Prediction of punching shear strength of two-way slabs

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\textbf{A B S T R A C T}

The punching shear strength of two way slabs without shear reinforcement and without unbalanced moment transfer is estimated using both neural networks and new simplified punching shear equations. An artificial neural network (ANN) was used to predict the punching shear strength of internal slab–column connections. Neural network analysis is conducted using 244 test data available in the literature and experiments conducted by the authors to evaluate the influence of concrete strength, reinforcement ratio and slab effective depth on punching shear strength. A wide range of slab thicknesses (up to 500 mm) and reinforcement ratios were used. In general, the results obtained from the neural network are very close to the experimental data available. The test results were used to develop two new simplified practical punching shear equations. The equations also showed a very good match with available experimental data. Four equations for the punching shear strength prescribed in well-known specifications were evaluated based on the available experimental results. This paper includes a discussion of the parameters of punching shear strength in the American, Canadian, British and European specifications.

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\section{1. Introduction}

The punching shear equations in the current building codes are empirical in nature. These equations are based on the statistical fitting of test results available at the time of developing these equations. Several equations have been proposed to predict the punching shear capacity of concrete slabs. The two equations that are used in North America are the ACI 318-08 [1] and CSA-A23.3-04 [2] equations. In Europe, the BS 8110-97 [3], CEB-FIP-90 [4] and Euro-code 2 (2004) [5] are among the most common codes. North American and European equations differ with regards to the calculation of shear strength and the ways that the shear strength is converted into a loading capacity.

The main objectives of the present study are to use test results available in the open literature to introduce reliable and accurate practical methods for punching shear calculations for both thin and thick slabs. Two methods for fitting the experimental results are used: a neural network fit and regression analysis. A neural network is used to find the best fit for test results of 244 slabs available in the literature. The neural network predictions were very close to the test results and provided a very good tool for punching shear calculations. The neural network was trained using a 60\% of the available testing data. Very accurate estimates were obtained for the punching shear load. A number of parameters were easily accounted for the neural network.

Regression analysis was used to obtain explicit equations for the shear punching load. The proposed equations gave excellent estimates for the shear punching load. The database used included test results for a wide range of slab thicknesses and reinforcement ratios. Both neural networks and the proposed equations provide the designer with a reliable tool to for estimating punching shear strength of two way concrete slabs. The tool is based on the use of large number of data sets, which provide a wider application. The work done before was based on thin slabs and was applied for both thin and thick slabs. Publications on the use of neural networks in predicting shear strength are very few. The data which was available to train the network included a limited range of slab thicknesses (35–120 mm). By considering the available up to date experimental data, the estimation of the punching shear is improved and can be applied to slab thicknesses up to 500 mm.