FINITE ELEMENT ESTIMATES OF PUNCHING SHEAR STRENGTH

By

Gehad Samir Mohammed Younis

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Structural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

Professor Dr. Adel Yehia Akl

Professor of Structural Engineering
Civil Engineering Department
Faculty of Engineering, Cairo University

Prof. Dr. Osman M.O. Ramadan

Professor of Structural Engineering
Civil Engineering Department
Faculty of Engineering, Cairo University

Dr.Kamal Ghamry Metwally

Ass. Professor of Structural Engineering
Civil Engineering Department
Faculty of Engineering, Beni-Suef University

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Approved by the Examining Committee :

Prof. Dr. Adel Yehia Akl (The main supervisor)
Professor of Structural Engineering - Faculty of Engineering - Cairo University

---

Prof. Dr. Osman M.O. Ramadan (Member)
Professor of Structural Engineering - Faculty of Engineering - Cairo University

---

Prof. Dr. Atef Samy Gendy (Internal examiner)
Professor of Structural Engineering - Faculty of Engineering - Cairo University

---

Prof. Dr. Ahmed Mousaa Abd El-Rahman (External examiner)
Professor of RC structures – Faculty of Engineering at Mataria - Helwan University

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2015

Engineer's Name: Gehad Samir Mohammed Younis
Date of Birth: 19/9/1987
Nationality: Egyptian
E-mail: enginegehad@hotmail.com
Phone: +201003575448
Address: 8 Afify Ramdan st., Qalioub, Qalioubia

Registration Date: 1 / 3 / 2011
Awarding Date: …./.../ 2015
Degree: Master of Science
Department: Structural Engineering

Supervisors:

Prof. Dr. Adel Yehia Akl
Prof. Dr. Osman Mohamed Osman
Dr.Kamal Ghamry Metwally
(Ass. Professor of Structural Engineering, Beni-Suef University)

Examiners:

Porf. Dr. Adel Yehia Akl
Porf. Dr. Osman Mohamed Osman
Prof. Dr. Atef Samy Gendy
Prof. Dr. Ahmed Mousaa Abd El-Rahman (External examiner)
(Professor of RC structures, Faculty of Engineering at Mataria - Helwan University)

Title of Thesis:

Finite Element Estimates of Punching Shear Strength

عنوان الرسالة:

تقدير مقاومة القص الثاقب بطريقة العناصر المحدودة

Key Words:

Flat plate; Reinforced concrete slab-column connections; Punching shear; Shear strength; ANSYS

Summary:

This study employs the finite element (FE) method to investigate the punching shear strength of RC slab-column connections focusing on the effect of moment transfer from slab to column. The objective of the study is to compare the FE results to the two methods adopted by ECP-203: the simplified approach and the detailed one. This comparison is carried out for interior, edge, and corner slab-column connections with various levels of the moment transferred from slab to column. Numerical calculations of the punching shear strength using the FE method are conducted using the ANSYS software.

Acknowledgments

Praise to **ALLAH** Almighty and Peace is upon his Prophet **Muhammad**.

I would like to express my deepest gratitude and appreciation to my supervisor Professor Dr. Adel Yehia Akl for his caring guidance, encouragement, and support.

Deep appreciation and thanks are due to my Professor Dr. Osman M. O. Ramadan for his constant supervision, planning, guidance, valuable suggestions, precise advice and constant encouragement during all stages of this research work.

I would like to thank Dr. Kamal Ghamry for his precious contribution, especially in using software package ANSYS. Without him it would have not been possible to get high accuracy of FEM results.

Finally, I dedicate this study to my dear parents, brother, and sister, for their continuous encouragement and fruitful care.

Dedication

To my dear father, mother, brother, and sister with all my respect and love

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Abstract

This study employs the finite element (FE) method to investigate the punching shear strength of RC slab-column connections focusing on the effect of moment transfer from slab to column. The objective of the study is to compare the FE results to the two methods adopted by ECP-203: the simplified approach and the detailed one. This comparison is carried out for interior, edge, and corner slab-column connections with various levels of the moment transferred from slab to column. Numerical calculations of the punching shear strength using the FE method are conducted using the ANSYS 14.0 software.

In the first part of the thesis, results of the detailed method of ECP-203 are compared with those of the simplified method adopted by the same code. Using these results, values of the factor β that if used with the simplified method would yield same results as the detailed method are estimated. Besides, the effect of the design variables like column size to slab thickness ratio, concrete strength, transfer moment, and column location (interior, edge, or corner) on the value of factor β are investigated. Thus, possible modification to the factor β is proposed for interior, edge, and corner slab-column connections.

Then, three-dimensional, nonlinear FE analyses of interior, edge, and corner slab-column connections subjected to general load configurations in which both vertical loads and moments are transferred from slab to column are conducted. The FE analyses considered the same design variables that were studied in the first part of the thesis and found to affect the punching shear strength of various slab-column connections. Besides, the FE results are used to describe the punching shear performance of slab-column connections and their modes of failure. Moreover, the punching shear strength, load-deflection relationship, and crack patterns predicted by the FE method are compared to their corresponding experimental results published by others. This comparison verified the accuracy and effectiveness of the adopted FE model in predicting the punching shear strength and performance of slab-column connections. Finally, the FE results are compared with the predictions of frequently applied design codes (ACI 318-05, ECP 203-07, CEBFIP MC 90 & BS 8110-97).