Bond assessment of corroded steel bars in structural concrete

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Summary

The present paper proposes a semi-empirical formulation accounting for both pull-out and splitting failures for assessing bond of corroded and non-corroded steel bars. This formulation is obtained by means of multiple linear regression analysis of a database of more than 650 tests of corroded and non-corroded bond tests, including tests performed in a former study [1] and data from literature. The database used includes a wide range of influencing variables regarding to bond, such as bar diameter, concrete strength, concrete cover, anchorage length, confinement ratio and cross-section loss due to corrosion. Several statistical criteria have been used to analyse the proposed formulation and the influence of the explanatory variables. Also a comparison with several formulations, including the proposal of Fib Model Code 2010 for corroded bars is performed. This formulation could be used in the structural assessment of corroded reinforced concrete members.

Keywords: Reinforced concrete, corrosion, Bond, pull-out, splitting, multiple linear regression, assessment of existing structures.

1. Introduction

Corrosion can affect the bond between reinforcing bars and concrete and hence the transfer of longitudinal stresses. Loss of bond normally leads to a potentially brittle type of structural behaviour thus it should be analysed within the framework of the assessment of deteriorated structures to avoid it.

Factors affecting bond behaviour include the weakening of concrete confinement due to cracking of concrete cover and/or corrosion of stirrups, development of corrosion products at the interface and in ribbed bars reduction of the bond index due to cross section loss of steel. In recent years a number of relevant studies have been conducted on bond with corroded steel (e.g. [2], [3], [4]), the findings have diverged rather widely, due primarily to differing test conditions.

In an attempt to address the inconsistencies in the prediction of bond with corroded steel, in a former study eccentric pull-out tests were conducted on specimens subjected to accelerated or natural corrosion as described in [1]. In this study a unified approach for the assessment of bond behaviour of corroded and non-corroded steel bars with a semi-empirical formulation accounting for both pull-out and splitting failures is proposed. The formulation is obtained with a multiple linear regression analysis.

2. Multiple linear regression model for bond assessment of corroded and non-corroded steel bars

2.1 Introduction

Initially to obtain the formulation for bond assessment 849 bond tests with corroded and non-corroded steel bars were collected from scientific literature (references [2], [3], [4] and from [7] to [19], among others). Natural corrosion processes need a long time to develop, therefore a galvanostatic method is normally used in bond tests to accelerate the process. This procedure applies a constant current density in the steel.

In this study only bond tests with corroded steel bars obtained with corrosion rates below or equal to 200 $\mu A/cm^2$ have been analysed. Higher corrosion rates may yield bond strengths which are not

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