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Epoxy-coated bars as corrosion control in cracked reinforced concrete

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One of the most common corrosion protection methods in reinforcing concrete bars is the application of fusion-bonded epoxy coatings. Although considerable research has been carried out on the performance of epoxy-coated bars (ECR), there are still many uncertainties about their performance in cracked concrete. In this experimental program, reinforcing steel bars with six types of epoxy coatings embedded in concrete slabs with a 0.4 mm wide preformed crack intersecting the reinforcing steel at right angles were tested. Results of corrosion potentials, corrosion current density, coating adhesion tests, chloride content, and visual examination after 68 months of exposure to a simulated marine environment are reported. Results revealed that under the studied conditions the ECR did not provide total protection of steel reinforcement in cracked concrete. Their use however, tended to reduce significantly the damage caused by the chloride-induced corrosion when compared with the uncoated bars embedded in concrete with similar characteristics.

1 Introduction

Corrosion of reinforced concrete structures is one of the major problems of concern and several methods have been recommended for its control and prevention. Among the more common methods is the use of epoxy coated reinforcing (ECR) bars which have been widely used in North America since 1973. As a result over 60 000 bridges, numerous buildings, wharves, and other structures have been built using epoxy-coated reinforcement [1]. Despite all the experience gained over the years, the effectiveness of ECR as a corrosion control method in reinforced concrete exposed to aggressive environments remains a subject of controversy, because some studies have reported good performance in laboratory testing and in field structures while others have suggested that their effectiveness is limited [2–5] For instance, experiments on the performance of small scale concrete slabs containing ECR with no damage and some with 1 and 2% damage to the coating and in which both were subjected to a simulated marine environment, indicated that beyond 2 years of testing, corrosion current densities registered were negligible for both undamaged and damaged ECR [6].

In another laboratory investigation, the corrosion potentials and mass loss results, gathered during 1-year testing in reinforced concrete specimens containing three different types of coatings, namely cement polymer composite, interpenetrating polymer network coating, and epoxy coating, indicated that epoxy-coating systems offered good performance in both high tide and seafloor level when compared to the control and two other coating systems [7]. Likewise, results of a electrochemical testing carried out in another structure indicate that after 18 years of exposure to a combined action of chlorides and extreme changes in temperature, the structure remains in good condition with only a few locations showing rust staining and cracking presumably caused by corrosion of the steel reinforcement [8]. Another example of the good performance of field structures reinforced with ECR was documented by the West Virginia DOT's in a report of the condition survey of several bridge decks built during 1974–1976 [9]. It was concluded that the use of ECR does result in a considerable reduction of delaminations of the bridge decks which lead to an increase of their intended service life.

In contradiction to all the published literature regarding the good performance of ECR, other field observations have indicated that the use of ECR in marine environments may lead to premature corrosion, severe cracking, and spalling of the reinforced concrete [10–12]. The first evidence of unsatisfactory

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