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Prophecy of Compressive Strength of Geopolymer Concrete using Artificial Neural Networks

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ABSTRACT: India is the second largest producer of cement in the world. In order to produce one ton of cement about one ton of Co2 is released into atmosphere. As per Global Cement and Concrete Association , Cement is the third highest contributor of Green house gases in the atmosphere. Inorder to decrease the negative impacts of cement in the atmosphere a new type of concrete is evolved by conducting countless researches that is Geopolymer Concrete. The Amount of Cement Content in Geopolymer Concrete is null and void. Artificial Neural Networks is bough of Artificial Intelligence. It is one of the sophisticated Computed technique to prognosticate the properties of Geoplymer Concrete with minimum Percentage of error. In this paper more than 170 hunks of data gathered from the literature to train and test the data .

Keywords: Geopolymer Concrete , Artificial Neural Networks, Greenhouse Gases.

I. INTRODUCTION

The term geoploymer is a brainchild of Devidovits in 1978, but it was first discovered by Chelokovski in 1950.The term geoployer is generically used to describe the amorphous to crystalline reaction products from the synthesis of alkali aluminiosillicates with alkali hydroxide/alkali silicate solution. Geoployer binder can provide comparable performance to traditional cementitious binder in a range of application with an added advantage of significantly reduced greenhouse gas emissions. The polymerization process involve a substantially fast chemical reaction under alkali conditions on Si-Al minerals, resulting in a three dimensional polymeric chain and ring structure consisting of Si-Al-O bonds.The most common activators are NaOH and KOH.

The Artificial Neural Networks are algorithm simulating the functioning human neuron. Mathematically it is defined as a function by which inputs are converted to outputs in a neural set The Regression analysis is a statistical process used to estimate the relationship between a dependent variable and one or independent variables which are known as predictors. The performance of the model depends n the neutrons in the hidden layers which are finalized by trial and error approach. The statistical values such as correlation coefficient ®, Absolute Fraction of Variance or Coefficient of determination (R2), Root mean Square Error (RMSE) and mean Absolute percentage error(MAPE) are calculated using the following equations

$$\text{RMSE} \sqrt{\frac{1}{n}\Sigma_{i=1}^{n}(ER-PR)^2}$$

$$\text{MAPE} = \frac{1}{n}\sum_{i=1}^{n}|\text{ER}-\text{PR}/\text{ER}| \times 100\%$$

$$\sum R^2 = 1 - \frac{\Sigma(ER-PR)^2}{\Sigma(PR)^2}$$

Where
PR is the Predicted result from the model.
n = number of observation
ER is the experimental result

Multilayer Perception often used in ANN due to several nodes are neurons grouped in three layers named input layers , hidden layers, output layers. The input and output layers have as many neurons as the dimension of the input and output vectors. However the only way to configure the hidden layers is trial and error method. In the paper Visual Gene Developer is a programme tool used to predict the compressive strength Of Geopolymer Concrete.

In ANN model, The Input are water, cement, coare aggregate ,Fine aggregate ,28 days compressive strength ,The output parameters 56 days compressive strength .Again 56 days compressive strength as input parameter, the output parameter is 91 days compressive strength(Chopra et.al. 2017).A 368 different high strength Concrete strength mix design were collected from the laboratory , A neural network model was conducted, trained and tested using the available data. The relative percentage error of the training data is 7.02%(Barbura et.al 2014).ANN model can be used to prophecy the damage detection of the bridge(Limin et.al. 2020).The cost of Geopolymer concrete for more than M30 Grade concrete is less than the OPC.(J Thaarini et.al 2016) .

In this paper 200 data set are collected and ANN model is prepared. Out of this 140 data sets are used for training the data , 30 data sets are used for validation , and remaining 30 data set are used for the testing the data . The number of hidden layers in the ANN model was found to be two.

II. OBJECTIVE

- Collect the data of mix proportions from the literature review on Geoploymer Concrete
- Prediction of the compressive strength is carried out by Visual Gene developer with built in Artificial neural network tool
- Analytical values predicted from the ANN tool are validated by experimentation and comparison studies are carried out.

