Research Article

An Artificial Neural Network Based Prediction of Mechanical and Durability Characteristics of Sustainable Geopolymer Composite

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Despite the growing environmental consequences of cement production, geopolymer concrete now has gradually evolved as an ecologically sustainable product. This study experimentally investigates the effect of addition of different proportions (0%, 10%, and 20%) of rice husk ash (RHA) and polypropylene (PP) fibers (0%, 0.1%, and 0.3%) on the mechanical and durability characteristics of fly ash (FA)-based geopolymer mortars. The strength property is assessed by testing the mortar specimen by uniaxial compressive strength and flexural strength while the durability properties were tested with water absorption, water sorptivity, and acid (10% concentration of H_2SO_4) resistance tests. The experimental findings revealed that the PP fiber addition is not significant in improving the compressive strength, while the addition up to 0.3% by volume had shown good improvement in flexural behavior. Water absorption increases with an increment in the replacement proportion of RHA. Water sorptivity also increases with an increase in RHA substitution levels. Furthermore, an artificial neural network prototype was proposed in this work to forecast the mechanical and durability properties of fiber reinforced FA-RHA blended geopolymer mortar. The ANN architecture was constructed utilizing the mechanical and durability characteristics of FA-RHA blended geopolymer mortar procured through experimental investigation. The RHA substitution proportion, sodium hydroxide (NaOH) liquid concentration, and polypropylene fiber content have been employed as input parameters in the construction of ANN framework. The predicted strength values of mechanical and durability tests achieved from the ANN framework agree well with experiment results. Use of geopolymer mortar has a high potential in repairing the structural elements, and further studies can be done on applying this mortar for the repairs.

1. Introduction

Ordinary Portland Cement (OPC) is commonly used as a traditional binding material in all concreting projects. The manufacturing of OPC consumes a tremendous amount of energy and disperses a huge proportion of carbon dioxide into the Earth's atmosphere. To mitigate carbon dioxide emissions, a new promising binder known as geopolymer was introduced [1]. Numerous researches have been carried out on the effective and comprehensive utilization of different industrial waste materials in the manufacturing process of geopolymer concrete [2]. Its manufacturing process includes the formulation of binders from the alumina and silica rich sources acquired from the industrial byproducts or low-cost materials such as fly ash (FA), ground granulated blast furnace slag (GGBS), metakaolin (MK), rice husk ash (RHA), high magnesium nickel slag (HMNS), palm oil fuel ash (POFA), waste glass powder (WGP), red mud, etc. using an alkali activator solution [3–5]. The presence of binding material in geopolymer

binder is supplemented by industrial/agricultural wastes that comprises pozzolanic characteristics comparable to OPC and abundant in alumina and silica proportions [6–8]. In order to extract the silica and alumina sourced from the raw materials, the alkali-activated solution is employed as a catalyst which contains a mixture of sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) solutions [9, 10].

FA and RHA are industrial byproducts of thermal power stations and rice husk burning, respectively. The principal objective of producing a geopolymer composite from an industrial byproduct is to promote a sustainable alternative for conventional Portland cement concrete by significantly lowering greenhouse gas emissions and industrial waste disposal concerns [11–13]. Earlier studies showed that the effectiveness and usage of higher molarity of alkaline solution significantly influence the early strength of the geopolymer concrete [3, 14, 15]. Literature reported that the required mechanical properties of the geopolymer concrete specimens could be achieved in the ambient curing conditions [16, 17]. On the other hand, FA-GGBS based geopolymer binders produced excellent mechanical and microstructural characterizations even after the exposure to elevated temperatures [18, 19]. The addition of copper slag in the FA type geopolymer concrete resulted in higher compressive strength results [20, 21]. Partial incorporation of RHA with FA in geopolymer concrete resulted in an increase in durability and mechanical strength properties [22, 23]. Incorporation of RHA as a source material in the slag-based geopolymer concrete resulted in greater compressive and split-tensile strength results [24].

ANN is based on machine learning framework that simulates a network of biological neural networks. It can be used extensively in the domain of science and engineering to overcome extremely complex problems [25, 26]. The ANN framework outperforms other techniques in aspects of nonlinear connection among input parameters [27]. According to recent findings, the ANN structure can be used successfully in the construction and building materials stream to estimate their strength properties with precision [28–30]. Khademi et al. employed multiple linear regression (MLR), artificial neural network, and adaptive neurofuzzy inference system (ANFIS) techniques to estimate the 28-day compressive strength of concrete [31]. Apart from mechanical strength, other important parameters like mix design [32], cement content [33], replacement level of recycled coarse aggregates [34], drying shrinkage of concrete [35], slump values [36], etc. can also be predicted with the help of neural networks along with experimental results. Several studies described that the compressive, split-tensile, and flexural (mechanical) properties of FA-based geopolymer matrix are predicted with the application of the ANN framework [37, 38].

Although the usage of FA in geopolymer production is significantly reported in the kinds of literature, the use of RHA and fibers is scanty. This experimental investigation is aimed at exploring the influence of fiber and RHA in the fly ash based geopolymer mortar, since the potential use of geopolymer mortar as a repair material for the strengthening of structures. In addition to this ANN framework was

TABLE 1: Chemical constituents of geopolymer precursors.

Chemical components (%)	Fly ash	Rice husk ash
SiO_2	63.39	87.42
Al_2O_3	26.85	2.85
CaO	2.54	0.71
Fe_2O_3	5.57	0.56
MgO	0.42	0.37
ZnO	—	0.02
MnO	0.02	—
LOI	0.30	0.88

developed using Levenberg-Marquardt (LM) Algorithm in MATLAB-2018a to estimate the mechanical and durability strength results of fiber incorporated RHA-FA-based geopolymer mortar.

