Spatial probabilistic analysis on a prestressed concrete slab bridge based on modified chloride diffusion coefficient model subject to chloride-induced corrosion

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Abstract

The performance of Prestressed Reinforced Concrete (PRC) structures degrades with time subject to chloride-induced corrosion. Corrosion could result in reduction of area of prestressing steel, cover cracking and even spalling due to corrosion products. This finally leads to a decrease of structural load-carrying capacity. Many factors influence corrosion induced by chloride ion, such as time, ambient humidity, temperature and loading. This paper proposes a modified chlorides diffusion coefficient model which considers the effect of time, ambient humidity, temperature and compressive stress. A spatial time-dependent reliability model is developed to predict probability of corrosion initiation over 100 years. Probabilistic evaluation of time to corrosion initiation has then been carried out for an aging PRC slab beam bridges exposed to aggressive environment. It is indicated that the probability of corrosion initiation for spatial variabilities considered with a scale of fluctuation of 3.0 is 1.06 times higher than that predicted for non-spatial. It is found that the probability of corrosion initiation for RH=90% is 12% higher than that predicted for RH=80%. It is also observed that a higher temperature will result in an increase in corrosion initiation probability. It is found from calculated results the spatial variability of parameters is important for reliability analysis.

Keywords: PRC bridge; chloride diffusion; spatial variability; structural reliability; parameter study

1 Introduction

Chloride-induced corrosion is one of the major causes of structural performance degrading [1-5]. Prestressed reinforced concrete (PRC) structures are always exposed to aggressive environment which can cause corrosion of prestressing steel or reinforcing bars and then affect structural serviceable performance. Chloride penetration in concrete can be affected by time, ambient humidity, temperature and loading [6], all of these factors have temporal and spatial uncertainties that should be taken into account to carry out a realistic uncertainty analysis of chloride ingress. In addition, chloride diffusion in concrete is a process that the chloride ions penetrate concrete cover to arrive at the surface of reinforcing bar, and the concentration of chloride ions reach a threshold level and it means corrosion initiation [7]. Yan [8] have carried out an experiment of chloride ingression in flexural RC beams, and the chloride concentrations at different depth in different

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