PREDICTION OF SFRC SPLIT TENSILE STRENGTH BY ARTIFICIAL NEURAL NETWORK (ANN) WITH CONTROL STRENGTH AND 4 INDEPENDENT PIE TERMS

Dr. A. M. Shende[1*], Dr. A. D. Kadam[2]

Abstract:-
The object of the present research paper is to develop Artificial Neural Network Simulation and by using five π-term from four independent pi terms. (Aspect ratio, aggregate-cement ratio, water-cement ratio, percentage of fibre and control strength)) for prediction of SFRC Split Tensile strength. The output of this network can be evaluated by comparing it with experimental strength and the predicted ANN simulation strength. The study becomes more fruitful when most influencing π-term is calculated for the prediction of SFRC strength. The beauty of the models is that we can predict compressive strength, flexural strength and split tensile strength by using same model.

Keywords: ANN model; 4 independent π Terms.

[1*]Principal, Priyadarshini J. L. College of Engineering, Nagpur, Maharastra, India.
[2]Assistant Professor, Priyadarshini J. L. College of Engineering, Nagpur, Maharastra, India.

***Corresponding Author:** Dr. A. M. Shende
*Principal, Priyadarshini J. L. College of Engineering, Nagpur, Maharastra, India.

DOI: 10.48047/ecb/2023.12.si10.0057

1. INTRODUCTION:

To arrive at mathematical model, the process started with development of some preliminary mathematical relations and then arriving at some single generalized equations. Mathematical models are developed to predict the strength of SFRC for different grade of concrete, for different Aspect ratio and different percentage of steel [58] [9].

Shende A. M et.al [7-10] studied the investigation for 1) Grade of concrete M20, M30 and M40 2) Aspect Ratio 50, 60 and 67 3) Percentage of steel fibres 0%, 1%, 2% and 3%.The mathematical modeling to calculate predicted compressive strength, flexural strength and split tensile strength of SFRC are studied by Shende [4]in 2013.In this paper an attempt is made to extend the work by developing artificial neural network model by using five independent π terms that is control strength, percentage of steel fibre, Aspect ratio, water cement ratio and Aggregate cement ratio for the prediction of steel fibre reinforced concrete split tensile strength prediction of steel fibre reinforced concrete split tensile strength.

Artificial Neural Network Simulation is developed to predict strength of SFRC by using Control Strength, percentage of fibers, Aspect ratio, water cement ration and Aggregate cement ration. The Experimental data-based modelling has been achieved through mathematical models for the five independent pi terms. In such complex phenomenon involving non- linear systems it is also planned to develop artificial neural network (ANN).
The output of this network can be evaluated by comparing it with observed data. For development of ANN, the designer has to recognize the inherent pie terms that are predicted SFRC strength. Same ANN Simulation model can predict split tensile strength.

An artificial neural network (ANN) consists of three layers i.e. the input layer, the hidden layer and the output layer. Its nodes represent neurons of the brain. The specific mapping performed depends upon the architecture and synaptic weight values between the neurons of ANN network. An artificial neural network is highly distributed representation and transformation that works in parallel. The control is distributed by highly interconnected. It is utmost important to compare the data generated through, experimentally observed data and ANN data to validate the phenomenon.

2. PROCEDURE FOR ARTIFICIAL NEURAL NETWORK PHENOMENON

The observed data from the experimentation is separated into two parts viz. input data or the data of independent pi terms and the output data or the data of dependent pi terms. The input data and output data are imported to the program respectively. Through principle component analysis the normalized data is uncorrelated. This is achieved by using "prestd" function. The input and output data is then categorized in three categories viz. testing, validation and training. The common practice is to select initial 75% training, last 75% data for validation and middle overlapping 50% data for testing. This is achieved by developing a proper code.

1. The data is then stored in structures for training, testing and validation.
2. Looking at the pattern of the data feed forward back propagation type neural network is chosen.
3. This network is then trained using the training data. The computational errors in the actual and target data are computed and then the network is simulated.
4. The uncorrelated output data is again transformed on to the original form by using "poststd" function.
5. After simulating the ANN, it is found that experimentally observed values are very close and in good agreement with the ANN predicted values.

Figure 1 shows simple multilayer feed forward network for ANN and Figure 2 shows the flow diagram of ANN simulation.

