Strength Analysis of Hypo Sludge Concrete By Using Artificial Neural Networks

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Abstract- *The Artificial neural networks (ANN) approaches, a sub-field of intelligent systems, are being widely used to solve a wide variety of problems in civil engineering applications. The artificial neural networks solve very complex problems with the help of interconnected computing elements. Basically, the processing elements of a neural network are similar to the neurons in the brain. ANN can be defined as a data processing system consisting of a large number of simple, highly inter-connected processing elements (artificial neurons) arranged in three different layers: input layer, hidden layers and output layer.Using this program, a neural network model with one hidden layer is constructed, trained and tested using the available test data. The data used in ANN model are arranged in a format of eight input parameters that covers the cement, F.A, C.A, water, super plasticizer, steel fiber, water-cement ratio and aspect ratio. The proposed ANN model predicts the 28 day compressive strength, flexural strength and elastic modulus.*

Keywords- Concrete Compressive Strength, Artificial Neural Networks (ANN), Modelling

I. INTRODUCTION

Artificial neural network are nonlinear information (signal) processing devices, which are built from interconnected elementary processing devices called neurons. An artificial neural network (ANN) is an information processing paradigm that is inspired by the way biological nervous system such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in union to solve specific problems. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process.Learning is biological systems involves adjustments to the synaptic connection that exist between the neurons. ANN's are a type of artificial intelligence that attempts to imitate the way a human brain works. Rather than using a digital model, in which all computations manipulate zeros and ones, a neural networks by creating connection between processing elements, the computer equivalent of neurons. The organization and weights of the connections determine the output.

II. LITERATURE REVIEW

Palika Chopra et al (2015) , An effort has been made to develop concrete compressive strength prediction models with the help of two emerging data mining techniques, namely, Artificial Neural Networks (ANNs) and Genetic Programming (GP). The data for analysis and model development was collected at 28-, 56-, and 91-day curing periods through experiments conducted in the laboratory under standard controlled conditions. The developed models have also been tested on in situ concrete data taken from literature. A comparison of the prediction results obtained using both the models is presented and it can be inferred that the ANN model with the training function Levenberg-Marquardt (LM) for the prediction of concrete compressive strength is the best prediction tool.

Vidivelli et al (2013), This paper presents artificial neural network (ANN) based model to predict the compressive strength of concrete containing Industrial Byproducts at the age of 28, 56, 90 and 120 days. A total of 71 specimens were casted with twelve different concrete mix proportions. The experimental results are training data to construct the artificial neural network model. The data used in the multilayer feed forward neural network models are arranged in a format of ten input parameters that cover the age of specimen, cement, Fly ash, Silica fume, Metakaolin, bottom ash, sand, Coarse aggregate, water and Superplasticizer. According to these parameter in the neural network models are predicted the compressive strength values of concrete containing Industrial Byproducts. This study leads to the conclusion that the artificial neural network (ANN) performed well to predict the compressive strength of high performance concrete for various curing period.

III. EXPERIMENTAL PROGRAM

TRAIN AND TEST DATA

Training consists of exposing the neural network to a set of known input-output patterns. The data are passed through the multi layered feed forward neural network in a forward direction only. As the data moves forward, it is subjected to simple processing within the neurons and along the links connecting neurons. The network performs successive iteration to adjust the weights of each neuron in order to obtain the target outputs according to a specific level of accuracy.The adjusting process of neuron weights is carried out to minimize, to a certain level the network error which is defined as a measure of the difference between the computed and target output pattern. After the NN is satisfactorily trained and tested, it is able to generalize rules and will be able to deal with input data to predict output within domain covered by the training pattern.

ANN TRAINING

In this work data are extracted from experimental tests gathered from literature. To train the ANN models, first the entire training data file is randomly divided into training and testing data sets.These data sets are used to train the different network architecture and they are used for testing to verify the prediction ability of each trained ANN model. Different training function available in MATLAB is experimented for the current application. The scaled conjugate gradient techniques built in MATLAB proved to be efficient training functions, and therefore, is used to construct the NN model. The network architecture or topology is obtained by identifying the number of hidden layers and the number of neurons in each hidden layers. There is no specific rue to determine the number of hidden layers and the number of neurons in each hidden layers. The network learns by comparing the output for each pattern with the target output for that pattern, then calculating the error and propagating an error function background through the neural network. To use the trained neural network, new values for the input parameters are presented to the network. The network then calculates the neurons output using the existing weight values developed in the training process.

VALIDATION PERFORMANCE

After testing and training level give the validation performance for input and output parameters. The multilayer feed forward back propagation technique is implemented to develop and train the neural network of the current study where the sigmoid transform functions are adopted. The validation performs should show on given graph plotation. The term ANN prediction is referred for ANN response for cases that are not used in the pre training stages. This is used in order to examine the ANN's ability to associate and generalize a true physical response that has not been previously seen.A good prediction for these cases is the ultimate verification test for the ANN models. These test have to be the applied for input and output response within the domain of training. It should expect that ANN would produce poor result for data that are outside the training domain. Preprocessing of data scaling is carried out to improve the training of the neural network.

