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Thesis Outline

Corrosion of steel reinforcement in concrete significantly affects the durability, strength, and serviceability of reinforced concrete (RC) structures. This study discusses the effects of reinforcement corrosion on bond deterioration due to corrosion and corrosion-induced cracks and strength reduction due to section loss of steel reinforcement. In addition, the assessment model for deteriorated reinforced concrete (RC) beams due to corrosion of reinforcement is proposed.

Introduction and literature review are provided in Chapter 1 and Chapter 2, respectively. The introduction explains the background, research motivation, objectives and scopes of this study, and the content of the dissertation. The literature review is summarized as bond between concrete and reinforcement, load-carrying mechanism of RC beams, corrosion of steel reinforcement in concrete, bond deterioration due to corrosion of steel reinforcement, structural performance of RC beams with corrosion of steel reinforcement, and identification of research gap.

In this study, two different types of the experimental program had been carried out to ascertain the effect of rebar corrosion in concrete on the structural behavior and limit states of corroded RC structures. In the first type of experiment, ten RC members with a single reinforcement (RC ties) were tested under axial tensile force. The RC ties in the first type of experiment were tested to investigate (1) the effects of both corrosion and corrosion-induced cracks and (2) the impacts of localized section loss of steel reinforcement on tensile performance of RC members. In Chapter 3, bond deterioration in corroded RC members was evaluated by incorporating cracking response and tension stiffening. A simplified numerical model using three-dimensional non-linear finite element (FE) analysis was performed to reproduce the average response of the corroded RC ties. In Chapter 4, influence of localized section loss of steel reinforcement in RC ties on the tensile response was clarified. The novel modeling approach to simulate interfacial transition zone between concrete and tensile reinforcement in the FE analysis was also introduced in this chapter.

In the second type of experiment, the flexural test was carried out to investigate the impact of localized section loss of steel reinforcement within flexural or shear span on structural performance of RC deep beams under arch-tie action as described in Chapter 5. The influence of section losses of reinforcement on structural performance of RC deep beams was investigated. In addition, the load carrying capacities of the beams with different locations of the section loss were examined.

The load-carrying mechanism of the RC deep beams with localized section loss was clarified by the numerical simulation.

Furthermore, the numerical model was developed in Chapter 6 accounting for the deterioration of tension stiffening due to the corrosion and corrosion-induced cracks, and for the non-uniform section loss of corroded tensile reinforcement. To model the deterioration of tension stiffening, the numerical model was validated by using the experimental results obtained from the tensile test of RC ties in this study and in the literature. To estimate the maximum section loss due to the non-uniform corrosion of reinforcement, statistical analysis was applied in the assessment model. The experimental results obtained from the literature were compared to verify the numerical assessment model for RC beams with corrosion of tensile reinforcement. The prediction agreed with the experimental results in both pre-yielding and post-yielding behaviors.

Finally, the findings in this study are summarized in Chapter 7. The conclusions obtained in the study and recommendations for further study are given.