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Strength of Concrete with Different Aggregates Through ANN : A Review

Rahul Bhargava[1], Nadish Pandey[2], Rajesh Joshi[3]
[1]P. G. Scholar, Department of Civil Engineering, RGPM, Bhopal, Madhya Pradesh, India
[2]Assistant Professor, Technocrats Institute of Technology, Excellence, Madhya Pradesh, India
[3]Head of Department, Rajiv Gandhi Proudyogiki Mahavidyalaya Bhopal, Madhya Pradesh, India

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ABSTRACT

Concrete is a fusion of cement, coarse aggregate, fine aggregates and water. Its success lies in its adaptability as can be designed to resist cruel environments although taking on the most inspirational forms. Scientists and Engineers are further aiming to enhance its limits with the help of novel admixtures and various waste alternate materials (WAMs).

Previously WAMs comprises of readily available materials, natural like diatomaceous earth or volcanic ash. The engineering marvels like Roman aqueducts, the Coliseum are examples of this practice used by Romans and Greeks. Currently, the majority concrete mixture consists ACMs which are mainly by-product or waste materials from other industrial processes.

From the perspective of economy in cement requirement for given w/c ratio rounded aggregates are more preferred than angular aggregates. Flat particles in concrete are having unpleasant effect over the workability of concrete, cement requirement, strength and durability. In common high content of flaky aggregates formed low quality concrete.

In th paper we are preenting review of literature related to our study on concrete utilizing ANN technique.

Keywords: Concrete, ANN, network, strength, review, analysis.

I. INTRODUCTION

In recent times, strict environmental – pollution controls and guidelines have brought into being an enhancement in the industrialized wastes and sub graded derivative which may be utilized as WAMs such as silica fume, fly ash, ground granulated blast furnace slag (GGBFC) etc. The utilization of WAMs in concrete constructions not only avoids these materials to check the pollution but also to improve the characteristics of concrete in hydrated and fresh states.

The WAMs can be separated in two classes based on their reaction type: hydraulic and pozzolanic. Hydraulic materials react thoroughly with water to make cementations compound like GGBS. Pozzolanic materials not having any cementations property but

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when utilized with lime or cement react with calcium hydroxide to make products acquiring cementations properties.

MARBLE POWDER AS WAMs

The development of concrete technology can decrease the use of natural resources and energy sources and lowers the load of pollutants on atmosphere. Currently huge amount of marble dust is produced in natural stone processing plants with a significant impact on environment and human beings. In building industry, Marble has been frequently used for different purposes like cladding, flooring, etc. The industrial removal of the marble powder material is in the form of a fine powder and constitutes as one of the atmospherically problems in the world. In India, marble dust is settled by sedimentation and then dumped away, results in environmental pollution. In addition to form dust in summer, threats both public health and agriculture. Therefore, consumption of the marble dust in various forms especially in construction, agriculture, paper and glass industries helps to protect the surroundings. Some measures have been taken to assess the chances of using waste marble powder in concrete and mortars and results of strength and workability were evaluated with control samples of traditional cement concrete. Some measures have been taken to assess the chances of using waste marble powder in concrete and mortars and results of strength and workability were evaluated with control samples of traditional cement concrete.

II. LITERATURE REVIEW

W. O, Ajagbe et al (2018) The research paper presented comprehensive data on the compressive strength of concrete made from aggregates obtained from different sources in Ibadan, Nigeria. Experiments were performed on 12 mixtures made up of fine aggregate from four sources and coarse aggregate from three different sources. The study utilized cement of the same strength (42.5R), the coarse aggregate of the same size (10mm), the same water/cement ratio (0.6), and concrete mix (1:2:4) in order to determine the influence of aggregate source on concrete strength.

Results revealed that only five mixtures had above the minimum cube compressive strength of 25N/mm2 recommended for the construction of the reinforced load-bearing building structural members. Three mixtures had above the cube compressive strength of 20N/mm2 recommended for use in plain concrete construction while the rest four mixtures had their cube strength between 19.3N/mm2 and 17.9N/mm2. Fine aggregate with higher compressive strength showed a lesser amount of deleterious materials. It was concluded that the compressive strength depends on the aggregate source.

