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رسالة الماجستير

العنوان: احتساب مقاومة الالتواء القصوى للعتبات الخرسانية المسلحة باستخدام الشبكات العصبية الصناعية

Prediction of Ultimate Torsional Strength of Reinforced Concrete Beams Using Artificial Neural Networks

**Supervisor: Prof. Dr. Nabeel Abdulrazzaq Jasim**

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**Abstract**

This study investigates the feasibility of using artificial neural network (ANN) to predict the ultimate strength of reinforced concrete rectangular beams subjected to pure torsion and to combination of torsion and bending. The fundamental and practical aspects of artificial neural networks are demonstrated and a view of their structures, topology and strengths are presented. The effects of the parameters, such as the number of nodes in the input layer, output layer and hidden layer, the pre-process (normalization) of the training patterns, the weight-factors initialization and the selection of the learning rate and momentum coefficient, on the behavior of the neural network have been investigated. Due to slower convergence of the gradient descent (GD) backpropagation algorithm, the faster algorithm called "resilient propagation algorithm"(RPROP) has been used to improve the performance of the neural network. After training, the generalization of the neural network was tested by patterns not included in the training patterns. Two structures of networks are worked out as follows:

1. The configuration 10:25:25:1 is used to predict the ultimate strength of reinforced concrete beams under pure torsion.
2. The configuration 11:8:1 is used to predict the ultimate strength of reinforced concrete beams under combined torsion and bending.

The neural network model was trained based on experimental results of other researches. It is found that normalizing the input and target values of training patterns reduces the training time. Gaussian weight-factor distribution with range (±1) is found to give a minimum mean square error (MSE). In addition, for gradient descent (GD) algorithm the effective values for learning rate and momentum coefficient are (0.5) and (0.8) respectively. Based on the ANN results, a parametric analysis was carried out to study the influence of parameters affecting the ultimate torsional strength of reinforced concrete beams and these results are compared with equations of ACI-318-89&05 Code.

أطروحة الدكتوراه

العنوان: تصرف الاعمدة الخرسانية القصيرة المقواة بالفيروسمنت

Behavior of Short Concrete Columns Strengthened with Ferrocement

**Supervisor: Prof. Dr. Nabeel Abdulrazzaq Jasim**

**Abstract**

One of the major requirements for strengthening or upgrading existing reinforced concrete structures is to increase their column capacities to withstand larger expected loads. There are different techniques to increase existing column capacities; however, such techniques differ in their advantages and disadvantages.

The main objective of the present study is to investigate the efficiency of confining plain concrete column with ferrocement jacket.

The study consists of two parts, experimental and theoretical. The main purpose of the experimental program was to investigate the structural behavior of concrete column strengthened with ferrocement jackets under monotonic and cyclic compression loading conditions. The experimental phase of this investigation consists of 48 short concrete columns. The main variables considered in this study were the volume fraction (number of wire mesh layers), the mortar compressive strength, column size, and column loading type. It was found that the ferrocement jacket provided sufficient lateral support to the concrete core and significantly increases both the strength and ductility of the specimens under axial loading. The ratio of strength of concrete column strengthened with ferrocement jacket to strength of plain concrete column ranged between 1.132 and 2.291 for columns with 35 MPa mortar compressive strength, whereas it was between 1.364 and 2.34 for columns strengthened with 45 MPa. Also, the validity of an envelope curve to describe cyclic behavior is discussed.

In the second part of the study, the tested columns are analyzed using nonlinear three-dimensional finite element models. ANSYS (11.0) program is used to analyze the three-dimensional model. Concrete core and ferrocement shell are modeled by using the 8-noded isoparametric brick elements (SOLID 65), while the loading steel plate as isoparametric brick elements (SOLID 45) with 8- nodes. Reinforcement in the ferrocement shell is assumed to be smeared throughout the concrete element. Perfect bond between concrete core and ferrocement shell is assumed. The adopted finite element models are found to give results in a good agreement with the test results. It is found that the ratios of experimental to theoretical values of ultimate loads are between 0.88 to 1.094 with average of 0.983 for strengthened concrete columns with ferrocement jackets.

Several parametric studies have been carried out to investigate the effect of some important parameters on the predicted finite element results. The effects of concrete compressive strength, modulus of elasticity of ferrocement shell and applied load on ferrocement shell have been investigated.

The research also proposed new models for stress-strain relationship of concrete column strengthened with ferrocement jacket under monotonic load and for envelope curve, unloading and reloading.