

Forecasting of Crushing Strength of Sustainable Concrete by Employing Deep and Random Forest Machine Learning

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Abstract

Sustainable concrete is one of the milestone of the concrete industry. This concrete fulfills the requirements of concrete manufacturing industry such as strengthen, Durability, environment friendly and many of other. With this properties of concrete, sustainable concrete is an ideal substitute for ordinary concrete in the concrete industry. In the 21th century Machine learning is a tool which is use to employ the characteristics of sustainable concrete by using deep learning and random forest algorithm and comparing their error and coefficient of correlation. Finding the results and value of properties of concrete conventional method is so time taking and laborious. The goal of this study is to fortune telling of the strength of sustainable concrete by machine learning tool.

Keywords: Sustainable concrete, machine learning, deep learning, random forest algorithm, compressive strength

INTRODUCTION

Concrete is a material which is known for its good compressive strength behavior. It is a primary material which is a mixture of cement, sand, aggregates, admixture and water. In contrast to conventional concrete from the last 20-30 year it has been used in construction work. Sustainable concrete is a concert that uses flue dust and GGBS [1]–[3]. Cement is the chief and cording ingredients in the normal concrete. Sustainable concrete is a building material that can be used as an alternative to cement concrete as it is economically and ecofriendly in comparison to cement and industrial waste can be utilized as the resource material producing the sustainable concrete. In the production of one tone of cement approx. one tone Carbon di oxide release in the environment [4]–[6]. Binding material composition and particle size are principal factor to commence the retort and firmness after retort but their proportion also play a key role to command the strength as per requirements. This concrete is more inexpensive than the typical concrete. It shrinks the all over cost 40% of its native cost. Compressive strength of concrete affect by the various parameter including internal and external aspects. external

aspect consists of degree of heat, curing time, variety of curing, sultriness and pollutant of air are play principal role where elite assets and different constituents are distant in inner factors [7]–[9]. Fly ash and slag have particle of fine size, due to this these have reacted fast their significant area, and it is growing the premature strength of the concrete. Liquid is a glue which play a chief contribution to behave and is stiff to achieve its firmness. Transparent, odorless, colorless liquid is required for and at the sustainable retort, but it will vaporize throughout the retort solidifying and it is not vital at the ending of the products sustainable concrete. The find out the characteristics of concrete mix by the

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Received Date: April 23, 2024

Accepted Date: August 08, 2024

Published Date: October 15, 2024

Citation: Pravesh, Kumar Tiwari, Manvendra Verma. Forecasting of crushing strength of sustainable concrete by employing deep and random forest machine learning. Journal of Polymer & Composites. 2024; 12(Special Issue 7): S41–S46p.

traditional process is so laborious and time consuming, machine learning tool and technique is very smooth and effective technique to predict the compressive strength by their previous data sets. This technique minimizes the time and labor work to find out the concrete compressive strength without dismantling of the sample in laboratory. Based upon old data compressive strength is predict by making the model [10]–[13]. Chance of error in prediction in the strength of concrete by machine learning is very less so it can be neglected. Artificial neural network is the remarkable proficiency used in the forecasting of compressive strength of concrete. This study has the object is to forecasting the crushing strength of concrete by applying random forest and deep learning and technique separately depend upon the exploratory particulars of raw material and crushing strength.

In the year 2022 solid wastes were produced approx. 2.24 billion tone [14], [15]. This is due to happen by drastic and quick growth of our culture and population. Now days in the civil engineering field two solid wastes named as flue ash and GGBS are the popular waste, these two wastes are used as proxy material of cement in concrete. Flue ash is found in the powder form by combustion of coal to producing the electric energy [16], [17]. In the business of steel manufacturing a waste GGBS is produced on very large scale. Due to their origin from the rich industries like steel and electric generation both have good characteristics like cement material. In the field of civil engineering both are used as substitute material and combination of these two form a very solid material which have some good characteristics which are required by civil engineers for construction of the civil engineering structures.

The stipulation of water is on the top of stipulation list of human being on globally platform and the concrete is the second enormous stipulation in this list. Name of concrete in this list is due to progression of countries and societies. In the progressive approach requirement of infrastructure is increased so manufacturing of concrete will epidemically be increasing. For manufacturing of concrete cement is the core material and manufacturing of cement hit the word wide environment.

