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The effect of penetration-reducing materials on concrete permeability and strength with "cylindrical chamber" and "Twist-off" tests

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ABSTRACT: Harmful materials penetrate the concrete and reduce its durability. Therefore, knowing the permeability of concrete is essential. Today, concrete penetration-reducing additives are widely used to construct various concrete structures such as water storage tanks. This paper discusses the effect of factors such as the amount of cement, water-to-cement ratio, penetration-reducing materials, concrete age, and the relation between surface strength, compressive strength, and surface water penetration into the concrete. Concrete cube samples are prepared with the strength of 25, 30, 35, and 40 MPa and ages of 7, 28, and 90 days. Permeation reducers such as waterproof, micro silica, and mezocret have been used in the samples. Using the torsion method with a cylindrical chamber device and a concrete breaker jack, the surface strength, permeability, and compressive strength of concrete specimens have been measured, and their relation with each other has been investigated. Also, the volume percentage of permeable pores was calculated according to ASTM C642-06. This standard was used as a criterion for measuring permeability. The results show that the highest permeability reduction is for waterproof, micro silica, mezocret, and without additive concrete samples, respectively, and its amount varies from 5 to 20 ml. Despite the complex structure of penetration-reducing materials, it is possible to predict the water penetrating volume into the concrete specimens with appropriate accuracy by obtaining the compressive and surface strength of concrete specimens and using the proposed regression equations

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1- Introduction

In the current research, the permeability of concrete samples containing waterproofing, microsilica and Mezukret materials has been investigated using the cylindrical chamber method [1]. Many researches have been conducted on the effect of additives on the durability and permeability of concrete [2-5]. Researchers have investigated the relationship between the compressive strength and permeability of porous concrete with different ratios of water to cement and aggregates to cement and have found that as the compressive strength of porous concrete increases, its permeability decreases, but the rate of this decrease gradually decreases. They also presented an empirical equation to express the relationship between permeability and compressive strength [6]. Among the on-site methods of concrete strength measurement, we can mention the "twist-off" test [7]. In research, it was found that if the "twist-off" test is used to measure the surface resistance of ordinary mortars and mortars modified with polymer, the correlation coefficient is high 0.95 between the results of the "twist-off" test and the results of the concrete breaker jack device. There are [8, 9].

2- Experimental programs

In order to perform the permeability and torsion test, 144 cubic specimens with dimensions of 150 × 150 × 150 mm^3 and to measure the compressive strength of 144 cubic specimens with dimensions of 100 × 100 × 100 mm^3, which were processed in water-lime, were used At least 3 samples have been used for each mixing design and for each age to perform the permeability test. The "twist-off" test was applied on the same permeability cube samples and the compressive strength test was also applied on at least 3 samples for each mixing design and for each age. the chamber is completely filled with water. Figure 1 shows the different parts of the cylindrical chamber device

3- Results and Discussions

In Figure 2, at a certain age without additives, an increase in resistance has been observed in Mezukret, microsilica and waterproof materials, and with the increase in the age of concrete from 7 to 90 days and in all cases of using infiltration reducing materials, the surface resistance of the samples increased. has found. The amount of changes in surface resistance in the samples ranges from about 6 MPa in 7-day samples without additives to 15 MPa in 90-day samples

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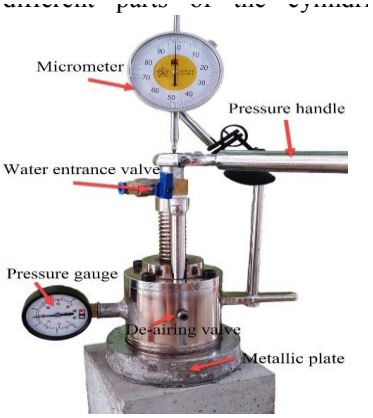

Fig. 1."Cylindrical chamber" apparatus.