Rama Mohan Rao. P and H.Sudarsana Rao (2012) research paper presented the use of conventional methods to find out the 28 and 90 days compressive strength of concrete, in which the cement content was replaced by 30%,40% and 50% of class C fly ash. The aggregate binder ratio was varies 1.50, 1.75 and 2.00 and the water binder ratio was varied 0.35, 0.40, 0.45 and 0.50. The artificial neural network can be effectively adopted for predicting the compressive strength of fly ash concrete. MATLAB software was used to predict the results using ANN.

The levenberg-Marquardt algorithm has been used for feed-forward back-propagation. Four ANN models have been developed by using MATLAB software for training and prediction of the three fracture parameters. ANN has been trained with about 70% of the total data sets and tested with about 30% of the total data sets. It was observed that the predicted values of maximum load, facture energy, critical stress intensity factor are in good agreement with those of the experimental values.

Amirreza Kandiri et al (2021) in the research paper, three different optimization algorithms including genetic algorithm (GA), salp swarm algorithm (SSA), and grasshopper optimization algorithm (GOA) are employed to be hybridized with artificial neural network (ANN) separately to predict the compressive strength of concrete containing recycled aggregate, and a M5P tree model is used to test the efficiency of the ANNs.

Results show that all ANNs have better performances than the M5P tree model. Moreover, the ANN that is hybridized with SSA has the lowest values of error, and the second simplest architecture. ANNGOA, on the other hand, has the simplest structure, with the highest values of error, and finally, ANNGA despite of its architecture, which is the most complex one, is the second most accurate model among the ANNs. Although all the ANNs are so close in both accuracy and complexity, the ANNSSA is recommended if accuracy is needed and the ANNGOA should be used if there is a need for simplicity. Increasing the amount of RA to 50% causes a decrease in the CS value at all ages. However, the CS value of the samples with 100% RA is higher than that of the samples with 50% RA at the age of 7 and 28 days, while the CS values of these two classes are almost equal at the age of 3 days.

Neela Deshpande et al (2014) in the research paper, back propagation was used to predict the 28 day compressive strength of recycled aggregate concrete (RAC) along with two other data driven techniques namely Model Tree (MT) and Non-linear Regression (NLR). Recycled aggregate is the current need of the hour owing to its environmental friendly aspect of re-use of the construction waste. The study observed that, prediction of 28 day compressive strength of RAC was done better by ANN than NLR and MT. The input parameters were cubic meter proportions of Cement, Natural fine aggregate, Natural coarse Aggregates, recycled aggregates, Admixture and Water (also called as raw data).

The research concluded that ANN performs better when non-dimensional parameters like Sand–Aggregate ratio, Water–total materials ratio, Aggregate–Cement ratio, Water–Cement ratio and Replacement ratio of natural aggregates by recycled aggregates, were used as additional input parameters. Study of each network developed using raw data and each non dimensional parameter facilitated in studying the impact of each parameter on the performance of the models developed using ANN, MT and NLR as well as performance of the ANN models developed with limited number of inputs. The results indicated that ANN learn from the examples and grasp the fundamental domain rules governing strength of concrete.

Mohamad Ali Ridho B K A et al (2021) the research paper aimed to investigate the recycled aggregate concrete compressive strength using Artificial Neural Network (ANN) which has been proven to be a powerful tool for use in predicting the mechanical properties of concrete. Three different ANN models where 1 hidden layer with 50 number neurons, 2 hidden layers with (50 10) number of neurons and 2 hidden layers (modified activation function) with (60 3) number of neurons are constructed with the aid of Levenberg-Marquardt (LM) algorithm, trained and tested using 1030 datasets collected from related literature. The 8 input parameters such as cement, blast furnace slag, fly ash, water, superplasticizer, coarse aggregate, fine aggregate, and age are used in training the ANN models. The number of hidden layers, number of neurons and type of algorithm affect the prediction accuracy. The predicted recycled aggregates compressive strength shows the compositions of the admixtures such as binders, water-cement ratio and blast furnace–fly ash ratio greatly affect the recycled aggregates mechanical properties.

The results show that the compressive strength prediction of the recycled aggregate concrete is predictable with a very high accuracy using the proposed ANN-based model. The proposed ANN-based model can be used further for optimising the proportion of waste material and other ingredients for different targets of concrete compressive strength.