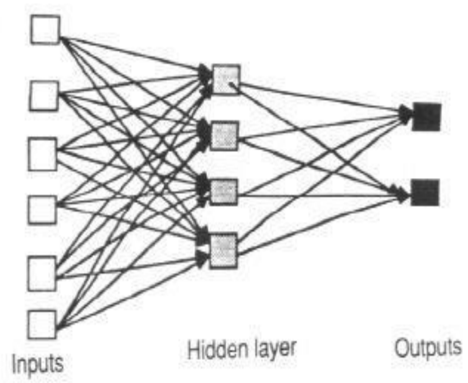

Figure 1: Simple multilayer feed forward network (ANN)

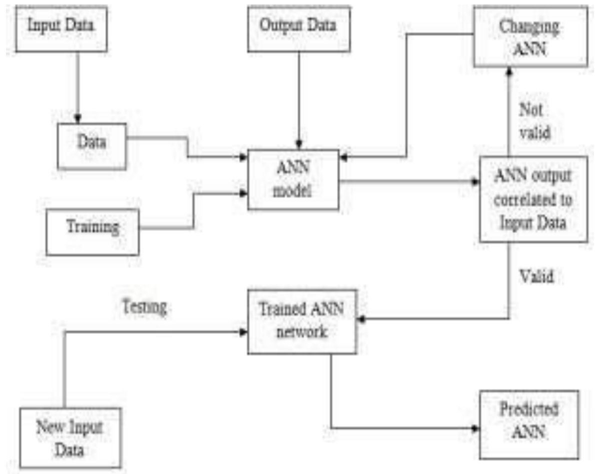

Figure 2: ANN Simulation flow diagram

Table 1 shows comparison of the values of dependent pi terms computed by experimentation, and ANN and. The values of R squared error in ANN, number of iterations, values of the regression coefficients for dependent pi terms and the plots of the actual data and target data for the dependent pi terms are shown in Figures for all response / dependent variables.

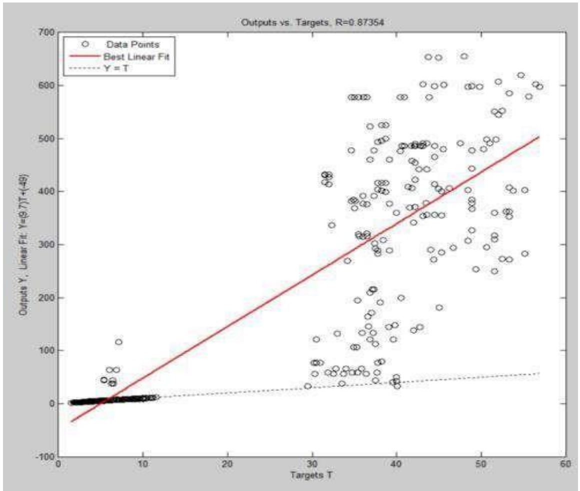

Figure 3: Target vs output graph (R2=0.7569)

It can be seen that the highest change takes place in strength, because of the π term π5(control strength) whereas the least change takes place due to Aggregate cement ratio and water cement ratio we cam developed without Aggregate cement ratio and water cement ratio model also.

Table No. 1: Performance Analysis of ANN and Comparison of Experimental and predicted Split Tensile strength

S.N.	π1	π2	π3	π4	π5	Experimental strength =□0	Predicted strength (ANNS)
1	0.43	3	1	60	3.58	4.43	5.2
2	0.43	3	0.75	60	3.58	4.31	5.8
3	0.43	3	0.5	60	3.58	3.97	4.6
4	0.43	3	0.25	60	3.58	3.74	4.40
5	0.4	4.68	0.5	55	4.34	4.55	5.80
6	0.4	4.68	0.75	55	4.34	4.63	6.0
7	0.4	4.68	1	55	4.34	4.75	6.75
8	0.4	4.68	0.5	55	4.34	4.58	7.0
9	0.4	4.68	0.75	55	4.34	5.03	7.0
10	0.42	3.2	0.75	45	2.69	3.18	5.20
11	0.42	3.2	1.5	45	2.69	2.8	4.3
12	0.44	4.7	0.25	50	3.72	3.74	5.6
13	0.44	4.7	0.5	50	3.72	3.75	4.35
14	0.44	4.7	0.75	50	3.72	3.78	5.6
15	0.44	4.7	1	50	3.72	3.96	4.3
16	0.5	4.94	1	50	3.73	4.03	5.6
17	0.5	4.94	1	50	3.73	4.43	4.35
18	0.5	4.94	1	50	3.73	3.7	5.4
19	0.5	4.94	1	50	3.73	3.91	5.20
20	0.5	4.94	1	50	3.73	3.61	5.30
21	0.5	4.94	1	50	3.73	4.32	5.60
22	0.5	4.94	1	50	3.73	4.41	5.50
S.N.	π1	π2	π3	π4	π5	Experimental strength =□0	Predicted strength (ANNS)
23	0.5	4.94	1	50	3.73	4.19	5.350
24	0.5	4.94	1	50	3.73	4.62	5.85
25	0.5	4.94	1	50	3.73	4.34	5.90
26	0.5	4.94	1	50	3.73	4.22	6.2

