Faculty of Engineering
Structural Engineering Department

STRENGTHENING OF FLAT SLABS IN PUNCHING SHEAR USING STEEL SHEAR BOLTS

A Thesis
Submitted in Partial Fulfillment of the
Requirements for the Degree of Doctor of philosophy
in
structural engineering

Prepared by

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STATEMENT

This dissertation is submitted to Ain Shams University, Faculty of Engineering for the degree of Ph.D. in Structural Engineering.

The work included in this thesis was carried out by the author in the department of Structure Engineering, Faculty of Engineering, Ain Shams University, from August 2015 to August 2018.

No part of the thesis has been submitted for a degree or a qualification at any other University or Institution.

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others

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DEDICATION

I wish to dedicate this work to who suffered to educate, support and encourage me during the thesis work

To my Parents,

My Brothers, my Wife &my Lovely kids

For the encouragement and support to complete this work.

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ABSTRACT

The objective of this study is to enhance the punching shear strength of flat slabs at interior column. For this purpose, an economical and easy to install strengthening method was applied to ½ scale flat slabs specimens. The proposed strengthening scheme employs the use of fabricated steel shear bolts placed around the column in different spacing and arrangements as vertical punching shear reinforcement. In addition, the effect of column aspect ratio on strengthening method was also investigated in the scope of this study. Strength increase of at least 30% was obtained for the strengthened specimens compared to the companion reference specimen. Three dimensional nonlinear finite element model was generated using ANSYS program to investigate the punching shear failure mechanism of test specimens. 3-D finite element models are successful in providing reasonable estimates of ultimate punching load capacity, load-deformation behavior and strains. Extended parametric study with new parameters was generated including new parameters. The effect of compressive strength, spacing between shear bolts, and column aspect ratio were investigated. A proposed guidelines and a design equation were generated from the parametric study results using regression analysis. The experimental punching load capacities of the specimens were compared with the estimations punching shear load given by ACI 318-14, Eurocode-2, and ECP203-2017.

Keywords: Punching Shear, Flat Slabs, Punching Shear RFT., Shear Bolts, Slab-Column Connections, Strengthening and Ductility, ANSYS, Finite Element Method.

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