A refined model of concrete carbonation by coupling of multi-factors

Yuanfei Ge, Shaojun Yu, Yu Zhang and Yongming Tu

Southeast University, Nanjing, PR China

Ulf Ohlsson

Luleå University of Technology, Luleå, Sweden

Contact: 1510516734@qq.com

Abstract

Studies on carbonation of concrete play an important role in accurately predicting the service life. However, most research work on carbonation of concrete was carried out in qualitative ways and seldom in quantitative ways. In this paper, based on conservation of mass of C₃S(s), C₂S(s), CSH(s), CH(s), CH(aq), CO₂(aq) and CO₂(g) and one-dimensional diffusion and reaction equation, a refined mathematical model of concrete carbonation composed of a series of partial differential equations (PDEs) was built. Corresponding MATLAB codes were developed with calculus of differences to solve the mathematical model of concrete carbonation.

The results of the mathematical models in this paper agree very well with measurements, which show that this model can be used to accurately predict concrete carbonation as well as remaining service life of concrete bridges and other concrete structures.

Keywords: Concrete carbonation; Kinetics of chemical reaction; One-dimensional diffusion; Partial differential equation; Mathematical model.

1 Introduction

The durability of reinforced concrete is a topic of great concern in the field of civil engineering. The use of steel reinforcements makes it possible to erect buildings with different shapes and design and build wide spans. Meanwhile, the steel reinforcement is protected from physical and chemical agents by the concrete layer. But it is limit for concrete layer to protect steel from corrosion, and it is known that carbonation is a chemical reaction that take place between concrete and CO₂, if the carbonation continues to develop, the value of pH will decrease, then steel will lose its protection from concrete.

Scholars have done a lot of researches related to carbonation. Previous studies are mainly focused on Macro-structural level, these studies about research factors and forecasting models mainly take experimental method based on experience.