AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Structural Engineering

Restoration of Bond Strength for Fire-Damaged RC Elements

A Thesis submitted in partial fulfilment of the requirements
of the degree of

Master of Science in Civil Engineering

(Structural Engineering)

by

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Bachelor of Science in Civil Engineering

(Structural Engineering)

The Higher Institute of Engineering, El Shorouk Academy, 2013

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Researcher Name : Nesma Abdel Hameed Mohammed Ghazaly

Thesis Title : Restoration of Bond Strength for Fire Damaged RC Elements

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Civil Engineering (Structural Engineering), Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

Reinforced concrete structures are vulnerable to high temperature conditions such as those during exposure to fire. The exposure of reinforced concrete (RC) structural elements to high temperature leads to loss in the mechanical properties of concrete and most importantly loss of bond between concrete and steel rebars. Recovering the structural integrity of heat-damaged RC elements requires extensive repair and rehabilitation works.

This thesis contains details of an experimental and analytical study conducted to evaluate the residual bond strength between concrete and steel rebars after subjected to elevated temperature and to investigate the effective repairing materials and techniques in restoring bond strength for heat –damaged concrete elements. The beam-end specimens were tested in three conditions, in ambient temperature, after subjected to elevated temperature of 800 °C, or after subjected to 600 °C. Steel fiber reinforced concrete and concrete were used as the repairing materials. Shallow and deep repair techniques were used as repairing techniques. The tested rebar was embedded in two concrete covers 30 and 50 mm. The embedded lengths 5Ø and 8Ø were conducted in this study.

The experimental results showed that the residual bond strength for the heated specimens was almost 26% and 32% at 800°C and 600°C respectively, of the original ultimate bond strength with significant increase in slip corresponding to the ultimate bond stress, especially when exposed to 800°C. The residual, restored and original bond strengths decreased with the increase of the bonded length from 5Ø to 8Ø. Although, they increased with the increase of the concrete cover. Considering the repair of heat- damaged specimens, the deep and shallow repair techniques using concrete restored almost 87% and 84% respectively, of the ultimate

bond strength. However, the restored bond strength almost 94% and 90% respectively, of the original ultimate bond strength for specimens repaired using steel fiber reinforced concrete. There is no difference in the restored bond strength for both repairing techniques for specimens exposed to ambient temperature. The effective repairing material used in this study, the steel fiber reinforced concrete (SF), it restored 96% and 91% of the original bond strength of specimens with 50 mm concrete cover.

To predict the bond stress – slip behavior for all specimens simple relationships are proposed based on experimental data and different parameters studied. The modified model for bond stress – slip curve, has been proposed by different researchers is suitable for reproduction of the ascending branch of the bond – slip curve. Key analytical results showed that the proposed equations give a good prediction of the bond strength for different specimens. Also, a good agreement between the modified proposed analytical model for bond stress- slip curve and the experimental data can be observed.

Keywords: Bond strength; Elevated temperature; Steel fiber; Deep repair; Bonded length; Heat damaged; Restoration.

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PUBLICATIONS

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TABLE OF CONTENTS

LIST OF FIGURES