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Menoufiya University
Faculty of Engineering
Civil Engineering Department

STRENGTHENING OF REINFORCED CONCRETE DEEP BEAMS USING NEAR- SURFACE MOUNTED TECHNIQUE (NSM)

By
Eng. Noha Yehia Gad El-wakkad
B.Sc. Civil Engineering Department,
Faculty of Engineering, Menoufiya University, 2004.

A THESIS
Submitted in Partial Fulfillment for the Requirements of the
Degree of Master of Science in Engineering.
(Structural Engineering-Concrete)

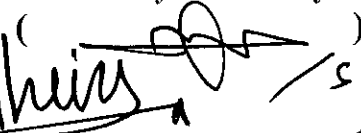
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2008



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Thesis Title:

STRENGTHENING OF REINFORCED CONCRETE DEEP BEAMS USING NEAR- SURFACE MOUNTED TECHNIQUE (NSM)

The work included in this thesis has been carried out by the author in the Department of Civil Engineering, Faculty of Engineering, Menoufiya University.

No part of this thesis has been submitted to any university or institute of the award of a degree or a qualification.

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STRENGTHENING OF REINFORCED CONCRETE DEEP BEAMS USING NEAR- SURFACE MOUNTED TECHNIQUE (NSM)

M.Sc. Thesis in Engineering

**Civil Engineering Department, Faculty of Engineering,
Menoufiya University**

By

Eng. Noha Yehia Gad El-Wakkad

ABSTRACT

Near-surface mounted (NSM) reinforcement techniques using traditional or advanced composite materials such as fiber-reinforced polymer (FRP) bars or strips are being increasingly recognized as a valid alternative to externally bonded laminates for enhancing flexural and shear strength of deficient concrete structures. As this technology emerges, the structural behavior of strengthened reinforced concrete (RC) elements strengthened using NSM technique needs to be fully characterized. In this research, an experimental program consists of testing sixteen RC deep beams (two control deep beams and fourteen strengthened deep beams). Steel bars, steel plates, carbon fiber reinforced polymer CFRP, and glass fiber reinforced polymer GFRP were used for shear strengthening of tested beams using NSM technique. The investigated variables in this study were strengthening material, strengthening pattern, and end anchorage of the rods. Beam models were tested and subjected to incremental loads till failure. Performance of the tested beams and modes of failure were presented and discussed in this research. The test results confirm that NSM technique can be used significantly to increase the shear capacity of RC deep beams, with different efficiency that varies depending on the selected variables.

The experimental program includes also a new approach for producing a well-compacted concrete with good characteristic properties using self-compacting concrete. The main objective of using self-compact concrete (SCC) is to resist segregation without any mechanical vibration however, self-compact concrete (SCC) is compacted under its own weight.

Two different numerical models using finite element method were applied to study the behavior of the tested deep beams. The first method based on 3-D finite elements. Each element is 20 nodes isoparametric brick element with embedded steel bars. The second model based on 2-D isoparametric degenerated layered elements. Each element with 8 nodes and each node with 5 degrees of freedom. Comparisons between experimental and numerical results show a good agreement.

Keywords:- Reinforced concrete deep beams, strengthening, Fiber reinforced polymers, Near surface mounted, Self-compact concrete, Finite element, Material nonlinearities.

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