III. EXPERIMENTAL INVESTIGATION

Prepare the Geopoloymer concrete based on the previous literature mix design. Cast the 150mm*150mm concrete cubes .There are two types curing is adopted for geopolymer concrete sun curing and oven curing . The preferred curing is oven curing since in oven curing the temperature is controlled unlike in sun curing. In this paper for the experimental work, oven curing is choosen. After 28 days curing , the concrete cube are taken out and tested in compressive strength machine and the compressive strength of concrete is found out.

Fig.1 Mixing of Constituent Materials

3.1 STEP BY STEP PROCEDURE TO FIND OUT THE COMPRESSIVE STRENGTH OF GEOPOLYMER CONCRETE USING ARTIFICIAL NEURAL NETWORK TOOL VISUAL GENE DEVELOPER SOFTWARE

Step 1**:** Prepare data set;- Enter all the mix proportion values in excel spreadsheet
Step 2**.** Normalize the values.
Step 3: Configure neural network'Training pattern' button in order to setup training data set. Immediately, you can see a new pop-up window. But it doesn't include any data initially.
Step 4**.** Copy the following region of the training data set in the Excel document.
Step 5. Click on the 'Paste all columns' button in the 'Neural Network - Training Pattern' window. It retrieves text data from clipboard and paste it to the table as shown in the figure
Step 6: Start learning process (=data regression)
Step 7: Predict new data set

IV. RESULTS

Table 1 :- Input and Output Parameters for predicting compressive strength

DATA INPUT	TYPE OF CONSTITUENTS
Input 1	Amount of fly ash in kg/m^3
Input 2	Amount of GGBS in kg/m^3
Input 3	Amount of fine aggregate in kg/m^3
Input 4	Amount of coarse aggregate in kg/m^3

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Input 5	Alkaline solution NaOH+Na2siO3 in kg/m^3
Input 6	Alkaline/binder ratio
Input 7	Na2siO3/NaOH ratio
Input 8	Molarity of the solution
Output	28 days compressive strength of GPC (for oven curing) in N/mm^2

Table 2:- VALIDATION DATA SET:

Inp 1	inp 2	inp 3	inp 4	inp 5	inp 6	inp 7	inp 8	output	Pred out
0.25	0.11	0.516	0.727	0.16	0.45	0.5	0.4	0.42	0.39021
0.25	0.11	0.516	0.727	0.18	0.5	0.5	0.4	0.43	0.39392
0.25	0.11	0.516	0.727	0.2	0.55	0.5	0.4	0.34	0.36937
0.25	0.11	0.516	0.727	0.16	0.45	0.5	0.4	0.42	0.34701
0.25	0.11	0.516	0.727	0.18	0.5	0.5	0.4	0.43	0.4082
0.25	0.11	0.516	0.727	0.2	0.55	0.5	0.4	0.33	0.36675
0.27	0.11	0.516	0.727	0.16	0.45	0.5	0.4	0.41	0.35516
0.27	0.11	0.516	0.727	0.18	0.5	0.5	0.4	0.43	0.41261
0.27	0.11	0.516	0.727	0.2	0.55	0.5	0.4	0.33	0.3517
0.27	0.12	0.516	0.727	0.16	0.45	0.5	0.4	0.41	0.36985
0.27	0.12	0.516	0.727	0.18	0.5	0.5	0.4	0.43	0.41581
0.27	0.12	0.516	0.727	0.2	0.55	0.5	0.4	0.33	0.33814
0.28	0.12	0.516	0.727	0.16	0.45	0.5	0.4	0.41	0.37884
0.28	0.12	0.516	0.727	0.18	0.5	0.5	0.4	0.43	0.41613
0.28	0.12	0.516	0.727	0.2	0.55	0.5	0.4	0.32	0.32249
0.29	0.12	0.516	0.727	0.16	0.45	0.5	0.4	0.41	0.38224
0.29	0.12	0.516	0.727	0.18	0.5	0.5	0.4	0.43	0.41462
0.29	0.12	0.516	0.727	0.2	0.55	0.5	0.4	0.32	0.30546
0.29	0.13	0.54	0.644	0.19	0.45	0.5	0.4	0.4	0.20508
0.29	0.13	0.54	0.644	0.21	0.5	0.5	0.4	0.44	0.29118
0.29	0.13	0.54	0.644	0.23	0.55	0.5	0.4	0.31	0.36165
0.3	0.13	0.54	0.644	0.19	0.45	0.5	0.4	0.4	0.2119
0.3	0.13	0.54	0.644	0.21	0.5	0.5	0.4	0.44	0.3052
0.3	0.13	0.54	0.644	0.23	0.55	0.5	0.4	0.33	0.36512
0.31	0.13	0.54	0.644	0.19	0.45	0.5	0.4	0.4	0.22873

