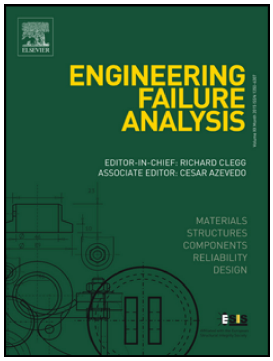

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Simulation of Corrosion Process for Concrete Filled Steel Tubular Columns with the Cellular Automata Method

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Abstract: In this paper, from the mesoscopic point of view, under the assumption of metal corrosion damage evolution being a diffusive process, the cellular automata (CA) method was proposed to simulate numerically the uniform corrosion damage evolution of the outer steel tube of concrete filled steel tubular columns subjected to corrosive environment, and the effects of corrosive agent concentration, dissolution probability and elapsed etching time on the corrosion damage evolution were also investigated. It was shown that corrosion damage increases nonlinearly with increasing elapsed etching time, and the longer the etching time, the more serious the corrosion damage; different concentration of corrosive agents had different impacts on the corrosion damage degree of the outer steel tube, but the difference between the impacts was very small; the heavier the concentration, the more serious the influence. The greater the dissolution probability, the more serious the corrosion damage of the outer steel tube, but with the increase of dissolution probability, the difference between its impacts on the corrosion damage became smaller and smaller. To validate the present method, corrosion damage measurements for concrete filled square steel tubular columns (CFSSTCs) sealed at both their ends immersed fully in a simulating acid rain solution were conducted, and Faraday's law was used to predict their theoretical values. Meanwhile, the proposed CA mode was applied for the simulation of corrosion damage evolution of the CFSSTCs. It was shown by the comparisons of results from the three methods aforementioned that they were in good agreement, implying that the proposed method used for the simulation of corrosion damage evolution of concrete filled steel tubular columns is feasible and effective. It will open a new approach to study and evaluate further the corrosion damage, loading capacity and lifetime prediction of concrete filled steel tubular structures.

Keywords: concrete filled steel tube; corrosion; cellular automaton; test result; theoretical prediction

1. Introduction

With the rapid development of modern industrial technology, the working environment of infrastructure structures is becoming increasingly severe. In various fields of structural engineering such as construction engineering, aviation engineering, petrochemical engineering, marine and nuclear engineering, accidents due to the structural failure under corrosive environment is nothing new in practical engineering. The accidents not only give rise to huge economic losses, but also bring about a lot of casualties. Therefore, to predict the integrity of engineering structures under corrosive environment and ensure the safety of structural operation, it is of important practical significance to have a better understanding of the evolution process of corrosion damages for engineering structures.

Concrete filled steel tube (CFST) has been widely used in high-rise building, bridge, high voltage transmission tower, oil drilling platform and offshore structure and other engineering structures owing to its excellent mechanical properties [1]. However, since long-term exposure to air or seawater, the outer steel tube is vulnerable to aggressive agents like acid rain, ocean climate, sea water and so on. As etching time goes, there will be large area corrosion and losing on the surface of outer steel tube, decreasing the rigidity of CFST structure, role of combined action and degradation of structural resistance, and thereby affecting its service life, that is durability and safety. On the study of the mechanical performances of CFST structures in corrosive environment, many experimental researches have been carried out [2,3]. Nevertheless, none of these studies takes into account that the environmental corrosion damage process is a complex dynamic system and the degradation of structural resistance is