Service life predictions for RC bridges under time-varying climate conditions and traffic loads

Chao JIANG

Dr.

Tongji University / University of Colorado Boulder

Shanghai, P.R. China / Boulder, US

cjiang@tongji.edu.cn / jiang.chao@colorado.edu

Dr. Jiang is now working on durability of RC structures as a postdoc at Tongji University and University of Colorado at Boulder.

Junyu CHEN

Mr.

Tongji University

Shanghai, P.R. China

1410226@tongji.edu.cn

Mr. Chen is now working on corrosion of steel reinforcements in concrete as a PhD candidate at Tongji University.

Contact: cjiang@tongji.edu.cn

1 Abstract

This paper evaluated the service life of RC bridges subjected to carbonation under a changing climate. Through integrating the carbonation depth prediction model, fatigue damage prediction model and climate model into a Monte Carlo simulation procedure, a case study was conducted to assess the service life of an RC bridge based on time-dependent reliability analysis, which considered the time-variant stochastic nature of environmental actions and fatigue damage, uncertainty of concrete properties and randomness of concrete cover thickness. The case study showed that the higher the reliability level, the shorter the service life. Moreover, climate change has noticeable effects on the service life. Under the reliability level of 1.5, the service life predicted at RC bridge bottom (top) with considering tensile (compressive) fatigue damage under RCP8.5 can be 33% (22%) shorter than that predicted under the climate 2013 without considering climate change. In addition, fatigue damage also poses obvious influences on the service life of RC bridges. Under the reliability level of 1.5, the service life with consideration of tensile (compressive) fatigue damage can be 49% (20%) shorter than that without consideration of fatigue damage under RCP4.5.

Keywords: time-dependent reliability, service life; carbonation; climate change; fatigue damage.

2 Introduction

RC bridges not only bear traffic loads but also undergo environmental actions. In the long run, reinforcement corrosion is the main reason for the performance deterioration of RC bridges. In an atmospheric environment, carbonation of concrete is one of the main causes of reinforcement corrosion. Moreover, fatigue damage induced by traffic loads usually causes initiation and propagation of micro-cracks in concrete [1], which in turn accelerates carbonation process. Hence, carbonation in fatigue-damaged concrete has drawn significant attention [2].

The authors proposed a numerical carbonation model which could predict carbonation depth

https://doi.org/10.2749/newyork.2019.1117

Distributed by Structurae