M. Deepak et al (2019) paper is mainly based on estimating the concrete slump and compressive strength based on concrete mix constituent data using the Artificial Neural Network. Higher the number of input variables leads to higher dimensionality and complexity of the models being developed. The research used a Back propagation feed-forward neural network, the data, matrix size of [103x7] was obtained. The data was classified into 3 sets' viz., training set, validation set, and testing set.

The ANN model operate in assessing the compressive strength and concrete slump of concrete. Higher R values plainly indicate the fact that neural network modeling is definitely well suited. The MSE values are quite small means that the outcomes will be most appropriate. Furthermore, rendering for the compressive strength outcomes predicted by employing ANN- (1), ANN- (2) and ANN- (3) models, the outcomes of ANN-(3) model are closer to the real outcomes. According to the slump outcomes expected by employing ANN-(4), ANN-(5) and ANN (6) models, the outcomes of ANN-(6) model are closer to the real investigation outcomes. L, RMSE and MSE record values which can be computed and intended for matching experimental outcomes with ANN model results have demonstrated this condition. This research uses data set which contains limited data. Using even more data units is suggested which might bring out unique conclusions. The conclusions have confirmed the prediction of compressive strength values and slump of mortars using ANN.

Sagar Chhetri et al (2021) research paper aimed to investigate the coarse aggregate size and source effect on the compressive strength of concrete. For this, four different sources were selected along the length of the Seti river. Coarse aggregate from these sources was collected and sieved to obtain the desired size of aggregate samples. Physical test i.e., specific gravity and water absorption of coarse aggregate obtained from these sources were determined. Mechanical tests such as aggregate crushing strength test, impact value test & Los Angles test were performed.

The result from the mechanical test showed that the aggregates from all the source are suitable construction materials with slight variation in mechanical properties. Concrete cubes of M20 grade nominal mix by volume was cast by keeping cement, sand and water-cement ratio constant for each source and coarse aggregate size as a variable. As per the 7 days & 28 days compressive strength result, the Hemja source showed a relatively higher value of compressive strength compared to Ramghat, Kotre and Damauli sources. Five different batches were cast using aggregate size range 20mm-25mm, 16mm-20mm, 10mm-16mm, 10mm-25mm and 4.75mm-25mm for each source and cube made from well-graded aggregate i.e., 4.75mm-25mm showed higher strength compared to others. In terms of the concrete cube failure mechanism, the major failure mechanism was initiated by bond failure for all the sources.

Magudeaswaran.P et al (2020) the objective of research was to investigate the possibilities of adapting neural expert systems like Artificial Neural Network (ANN) in the development of simulators and intelligent systems and to predict the durability and strength of HPC composites. This soft computing method emulate the decision-making ability of a human expert benefits both the construction industry and the research community. These new methods, if properly utilized, have the potential to increase speed, service life, efficiency, consistency, minimizes errors, saves time and cost which would otherwise be squandered using the conventional approaches.

The developed model labeled as a simulation of HPC is that the pc simulating system developed by MATLAB works. In Artificial Neural Network, the numerous parameters of HPC were trained, tested, and valid using a feed-forward neural network. The sse is that the add square error of the system used for training, testing, and verificatory datasets. An adaptive Neuro-Fuzzy reasoning System, the assorted parameters of HPC were trained and valid victimization subtractive using method. The RMSE is that the root mean square error of the system used for using and checking datasets. Among these ANFIS models are superior in terms of the accuracy of their prognostic ability; the results conjointly show ANN-BP to possess a relatively smart level of accuracy.

Sakshi Gupta (2013) the research paper presented the ANN model for 28-day compressive strength has been developed. The model was trained with input and output experimental data. Correlation coefficient, RMSE and MAE are statistical values that are calculated for comparing experimental data with ANN model. As a result, compressive strength values of concrete can be predicted in ANN models without attempting any experiments in a quite short period of time with some error rates which can be minimized further by using other data mining techniques such as M5 method, fuzzy logic techniques, etc. Hence the correlation coefficient was found to be 0.8685.

Palika Chopra et al (2016) the research paper aimed 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.

On the comparative analysis of GP and ANN techniques, used for the prediction of concrete compressive strength without and with FA, it was concluded that ANN model is the most reliable technique for the purpose. The RMSE values, so obtained, are small enough to indicate that the estimates are most precise and the trained networks supply superior results. According to statistics, if a proposed model gives $R2 > 0.8$, there is a well-built correlation between predicted and measured values for the data available in the dataset.

