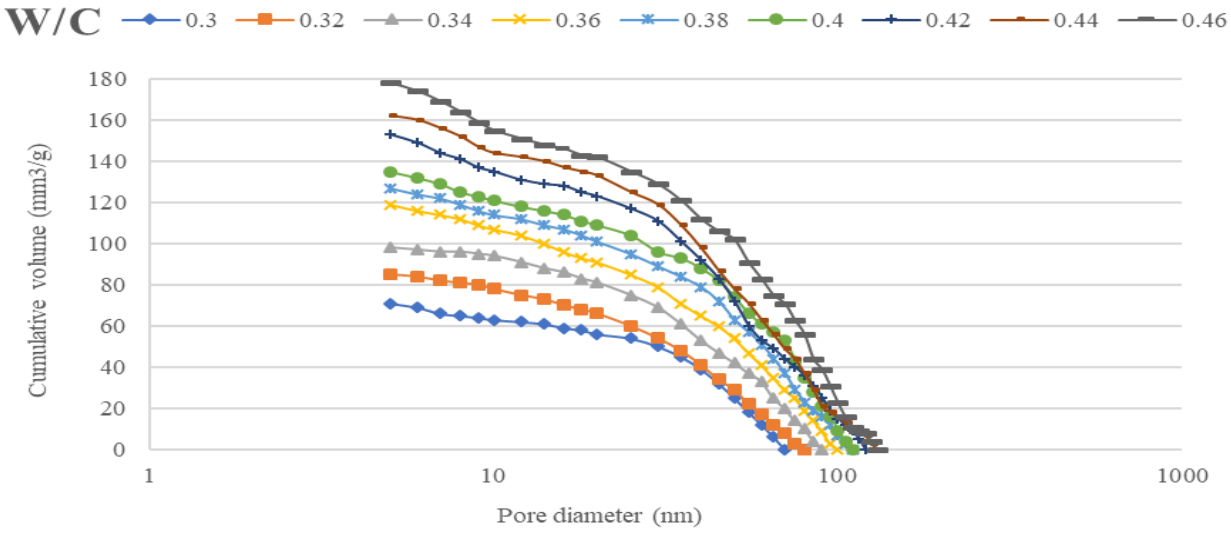

Fig. 2. Effect of water to cement ratio on concrete porosity

with a mixed design according to Table 4 is based on the ASTM C1202 / AASHTO T277 standard between moderate to high. In other words, increasing the water to cement ratio (w/c) increases the rapid penetration of the chloride ion. As shown in Fig. 2, the results show that with decreasing water/ cement ratio, concrete porosity decreases from 0.46 to 0.3.

3.2. Influence of fly ash on concrete strength against chloride ion penetration and porosity

The results of the test show that there is a relationship between the rate of chloride ion penetration and the percentage of fly ash. That's why the relationship is more accurate. By increasing the percentage of all three classes of fly ash, the permeability of the fly ash decreases, resulting in a decrease in the total flow rate by Columbus. In addition by increasing the percentage of all three classes of fly ash, the descending slope of graphs decreases. The permeability can be reduced by increasing the percentage of all three classes of fly ash. As a result, the total flow rate is reduced by coulomb. The results of the test show that with increasing the percentage of all three classes of fly ash, the diameter of the porous and the penetration volume decreases.

4. Conclusions

* By decreasing water to cement rat, the rapid penetration of the chloride ion and the porosity diameter and pore volume is reduced.

* Adding fly ash as an additive to concrete can increase chloride ion uptake and strengthen.

* By increasing the percentage of all three classes of fly ash, the porosity and infiltration volume decreased.

* By increasing the percentage of all three classes of fly ash, the chloride ion penetration decreases, and thus the total flow of passes decreases. This reduction intensifies with the use of Classes A, C, in particular the A-brand industrial ash, and it is better to use higher grade air ash grade, especially Class A.

* Increasing fly ash compared with decreasing water/cement ratio has more effect on the chloride ion resistance and decreasing water/cement ratio decreases concrete efficiency.

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