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Finite element analysis of cracks due to reinforcement bars corrosion in RC structures

Mohammad Javad Mirzaee[1], Farshid Jandaghi Alaee[2], Mohammad Hajsadeghi[3]

1- M.Sc. Candidate, Department of Civil Engineering and Architectural, University of Shahrood
2- Associate Professor, Department of Civil Engineering and Architectural, University of Shahrood
3- Ph.D. Candidate, Department of Civil Engineering and Architectural, University of Shahrood

m.j.mirzaee@shahroodut.ac.ir

Abstract

Concrete cover cracking due to corrosion of steel reinforcing bars is one of the main causes of the reinforced concrete (RC) structures deterioration, exposed to marine environments. Depending on the oxidation level of rebar, corrosion may result in expansion of reinforcement bars. This expansion may causes the through thickness cracking of the cover concrete; which could indicate the loss of service life structures due to corrosion. In this paper, the parameters which influence the concrete cover cracking have been investigated via finite element method (FEM) for which ABAQUS software was employed. The results indicated that the most important factor in concrete cover cracking is cover thickness to rebar diameter ratio (C/d).

Keywords: reinforcement corrosion, expansive corrosion products, concrete cover cracking, finite element method.

1. INTRODUCTION

The corrosion of steel reinforcements in concrete is a longstanding a global problem that has caused widespread damage to concrete structures. It is normally caused by aggressive agents such as chloride ions from marine environments, dicing salt and chloride-contaminated aggregate. The formation of corrosion products (rust) involves a substantial increase a volume, resulting in expansive stresses around corroded steel bars. These stresses can cause concrete cover to crack and spall, thereby reducing the serviceability of concrete structures. The general mechanism of corrosion, which can cause cracking of concrete cover, is shown in Figure 1 [1].

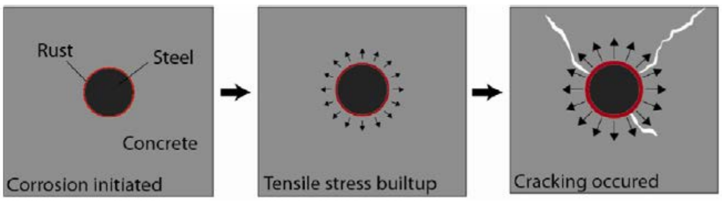

Fig. 1. Generally mechanism of corrosion-induced cover cracking

A considerable number of studies have focused on corrosion-induced cracking of concrete, and as a result various cracking models have been proposed. Finite element modeling (FEM) has been mostly used to study the propagation, rather than initiation, of corrosion-induced cracks. Compared to other models, it allows a more convenient treatment of material characteristics and geometric complexities. Dagher and kulendran used FEM to supply information for condition assessment of corroding bridge decks [2]. The volume expansion of corrosion products was simulated by nodal displacements and the failure was defined using the equivalent strength criterions. Molina et al. modeled the generation of corrosion products and the corresponding pressure by reducing the modulus of elasticity of the steel elements at corrosion front and the application of cumulative nodal displacement, respectively [3]. In a similar manner, Yokozuki et al. simulated the internal pressure by imposing strain to the corrosion front [4]. Zhou et al. also use nodal