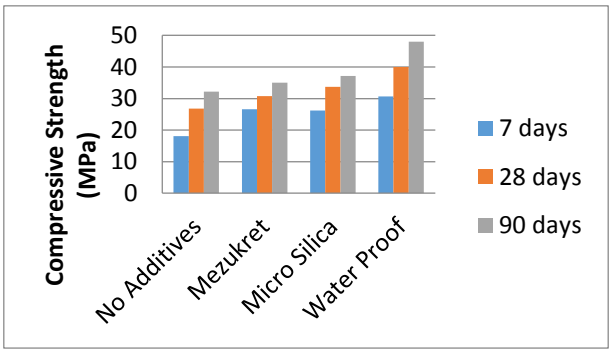

Fig. 3. Average compressive strength of samples at the age of 7, 28 and 90 days

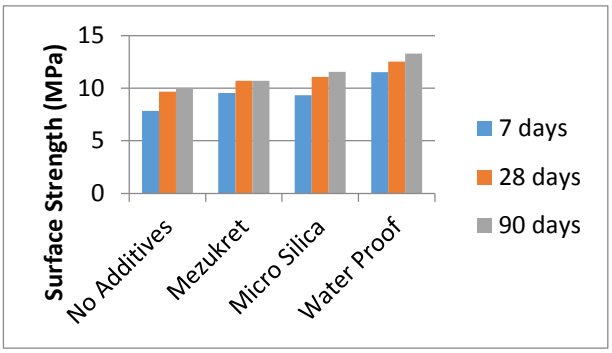

Fig. 2. The average surface resistance of samples at the age of 7, 28 and 90 days.

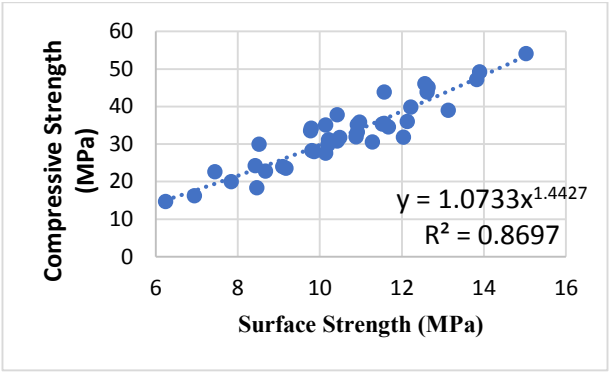

Fig. 4. The relationship between "compressive strength" and the results of the "twist-off" method.

containing waterproofing.

On the other hand, with the passage of time and the increase in the age of concrete from 7 to 28 and 90 days, we see an increase in the compressive strength of concrete samples (Figure 3). By examining the observations, it can be seen that at a certain age, the compressive strength decreases with the increase of the water-cement ratio. As the water-cement ratio increases, the amount of water in the concrete mix is equal to one unit weight of cement. This trapped water evaporates, leaving voids in the concrete, which causes an increase in pressure.

In Figure 4, the relationship between the compressive and surface resistances of concrete samples is examined and by drawing the diagram and the related diagram, the close relationship between the resistance and compressive surfaces can be maintained. It is possible to calculate the compressive strength of concretes containing reducing additives by measuring the surface resistance with the "twist-off" method.

Figure 5 shows the relationship between the compressive strength of concrete samples and the results of the "Cylindrical chamber" test. From Figure 13, it can be seen that the results of the "Cylinder Enclosure" test with the compressive strength of concrete samples have a correlation coefficient of 0.91. According to the correlation coefficient between the compressive strength of concrete samples with the results of similar methods, it is possible to establish a proper relationship between the compressive strength and the permeability of concrete samples.

4- Conclusions

According to the correlation coefficient equal to 0.93 between the results of the torsion test and the compressive strength of concretes containing infiltration-reducing materials, but it is possible to evaluate the compressive strength of concretes containing reducing materials with higher accuracy using the torsion-test. The inversion between

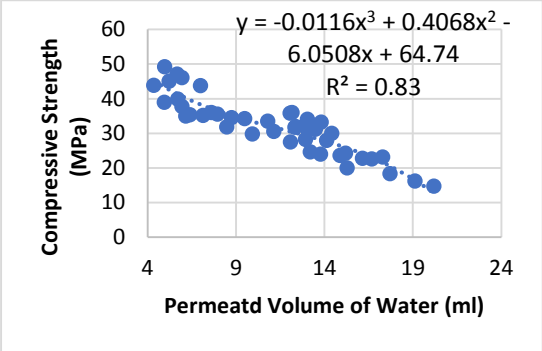

Fig. 5. The relationship between the "compressive strength" test results and the permeability values obtained from the "cylindrical chamber" test method.

pressure and surface is proportional to the permeability of resistant concrete samples so the highest permeability is in samples with resistant resistance. For example, the surface resistance of C40 concrete is about 29% higher than C25 concrete, but the permeability is reduced by about 17%.

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