International Journal of Engineering

Journal Homepage: www.ije.ir

# Estimation of Punching Shear Capacity of Concrete Slabs Using Data Mining Techniques

Y. Aggarwal, P. Aggarwal*, P. Sihag, M. Pal, A. Kumar

*Department of Civil Engineering, National Institute of Technology, Kurukshetra, Haryana, India*

*P A P E R I N F O*

*Paper history:*
Received 02 August 2018
Received in revised form 26 March 2019
Accepted 03 May 2019

*Keywords:*
*Adaptive Neuro-fuzzy Inference System*
*Artificial Neural Network*
*Coefficient of Correlation*
*Generalized Neural Network*
*Punching Load*

*A B S T R A C T*

Punching shear capacity is a key factor for governing the collapsed form of slabs. This fragile failure that occurs at the slab-column connection is called punching shear failure and has been of concern for the engineers. The most common practice in evaluating the punching strength of the concrete slabs is to use the empirical expressions available in different building design codes. The estimation of punching loads involves experimental setup which is time-consuming, uneconomical and also, more manpower and materials are required. The present study demonstrates the use of data mining techniques as a substitute of former to predict the punching loads on the variation of various parameters. In this study, various type of data mining techniques including Adaptive Neuro-fuzzy Inference System (ANFIS), Artificial Neural Network (ANN) and Generalized Neural Network (GRNN) were applied to model and estimate the punching load of reinforced concrete slab–column connections. For the study, a data set consisting of 89 observations from available literature was analysed and randomly selected 62 observations were used for model development whereas the rest 27 were used to test the developed models. While the outcomes of ANN and GRNN model provides suitable estimation performance, the Gaussian membership based ANFIS model performed best in the determination of coefficient of correlation ($C_c$). Sensitivity study indicates that the parameter effective depth of slab (d) is the most influencing one for the estimation of punching load of reinforced concrete slab–column connections for this data set.

***doi**: 10.5829/ije.2019.32.07a.02*

## 1. INTRODUCTION

Punching shear capacity is an important factor for governing the collapsed form of slabs. In the link of slab-column, high shear stresses are the main reason for punching shear failure. The failure mode of punching is fragile in nature and diagonal cracks chase the surface of a truncated cone around the column. The failure that occurs at the connection between the slab and the column, called punching shear failure has been of concern for the designers and engineers [1, 2]. The most common practice in evaluating the punching strength of the concrete slabs is to use the empirical expressions available in different building design codes for calculating punching loads. The empirical expressions given in design codes are based on experimental results on specimens of a column and a portion of the slab [3]. The estimation of punching loads involves experimental setup which is time-consuming and also, a lot of labor and materials are required. The experimental part is also not economical and can be easily substituted by using data mining techniques to predict the punching loads on the variation of various parameters. Some of the parameters influencing the punching strength of slabs are: the cylinder strength of concrete ($f_c$), yield strength of steel ($f_y$), effective depth of slab (d), radius of a column or loaded area ($r_o$) and geometrical ratio of reinforcement ($\rho$) can be considered for the development of the model. The present treatments of codes of practices (e.g. ACI [4], BS8110 [5]) for the problem of punching shear in reinforced concrete slabs consist mainly of empirical formulations derived from tests on specimens of a column and a portion of slab within the elastic line of contra flexure. Existing theoretical approaches by

*Corresponding Author Email: *paratibha@rediffmail.com* (P. Aggarwal)

Please cite this article as: Y. Aggarwal, P. Aggarwal, P. Sihag, M. Pal, A. Kumar, Estimation of Punching Shear Capacity of Concrete Slabs Using Data Mining Techniques, International Journal of Engineering (IJE), IJE TRANSACTIONS A: Basics Vol. 32, No. 7, (July 2019) 908-914