Table 3 :- TRAINING DATA SET:

inp1	inp 2	inp 3	inp 4	inp 5	inp6	inp 7	inp 8	output	pred out
0.31	0.13	0.54	0.644	0.21	0.5	0.5	0.4	0.44	0.4167
0.31	0.13	0.54	0.644	0.23	0.55	0.5	0.4	0.34	0.36715

0.32	0.14	0.507	0.648	0.2	0.45	0.5	0.4	0.39	0.34824
0.32	0.14	0.507	0.648	0.23	0.5	0.5	0.4	0.44	0.45492
0.32	0.14	0.507	0.648	0.25	0.55	0.5	0.4	0.35	0.4392
0.22	0.14	0.516	0.727	0.16	0.45	0.5	0.4	0.56	0.53809
0.22	0.14	0.516	0.727	0.18	0.5	0.5	0.4	0.57	0.61791
0.22	0.14	0.516	0.727	0.2	0.55	0.5	0.4	0.53	0.5687
0.22	0.15	0.516	0.727	0.16	0.45	0.5	0.4	0.56	0.53459
0.22	0.15	0.516	0.727	0.18	0.5	0.5	0.4	0.58	0.63148
0.22	0.15	0.516	0.727	0.2	0.55	0.5	0.4	0.54	0.57336
0.23	0.15	0.516	0.727	0.16	0.45	0.5	0.4	0.57	0.53659
0.23	0.15	0.516	0.727	0.18	0.5	0.5	0.4	0.59	0.6463
0.23	0.15	0.516	0.727	0.2	0.55	0.5	0.4	0.55	0.57423
0.23	0.16	0.516	0.727	0.16	0.45	0.5	0.4	0.57	0.54456
0.23	0.16	0.516	0.727	0.18	0.5	0.5	0.4	0.6	0.66082
0.23	0.16	0.516	0.727	0.2	0.55	0.5	0.4	0.56	0.57099
0.24	0.16	0.516	0.727	0.16	0.45	0.5	0.4	0.58	0.55815
0.24	0.16	0.516	0.727	0.18	0.5	0.5	0.4	0.61	0.67353
0.24	0.16	0.516	0.727	0.2	0.55	0.5	0.4	0.57	0.5636
0.25	0.16	0.516	0.727	0.16	0.45	0.5	0.4	0.58	0.57591
0.25	0.16	0.516	0.727	0.18	0.5	0.5	0.4	0.62	0.68331
0.25	0.16	0.516	0.727	0.2	0.55	0.5	0.4	0.58	0.55229
0.25	0.17	0.54	0.644	0.19	0.45	0.5	0.4	0.59	0.43876
0.25	0.17	0.54	0.644	0.21	0.5	0.5	0.4	0.62	0.54515
0.25	0.17	0.54	0.644	0.23	0.55	0.5	0.4	0.59	0.64956
0.26	0.17	0.54	0.644	0.19	0.45	0.5	0.4	0.58	0.42591
0.26	0.17	0.54	0.644	0.21	0.5	0.5	0.4	0.62	0.55595
0.26	0.17	0.54	0.644	0.23	0.55	0.5	0.4	0.57	0.66073
0.26	0.18	0.54	0.644	0.19	0.45	0.5	0.4	0.57	0.41759
0.26	0.18	0.54	0.644	0.21	0.5	0.5	0.4	0.62	0.56979
0.26	0.18	0.54	0.644	0.23	0.55	0.5	0.4	0.56	0.66993
0.27	0.18	0.54	0.644	0.19	0.45	0.5	0.4	0.57	0.41478
0.27	0.18	0.54	0.644	0.21	0.5	0.5	0.4	0.61	0.58548
0.27	0.18	0.54	0.644	0.23	0.55	0.5	0.4	0.54	0.67674
0.18	0.18	0.516	0.727	0.16	0.45	0.5	0.4	0.62	0.61501
0.18	0.18	0.516	0.727	0.18	0.5	0.5	0.4	0.65	0.65135
0.19	0.19	0.516	0.727	0.16	0.45	0.5	0.4	0.61	0.6062
0.19	0.19	0.516	0.727	0.18	0.5	0.5	0.4	0.65	0.6483

