Soft Computing Techniques using in Ready Mix Concrete

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Abstract— Ready mix concrete industry in India is still in its infancy but it is an emerging sector. Ready-mix concrete (RMC) is a ready-to-use material, with predetermined mixture of cement, sand, aggregates and water. Use of Ready mixed Concrete has increased considerably in the last few years. Today's high rise structures demands smaller column sizes, faster construction, prompting use of high grade Ready Mix concrete. Use of Ready Mixed concrete was expected to give better control on the quality of concrete as compared with the site mixed concrete. The RMC is subject to varying site conditions like compaction, curing, workability etc. directly affecting the in-situ strength. Information obtained from many sites using ready mixed concrete indicates many instances where the strength of concrete obtained is lower than that specified. Ready mixed concrete (RMC) is an essential material in contemporary construction and engineering projects.

Key words: Ready mixed concrete (RMC), Artificial Neural Network (ANN), Adaptive Neuro Fuzzy Inference System (ANFIS)

I. INTRODUCTION

Ready mixed concrete (RMC) is an essential material in contemporary construction and engineering projects. Compressive strength of concrete is a major and perhaps the most important mechanical property, which is usually measured after a standard curing of 28 days. In this research work, 28-day compressive strength of Ready Mix Concrete has been estimated by using feed forward back propagation neural network, Fuzzy Logic and Adaptive Neuro Fuzzy Inference System (ANFIS) modeling.

The data for the ready mixed concretes (RMC) were collected from RMC batching plant. Various models has been has been developed for different input scenarios. The compressive strength was modeled as a function of five variables, the effects of each parameter on networks were studied for Artificial Neural Network (ANN), Fuzzy Logic and ANFIS models. ready mixed concrete indicates many instances where the strength of concrete obtained is lower than that specified. Ready mixed concrete (RMC) is an essential material in contemporary construction and engineering projects.

Compressive strength of concrete is a major and perhaps the most important mechanical property, which is usually measured after a standard curing of 28 days. Concrete strength is influenced by lots of factors like concrete ingredients, age, ratio of water to cementitious materials, etc. Conventional methods of predicting the strength of concrete are usually based on the linear and nonlinear regression methods. Nowadays, the artificial intelligence based techniques like the artificial neural networks and so called adaptive network-based fuzzy inference systems (ANFIS) have been successfully applied in this area (Jafar Sobhani, 2010).

Obtaining the tested values of the early strength takes time thus results in time delay in forecasting 28-day strength. Furthermore, choosing a suitable regression equation involves technique and experience and is not a simple task. Such traditional prediction model have been developed with a fixed equation form based on the limited number of data and parameters. If new data is quite different from original data, then the model should update not only its coefficients but also its equation form (J. Noorzaei, 2009).In this case the soft computing method like ANN, Fuzzy Logic and ANFIS models does not need such a specific equation form. Instead of that, this model needs sufficient input–output data. Also, it can continuously re-train the new data, so that it can conveniently adapt to new data. ANN has been investigated to deal with the problems involving incomplete or imprecise information (Jafar Sobhani, 2010).

A. Ready Mix Concrete (RMC)

Ready mix concrete industry in India is still in its infancy but it is an emerging sector. Ready-mix concrete (RMC) is a ready-to-use material, with predetermined mixture of cement, sand, aggregates and water. RMC is a type of concrete manufactured in a factory according to a set recipe or as per specifications of the customer, at a centrally located batching plant. It is delivered to a worksite, often in truck mixers capable of mixing the ingredients of the concrete en route or just before delivery of the batch. This results in a precise mixture, allowing specialty concrete mixtures to be developed and implemented on construction sites. The second option available is to mix the concrete at the batching plant and deliver the mixed concrete to the site in an agitator truck, which keeps the mixed concrete in correct form.

RMC is preferred to on-site concrete mixing because of the precision of the mixture and reduced worksite confusion. It facilitates speedy construction through programmed delivery at site and mechanized operation with consequent economy. It also decreases labor, site supervising cost and project time, resulting in savings. Proper control and economy in use of raw material results in saving of natural resources, it assures consistent quality through accurate computerized control of aggregates and water as per mix designs. It minimizes cement wastage due to bulk handling and there is no dust problem and therefore, pollution-free.

II. SOFT COMPUTING TECHNIQUE

The definition of soft computing is not precise. Lotfi A. Zadeh, the inventor of the term soft computing, describes it as follows (Zadeh, 1994):''Soft computing is a collection of methodologies that aim to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness, and low solution cost. Its principal constituents are fuzzy logic, neuro computing, and probabilistic reasoning, soft computing is likely to play an increasingly

important role in many application areas, including software engineering. The role model for soft computing is the human mind.''

Soft Computing is an emerging field that consists of complementary elements of fuzzy logic, neural computing, evolutionary computation, machine learning and probabilistic reasoning. Due to their strong learning, cognitive ability and good tolerance of uncertainty and imprecision, soft computing techniques have found wide applications. Generally speaking soft computing techniques resemble human reasoning more closely than traditional techniques which are largely based on conventional logical systems, such as sentential logic and predicate logic, or rely heavily on the mathematical capabilities of a computer.

