# A Mechanics Simulation of the Influence of Reinforcement Corrosion on RC Beam Behaviour


by

Qian Feng


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Department of Civil, Environment and Mining Engineering

The University of Adelaide

Australia


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# ABSTRACT

Corrosion influences both of the serviceability limit state and the ultimate limit state of the reinforced concrete structures. The mass loss of reinforcement caused by corrosion not only reduces cross sectional area of the reinforcement but also the bond between the steel reinforcement and surrounding concrete. By reducing the bond between the reinforcement and surrounding concrete, at serviceability limit state, corrosion may lead to an increase crack width and deflection, while at the ultimate limit state it may lead to reinforcement debonding. Hence, knowledge of the influence of corrosion on the bond between reinforcement and concrete is required to evaluate structural behaviour and extend the life span of the reinforced concrete structures.

This thesis first investigates the influence of corrosion on bond properties yielding a new bond-slip material model which has been developed from the analysis of a large data base of 377 individual test results obtained from published experimental results. From the resulting bond-slip model it is shown the debonding of reinforcement may occur at relatively low levels of corrosion and that the influence of corrosion on bond is more significant corrosion for large bar diameters.

Having developed a material model illustrating how corrosion influences the bond-slip relationship, the impact of corrosion on reinforced concrete beams is considered. Firstly the performance of beams at the ultimate limit state is considered through the development of a numerical segmental analysis technique to simulate member behaviour prior to and post debonding. Importantly this model shows that although debonding of reinforcement may occur at a relatively low level of corrosion, it does not always negatively impact member strength or ductility.

The impact of reinforcement corrosion at the serviceability limit state is then considered through the extension of the segmental approach to incorporate not only the influence of bond but also concrete creep and shrinkage. The resulting model couples concrete creep and shrinkage with reinforcement corrosion and predicts the influence of each on crack width and member deflection. Significantly it is shown that reinforcement corrosion can be much more easily monitored through measurement of crack widths over time rather than through consideration of member deflection and the approach proposed may be used to provide guidance on the variation in reinforcement corrosion along a span.

# STATEMENT OF ORIGINALITY

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# LIST OF PUBLICATIONS

Feng, Q, Visintin, P and Oehlers, DJ (2016) Deterioration of bond–slip due to corrosion of steel reinforcement in reinforced concrete. Magazine of Concrete Research, 68(15): 768-781.

Feng, Q, Visintin, P and Oehlers, D (2016) Quantifying through bond mechanics the effect of steel bar corrosion on the flexural capacity of RC beams. Submitted to Proceedings of the Institution of Civil Engineers-Structures and Buildings.

Feng, Q, Visintin, P and Oehlers, D (2016) A mechanics prediction of reinforcement corrosion in RC beams through the measurement of crack widths. Submitted to Structural Concrete.

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