0.19	0.19	0.516	0.727	0.16	0.45	0.5	0.4	0.6	0.59779
0.19	0.19	0.516	0.727	0.18	0.5	0.5	0.4	0.65	0.64569
0.2	0.2	0.516	0.727	0.16	0.45	0.5	0.4	0.6	0.58981
0.2	0.2	0.516	0.727	0.18	0.5	0.5	0.4	0.65	0.64368
0.2	0.2	0.516	0.727	0.16	0.45	0.5	0.4	0.59	0.58233
0.2	0.2	0.516	0.727	0.18	0.5	0.5	0.4	0.65	0.64249
0.21	0.21	0.516	0.727	0.16	0.45	0.5	0.4	0.58	0.57547
0.21	0.21	0.516	0.727	0.18	0.5	0.5	0.4	0.64	0.64235
0.21	0.21	0.54	0.644	0.19	0.45	0.5	0.4	0.58	0.57851
0.21	0.21	0.54	0.644	0.21	0.5	0.5	0.4	0.64	0.6396
0.22	0.22	0.54	0.644	0.19	0.45	0.5	0.4	0.57	0.567
0.22	0.22	0.54	0.644	0.21	0.5	0.5	0.4	0.63	0.63618
0.22	0.22	0.54	0.644	0.19	0.45	0.5	0.4	0.56	0.55609
0.22	0.22	0.54	0.644	0.21	0.5	0.5	0.4	0.63	0.63306
0.23	0.23	0.507	0.648	0.2	0.45	0.5	0.4	0.55	0.53377
0.23	0.23	0.507	0.648	0.23	0.5	0.5	0.4	0.62	0.61903
0.25	0.11	0.516	0.727	0.22	0.6	0.5	0.4	0.29	0.26371
0.26	0.11	0.516	0.727	0.22	0.6	0.5	0.4	0.28	0.26803
0.27	0.11	0.516	0.727	0.22	0.6	0.5	0.4	0.28	0.27015
0.27	0.12	0.516	0.727	0.22	0.6	0.5	0.4	0.28	0.27019
0.28	0.12	0.516	0.727	0.22	0.6	0.5	0.4	0.27	0.26817
0.29	0.12	0.516	0.727	0.22	0.6	0.5	0.4	0.27	0.26408
0.29	0.13	0.54	0.644	0.19	0.6	0.5	0.4	0.27	0.26487
0.3	0.13	0.54	0.644	0.19	0.6	0.5	0.4	0.28	0.26816
0.31	0.13	0.54	0.644	0.19	0.6	0.5	0.4	0.29	0.26699
0.32	0.14	0.507	0.648	0.27	0.6	0.5	0.4	0.29	0.26979
0.22	0.14	0.516	0.727	0.16	0.6	0.5	0.4	0.51	0.49364
0.22	0.15	0.516	0.727	0.16	0.6	0.5	0.4	0.52	0.50729
0.23	0.15	0.516	0.727	0.16	0.6	0.5	0.4	0.53	0.51796
0.23	0.16	0.516	0.727	0.16	0.6	0.5	0.4	0.54	0.52561
0.24	0.16	0.516	0.727	0.16	0.6	0.5	0.4	0.55	0.53043
0.25	0.16	0.516	0.727	0.16	0.6	0.5	0.4	0.56	0.5327
0.25	0.17	0.54	0.644	0.25	0.6	0.5	0.4	0.57	0.53382
0.26	0.17	0.54	0.644	0.25	0.6	0.5	0.4	0.54	0.52744
0.26	0.18	0.54	0.644	0.25	0.6	0.5	0.4	0.52	0.51754
0.27	0.18	0.507	0.648	0.27	0.6	0.5	0.4	0.5	0.4909
0.18	0.18	0.516	0.727	0.2	0.55	0.5	0.4	0.53	0.52015

