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EXPERIMENTAL STUDY OF COMPRESSIVE STRENGTH OF CFST USING ANN

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Abstract: It is crucial to study the axial compression behaviour of concrete-filled steel tubular (CFST) columns to ensure the safe operation of engineering structures. The restriction between steel tubular and core concrete in CFST is complex and the relationship between geometric and material properties and axial compression behaviour is highly nonlinear. These challenges have prompted the use of soft computing methods to predict the ultimate bearing capacity (Nu) under axial compression. This study presents a new approach to simulate the capacity of circular CFST columns under axial loading condition, using a large database of experimental results by applying artificial neural network (ANN). A well trained ANN is established and is used to simulate the axial capacity of CFST columns. The validation and testing of the ANN is carried out. The current study can be used to propose a simplified equation that can predict the ultimate strength of the axially loaded columns with high level of accuracy. The result indicate ANN predict strength of CFST within short time and cost too.

Keywords: ANN, CFST, Concrete Axially Loaded Column, Artificial Neural Network, Concrete Filled Steel Tube.

I.INTRODUCTION

Optimized use of materials is of great importance especially in structural performance. Concrete and steel are widely used in construction. If both materials are used in a way that improves the performance together, designed structure could provide appropriate behaviour versus applied loads. So, the structural member can absorb considerable energy and dissipate it efficiently. The appropriate combination of these two materials obtains a better performance than using them separately. Nowadays, Among composite columns, CFST has a better application and performance compared to other types of composite columns. In these columns, steel tube is located in the periphery of the cross section and causes a significant increase in compressive strength of concrete. Concrete prevents premature buckling of steel tube and delays it. Unfortunately, interaction influences between concrete and steel is not well known and current design specifications cannot explain this interaction well. In recent decades, many experimental and theoretical studies carried out on circular concrete filled steel tube and some models have been presented, but these models are not capable of predicting the behaviour of these columns under loading condition with a good degree of precision. [3-7] The advances in the field of artificial intelligence keep having strong influence over the civil engineering area. Mass experimental data have been produced by previous studies, that provide a data basis for mathematical modelling to estimate the ultimate axial capacity of CFST column. Yu et al. developed a simplified statistical method based on 663 tests to predict the ultimate strength of circular CFST columns under concentric load. The confinement effect on the concrete and the influence of relative slenderness were taken into account. Other simplified calculation methods have also been proposed. For example, a simple method using an equivalent slenderness ratio was suggested by Zheng et al.To calculate the load-bearing capacity of CFST laced columns. None of the above-proposed method shave been extensively used due to the limitations of application scope. It is imperative to develop a general and precise method for calculating the ultimate axial capacity

New methods and artificial intelligence are emerging that enable civil engineers to use computing in different ways. Nowadays, the artificial intelligence applied to different fields such as prediction compressive strength of concrete, damage detection in skeletal structures, regional transportation corridors hazardous zones identification, prediction of ultimate strength of reinforced concrete beams FRP strengthened in shear, and shape optimization of arch dams. Using artificial neural network (ANN) can present a new method that advance the accuracy and influence compressive strength of the confined concrete on capacity of concrete filled steel tube columns. Hence, the aim of this paper is to try using the results of extensive experimental data and the use of neural networks algorithm, an appropriate network is created and using this network some equations were derived which could be used in the absence of the ANN model.

II.ARTIFICIAL NEURAL NETWORK (ANN): In its simplest form, an artificial neural network (ANN) is an imitation of the human brain. A natural brain has the ability to learn new things, adapt to new and changing environment. Artificial Neural Network (ANN) is a technique that uses existing experimental data to predict the behaviour of the same material under different testing conditions. In the present work, the prediction of the load carrying capacities for axially cyclic loaded circular composite tubes is evaluated using ANN. To test the validity of using ANN in determining the crushing behaviour of these tubes, the study will compare the predictions obtained to the experimental results using the neural network.

ANN have emerged as a useful concept from the field of artificial intelligence, and has been used successfully over the past decade in modelling engineering problems in general, and specifically those relating to the mechanism behaviour of composite material.

2.1 BRAIN AND ANN NEURON

Brain is made of cells called neurons. Interconnection of such cells (neurons) makes up the neural network or the brain. There are about 1011 neurons in the human brain and about 10000 connections with each other. ANN is an imitation of the natural neural network where the artificial neurons are connected in a similar fashion as the brain network. A biological neuron is made up of cell body, axon and dendrite. Dendrite receives electro-chemical signals from other neurons into the cell body. Cell body, called Soma contains nucleus and other chemical structures required to support the cell. Axon carries the signal from the neuron to other neurons. Connection between dendrites of two neurons, or neuron to muscle cells is called synapse.

