Republic of Iraq
Ministry of Higher Education
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University of Technology
Building and Construction Department
Structural Engineering Branch

Nonlinear Finite Element Analysis for Punching Shear Resistance of Steel Fibers High Strength Reinforced Concrete Slabs

A Thesis
Submitted to the Department of Building and Construction of the University of Technology in Partial Fulfillment of the Requirements for the Degree of Master of Science in Structural Engineering

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ABSTRACT

This study is devoted to investigate the punching shear resistance of high strength reinforced concrete slabs with steel fibers by using (P3DNFEA) a non-linear finite element program for three-dimensional analysis of reinforced concrete structure. The 20-node isoparametric brick element has been used to model the concrete, while reinforcing steel bars are modeled as axial members embedded within the brick element. Perfect bond was assumed to occur between the concrete and the reinforcing bars.

The compressive behavior of the steel fiber reinforced concrete is simulated by an elastic-plastic work hardening model followed by a perfect plastic response, which is terminated at the beginning of crushing. A fixed smeared crack model has been used to simulate the behavior of concrete in tension with a tension-stiffening model to represent the retained post-cracking tensile stresses. The degradation of the shear strength of concrete due to cracking is accounted for by employing a shear-retention model.

The nonlinear equations of equilibrium have been solved using an incremental-iterative technique operating under load control. The solution algorithm used was the modified Newton-Raphson method. The numerical integration has been conducted by using the 27-point Gaussian type rule.

Nine high strength reinforced concrete slabs with steel fibers and one without steel fibers, have been analyzed in the present study. The slabs was tested experimentally by Abdulhameed [7] in 2006, at the College of Engineering -University of Salahaddin. The finite element solutions are compared with the available experimental data. In general, accepted agreement between the numerical results and the experimental results has been obtained.

Parametric studies have been carried out to investigate the effect of concrete compressive strength, steel fiber content, amount of steel rebars, slab depth and column dimensions on the behavior and ultimate strength of reinforced
concrete slabs.

The numerical analysis indicated that the increase in the concrete compressive strength (f'_c) from 40 to 80 MPa has led to an increase in the strength by 69% and 84% for slabs without and with 0.5% steel fibers, respectively.

The numerical analysis indicated that by using 2.0% steel fibers, the ultimate capacity is increased by 81.7%, compared to a slab without fibers.

Also, the finite element solution revealed that increasing the longitudinal reinforcement ratio in the slab from 1 to 2% led to an increase in the ultimate shear strength of about 57%.

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من قبل:

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