0.19	0.19	0.516	0.727	0.2	0.55	0.5	0.4	0.53	0.51731
0.19	0.19	0.516	0.727	0.2	0.55	0.5	0.4	0.52	0.51492
0.2	0.2	0.516	0.727	0.2	0.55	0.5	0.4	0.52	0.51328
0.2	0.2	0.516	0.727	0.2	0.55	0.5	0.4	0.52	0.51267
0.21	0.21	0.516	0.727	0.2	0.55	0.5	0.4	0.51	0.5133
0.21	0.21	0.54	0.644	0.21	0.55	0.5	0.4	0.51	0.5387
0.22	0.22	0.54	0.644	0.21	0.55	0.5	0.4	0.52	0.53726
0.22	0.22	0.54	0.644	0.21	0.55	0.5	0.4	0.53	0.53662
0.23	0.23	0.507	0.648	0.25	0.55	0.5	0.4	0.54	0.55202
0.9	0	0.599	0.407	0.41	0.45	0.5	0.4	0.52	0.49722
0.81	0.09	0.599	0.407	0.41	0.45	0.5	0.4	0.54	0.53585
0.72	0.18	0.599	0.407	0.41	0.45	0.5	0.4	0.55	0.53933
0.63	0.27	0.599	0.407	0.41	0.45	0.5	0.4	0.56	0.55698
0.54	0.36	0.599	0.407	0.41	0.45	0.5	0.4	0.58	0.58007
0.9	0	0.599	0.407	0.41	0.45	0.5	0.6	0.53	0.52125
0.81	0.09	0.599	0.407	0.41	0.45	0.5	0.6	0.55	0.54479
0.72	0.18	0.599	0.407	0.41	0.45	0.5	0.6	0.57	0.5671
0.63	0.27	0.599	0.407	0.41	0.45	0.5	0.6	0.59	0.58279
0.54	0.36	0.599	0.407	0.41	0.45	0.5	0.6	0.59	0.58513
0.9	0	0.599	0.407	0.41	0.45	0.5	0.8	0.54	0.54826
0.81	0.09	0.599	0.407	0.41	0.45	0.5	0.8	0.58	0.57555
0.72	0.18	0.599	0.407	0.41	0.45	0.5	0.8	0.59	0.59691
0.18	0.72	0.599	0.407	0.41	0.45	0.5	0.4	0.72	0.71927
0.09	0.81	0.599	0.407	0.41	0.45	0.5	0.4	0.77	0.76342
0	0.9	0.599	0.407	0.41	0.45	0.5	0.4	0.79	0.79376
0.18	0.72	0.599	0.407	0.41	0.45	0.5	0.6	0.77	0.78496
0.09	0.81	0.599	0.407	0.41	0.45	0.5	0.6	0.82	0.81577
0	0.9	0.599	0.407	0.41	0.45	0.5	0.6	0.85	0.8336
0.18	0.72	0.599	0.407	0.41	0.45	0.5	0.8	0.87	0.83969
0.09	0.81	0.599	0.407	0.41	0.45	0.5	0.8	0.83	0.85004
0.41	0	0.354	0.843	0.14	0.35	0.5	0.5	0.37	0.40543
0.41	0	0.381	0.87	0.14	0.35	0.5	0.5	0.47	0.50602
0.41	0	0.408	0.898	0.14	0.35	0.5	0.5	0.51	0.516
0.41	0	0.435	0.925	0.14	0.35	0.5	0.5	0.48	0.50085
0.4	0	0.567	0.633	0.2	0.49	0.5	0.6	0.23	0.2292
0.4	0	0.567	0.633	0.2	0.5	0.5	0.6	0.37	0.36439
0.4	0	0.439	0.815	0.14	0.35	0.5	0.7	0.25	0.2957