2. Materials and Experimental Program

2.1. Materials and Sample Preparation. In this study, the materials procured for the geopolymer mortar preparation were FA and RHA. The FA and RHA obtained from Kolkata were used as the source materials. Table 1 presents the chemical compositions of the geopolymeric precursor products acquired from X-ray fluorescence (XRF) analysis. Locally resourced river sand with specific gravity 2.5 was used as fine aggregate. The mixture of commercially available sodium hydroxide (flakes type) and sodium silicate (liquid gel type) sourced and supplied by Sharma brothers, India, was employed as an alkaline activator solution. The alkali activator solution was produced by blending sodium silicate solution with a molar ratio (SiO_2/Na_2O) of 2.65 and sodium hydroxide. The specific gravity and molar mass of the sodium silicate solution and sodium hydroxide pellets employed were 1.52 and 2.14 and 123 g/mol and 38.8 g/mol, respectively. The source materials present in the FA and RHA geopolymer mortars were enhanced by the alkali activator solution. Commercially available PP fibers and sulfuric acid were used. Figure 1 illustrates the visual appearances of the geopolymeric source materials (RHA and FA) and PP fibers used in this investigation.

A partial replacement of FA was carried out using RHA (0%, 10%, and 20%) with the addition of polypropylene fiber of 0.0%, 0.1%, and 0.3% by volume and mixed thoroughly with alkaline activator solution to obtain uniform slurry. Fine aggregate was then introduced to the slurry in the ratio of 1 to FA to obtain geopolymer mortars. Geopolymer specimens were prepared in two layers using $70 \times 70 \times 70$ mm cubes and vibrated for about two minutes in table vibrator to remove the entrapped air present in mortars. The geopolymer mortar specimens thus prepared were cured in the hot air oven for about 24 hours at the temperature of 110°C and then kept in the ambient conditions until further testing.

2.2. Experimental Approach. The various mix proportions considered for the experimental investigations on FA-RHA geopolymer mortar influenced with polypropylene fibers are listed below. The mixes with varying % of RHA and the
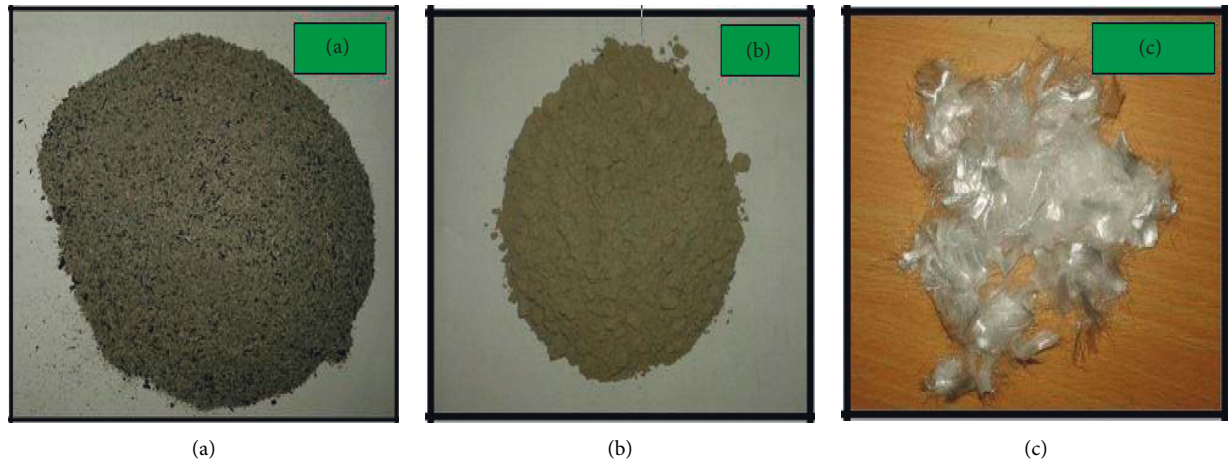
(a)

(b)

(c)

Figure 1: Visual appearance of materials used in the study: (a) RHA, (b) FA, and (c) PP fibers.

Table 2: Details of the geopolymer mortar mixes.

Mix ID	FA (Kg/m^3)	RHA (Kg/m^3)	Fiber (%)	FA (%)	RHA (%)	Molarity of NaOH
G_{1-3}	600	0	0	100	0	5 M, 10 M, 15 M
G_{4-6}	600	0	0.1	100	0	5 M, 10 M, 15 M
G_{7-9}	600	0	0.3	100	0	5 M, 10 M, 15 M
G_{10-12}	540	60	0	90	10	5 M, 10 M, 15 M
G_{13-15}	540	60	0.1	90	10	5 M, 10 M, 15 M
G_{16-18}	540	60	0.3	90	10	5 M, 10 M, 15 M
G_{19-21}	480	120	0	80	20	5 M, 10 M, 15 M
G_{22-24}	480	120	0.1	80	20	5 M, 10 M, 15 M
G_{25-27}	480	120	0.3	80	20	5 M, 10 M, 15 M

polypropylene fibers resulted in 27 mixes, as reported in Table 2. The strength reported was the average of three identical specimens. To achieve the preferred workability in all mixture proportions, the alkaline to binder ratio and sodium silicate to sodium hydroxide fraction were selected to 0.5 and 2.5, respectively. For all of the mix composition, the quantities of fine aggregates, binder content, sodium silicate solution, and sodium hydroxide flakes selected were 600 kg/m^3, 600 kg/m^3, 257.15 kg/m^3, and 102.85 kg/m^3, respectively.

Universal Testing Machine (UTM) was used for calculating the uniaxial compressive strength of geopolymer mortars at 28 days as per IS 516 (1959) provisions. The flexural strength characteristics of fiber reinforced FA-RHA based geopolymer mortar specimens were ascertained in accordance with IS 516 (1959) standards using a Universal Testing Machine of 1000 kN capacity [39]. Prism samples of size 40 × 40 × 160 mm were casted and examined for flexural performance after 28 days. The method monitored for the determination of water absorption of geopolymer samples was in accordance with ASTM C 642 standards [40]. After measuring the weights of 28-day-old geopolymer mortar samples, they were dried at 110°C for 24 hours before being immersed in water. The specimens were then removed from the water and wiped clean and directly weighed in saturated surface dry conditions to find an increase in weight.

