Compressive Strength of Concrete-Prediction by using Machine Learning

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Abstract: **Construction industry is upgrading towards the efficient work done by using statistical data and prediction of compressive strength of concrete by using " Machine Learning" which is based on the mixed proportions,on an account of its importance in construction sector,various studies has proven that the data can be made available to meet the demand of new innovative techniques in construction industry, the research was based from the minimum sets of data in laboratory, predictive models are enforced to observe relationships between the mixture design variables and strength, and to develop estimate of about 28 days strength,the data from actual site and in laboratory are put into comparison and the compressive strength is examined.Furthermore, such samples are used to design optimal concrete mixtures that minimized the cost and embodied CO2 impact while satisfying imposed target strength.**

Index Terms **– Compressive Strength of Concrete, Machine Learning, Optimal Concrete.**

I. INTRODUCTION

Humans have used concrete for ages. Its primary ingredients date back to the ancient Egyptian civilization. But with the development of new concrete additives, today, we are able to produce a more robust and workable mixture. In fact, concrete is now a globally used material, for it is strong and very much durable. But talking of concrete's strength, there are different ways to access the same. Concrete achieves varying qualities with different strength properties to make for an ideal solution in diverse use cases.

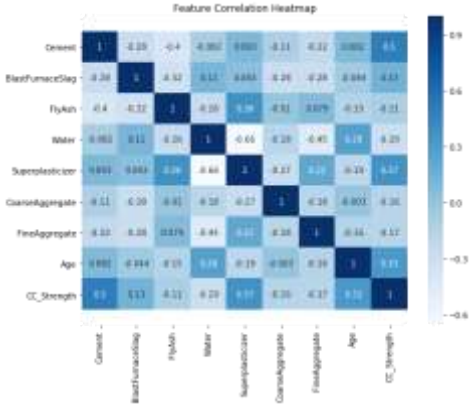
A. RESEARCH OBJECTIVE

- To determine the compressive strength of concrete by using the technique of machine learning.
- How machine learning plays an important role in efficient construction work.
- To evaluate all the data formed by the inputs and to compare the same with actual onsite readings.
- Precised working of machine learning algorithms to determine compressive strength of concrete.

II. RELATED WORK

A. PREDICTION OF COMPRESSIVE STRENGTH OF CONCRETE BY MACHINE LEARNING

Machine learning is the brain where all the learning takes place. The way the machine learns is similar to the human being. Humans learn from experience. The more we know, the more easily we can predict. By analogy, when we face an unknown situation, the likelihood of success is lower than the known situation. Machines are trained the same. To make an accurate prediction, the machine sees an example. When we give the machine a similar example, it can figure out the outcome. However, like a human, if its feed a previously unseen example, the machine has difficulties to predict. The core objective of machine learning is the learning and inference. First of all, the machine learns through the discovery of patterns. This discovery is made thanks to the data. One crucial part of the data scientist is to choose carefully which data to provide to the machine. The list of attributes used to solve a problem is called a feature vector. You can think of a feature vector as a subset of data that is used to tackle a problem.



B. CONCRETE AND MACHINE LEARNING RESEARCH

Foamed concrete material is a sustainable material which is widely used in the construction industry due to their sustainability. Accurate prediction of their compressive strength is vital for structural design. However, empirical methods are limited to consider simultaneously all influencing factors in predicting the compressive strength of foamed concrete materials. Thus, this study proposed a novel hybrid artificial intelligence (AI) model which couples the least squares support vector regression (LSSVR) with the grey wolf optimization (GWO) to consider effectively the influencing factors and improve the predictive accuracy in predicting the foamed concrete's compressive strength. Performance of the proposed model was evaluated using a real-world dataset. Comparison results confirm that the proposed GWO–LSSVR model was superior than the support vector regression, artificial neural networks, random forest, and M5Rules with the improvement rate of 144.2–284.0% in mean absolute percentage error (MAPE). Notably, the evaluation results show that the GWO–LSSVR model showed the good agreement between the actual and predicted values with the correlation coefficient of 0.991 and MAPE of 3.54%. Thus, the proposed AI model was suggested as an effective tool for designing foamed concrete materials.

The algorithms used to predict the compressive strength of concrete are being modalized in the form that the inputs of data are given to the module and the module predict the following outputs accordingly.