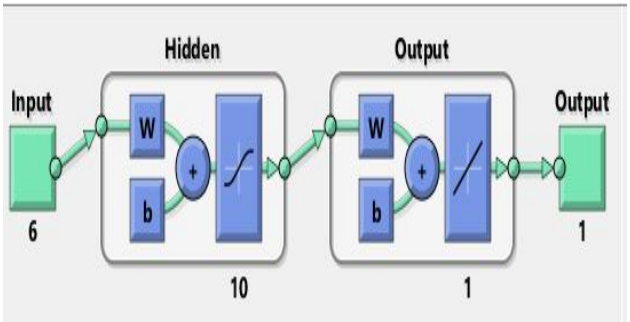

Fig. 1 ANN Setup

IV. RESULT AND DISCUSSION

Table 1 Comparison of Experimental and ANN Results forCompressive strength

S. NO	TYPE	Experimental RESULTS (N/mm²)	ANN RESULTS (N/mm²)	% ERROR
1	Conventional concrete	26.60	26.60	0.000
2	10% replacement of hypo sludge as F.A	26.49	26.49	0.000
3	20% replacement of hypo sludge as F.A	27.65	27.65	0.000
4	30% replacement of hypo sludge as F.A	19.05	31.13	12.087
5	40% replacement of hypo sludge as F.A	16.53	28.91	12.385

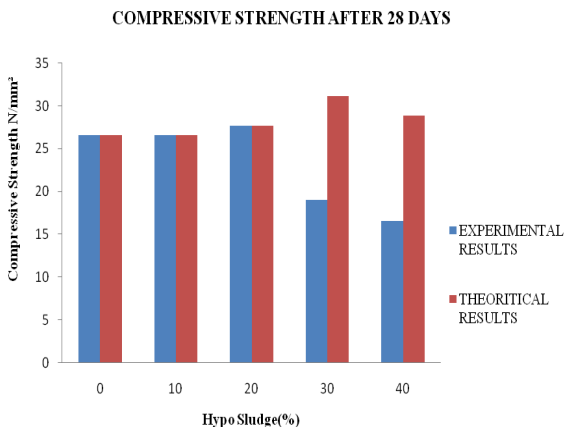

Fig.2. comparison of Experimental and ANN Results

Table 2 Comparison of Experimental and ANN Results forFlexural strength

S.NO	Description	Experimental Results (N/mm²)	ANN Result (N/mm²)	% Error
1	Conventional concrete	3.14	3.14	0.000
2	10% replacement of hypo sludge as F.A	3.25	3.12	0.127
3	20% replacement of hypo sludge as F.A	3.37	3.37	0.000
4	30% replacement of hypo sludge as F.A	2.5	2.50	0.000
5	40% replacement of hypo sludge as F.A	1.96	1.93	0.021

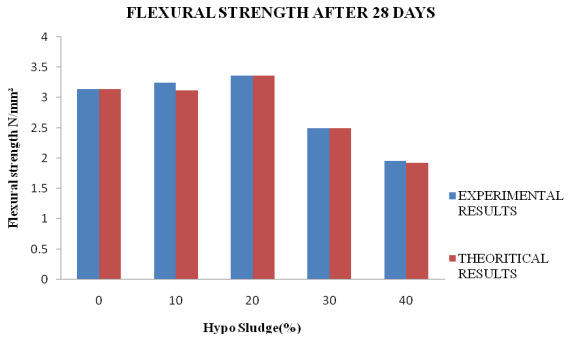

Fig.3 comparison of Experimental and ANN Results

Table 3 Comparison of Experimental and ANN Results forModulus of elasticity strength after 28 days

S.NO	Description	Experimental Results (N/mm²)	ANN Result (N/mm²)	% Error
1	Conventional concrete	2.23	2.35	-0.122
2	10% replacement of hypo sludge as F.A	2.34	2.42	-0.082
3	20% replacement of hypo sludge as F.A	2.45	2.44	0.002
4	30% replacement of hypo sludge as F.A	2.10	2.09	0.002
5	40% replacement of hypo sludge as F.A	2.00	1.99	0.002

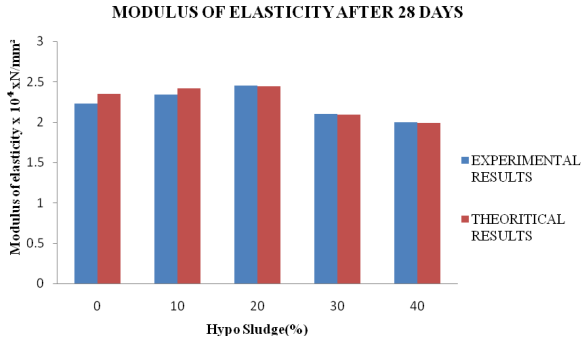

Fig 4 comparison of Experimental and ANN Results

V. CONCLUSION

- The physical properties of specific gravity of hypo sludge is 15% lower than the fine aggregate.
- The workability of fresh concrete is measured in terms of slump, the overall workability of hypo sludge concrete is less compared to conventional concrete.
- The various replacement of hypo sludge concrete, the optimum strength is obtained at 20% replacement of hypo sludge as fine aggregate.
- The Compressive strength of concrete by partial replacement of hypo sludge as fine aggregate with different curing periods which are 7,14,28 days. The strength of the hypo sludge is 3.9% more than the conventional concrete.
- The 30%, 40% replacement is start decreasing in strength.
- In the flexural strength of the hypo sludge concrete is 7.3% higher when compared to the conventional concrete at 20% replacement.

- Similarly the elastic modulus for hypo sludge concrete is 9.6% higher than the conventional concrete.

VI. ACKNOWLEDGEMENT

We are thankful to Mr. T. Manikandan, Mr. P. Bharath, Assistant Professors in Department of Civil Engineering, SRVEC and Ms. R.Rashmiya, Lecturer in Department of Civil Engineering, Sembodai Rukmani Varatharajan Engineering College, Ms. G. Sountharya, PG Scholar in Department of Structural Engineering, Sembodai Rukmanivaratharajan Engineering College to support our research works.

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