Existing literature reports proved that geopolymer binders were acid resistant, providing them a promising and alternative construction material for the sewer environment. This study examines the durability of FA-RHA based geopolymer mortars subjected to 10% sulfuric acid concentration for 56 days and tested for its strength according to ASTM C 643 standards [41]. The rate of capillary rise absorption by mortar cube is ascertained by the sorptivity test. The samples are initially coated with waterproof enamel paint on all sides except the bottom and top surfaces, so as to allow capillary uptake of water only from the bottom. The specimens are then conditioned at 110°C for 24 hours to obtain constant mass. Test samples are made to rest on supports (a supporting wire mesh in the present case) in a manner such that only the lowest 2 to 5 mm of the cube is underwater. The rise in the mass of the sample with time is noted. Then water uptake per unit area of concrete surface I (g/mm^2) is plotted with the square root of time for the suction periods (t). Hence $I = C + St^{1/2}$ where I = increase in mass per unit area (g/mm^2); t = time, measured in minutes at which the mass is determined; S = sorptivity in g/mm^2/min$^{0.5}$; $C = a$ constant.

3. Prediction of Strength and Durability Characteristics Using ANN

ANN is indeed a massively simultaneous computing intelligence processing architecture which operates equivalent to biological neural systems [42]. It also has the ability to comprehend and extrapolate mostly from provided
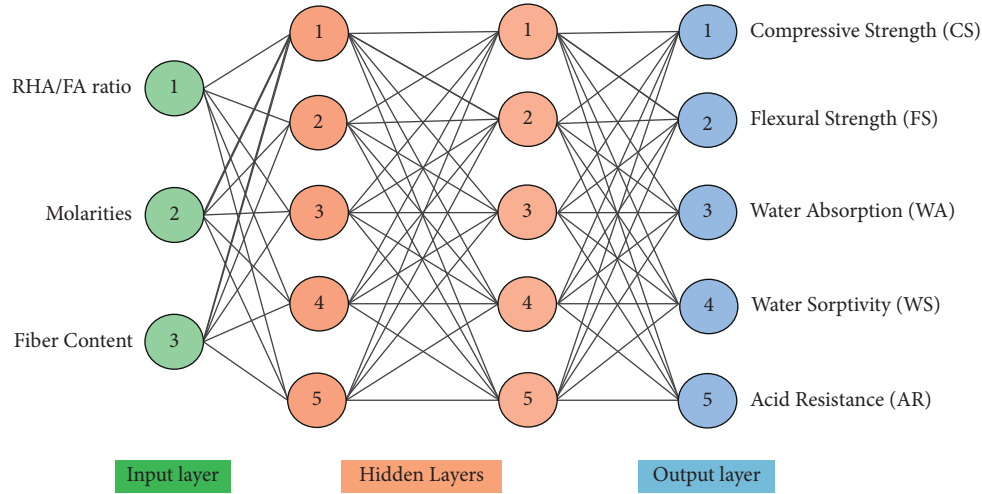
FIGURE 2: ANN (3-5-5-5) architecture selected for the preset study.

TABLE 3: The ranges of input and output parameters selected in ANN framework.

Si. No.	Variables	Units	Limits	Remarks
1.	RHA/FA ratio	—	0 to 0.25	
2.	NaOH concentration	M	5 to15	Inputs
3.	Fiber content	%	0 to 0.3	
4.	Compressive strength	MPa	40 to 62	
5.	Flexural strength	MPa	7.5 to 12.4	
6.	Water absorption	%	0.759 to 4.0	Outputs
7.	Water sorptivity	mm/min$^{0.5}$	0.208 to 1.10	
8.	Acid resistance	MPa	20 to 44	

information and intended to deliver appropriate responses even though the group of input variables comprises an inconsistency or is ambiguous [37, 43]. It comprises several interlinked engineered neuron-like structures, each of which delivers a distinct response (Y) from most of the inputs (X_j) across equation (1) [44]. The activation function (f) is associated with the sum of input parameters procured from the sum function and determines the neuron's output. Phrase (H) illustrates the amount of the input parameters that can be anticipated using equation (2), and "b" is the bias coefficient, which is applied to influence the activation function.

$$Y = f(H) = \frac{1}{1 + e^{-H}}, \tag{1}$$

$$S = \sum_{j=1}^{n} X_j W_j + b. \tag{2}$$

Since the ANN framework constitutes three components, it can be regarded as a Multilayer Perception (MLP) structure, as illustrated in Figure 2. The first layer (input layer) contains three independent variables (RHA/FA ratio, different molarities, and percent of fibers) that are used for entering data. The second layer is regarded as the hidden layer or computational layer, whereas the third layer is recognized as the output layer, from which ANN model

estimates compressive, flexural, water absorption, acid resistance, and water sorptivity values.

Different variables such as RHA/FA ratio, varying concentrations of NaOH solution, and percentages of polypropylene fibers have a significant impact on the strength and durability characteristics of geopolymer mortar mixes [45, 46]. Hence, the RHA/FA ratio, different molarities, and percentages of polypropylene fibers were preferred as input parameters for the geopolymer mortar mixes, and the target variables were compressive strength (CS), flexural strength (FS), water absorption (WA), water sorptivity (WS), and acid resistance (AR) of geopolymer mortar specimens.