III. OBJECTIVES

The main objective was to explore the feasibility of ANN, Fuzzy Logic and ANFIS models for predicting the 28 day compression strength of Ready Mix Concrete. The objective was to compare and to know the best of ANN, Fuzzy Logic and ANFIS models for predicting the 28 day compression strength of Ready Mix Concrete. Concrete were considered, namely normal strength ready mixed plant mixes where only retarders with moderate water reducing properties were used. The data were obtained from industry. Furthermore, types of mixes involved admixtures and/or additives over and above the basic concrete constituents, thus testing the soft computing in applications which are not very well covered by conventional mix design methods and, hence, where they would be particularly useful. The data for the ready mixed concretes RMC were collected from RMC batching plant. Of these records were used for training and for testing.

IV. SOFT COMPUTING TECHNIQUE

- Artificial Neural Network
- Fuzzy Models
- ANFIS Model

Work on artificial neural networks, commonly referred to as neural networks, has been motivated right from its inception by the recognition that the brain computes in an entirely different way from the conventional digital computer The term "fuzzy set" first appeared in 1965 when professor Lotfi A. Zadeh from the university of Berkeley, USA, published a paper entitled "Fuzzy sets". Since then he has achieved many major theoretical breakthroughs in this field and has been quickly joined by numerous research workers developing theoretical works. ANFIS is the famous hybrid neuro-fuzzy network for modeling the complex systems. ANFIS incorporates the human-like reasoning style of fuzzy systems through the use of fuzzy sets and a linguistic model consisting of a set of IF–THEN fuzzy rules. The main strength of ANFIS models is that they are universal approximators with the ability to solicit interpretable IF–THEN rules. The Adaptive Network Based Fuzzy Inference System (ANFIS) which integrates the best features of fuzzy systems and neural networks is defined by Jang (1992).

V. METHODOLOGY

It is observed from the above literature that, the number of individual studies using Artificial Neural Network (ANN), Fuzzy Logic (FL) and Adaptive Network based Fuzzy Inference System (ANFIS) have been carried out for predicting compressive strength of concrete. But, the number of comparative studies of above techniques (ANN, FL and ANFIS) is very less in literature. So, it is significant to conduct a comparative study on common platform using various soft computing techniques.

So the objective will,

- To explore the feasibility of ANN model for predicting the 28 day Compression Strength of Ready Mix Concrete.
- To explore the feasibility of Fuzzy Logic model for predicting the 28 day Compression Strength of Ready Mix Concrete.
- To explore the feasibility of ANFIS model for predicting the 28 day Compression Strength of Ready Mix Concrete.

VI. APPLICATIONS USING SOFT COMPUTING

- Application of soft computing to handwriting recognition
- Application of soft computing to automotive systems and manufacturing
- Application of soft computing to image processing and data compression
- Application of soft computing to architecture
- Application of soft computing to decision-support systems
- Application of soft computing to power systems

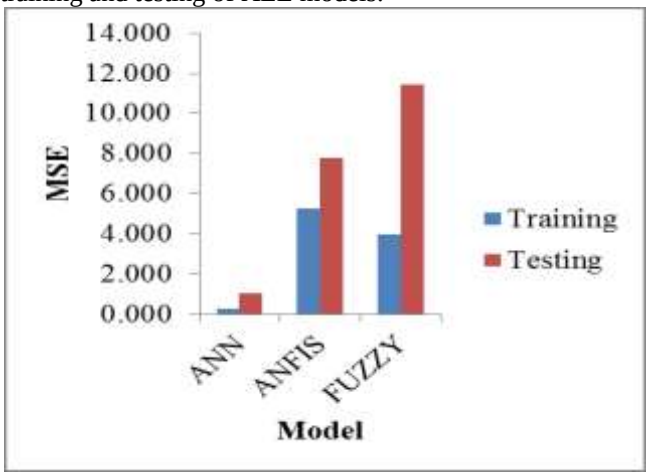
VII. CONCLUSIONS

- Neural network model trained by feed forward back-propagation algorithm have the Logsig transfer function with 1 hidden layers having 3 numbers of neurons in hidden layer could predict the 28- day compression strength of ready mix concrete with satisfactory performance.
- The ANFIS which have the Triangular membership function could predict the 28-day compression strength of ready mix concrete in a best manner and the minimum required error in comparison with the fuzzy models.
- The ANN models, which can easily incorporate additional model parameters, give less scattered estimated value results than those given by the other models.
- From the results obtained it can be concluded that the ANN models are more suitable and feasible in modeling of complex problems and save a lot of computational effort compared to conventional methods significantly. The use of these networks will help in solving more complex problems.
- Models having all five parameters show good performance in all models than changing one parameter, so it proves that all five parameters are essential for estimating of compressive strength of RMC.

A. All Models As Overall Comparison

The overall performance of all models are shown in fig. in the form of MSE , MAE and Cc. Fuzzy model shows very high error in model and ANN shows very less error while

both training and testing of model. Error analysis during training and testing of ALL models.



Showing the different models Vs. MSE

Fig shows the different models Vs. MSE. The Fuzzy model shows higher errors during training than other two models and for testing compare to ANN. ANN shows very negligible mean square error. ANFIS shows the medium errors compared to ANN and Fuzzy for testing

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