Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 55(9) (2023) 391-394
DOI: 10.22060/ceej.2023.22079.7897

The effect of different temperature cycles on permeability and surface resistance of concretes containing permeability-reducing materials

M. Naderi[1], A. Saberi Vaezaneh[2]*, M. Parhizkari[3]

[1] Department of Civil Engineering, Imam Khomeini International University, Qazvin, Iran
[2] Natural Disasters Research Institute, Tehran, Iran

ABSTRACT: One of the important reasons that causes cracking and deformation in concrete elements, especially in the surface area of concrete, is different climatic conditions and temperature changes. In the previous researches, not many researches have been done regarding the relationship between the penetration rate value and the surface strength. The reason for the lack of research in this regard is the lack of simple methods or the high price of equipment to evaluate surface strength. In this article, infiltration- reducing materials with the brand names of Supergel and Mesocrete are used, which are widely used in Iran today. A simple "twist-off" test has been used to evaluate the surface strength. Also, "cylindrical chamber" test was used to measure the permeability. To apply the cycles of temperature changes, the samples were subjected to cycles of 50, 100, and 150 cycles. The obtained results show in the 150th cycle, the surface resistance of ordinary concrete has decreased by about 30%, but the reduction of the surface strength of concrete with penetration-reducing materials is less than 20%. Also, the increase in the permeability of ordinary concrete in the 150th cycle is equal to 486%, but this value is half of this value in concretes containing permeation-reducing substances. In the following, by using MATLAB software, it was determined that the relationship between permeability and concrete strength is close to each other, and this issue is established in terms of formulation with a first-order plane equation with a correlation coefficient of about 91%.

Review History:

Received: Jan. 03, 2023
Revised: Aug. 16, 2023
Accepted: Aug. 19, 2023
Available Online: Aug. 26, 2023

Keywords:

In situ test
Temperature cycles
Strength
Penetration rate
Concrete

1- Introduction

Concrete is one of the most important practical and cost-effective materials with suitable flexibility in the construction industry. Concrete is damaged and loses its strength and resistance due to changing weather conditions and with the passage of time. Permeability and resistance are very important in the lifetime and durability of concrete. The impact of damaging factors on concrete structures due to temperature changes over the years and seasonal changes from winter to summer leads to a decrease in the useful life of the structures [1]. In reservoirs and dams that are used to store water and have high hydrostatic pressures, permeability is a very important factor. Under the conditions of temperature changes that can reach 50 to 60 degrees Celsius throughout the year, the possibility of increasing cracks and small pores in concrete increases, and in this case, the possibility of water penetration into the concrete increases and causes a decrease in the resistance of the structure against loads. is entered [2].

In the conducted research, the method of processing has an effect on the permeability of concrete [3]. In the method of carrying out the permeability test in the British standard; The concrete cube samples are subjected to water pressure of 5 times for three days and then the maximum depth of water penetration in the cut section is measured [4]. To measure the volume of water infiltrated into the cubic concrete sample, in this research, the "cylindrical enclosure" test invented by Naderi [5] was used. This method is cost-effective compared to other methods and can be easily applied in different situations [6]. In British standard methods and "cylindrical enclosure" a high correlation coefficient can be seen between the results of these two tests in the permeability of concrete cube samples[7]. In another research, a direct relationship between the volume of existing permeable pores and the permeability of concrete has been obtained [8].

In the current research, the permeability and surface and compressive strengths of concrete samples containing permeation-reducing materials with Super Gel and Mesocrete brand names have been investigated under the influence of different cycles of temperature changes. Temperature changes have been applied in 4-hour intervals inside the oven at 60 degrees Celsius and in the open air at 20 degrees Celsius. The results show that there is an inverse relationship between the surface resistance and the permeability rate so that the results of the "cylindrical enclosure" test with the values of the "twist" test of concrete samples containing infiltration reducing materials have a correlation coefficient of 85%,