The overall amount of hidden compartments and the number of neurons in every hidden compartment in the ANN structure could be ascertained through implementing the handful of assessments throughout the training and testing period until the desired outcomes are achieved with negligible error values. The LM algorithm was implemented in ANN model with feedforward backpropagation technique to estimate the durability and mechanical properties of geopolymer mortar using an ANN model with two hidden layers and five neurons in each layer. Out of 27 experimental test results, 19 were selected for training, 4 for testing, and 4 for validation phase. The limits for input and output responses considered for this study are listed in Table 3. The accuracy of the output responses recorded from the
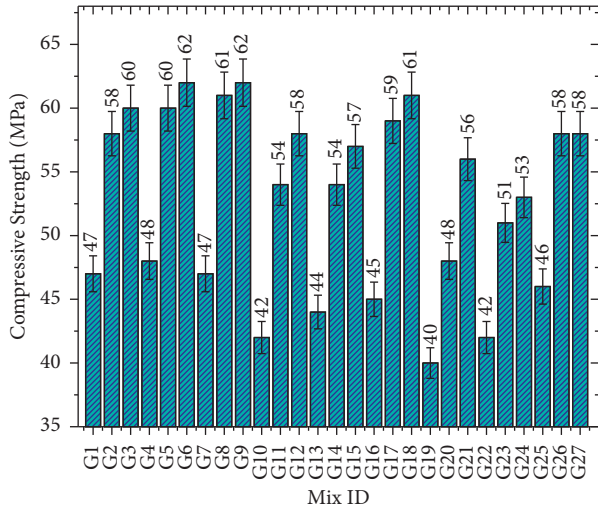
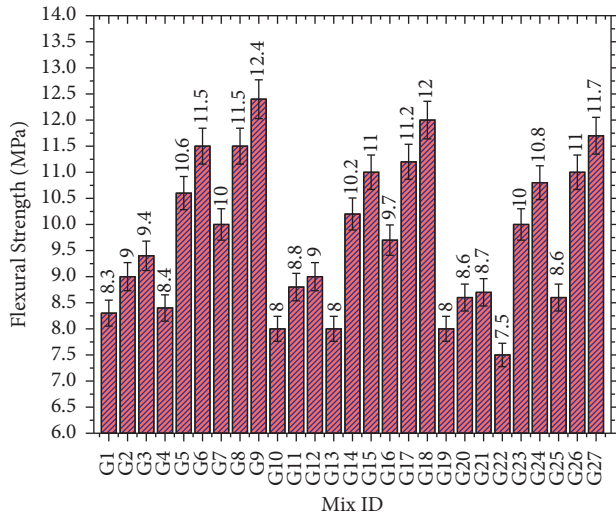FIGURE 3: Compressive strength development of FA-RHA based geopolymer mortars.

FIGURE 4: Flexural strength development of FA-RHA based geopolymer mortars.

developed ANN framework were ascertained in terms of error percentages using the following equation [44]:

$$\text{error prediction}(\%)$$

$$= \frac{\text{experimental results} - \text{predicted results}}{\text{experimental results}} \times 100. \quad (3)$$

4. Results and Discussion

4.1. Compressive Strength. The compressive strength development of ambient cured (110°C for 24 hours) FA-based geopolymer mortar samples containing varying proportions of RHA (0%, 10%, and 20%), polypropylene fibers (0%, 0.1%, and 0.3%), and NaOH solution concentrations (5 M, 10 M, and 15 M) was represented in Figure 3. According to Figure 3, the highest compressive strength value of 62 MPa was
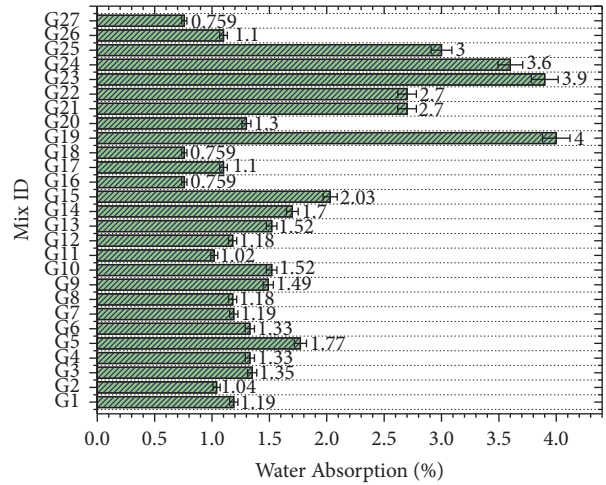

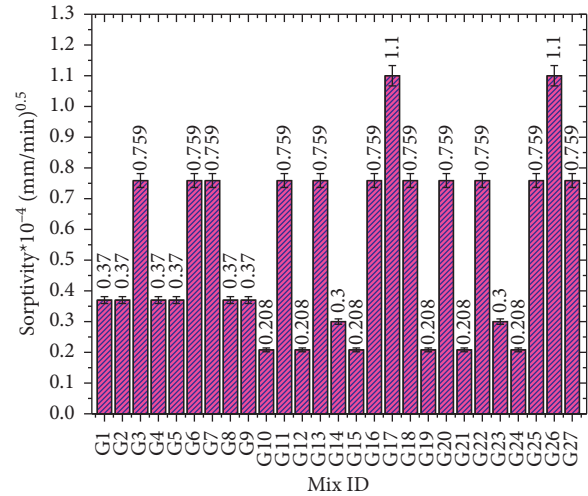FIGURE 5: Water absorption results of geopolymer mortar specimens.

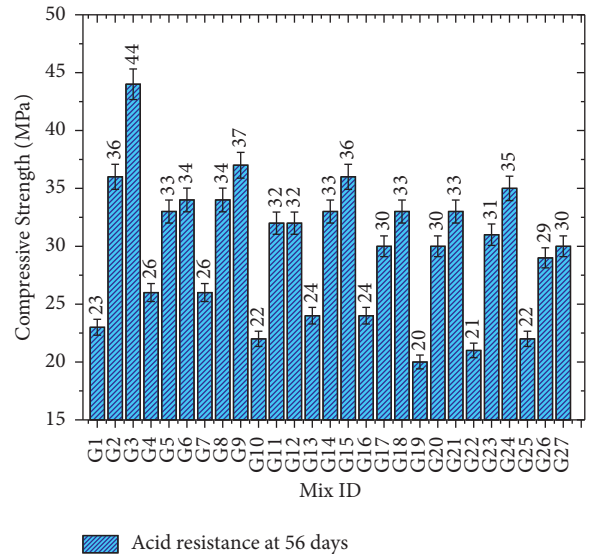FIGURE 6: Water sorptivity test results for geopolymer mortar samples.

FIGURE 7: Compressive strength at 56 days of 10% of H_2SO_4 solution exposure.

TABLE 4: Percentage of error values obtained from the ANN framework.

