Ain Shams University
Faculty of Engineering
Structural Engineering Department

CFRP STRENGTHENING OF PRESTRESSED HOLLOW CORE SLABS IN POSITIVE MOMENT REGION

By
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B.Sc. 2005, Structural Division
Civil Engineering Department
Ain Shams University

Thesis
Submitted in partial fulfillment of the
requirements of the degree of
MASTER OF SCIENCE
in
Civil Engineering (Structural)

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STATEMENT

This thesis is submitted to Ain Shams University, Cairo, Egypt, in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering (Structural).

The work included in this thesis was carried out by the author at reinforced concrete lab of the faculty of engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at any other university or institute.

Date : / / 2009

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ABSTRACT

This thesis presents an experimental and analytical investigation on the structural behavior of precast prestressed hollow core RC slabs strengthened in flexure by positive bending CFRP laminates. The strengthening technique; i.e., either externally bonded or near surface mounted (NSM) laminates, the area and mechanical anchorage of CFRP laminates were the main test parameters.

The key test results demonstrated that the NSM technique resulted in optimum strengthening efficiency, including capacity enhancement up to 80% at comparable failure deformations to the control slab. The increased bond strength also resulted in full activation of the NSM laminates at failure. Nonetheless, the NSM flexural strengthening level should be carefully designed to avoid unfavorable shear-tension failure.

On the other hand, moderate efficiency was associated with the externally bonded technique due to the premature de-bonding. However, the latter efficiency was optimized (up to 70% capacity enhancement) by the provision of transverse CFRP anchorage at the laminates' ends and two-thirds of the slabs' spans, which redirected de-bonding further away from the laminates' ends and delayed failure, but at much lower deformations than those of the control slab. Nonetheless, highest post-cracking stiffness was associated to the externally bonded technique. Accordingly, while the NSM technique appears to be favorable in strength and seismic oriented applications, the externally bonded technique appears attractive in serviceability oriented ones.

Finally, a rational analytical study was conducted, where the strain compatibility approach, the ACI 440.2R-08 and the CPCI design manual were used for flexural capacity, CFRP de-bonding and shear capacity predictions, respectively. The analytical deflections were also calculated using the integration of curvature along the span, and incorporating the CFRP tensile and bond characteristics. Comparisons between the experimental and analytical results demonstrated satisfactory agreements.

Keywords: Precast prestressed hollow core RC slabs; Flexural strengthening; CFRP laminates; Near surface mounted (NSM); Externally bonded; Transverse anchorage; Strengthening efficiency; Intermediate crack de-bonding (ICD); Rational analytical model.

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