27	0.52	6	1	38	2	2.16	4.2
28	0.52	6	1	38	2	2.32	4.35
29	0.52	6	1	38	2	2.3	4.40
30	0.52	6	1	38	2	2.47	5.0
31	0.52	6	1	38	2	2.26	4.80
32	0.5	4.8	0.5	90	4.4	4.8	6.90
33	0.5	4.8	1	90	4.4	5.4	7.64
34	0.5	4.8	1.5	90	4.4	5.8	8.20

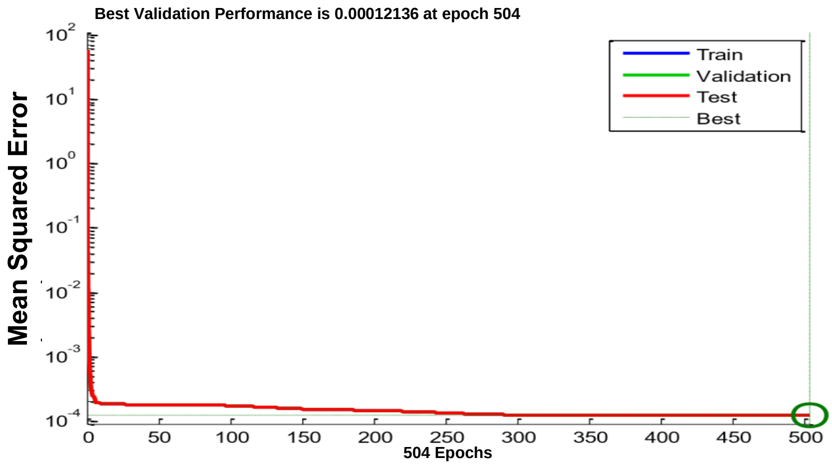

Figure 4: Shows best validation performance

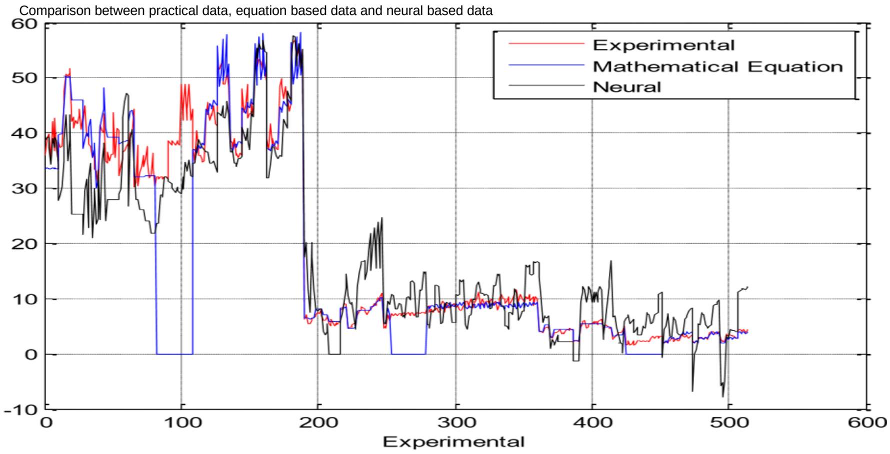

Figure 5: Comparisons between experimental data and ANN predicted strength 4 pie

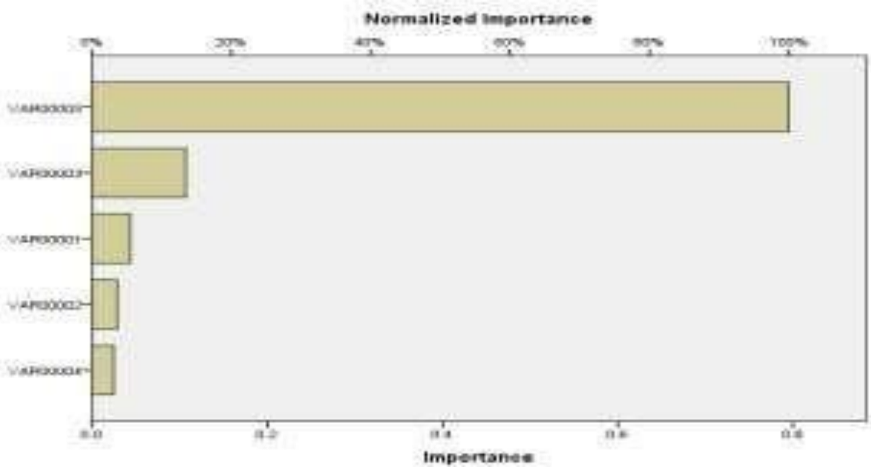

Figure 6: Shows the importance of π terms in ascending order (4 pie Terms)

It can be seen that the highest change takes place in strength, because of the π term π_5(control strength) π_5 related to control strength Variables is most important π term and π_3 related to Percentage of fiber is second important π term is the normalized importance.

3. CONCLUSION

- ANN Simulation model developed for prediction of SFRC strength, using strength of controlled concrete, percentage of fibres, aspect ratio, aggregate cement ratio and water cement ratio can very well be used in prediction of split tensile strength of SFRC using the four parameters listed above.
- ANN Simulation model developed for prediction of SFRC strength, using strength of controlled concrete, percentage of fibres, and aspect ratio can very well be used in prediction of split tensile strength of SFRC using the three parameters listed above.
- The significance of the model can very well be seen from the data presented in column experimental strength and the predicted ANN simulation strength in Table No 1 and Table No 2.
- From fig no 5 and fig no 6 it is clear that ANN simulation model developed for prediction of split tensile strength when compared with experimental strength it is observed that predicted strengths and observed experimental strength are close to each other

REFERENCES

1. P. Modak & Mrs. S. D. Moghe, "Design & Development of a Human Powered Machine for the Manufacture of Lime-Fly-ash-SandBricks" Human Power Vol. 13, pp 3-8, 1998, Journal of International Human Powered Vehicle Association, U.S.A.