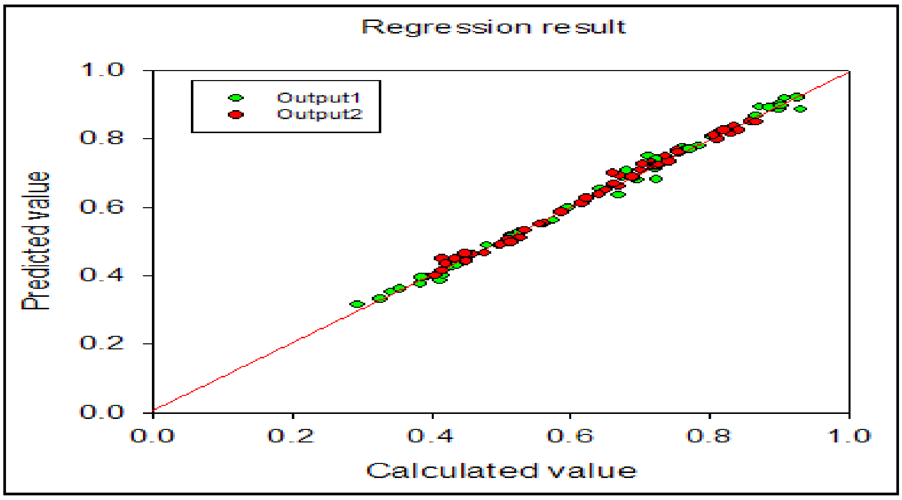
0.4	0	0.439	0.815	0.14	0.35	0.3	0.7	0.27	0.30052
0.41	0	0.369	0.863	0.15	0.37	0.4	0.7	0.32	0.33897

Table 4:- Prediction Data set

inp 1	inp2	inp3	inp 4	inp 5	inp 6	inp 7	inp 8	output	pred out
0.41	0	0.369	0.863	0.15	0.37	0.4	0.7	0.33	0.33897
0.41	0	0.431	0.801	0.14	0.35	0.5	0.7	0.37	0.33897
0.41	0	0.431	0.801	0.14	0.35	0.5	0.8	0.4	0.41637
0.41	0	0.369	0.863	0.14	0.35	0.5	0.7	0.4	0.37874
0.41	0	0.431	0.801	0.14	0.35	0.5	0.6	0.42	0.46386
0.41	0	0.431	0.801	0.14	0.35	0.5	0.7	0.43	0.57368
0.41	0	0.431	0.801	0.14	0.35	0.5	0.5	0.45	0.46547
0.41	0	0.431	0.801	0.14	0.35	0.5	0.4	0.44	0.46973
0.41	0	0.369	0.863	0.17	0.41	0.28	0.4	0.57	0.54388
0.48	0	0.369	0.863	0.14	0.3	0.5	0.4	0.63	0.65127
0.48	0	0.369	0.863	0.17	0.3	0.5	0.7	0.68	0.68374
0.41	0	0.431	0.801	0.14	0.35	0.5	0.7	0.89	0.57368
0.41	0	0.369	0.831	0.14	0.35	0.5	0.4	0.29	0.29691
0.41	0	0.369	0.72	0.14	0.35	0.5	0.4	0.29	0.30799
0.41	0	0.369	0.829	0.14	0.35	0.5	0.4	0.25	0.28898
0.41	0	0.411	0.821	0.15	0.37	0.43	0.7	0.28	0.2769
0.41	0	0.411	0.821	0.16	0.37	0.37	0.4	0.33	0.34556
0.41	0	0.411	0.821	0.14	0.35	0.5	0.7	0.35	0.39465
0.41	0	0.411	0.821	0.14	0.35	0.5	0.8	0.48	0.49009
0.41	0	0.411	0.821	0.14	0.35	0.5	0.6	0.51	0.50635
0.41	0	0.411	0.821	0.14	0.35	0.5	0.5	0.52	0.4894
0.41	0	0.411	0.821	0.14	0.35	0.5	0.4	0.55	0.54007
0.42	0	0.37	0.688	0.12	0.27	0.43	0.5	0.34	0.36072
0.35	0	0.43	0.8	0.14	0.41	0.5	0.4	0.2	0.22099
0.37	0	0.401	0.745	0.11	0.29	0.42	0.5	0.35	0.35834
0.25	0	0.463	0.86	0.07	0.28	0.42	0.5	0.37	0.38643
0.31	0	0.432	0.803	0.09	0.27	0.42	0.5	0.42	0.43332
0.4	0	0.36	0.822	0.15	0.37	0.5	0.8	0.44	0.45574
0.41	0	0.431	0.801	0.16	0.37	0.3	0.7	0.36	0.36425
0.41	0	0.431	0.801	0.17	0.41	0.3	0.7	0.38	0.38872
0.37	0	0.369	0.863	0.18	0.5	0.49	0.4	0.54	0.54264
0.53	0	1.067	0	0.14	0.26	0.5	0.4	0.56	0.5777

