

Article

Comparison of Standardized Methods for Determining the Diffusion Coefficient of Chloride in Concrete with Thermodynamic Model of Migration

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Abstract: This research paper is the result of observations made during tests according to various standards carried out on behalf of industry. The article presents diffusion coefficient values calculated according to the thermodynamic migration model for twenty different concrete mixes and some selected mixes of the codified approaches known as ASTM 1202, NT BUILD 443, NT BUILD 492, ASTM 1556. The method used here, according to the thermodynamic model of migration, allows determination of the value of the diffusion coefficient after short studies of the migration of chloride ions into concrete and was described in earlier works by one of the authors. Unfortunately, when using standard methods, the values of diffusion coefficients differ significantly from each other. In each concrete, diffusion tests were carried out in the conditions of long-term natural diffusion to verify the values determined by standard methods and according to the thermodynamic model of migration. The analysis conducted for this research paper reveals that the chloride permeability test method according to the standard ASTM C1202-97 has an almost 2.8-fold greater dispersion of the obtained results compared to the thermodynamic model of migration. It was observed that the standard NT BUILD 492 has a 3.8-fold dispersion of results compared to the method with the thermodynamic model of migration. The most time-consuming method is the standard method NT BUILD 443. The largest 3.5-fold dispersion of values concerning the reference value are observed in that method. Moreover, a method based on a thermodynamic migration model seems to be the best option of all analyzed methods. It is a quite quick, but laborious, method that should be tested for a larger number of concrete mixes. A great advantage of this method is that it is promising for a wide range of concrete mixtures, both plain concrete and concrete with various additives and admixtures, as well as high-performance concrete.

Keywords: diffusion coefficient; diffusion model; chloride migration; standard methods; chloride ions; Fick's second law



Citation: Sawecka, Z.; Gołaszewski, J.; Ghosh, P.; Lehner, P.; Konečný, P. Comparison of Standardized Methods for Determining the Diffusion Coefficient of Chloride in Concrete with Thermodynamic Model of Migration. *Materials* **2023**, *16*, 637. <https://doi.org/10.3390/ma16020637>

Academic Editor: Jeong Gook Jang

Received: 9 December 2022

Revised: 31 December 2022

Accepted: 3 January 2023

Published: 9 January 2023



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1. Introduction

The rate of chloride ion penetration into fully and partially saturated concrete is described by diffusion parameters. The process of chloride ion penetration into concrete is described by Fick's diffusion equations and the Nernst-Planck equation in the migration process [1,2]. Therefore, a very important issue in the case of reinforced and prestressed concrete structures is the precise determination of the diffusion coefficient value. Currently, there are many valid standard methods for determining the value of the chloride diffusion or migration coefficient [3]. Firstly, the method contained in two standards, ASTM C1556 [4]

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