Numerical Approach to Structural Performance Assessment of Corroded Reinforced Concrete Structures

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Summary

This paper presents a reliable method for assessing structural performance of reinforced concrete structures. A spring network model, which is one of the discrete-type numerical approaches, is used to predict current structural performance of deteriorated reinforced concrete structures due to steel corrosions. The influence of corrosion distribution of steel reinforcing bars on flexural behavior of reinforced concrete beams is studied. The numerical results indicates that the flexural capacity of reinforced concrete beams with steel corrosion depends on the minimum cross sectional area of corroded steel bars, and ductility of beams is strongly influenced by the condition of bond deterioration between concrete and steel bars.

Keywords: corrosion, flexural capacity, ductility, numerical analysis, rigid-body-spring model, corrosion distribution, performance assessment of existing structures

1. Introduction

The deterioration of reinforced concrete structures, primarily due to corrosion of steel reinforcement, has become a major concern of infrastructure owners and operators. Computer models are one of the most suitable approaches for assessing the performance of deteriorated concrete structures, since the computer-aided tools enable designers to study the influence of the various parameters that affect the structural performance. The accurate understanding of corrosion induced damage would assist them to optimize inspection/repair strategies in maintaining the reliability of concrete structures. Because of financial and physical restriction, it is, however, difficult to obtain enough and accurate information for the analysis input from inspection of deteriorated structures in service. Thus, it requires developing a method to estimate the condition of deterioration from the minimal information obtained by effective inspection, for assessing the performance of the structures quantitatively by using nonlinear numerical analyses based on the input.

The structural response of corroded reinforced concrete beams has been investigated numerically by Lee et al. [1] and Coronelli & Gambarova [2]. Nonlinear finite element approaches can be used to assess the serviceability and safety of damaged or deteriorated structures, although such procedures still have difficulties in accounting for environmental effects and modelling physical and chemical mechanisms of material deterioration.

Rigid-body-spring networks (RBSN) are used in this work to analyze corroded reinforced concrete beams (Bolander and Saito [3], Saito and Hikosaka [4]), since such discrete approaches have advantages in modelling the material discontinuity that develop in concrete structures, relative to smeared-crack continuum models.

This preliminary work focuses on local damage of corroded reinforcing steel that affect the structural performance of reinforced concrete beams.

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