III. SCOPE OF RESEARCH

- To help understand feasible use of ML in construction sector.
- To explore previous and upcoming innovations in the field of construction for predicting compressive strength of concrete.
- To understand the benefits of ML in construction sector.

IV. RESEARCH METHODOLOGY

The uniaxial compressive strength (UCS) is one of the most important mechanical properties of concrete. This paper aims to demonstrate that the UCS of concrete can be accurately predicted from its compositions and age using the extreme gradient boosting regression (XGB) method. The artificial neural networks (ANN) and the support vector machine (SVM) methods are also considered to compare with the XGB method. A relevant laboratory measurement dataset available in literature is considered to train and test the machine learning (ML) methods. We observe that all the three considered ML methods provide accurate results.

V. DATA COLLECTION

The data was acquired with the help of Google Research and the results were obtained on software with the help of python language.

VI. RESULTS

Through this research a lot of things have become clear. Following are the points that are our opinions and views on the basis of the research and we concluded –

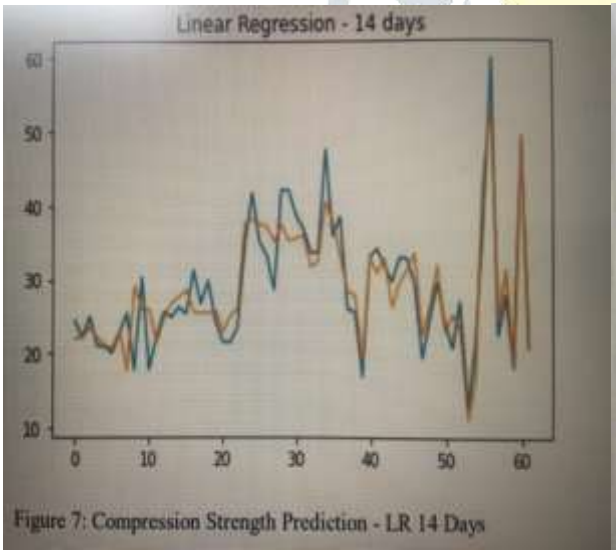


Figure 7: Compression Strength Prediction - LR 14 Days

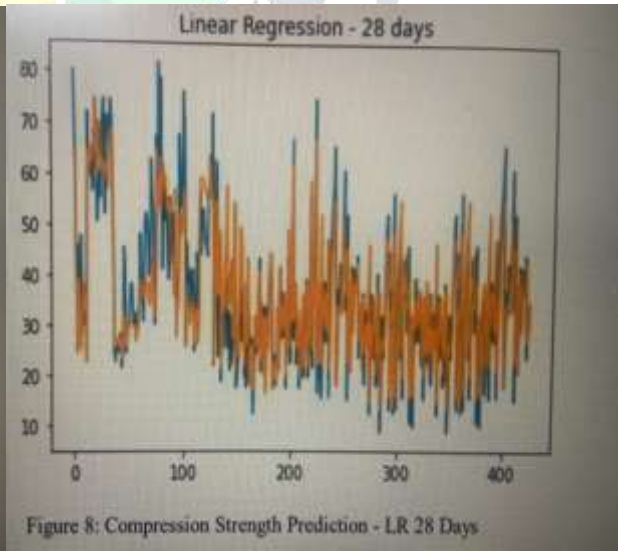


Figure 8: Compression Strength Prediction - LR 28 Days

The implementation of the work was done for evaluating the proposed model. The machine learning method for the compression strength prediction was modeled as a regression model. It was then implemented using python using the packages like numpy, sklearn, pandas, etc. The models were trained during a CPU based system with 8GB RAM. For evaluating the model correctness, we have considered the RMSE value. The table below shows the RMSE value of the different regression models for the compression strength prediction for different curing time.

VII. CONCLUSION

The technological advancements in the field of machine learning pave a great way to reach interdisciplinary research application. One such problem in civil engineering, to find a mathematical relationship for the amount of different componets used for creating a concrete mix and the compression strength was considered. In this paper we proposed a machine learning pipeline, using linear regression techniques for predicting the compression strength of a particular concrete mix. From the raw dataset by apply feature selection 7 attributes where selected and pre-processed to create a curated dataset.