

The Research of Numerical Simulation of Concrete Durability

Airong Chen

Professor
Tongji University
Shanghai, China
a.chen@tongji.edu.cn

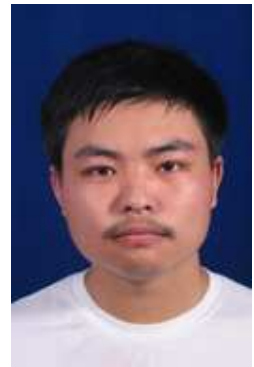
Airong Chen, born 1963, received his Ph.D. in civil engineering from Tongji University in 1993, and became professor in 1999.



Zichao Pan

Ph.D. Candidate
Tongji University
Shanghai, China
panzichao@gmail.com

Zichao Pan, born 1984, received his bachelor degree in civil engineering from Tongji University, and now studies for his Ph.D. in the same place.



Summary

The technology of numerical simulation becomes the focus of study in concrete durability gradually since it can help the engineers to evaluate the durability performance of concrete structure without experiments. Some important achievements in the fields of chloride penetration, concrete carbonation and steel corrosion are reviewed in this paper. A new computer program called the Numerical Simulation System of Concrete Durability, as well as its applications in detailed structure design, mechanism study and durability evaluation is also briefly introduced.

Keywords: concrete; durability; chloride; carbonation; numerical simulation.

1. Introduction

Concrete has been widely used in bridge construction for its moderate price and stable performance. According to an investigation in 1994 by USA, during the past 40 years, the use of steel in bridge construction has decreased by 25%, while the use of concrete has increased by 70%. These data shows, concrete bridge plays an important role in the past and present bridge construction.

Because of the wide use of concrete bridge, many researchers in different countries have studied the performances of concrete since its emergence. The main research work has focused on the strength theory of concrete by the 1970s. But during the operation stage of bridges, many developed countries have found that durability problem has seriously affected the service life of concrete bridge, and brought out a great deal of economics loss. A report in 1989 on the present situation of bridges in USA says "The cost for the maintenance of present RC bridges which need repairing is about 155 billion Dollars". The annual maintenance cost for the steel corrosion of RC structures in Britain is about 50.5 billion Pounds, which has already covered 1.1% of the total transaction value of building industry. The annual maintenance cost for highway bridges in Germany is about 0.8 billion Marks [1]. According to the above data, it can be easily found that the price advantage of concrete will vanish when considering the life-cycle cost of structures.

In this background, a lot of experimental research on the durability of concrete has been brought out since the 1970s. The mechanisms relating to the durability problem of concrete have been gradually revealed, and the experimental method which can be used to evaluate the durability performance of concrete has been preliminary founded. But the needs of such experiment cannot be satisfied in most situations because of its expensive equipments and long test period. So the durability problem of concrete cannot be completely solved only with the help of experiment.

With the rapid development of electronic computer and numerical calculation, it becomes possible to use the numerical simulation technology to study the durability problem of concrete structure. Since the 1980s, a lot of research work has been done on the mass transport in concrete, carbonation of concrete and prediction of steel corrosion at the micro and macro levels. The concrete durability numerical simulation technology can make it possible to evaluate the durability performance of in-service concrete structures, and also help the design work of future structures without experiments.