Mix ID	Predicted error in percentage (%)				
	Compressive strength	Flexural strength	Water absorption	Sorptivity	Acid resistance
G1	1.91	3.61	−3.36	2.16	2.17
G2	−0.17	−1.11	−2.88	−3.78	−3.89
G3	−2.97	−1.06	−1.48	−3.95	−1.59
G4	1.46	−1.19	−3.76	3.24	2.69
G5	0.17	3.77	−3.39	−2.70	1.82
G6	−0.32	1.74	−4.51	−2.24	0.65
G7	0.19	3.50	−2.52	2.11	−3.27
G8	0.66	2.61	−2.54	−2.70	−3.88
G9	−1.13	−1.61	−2.01	2.97	1.54
G10	−3.21	1.25	−1.97	−0.96	−4.77
G11	0.19	3.41	4.90	−1.84	−2.97
G12	0.69	−3.33	−2.54	−5.77	1.78
G13	1.36	−2.50	−4.61	−0.66	2.63
G14	2.22	−1.96	−4.12	6.33	−0.64
G15	0.35	0.91	−3.94	−2.40	0.69
G16	−0.89	3.09	−5.40	−2.77	−0.21
G17	1.86	−1.79	−1.82	−6.36	−1.00
G18	−0.66	1.67	−5.40	1.98	3.52
G19	−1.50	2.13	−2.75	1.92	−6.15
G20	−1.04	−1.16	−3.08	−0.79	4.17
G21	1.25	−1.15	−4.81	−1.44	1.39
G22	0.95	−4.00	−2.96	2.37	3.24
G23	2.94	2.00	3.33	1.33	−1.03
G24	−1.13	−0.93	1.94	−3.37	0.74
G25	0.43	3.49	−4.00	2.24	−0.23
G26	−0.55	−1.82	−4.55	−1.82	−3.00
G27	0.69	0.85	−2.77	−1.45	2.33

FIGURE 8: Comparison of experimental and predictive compressive strength results.
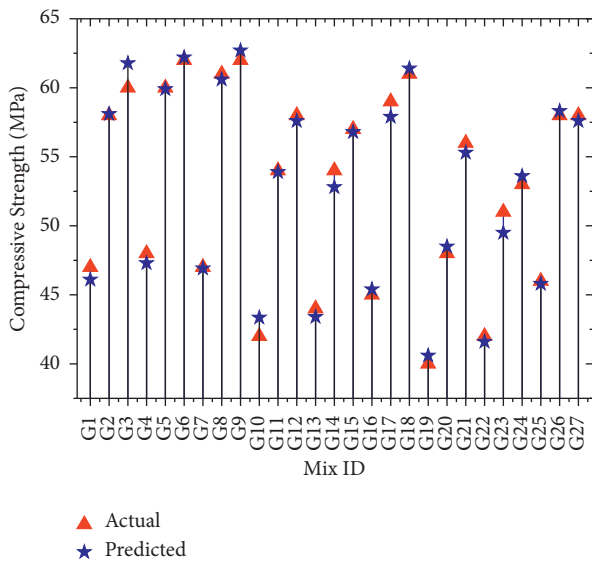

FIGURE 9: Comparison of experimental and predictive flexural strength results.

ascertained for G6 and G9 mortar mixes featuring 100 percent FA. Due to the higher geopolymerization reaction, equivalent higher compressive strength results were observed for mortar mixes containing 10% and 20% substitution levels of RHA with a 15 M concentration of NaOH solution [47, 48]. In addition, the compressive strength
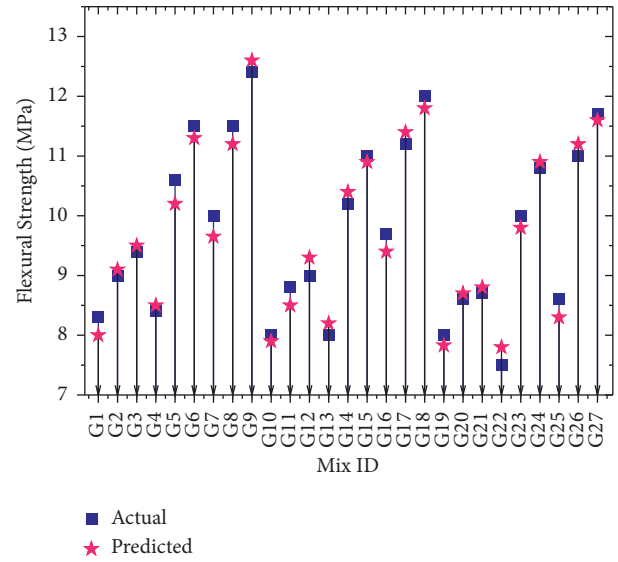
properties of geopolymer specimens consisting of 10 M and 15 M concentration of NaOH solution were comparable. Furthermore, it can be stated that inclusion of different proportion of PP fibers did not produce significant change in the compressive strength of FA-RHA based geopolymer mortars.
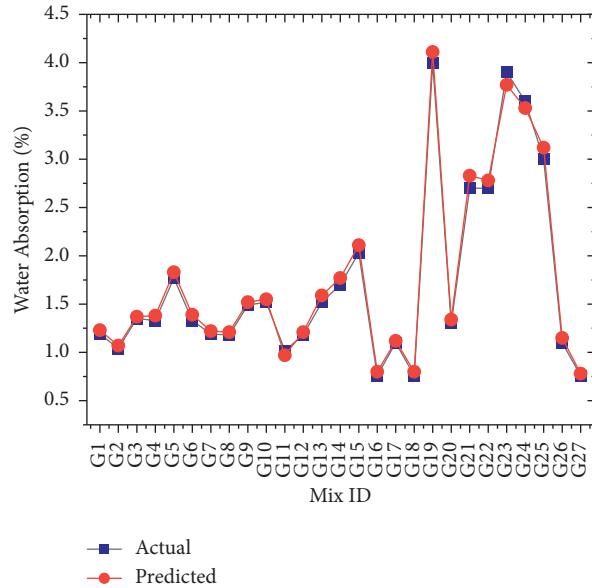
FIGURE 10: Comparison of experimental and predictive water absorption values.
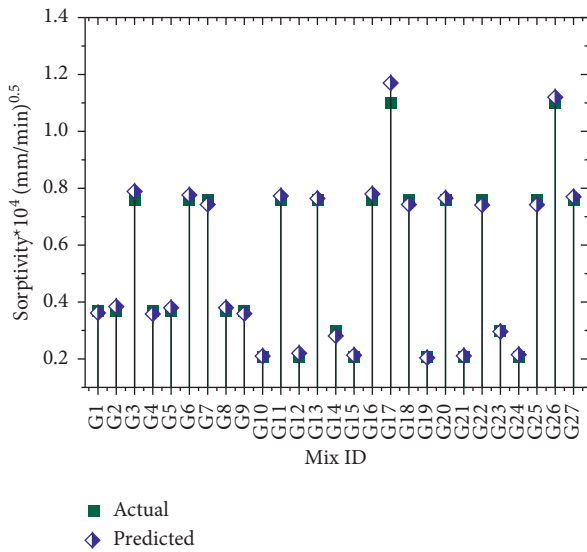

