

# Preface

Since the mid 1970s, a number of durability-related problems have emerged and stimulated research of the key factors that relate to the durability problems of concrete structures. Reinforcing steel corrosion is one of the major reasons for deterioration of reinforced concrete structures. Steel corrosion in concrete will induce sectional loss of steel bar, degradation of bond stress between steel and concrete, and cracks parallel to longitudinal bars. Field studies have suggested that cracking and spalling are most concerning to asset owners. Structural collapse of reinforced concrete structures due to steel corrosion is rare; cracking, rust staining, and spalling of the concrete cover usually appear well before a reinforced concrete structure is at risk. Therefore, the cracking of the concrete cover induced by steel corrosion is important and is usually defined as the serviceability limit state.

The authors have focused on this research field since 1998, and have carefully investigated the origin, mechanism, and development of corrosion-induced cracking in concrete. Considering the importance of this topic, the authors summarize the related research achievements obtained and share with other researchers and engineers who are interested in this field. This book concentrates on the concrete cracking process induced by steel corrosion. After the background introduction and literature review in chapter "Introduction," the mechanisms of steel corrosion in concrete are introduced in chapter "Steel Corrosion in Concrete." The composition, expansion coefficient, and elastic modulus of steel corrosion are carefully investigated in chapter "The Expansion Coefficients and Modulus of Steel Corrosion Products," considering the importance of the properties of steel corrosion in concrete cracking models. With these parameters of steel corrosion, the damage analysis is applied to analyze the corrosion-induced concrete cracking process in chapter "Damage Analysis and Cracking Model of Reinforced Concrete Structures With Rebar Corrosion," and the critical thickness of the rust layer at the moment of surface cracking of concrete cover is studied in chapter "Mill Scale and Corrosion Layer at Concrete Surface Cracking." In chapter "Rust Distribution in Corrosion-Induced Cracking Concrete," the authors investigate the rust distribution in the corrosion-induced cracks and find that the rust did not fill the corrosion-induced cracks in the concrete cover before concrete surface cracking. A Gaussian function is proposed to describe the nonuniform spatial distribution of corrosion products in chapter

“Nonuniform Distribution of Rust Layer Around Steel Bar in Concrete.” The shape of the corrosion-induced cracks in the concrete cover is observed in chapter “Crack Shape of Corrosion-Induced Cracking in the Concrete Cover,” and a linear model was proposed to describe the variation in the total circumferential crack width along the radial direction in the concrete cover. Rust distribution at the steel–concrete interface is presented in chapter “Development of Corrosion Products-Filled Paste at the Steel–Concrete Interface”; and the penetration of corrosion products into the porous zone of concrete and formation of a corrosion layer at the steel–concrete interface process simultaneously. Finally, in chapter “Steel Corrosion-Induced Concrete Cracking Model,” an improved corrosion-induced cracking model is proposed, which considers the corrosion layer accumulation and corrosion products filling occurring simultaneously in concrete. The time from corrosion initiation to concrete surface cracking is discussed. The need for more research regarding the corrosion-induced cracking model is also discussed in this book.

The authors hope this book is useful for researchers interested in the durability of concrete and concrete structure fields, for industry engineers who pay attention to the deterioration mechanisms and the life cycle of reinforced concrete structures, and for graduate students whose research topics include corrosion-induced deterioration of reinforced concrete structures.