MATERIALS AND METHODOLOGY

Sustainable concrete is fabricated with flueash, Natrium hydroxide, natrium silicate, aggregate of both the categories, super plasticizers and Transparent, odorless, colorless liquid etc. In vast production of concrete basic material of concrete such as cement, aggregate is checked in laboratories. All time Fly ash is supplied from the accessible thermoelectric power station and superplasticizer from chemical industries. Fine and coarse aggregate are escort from the provincially material. Transparent, odorless, colorless liquid is used as per BIS code. Geopolymer concrete is required more time to mixing as compare to conventional concrete, so hand mixing is avoided. XRF test was perform and fly ash and other pozzolonic materials for ensuring the percentage of different minerals [18], [19]. At the time of purchasing chemicals, minimum requirements of mineral should be provided. Various characteristics like relative density, elongation table of content, flakiness table of content, impact value, compressive value and chafing value of broad aggregate were resolute in the lab by using code (IS 383, 1970, 1997). These all test are performed before going to start the amalgamate of concrete. In the 21 of century research and development work demand the automatic learning process. This technique have so much here after demand in all the various discipline of investigation. Fundamental and basic of this technique is purely mathematical tool and models [6], [20]. This have so much variations in accordance with the requirements to the forecast the upcoming requirements. Neural approach is the simple and well liked approach is adopted for the future casting of the data in accordance with the older data [21]–[23].

Geopolymer concrete taken as sustainable concrete due to its prominent environment friendly and sustainable nature. It acts as cement firstly it transfigures, and harden to provide the adhesive property in the concrete. Flue ash is a splendid aluminosilicate material produced by the fiery of coal in the coal industry. Some researchers prove in their research work that grain size of the flue ash was recognizing with the momentous physical performance characteristics. Improvement of compressive strength directly proportional to the grain size of flue ash ie with reducing the size of flue ash the compressive strength of sustainable concrete is increase [24], [25].

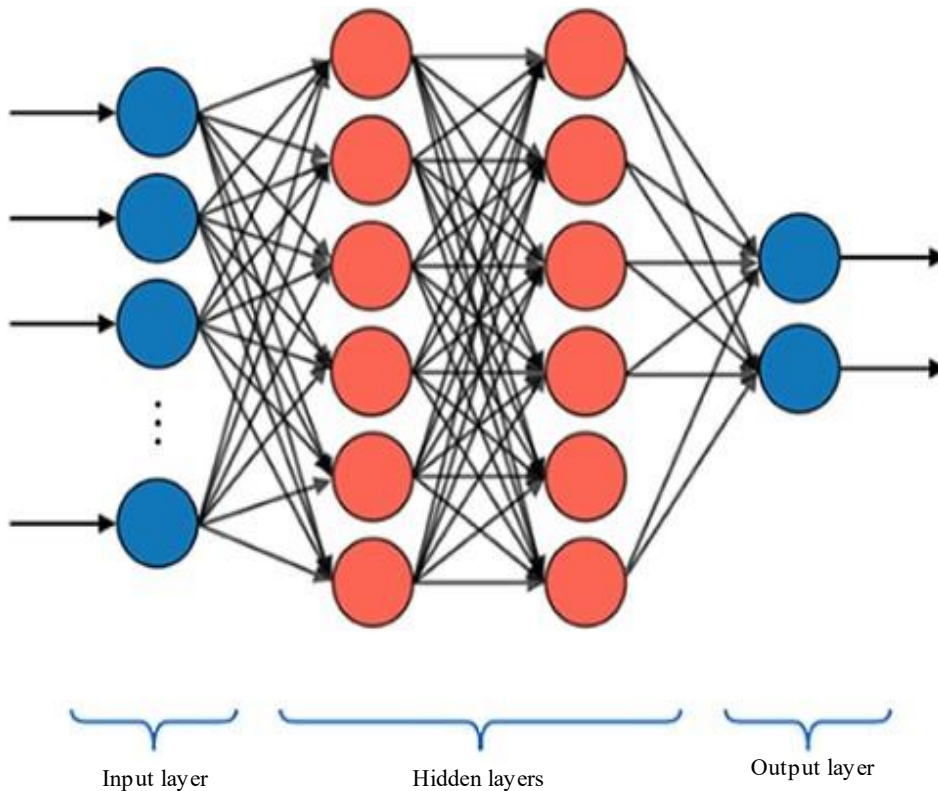


Figure 1. Neural network layers.

In this technique the available data is transfigure via of neurons layers, so much critical pattern easy to understand in the neural network. Diagram 1 depict shows the elementary of no of layer cognizance (Figure.1)

Another algorithm not so much of capable to develop the relationship between the features as compare with the neural network [10], [26]. The required no of film in the neural network are the three numbers. The resource film, secret film and the return film. When the nod of secret film is combined than a deep neural network is constructed and this is picking as deep learning model. Endmost layer of the neural network will construct by systematic number of films that is created by a sole neuron. for checking the forecasting of correctness, it is just expose with the errorless value. This process is work on linear connection [27]. Linear connection value is lie between negative to positive infinity or between zero and infinity. Succeeding off take linear connection, this technique put in the MSE mathematical model. Quadratic error between the forecasting and exact value is find out in this way [28], [29].