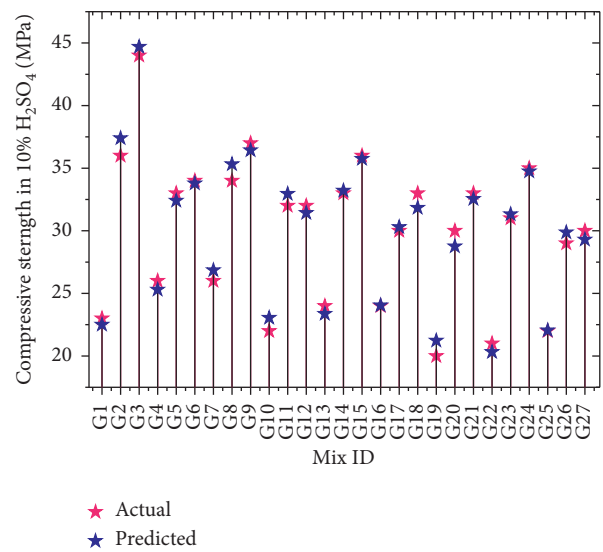FIGURE 11: Comparison of experimental and predictive sorptivity results.

FIGURE 12: Comparison of experimental and predictive acid resistance results.

4.2. Flexural Strength.

Figure 4 depicts the flexural strength characteristics of various geopolymer mortar mixes evaluated in this experimental investigation. From Figure 4, it can be observed that the incorporation of 0.3 percent polypropylene fibers in FA-RHA blended geopolymer mortars resulted in a marginal increase in flexural strength characteristics for G7, G8, G9, G16, G17, G18, G25, G26, and G27 mixes when compared to the other mortar mix proportions. The maximum flexural strength of 12.4 MPa was recorded for the geopolymer mix G9 comprising 100% FA and 0.3% polypropylene fiber. Furthermore, the experimental results of flexural tests revealed that a higher concentration (15 M) of NaOH solution resulted in a significant increase in flexural strength of geopolymer specimens

[15, 49]. A higher concentration of NaOH solution enhances the solubility of Al and Si ions from the precursor materials, resulting in the generation of relatively strong Si–O–Al, C-A-S-H, and N-A-S-H gels which resulted in the increase in strength properties. However, the different RHA substitution levels have no effect on the development of flexural strength in FA-based geopolymer mortars. The increased proportion of RHA results in a significant concentration of unreacted RHA granules in the geopolymer mixture, resulting in a relatively weak and less ductile geopolymer matrix. The enhanced quantity of SiO_2 disruptions the interaction of Si and Al particles ultimately results in a lesser density geopolymer binder with lower flexural strength [50].
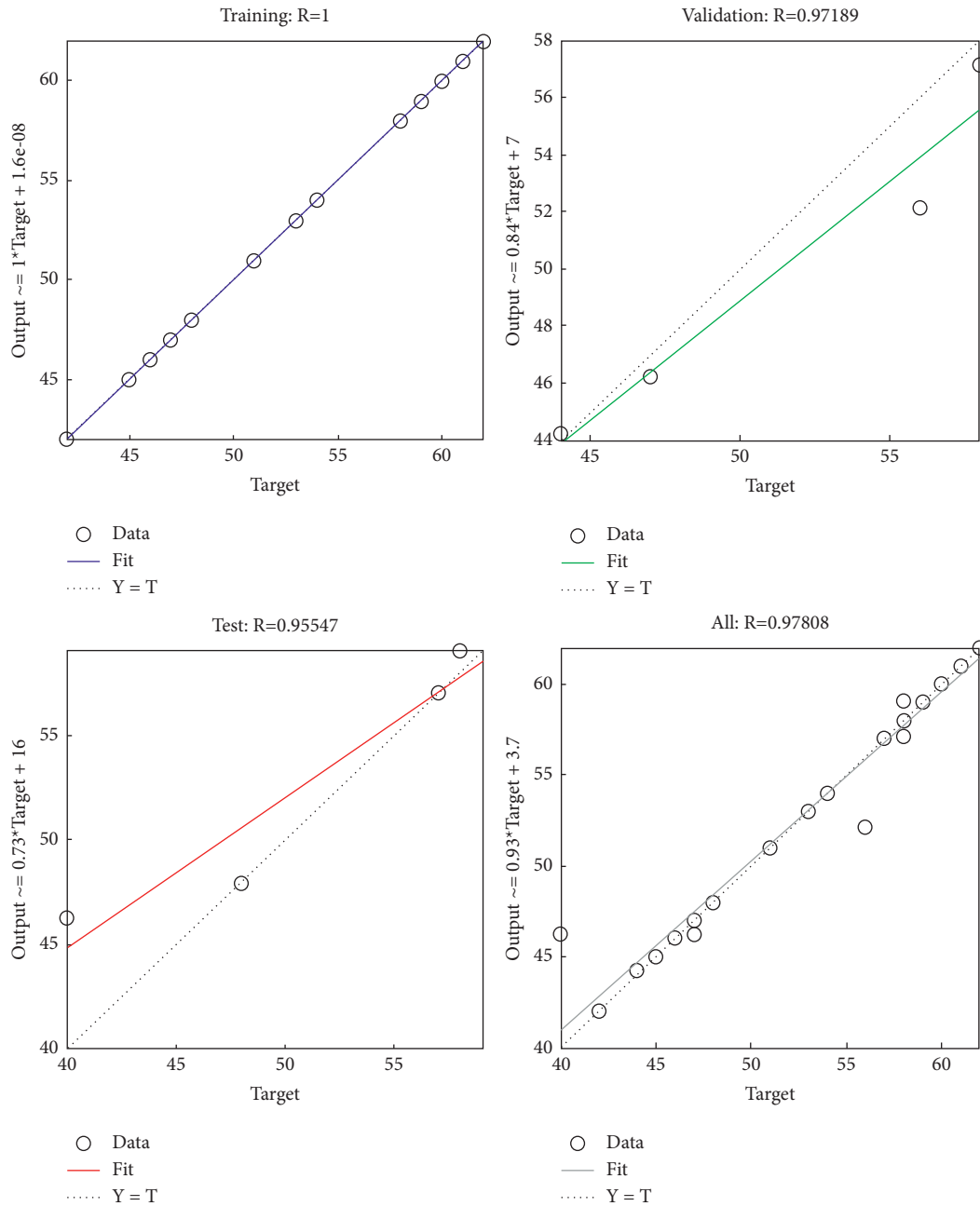
FIGURE 13: Assessment of predicted compressive strength results.