0.38	0	0.369	0.863	0.17	0.46	0.5	0.6	0.35	0.35207
0.41	0	0.431	0.801	0.2	0.49	0.44	0.6	0.54	0.54103
0.4	0	0.427	0.793	0.14	0.35	0.5	0.7	0.37	0.41373
0.4	0	0.427	0.793	0.14	0.35	0.5	0.7	0.36	0.41373
0.4	0	0.427	0.793	0.2	0.5	0.5	0.7	0.76	0.74798
0.41	0	0.431	0.801	0.14	0.35	0.5	0.8	0.42	0.41636
0.4	0	0.427	0.793	0.44	0.98	0.5	0.7	0.66	0.65622
0.43	0	0.42	0.78	0.17	0.39	0.4	0.7	0.2	0.28518
0.43	0	0.42	0.78	0.17	0.39	0.4	0.7	0.24	0.28518
0.43	0	0.42	0.78	0.17	0.39	0.5	0.7	0.28	0.28378
0.43	0	0.42	0.78	0.17	0.39	0.5	0.7	0.29	0.28378
0.44	0	0.42	0.78	0.16	0.36	0.5	0.7	0.3	0.35317
0.43	0	0.42	0.78	0.17	0.39	0.5	0.7	0.3	0.28378
0.43	0	0.42	0.78	0.17	0.39	0.4	0.4	0.32	0.32295
0.43	0	0.42	0.78	0.17	0.39	0.4	0.5	0.35	0.37257
0.43	0	0.42	0.78	0.17	0.39	0.4	0.7	0.4	0.28518
0.43	0	0.42	0.78	0.17	0.39	0.4	0.6	0.43	0.44104
0.41	0	0.369	0.863	0.14	0.35	0.5	0.7	0.36	0.37874
0.41	0	0.369	0.863	0.14	0.35	0.5	0.4	0.56	0.57592
0.49	0	0.461	0.572	0.2	0.5	0.2	0.7	0.42	0.43682
0.42	0	0.466	0.618	0.36	0.8	0.9	0.75	0.83	0.84511
0.42	0	0.466	0.618	0.36	0.85	0.9	0.75	0.37	0.35601
0.42	0	0.471	0.624	0.33	0.79	0.52	0.75	0.35	0.3274
0.41	0	0.462	0.612	0.38	0.72	0.52	0.75	0.3	0.28657
0.41	0	0.457	0.606	0.33	0.81	0.32	0.75	0.22	0.20755

Regression Curve



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V. CONCLUSIONS

Based on the objectives of the study the following conclusions are drawn:

1. Artificial Neural Network (ANN) model is a reliable computational model to solve different complex problems such as prediction problems.
2. Present study is the application of artificial neural network to predict the 28 days compressive strength of geopolymer concrete based on different concrete characteristics.
3. ANN analysis indicates good correlation between the input and output variable.
4. The statistical parameter R^2 is 0.92, 0.934, and 0.905 for training, validation, and testing steps, respectively, which implies good efficiency of the ANN model.
5. It is concluded that ANN presents good accuracy in predicting the 28 days compressive strength of geoploymer concrete.
6. Therefore, in order to predict the compressive strength of concrete with high reliability, instead of using costly experimental investigation, ANN model can be replaced.
7. Further time can also be saved and also huge amount of materials required for conducting investing can also be saved and within a time of not more than a day we can get the compressive strength of geoploymer concrete instead of waiting for a period of 28 days and conducting test to know the compressive strength.
8. More over geoploymer concrete is a booming sector in near future and also a great sustainable material to the civil engineers as well as to the environmental effects as cement is completely replaced with binder content avoiding the huge carbon emissions and acquiring a high strength within a less time compared to conventional concrete.

Scope of the project

1. Further studies should carried out on various properties like flexural and shear behaviour of GPC
2. Apply the ANN to different types of concrete which are used in market

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