# EFFECT OF CONFINEMENT WITH LATERAL REINFORCEMENT ON REINFORCED CONCRETE COLUMNS

By
Eng. Mohamad Abdelzaher Mohamed Shanan

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
Structural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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**Title of Thesis:**

Effect of Confinement with Lateral Reinforcement on Reinforced Concrete Columns

**Key Words:**
ANSYS, Strength; Confinement; nonlinear finite element analysis; Nonlinear behavior.

**Summary:**

This study presents the effect of confinement variables on strength and ductility of normal and high strength reinforced concrete columns confined with transverse steel under axial compressive loading. Nineteen normal strength concrete rectangular columns were tested in this research. A set of Twenty high strength concrete columns tested by other researchers were analyzed. The study presents a nonlinear finite element analysis for these specimens using ANSYS15. A parametric numerical study was conducted by ANSYS15 to clarify and evaluate the effect of new values of variables on strength and ductility of the columns. Analytical model for effective concrete strength was developed for normal-strength and high-strength concrete columns.

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# Nomenclature

$A_c$ Area of concrete core of column section.

$A_{ch}$ Cross-sectional area of a column measured out-to-out of confining steel.

$A_g$ Gross area of column section.

$A_s$ Area of longitudinal steel.

$A_{sh}$ Total cross-sectional area of transverse reinforcement within spacing‘s’.

$A_{shx}$ , $A_{shy}$ Total area of lateral steel perpendicular to x and y axes, respectively.

$\sum A_s$ Summation of transverse reinforcement area.

Asp Area of circular hoop

$\sum A_{st}$ Summation of transverse reinforcement area.

$b_c$ Core dimension measured center-to-center of perimeter hoop.

$b_{cx}$, $b_{cy}$ Core dimension measured center-to-center of perimeter hoop.

$d_b$ Bar diameter of transverse reinforcement.

Cx , Cy Widths of concrete core parallel to the x-axis and y-axis, respectively.

D' Diameter of core concrete

d Effective depth of tension reinforcement.

$d_s$ Diameter of spiral reinforcement.

E Modulus of elasticity.

$E_c$ Modulus of Elasticity of plain concrete.

$E_{sec}$ Secant modulus of elasticity of confined concrete.

$f'_c$ Ultimate compressive strength of plain concrete obtained from standard cylinder test.

$f'_{cc}$ Confined concrete compressive strength in member.