4.3. Water Absorption. Figure 5 demonstrates the water absorption test results after 240 mins for oven cured FA-based geopolymer mortar specimens with varying levels of RHA (0%, 10%, and 20%), polypropylene fibers (0%, 0.1%, and 0.3%), and NaOH (5 M, 10 M, and 15 M). From Figure 5, it can be observed that G7, G8, G9, G16, G17, G18, G25, G26, and G27 geopolymer mixes with 0.3 percent PP fiber incorporation had lower water absorption than the other mixes.

The behavior of the PP fibers restricts the formation of microcracks, which reduces the water absorption capacity of the mortar mixes. Furthermore, the PP fiber's non-absorbability (hydrophobicity) nature contributed to a decrease in waster absorption capacity [51]. Moreover,

introducing 20% RHA replacement levels to FA-based geopolymer mortar resulted in increased water absorption test result compared to other combinations.

4.4. Water Sorptivity. Water sorptivity test results for the series of the FA-based geopolymer mortars substituted with varying proportions of RHA (0%, 10%, and 20%) and polypropylene fibers (0%, 0.1%, and 0.3%) under the influence of different NaOH solution (5 M, 10 M, and 15 M) were represented in Figure 6. From the test results it can be observed that the rate of water absorption for geopolymer mortars containing (100% FA) and (90% FA: 10% RHA) produced less sorptivity values. On the other hand,
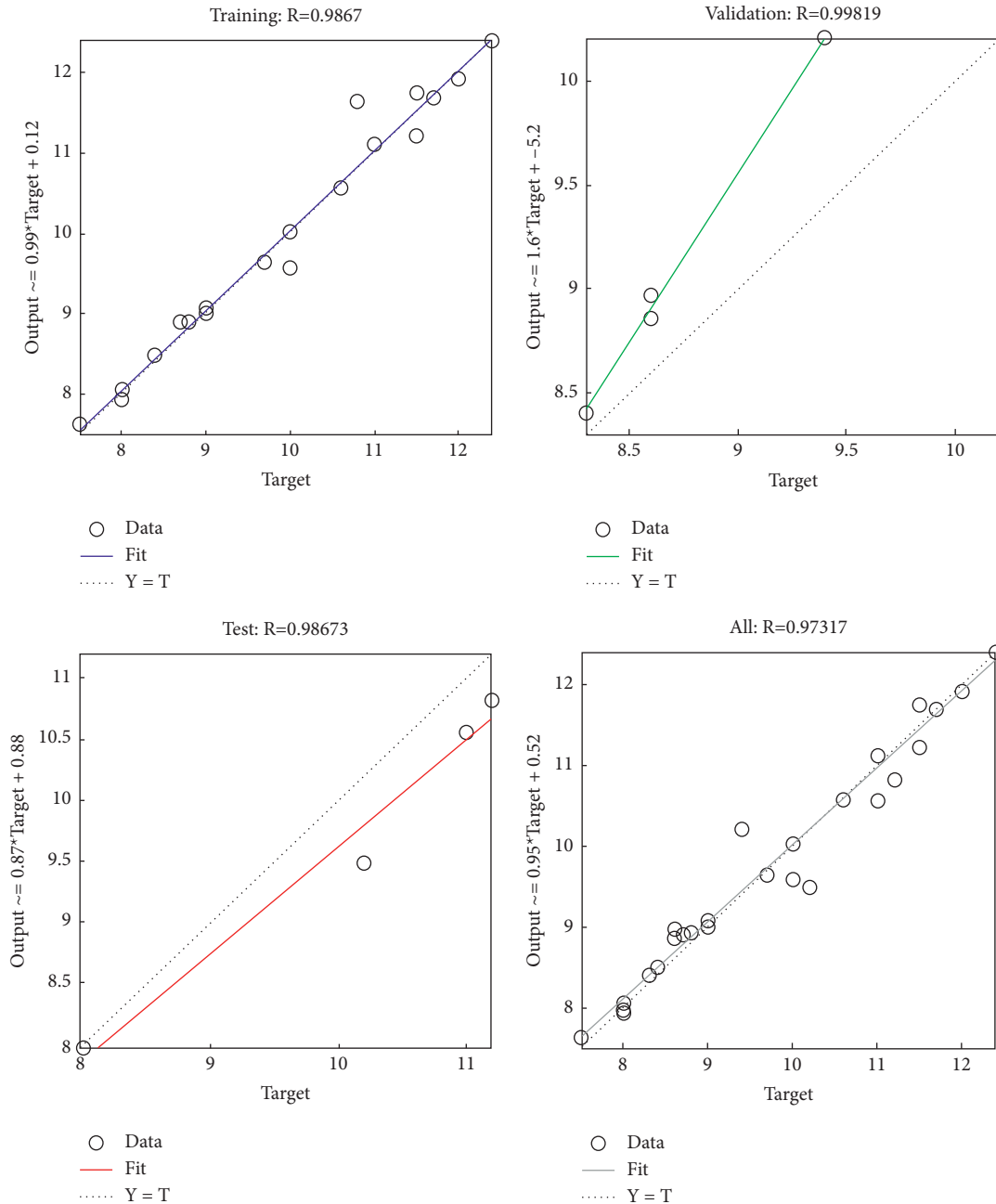
FIGURE 14: Assessment of predicted flexural strength values.

geopolymer mortar mixes constituting 80% FA and 20% RHA showed higher rate of water absorption due to the inferior properties of RHA particles such as higher water absorption capacity than FA [50].