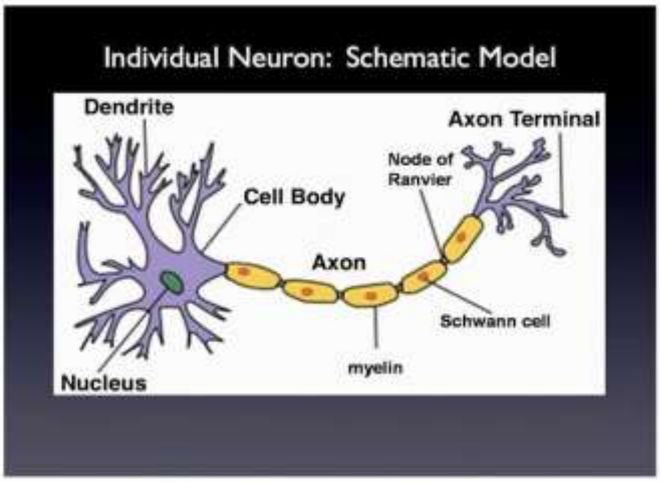

Fig. Human Brain Neuron Network

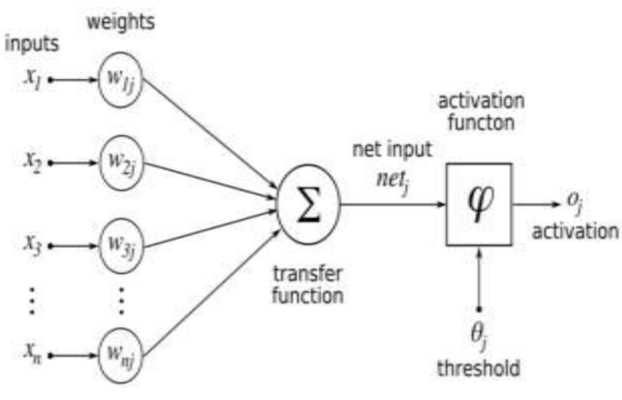

Fig.ANN

III.EXPERIMENTAL WORK AND INPUT

The experimental work includes casting of different square and cylindrical steel CFST specimen in laboratory. Shape of specimen as per suitability of work used but cylindrical specimen have more sustainability than square shape specimen. Different diameters of cylindrical specimen used and same for square specimen have various sizes. As per decided grades M20, M30, M35 CFST tube were casted for 28 days. For curing gunny bags were used on both side of CFST.after 28 days strength were checked for axial loading in UTM and all test specimen CFST related basic terms are used as a input for ANN modelling. This are as follows:

1)Number of test specimens
2) Outer diameter of cylindrical hallow barsD (mm)
3) Thickness of bars t (mm)
4) Length of cylindrical bar section L (mm)
5) Compressive strength of concrete fc' (MPa)
6) yield stress of steel tube fy (MPa)
7)Pu experimental (KN) etc.

IV.CONSTRUCTION OF ANN MODEL

The number of input neurons is determined from the variables that influence concrete strength because there are too many variables. In present problem only three input parameters namely Workability, setting time of concrete and actual tested compressive strength (N/mm2) are considered. MATLAB is a mathematical computing software having ANN toolbox which has inbuilt ANN architectures, learning, training functions. MATLAB is widely accepted because of its matrix/vector notations and graphics, and has a convenient environment to experiment with ANN. A MATLAB programming has been done using inbuilt functions to develop a Feed Forward Neural Network model with error back propagation learning rule. The parameters that play an important role in training and testing of ANN using MATLAB are:

(i) Network Type
(ii) Number of layers
(iii) Number of neurons.
(iv) Input Ranges.
(v) Transfer function.
(vi) Adaptation learning rule.
(vii) Training Function.
(viii) Performance function

One of the main steps for effective design of the ANN is the large, well patterned and varied data. Not only the collection of data in proper ANN is required but it is to be properly presented to the ANN for Training, Validation and Testing purpose.

A methodology for compressive strength neural identification is developed. It is shown schematically in Figure . Experimental results, forming a set of data on concrete, used for training and testing the neural network are an integral part of upper block1. The experimental results as a set of patterns were saved in a computer file which was then used as the input data for the network in block 2 middle layer of three blocks. The data were divided into data for training and testing the neural network. If the neural network correctly mapped the training data and correctly identified the testing data, it was considered trained. The obtained results were analyzed in block 3 i.e. lower block whose output was identified. The training patterns were randomly given into the network as following:

(1) 70% of total data for training of the neural network
(2) 15% of total data for validation of the neural network
(3) 15% of total data for testing of the neural network,

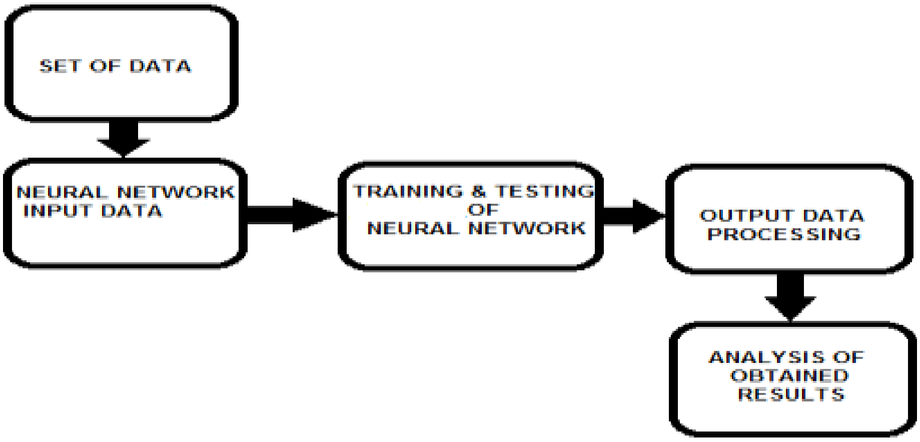

Fig. .Block diagram for the ANN development

V.PROCEDURE

1) Make a excel sheet all input and target parameters
2) By using MATLAB software predicts compressive strength of CFST, in workspace of MATLAB create input function ,add all input from excel into this input function.
3) After that make target function add target value from excel sheet.
4) In command editor of MATLAB type nntools and enter.
5) This gives predicted value.

VI.CONCLUSION

The ANN model was developed for predicting the concrete strength development. The conclusions were as follows:
1. ANN model predicts better than experimental method within the cylinder and square test data referred in this study. It could also deal with sufficient factors to influence the concrete strength development.
2. Modular neural networks are more suitable for predicting the concrete strength.
3.By using ANN and various input parameter like yield strength of steel tube, compressive strength of concrete, diameter and height of steel column, a network for strength prediction of circular and square section was proposed.[3].

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