RESULT AND DISCUSSION

In this section, Results of machine learning methods using the random forest algorithm, deep learning and multilayer perception. In the first step, we save the data or information which is collected by testing the concrete sample in the Ia and input it into mat lab with 70% of its going towards model and 30% training. The process of machine learning process tool in such in Figure (2).

At the machine learning technique utilize the same procedure in all the various methods and varying parameter. After selecting the methods to build the model based on the data and desired output data. It shows the initial input characteristics that are made up of the basic of data to construct model. Machine learning technique follow a SD procedure to predict the output data. Figure (3) shows the entirely process chart of deep learning technique output prediction procedure.

Step-1: Start

Step-2: Load training type

Step-3: Set input parameter

- Step-4: Input training data into classifier
- Step-5: Training finished
- Step-6: Input training data into classifier
- Step-7: Training finished
- Step-8: End

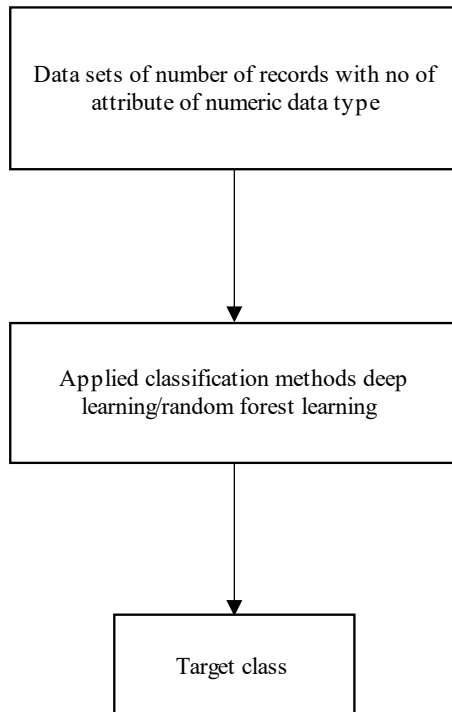


Figure 2. Workflow chart.

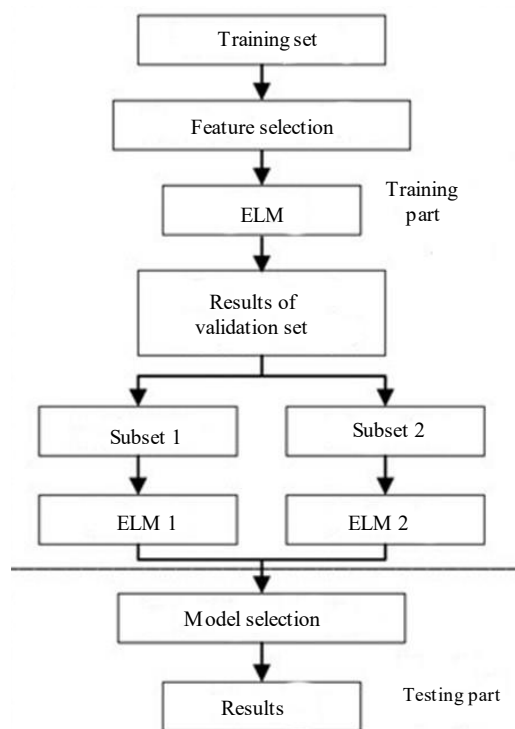


Figure 3. Modelling process chart.

In the primary activity it includes input, output and data training. If compare input data, no of parameter and single output parameter in the initialization phase. Collecting the data or information. Data set will be prepared for the training phase. After training phase this data set with classifiers complete the data training and obtain the results. This is the complete process of utilizing deep learning to make prediction based on actual data.

Model of deep learning is shown in the figure 3. In this diagram we can set the three layer that are input layer, output layer and hidden layer. Input layer have no of various parameter whereas output layer has only single parameter. Input parameter have the mix constituents such as fly ash content, curing period, curing types, temperature, percentage of coarse and fine aggregate, percentage of superplasticizer etc. whereas output parameter is compressive strength in MPa. Form this study we have found that result through the machine learning is similar to the actual results of compressive strength of sustainable concrete of sustainable concrete sample. In the prediction of compressive strength by deep learning and forest learning have some error which were calculated by following mathematical formulae such as MAE, R^2 , RAE, RMSE, and RRSE.

CONCLUSION

- In this study we have found that with the using of machine learning technique prediction of results of compressive strength are good
- Mathematical formulae RAE, RMSE, MAE, and RRSE were used for compute error.
- Random forest technique is more accurate than the deep learning.
- Random forest shows less errors in predicted data.

Acknowledgement

The authors gratefully acknowledge the Guide, staff, and authority of Civil department for their cooperation in the research.

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