*Corresponding author's email: ali.saberi@edu.ikiu.ac.ir

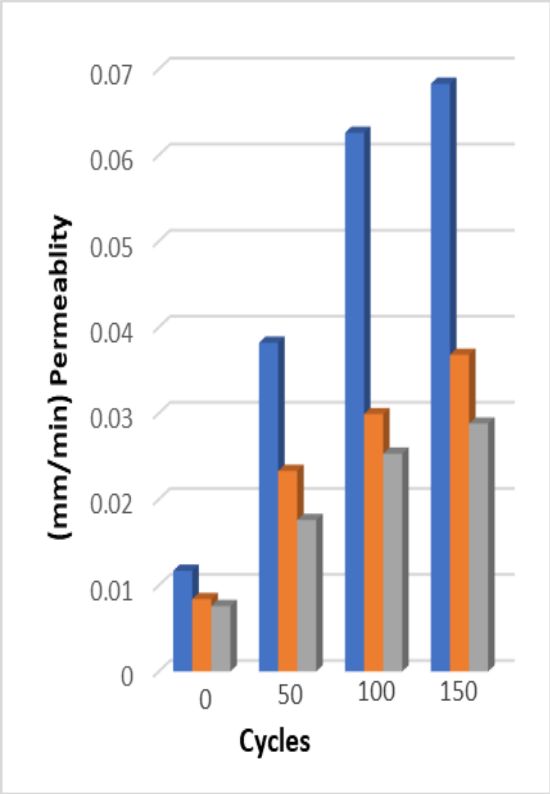

Fig 1. Permeability changes in different cycles

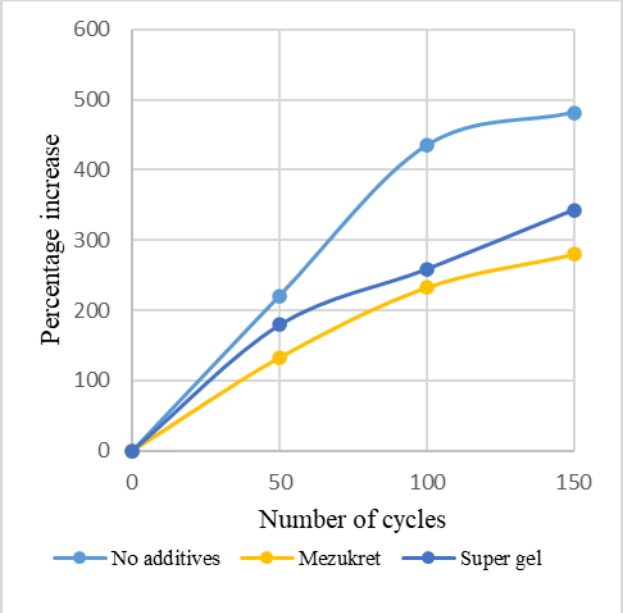

Fig 2. The overall percentage of permeability increases in different cycles

which results With the increase of permeability rate and the increase of empty spaces and the exit of moisture from concrete, the surface resistance of concrete decreases. This relationship between compressive strength and permeability has a coefficient of 90%.

2- Materials Used

The materials used are type 2 cement, urban drinking water, epoxy resin glue, and polycarboxylate type superlubricant.

3- The effect of permeation-reducing materials on the permeability of concrete under different temperature cycles

Figure 1 shows the average permeability of concretes with different resistance classes. In Figure 2, the overall percentage increase in the permeability of the samples can be seen using the "cylindrical enclosure" test.

4- Conclusions

In this research, the effect of acute environmental conditions, including different cycles of temperature changes, on ordinary concrete and concrete containing infiltration-reducing materials, as well as the relationship between the compressive and surface resistance of concrete with the rate of water penetration into the concrete by testing New ones have been reviewed. The obtained results are:

- By drawing three-dimensional diagrams in MATLAB software, it was observed that the relationship between surface resistance, pressure, and permeability rate is close to each other, and this relationship is established in terms of formulation with the equation of the first degree plane with a correlation coefficient of 0.90.

- The results of the permeability of concrete samples containing reducing materials under temperature change cycles show that the value of the penetration rate in concrete samples increased steeply up to the temperature change cycle of 100 cycles and then towards 150 cycles, the slope becomes gentler.

- In ordinary concrete, the permeability of the samples under 150 temperature cycles using the cylindrical chamber test has increased more than 5 times. However, in concretes containing supergel and mesocrete permeation reducing substances, the permeability rate of concrete increased by 343% and 280% in 150 full cycles, respectively, which is far less than concretes without additives.

References

[1] X. Li, Q. Xu, and S. Chen, An experimental and numerical study on water permeability of concrete, Construction and building materials, 105(3) (2016) 503-510.

[2] S.C. Kou, C.S. Poon, and M. Etxeberria, Residue strength, water absorption and pore size distributions of recycled aggregate concrete after exposure to elevated temperatures, Cement and Concrete Composites, 53 (2014) 73-82.

[3] Y. Sakai, Y. Yokoyama, and T. Kishi, Relationship among the permeation rate of water into concrete, the mix design, curing, and the degree of drying, Journal of Advanced Concrete Technology, 15(10) (2017) 595-602.

[4] B.S. EN, Testing hardened concrete–Part 3: Compressive strength of test specimens, British Standard Institution, London, UK, (2009).

[5] M. Naderi, Determine of concrete, stone, mortar, brick and other construction materials permeability with cylindrical chamber method, Registration of Patent in Companies and industrial property Office, (2010).

[6] M. Naderi, A. Kaboudan, and K. Kargarfard, Studying the compressive strength, permeability and reinforcement corrosion of concrete samples containing silica fume, fly ash and zeolite, Journal of Structural and Construction Engineering, 8(2) (2021) 25-43.

[7] M. Naderi, A. Kaboudan, and A. Akhavan Sadighi, Comparative study on water permeability of concrete using cylindrical chamber method and British standard and its relation with compressive strength, Journal of Rehabilitation in Civil Engineering, 6(1) (2018) 116-131.

[8] A. Kaboudan, and M. Keshtkar, Studying the permeability and strength of concretes containing silica fume, zeolite and fly ash using“Cylindrical chamber”method and British standard, Journal of Structural and Construction Engineering, 7(3) (2020) 92-113.

HOW TO CITE THIS ARTICLE

Mahmood Naderi, Ali Saberi Vaezaneh, Majid Parhizkari, The effect of different temperature cycles on permeability and surface resistance of concretes containing permeability-reducing materials , Amirkabir J. Civil Eng., 55(9) (2023) 391-394.

DOI: 10.22060/ceej.2023.22079.7897