2. R. Bapat, "Experimental Optimization of a Manually Driven Flywheel Motor" M.E. (By Research) Thesis of Nagpur University 1989, under the supervision of Dr. J. P. Modak.
3. S. D. Moghe & J. P. Modak, "Design and Development of a Human Powered Machine for the Manufacture of Lime - Fly-ash-Sand Bricks", Human Power, Vol. 13,pp 3-8, 1998.
4. Shende A. M. The investigation and comparative study on properties of steel fibre reinforced concrete members, Thesis.
5. Clifford N. MacDonald, Julian Trangsrud, 2004, Steel Fibre Reinforced Concrete PreCast Pipe, Proceedings of ICFRC, Vol I, pp 19-28.
6. Coutts R.S.P., 2005, A review of Australian research into natural fibre cement composites Cement & Concrete Composites. 27, pp 518526.
7. Shende A. M. & Pande A.M., 2011, "Experimental study and prediction of Tensile Strength for Steel Fiber Reinforced Concrete", International Journal of Civil and Structural Engineering", Vol.1, No 4, pp 910-917.
8. Haroon S.A., Nur Yazdani & Kamal Tawfiq, 2004, Properties of Fibre Reinforced Concrete for Florida Applications, Proceedings of ICFRC, Vol I, pp 135-144.
9. Jagannathan, 2010, Flexural Strength Characteristics of Hybrid Fibre Reinforced Cementitious Matrix, Proceeding of International conference on Innovation, Vol I, pp 347-353.
10. Shende A. M. & Pande A. M., 2011, "Mathematical Model to Calculate Predicted Compressive Strength and Its Comparison with Observed Strength", International Journal of Multidisciplinary Research and Advances in Engg. (IJMRAE), Application, Vol. 3, No. IV, pp 145-156.
11. Sashidhar C., Rao H. S. & Ramana N.V., 2004, Strength Characteristics of Fiber-Reinforced Concrete with Metakaolin, Proceedings of ICFRC, Vol I, pp 247-256.
12. Shende A. M. & Pande A. M., 2011, "Comparative study on Steel fibre reinforced cum control concrete under flexural and deflection", International Journal of Applied Engineering Research", Vol. 1, No 4, pp 942950.