Hosein Naderpour et al (2018) the research paper aimed to predict RAC compressive strength by using Artificial Neural Network (ANN). The training and testing data for ANN model development were prepared using 139 existing sets of data derived from 14 published literature sources. The developed ANN model uses six input features namely water cement ratio, water absorption, fine aggregate, natural coarse aggregate, recycled coarse aggregate, water-total material ratio. The ANN is modelled in MATLAB and applied to predict the compressive strength of RAC given the foregoing input features. The results indicate that the ANN is an efficient model to be used as a tool in order to predict the compressive strength of RAC which is comprised of different types and sources of recycled aggregates.

R. Pranamika et al (2021) the research paper aimed to predict lightweight concrete's mechanical properties using MRA and ANN accurately. The study portraits a MRA & ANN-based prediction model for the mechanical, split tensile strength & density of LWAC. The whole prediction was given by R2 value. The research probed the doability of modelling a predictive analysis through earlier study data, transfiguring the unstructured factors to possible structured parameters & using those in creating the MRA model & ANN model.

Results stated that for 3 days compressive strength, ANN model (15neurons) gives the maximum R2 value of 0.8675 when compared to ANN (10neurons) & MRA has a R2 value 0.4753 with RMSE of 7.9. 2. For 7 days compressive strength, ANN model (15neurons) gives the maximum R2 value of 0.82929 when compared to ANN (10neurons) & MRA has a R2 value 0.4878with RMSE of 9.958. For 14 days compressive strength, ANN model (15neurons) gives the maximum R2 value of 0.8422 when compared to ANN (10neurons) & MRA has a R2 value 0.4969 with RMSE of 10.715. 4. For 28 days compressive strength, ANN model (15 neurons) gives the maximum R2 value of 0.8498 when compared to ANN (10 neurons) & MRA has a R2 value 0.4969 with RMSE of 11.877. 5. For split tensile strength, ANN model (15 neurons) gives the maximum R2 value of 0.7383 when compared to ANN (10 neurons) & MRA has a R2 value 0.4076 with RMSE of 1.276. 6. For density, ANN model (15 neurons) gives the maximum R2 value of 0.7955 when compared to ANN (10 neurons) & MRA has a R2 value 0.6315with RMSE of 250.599.

Faezehossadat Khademi and Sayed Mohammadmehdi Jamal (2016) the research paper presented the application of artificial neural network to predict the 28 days compressive strength of concrete based on different concrete characteristics. ANN analysis indicates good correlation between the input and output variable. The statistical parameter R2 is 0.9111, 0.9283, and 0.9543 for training, validation, and testing steps, respectively, which implies good efficiency of the ANN model.

Results conlcuded that ANN presents good accuracy in predicting the 28 days compressive strength of concrete. Therefore, in order to predict the compressive strength of concrete with high reliability, instead of using costly experimental investigation, ANN model can be replaced.

Faezehossadat Khademi et al (2016) in the research paper, three different data-driven models, i.e., Artificial Neural Network (ANN), Adaptive Neuro-Fuzzy Inference System (ANFIS), and Multiple Linear Regression (MLR) were used to predict the 28 days compressive strength of recycled aggregate concrete (RAC). Recycled aggregate is the current need of the hour owing to its environmental pleasant aspect of re-using the wastes due to construction. 14 different input parameters, including both dimensional and non-dimensional parameters, were used in investigation for predicting the 28 days compressive strength of concrete.

The results concluded that estimation of 28 days compressive strength of recycled aggregate concrete was performed better by ANN and ANFIS in comparison to MLR. In other words, comparing the test step of all the three models, it was further concluded that the MLR model is better to be utilized for preliminary mix design of concrete, and ANN and ANFIS models are suggested to be used in the mix design optimization and in the case of higher accuracy necessities. In addition, the performance of data-driven models with and without the non-dimensional parameters is explored. It was observed that the data-driven models show better accuracy when the non-dimensional parameters were used as additional input parameters. Furthermore, the effect of each non-dimensional parameter on the performance of each data-driven model was investigated.

III. CONCLUSION

In this review we observed that authors in past performed various experimental investigations related to concrete technology but none of them utilizes ANN technique considering fibers in concrete.

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