

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



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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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Table of Contents Comparison Of Methods For Determining Th

1. Understanding the eBook Comparison Of Methods For Determining Th
 - The Rise of Digital Reading Comparison Of Methods For Determining Th
 - Advantages of eBooks Over Traditional Books
2. Identifying Comparison Of Methods For Determining Th
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Comparison Of Methods For Determining Th
 - User-Friendly Interface
4. Exploring eBook Recommendations from Comparison Of Methods For Determining Th
 - Personalized Recommendations

- Comparison Of Methods For Determining Th User Reviews and Ratings
- Comparison Of Methods For Determining Th and Bestseller Lists
- 5. Accessing Comparison Of Methods For Determining Th Free and Paid eBooks
 - Comparison Of Methods For Determining Th Public Domain eBooks
 - Comparison Of Methods For Determining Th eBook Subscription Services
 - Comparison Of Methods For Determining Th Budget-Friendly Options
- 6. Navigating Comparison Of Methods For Determining Th eBook Formats
 - ePub, PDF, MOBI, and More
 - Comparison Of Methods For Determining Th Compatibility with Devices
 - Comparison Of Methods For Determining Th Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Comparison Of Methods For Determining Th
 - Highlighting and Note-Taking Comparison Of Methods For Determining Th
 - Interactive Elements Comparison Of Methods For Determining Th
- 8. Staying Engaged with Comparison Of Methods For Determining Th
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Comparison Of Methods For Determining Th
- 9. Balancing eBooks and Physical Books Comparison Of Methods For Determining Th
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Comparison Of Methods For Determining Th
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Comparison Of Methods For Determining Th
 - Setting Reading Goals Comparison Of Methods For Determining Th
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Comparison Of Methods For Determining Th
 - Fact-Checking eBook Content of Comparison Of Methods For Determining Th

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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