4.5. Acid Resistance. Figure 7 demonstrates the compressive strength progression of polypropylene fiber (0%, 0.1%, and 0.3%) reinforced geopolymer mortar samples immersed in 10% H_2SO_4 solution for 56 days with different levels of RHA (0%, 10%, and 20%) under varying concentrations of NaOH solution. According to Figure 7, geopolymer mixtures with higher molar concentrations of NaOH solution (10 M and 15 M) demonstrate a similar phenomenon in compressive strength results; meanwhile combinations with a 5 M concentration of NaOH produced relatively low strength values. Consequently, geopolymer mixes featuring 100 FA achieved superior compressive strength performance in an acid (10% H_2SO_4) environment, whereas mortar samples enclosing 10% and 20% RHA percentages developed comparatively lower strength results. From the experimental outcomes, it can be inferred that increase in
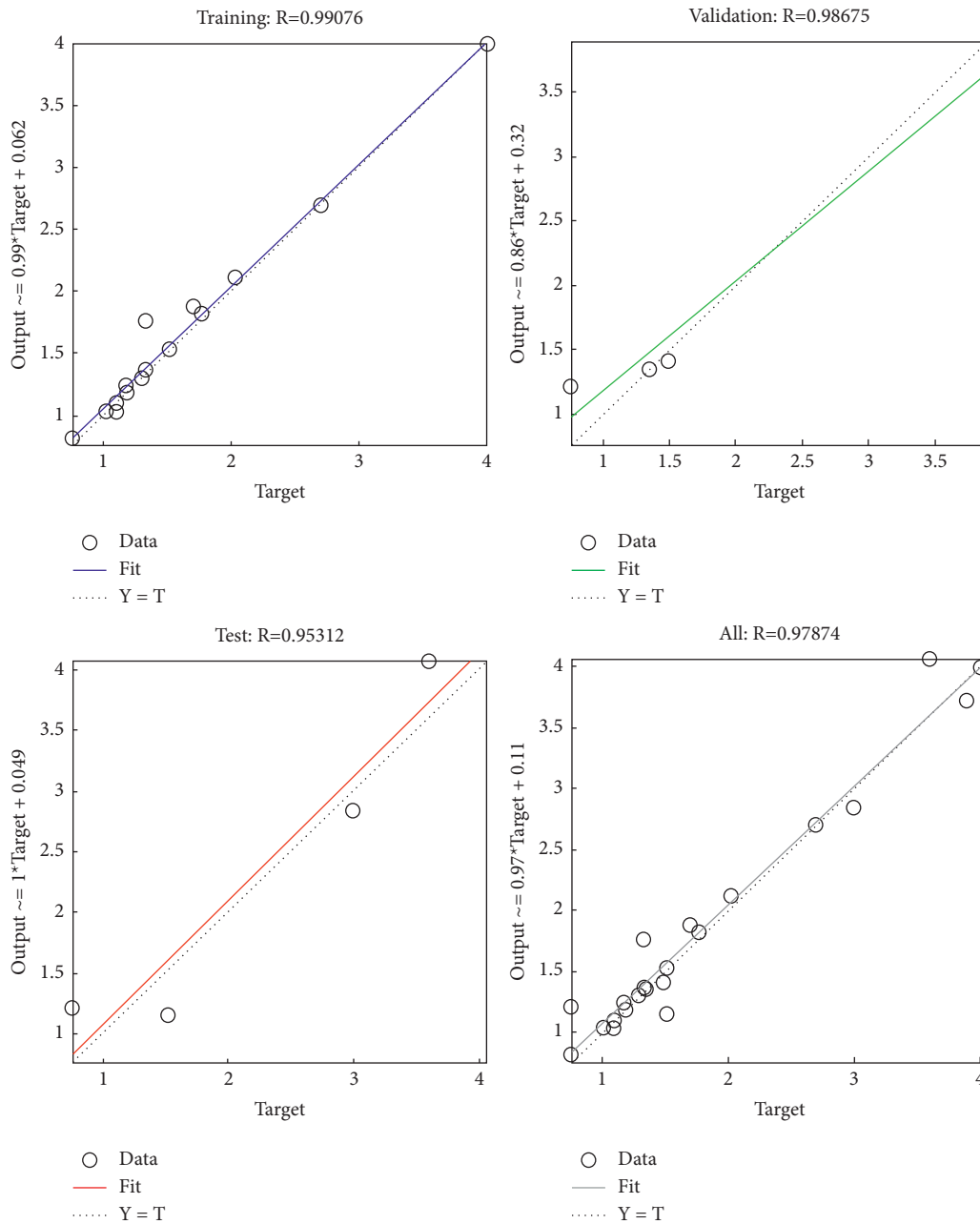
FIGURE 15: Prediction evaluation of water absorption results.

RHA substitution levels in FA-based geopolymer mortar resulted in the gradual decrease in compressive strength under acid environment.

5. Prediction of Strength and Durability Properties Using ANN

The percentages of error values for the strength and durability characteristics of geopolymer mortars obtained from ANN model were listed in Table 4. As seen in Table 4, it can be stated that the maximum percentages of error observed for the geopolymer mortar mixes under compressive, flexural, water absorption, sorptivity, and acid resistance test results were found to be 2.94%, 4.0%, 5.40%, 6.36%, and

6.15%, respectively. The error values obtained from (3) are negligible as the error percentage for all the predicted values is less than 10 percentage. According to the preceding sentence, the ANN framework could be utilized to estimate the mechanical and durability characteristics of fiber influenced FA-RHA-based geopolymer mortars. The comparison between the experimental and the predicted values of compressive strength results for fiber influenced FA-RHA based geopolymer mortars is expressed in Figure 8. Figure 9 depicts the correlation among the predicted and experimental flexural strength results. In case of water absorption test results, the variation between experimental and predicted values is illustrated in Figure 10. Consequently, Figures 11 and 12 represent the variation of predicted and
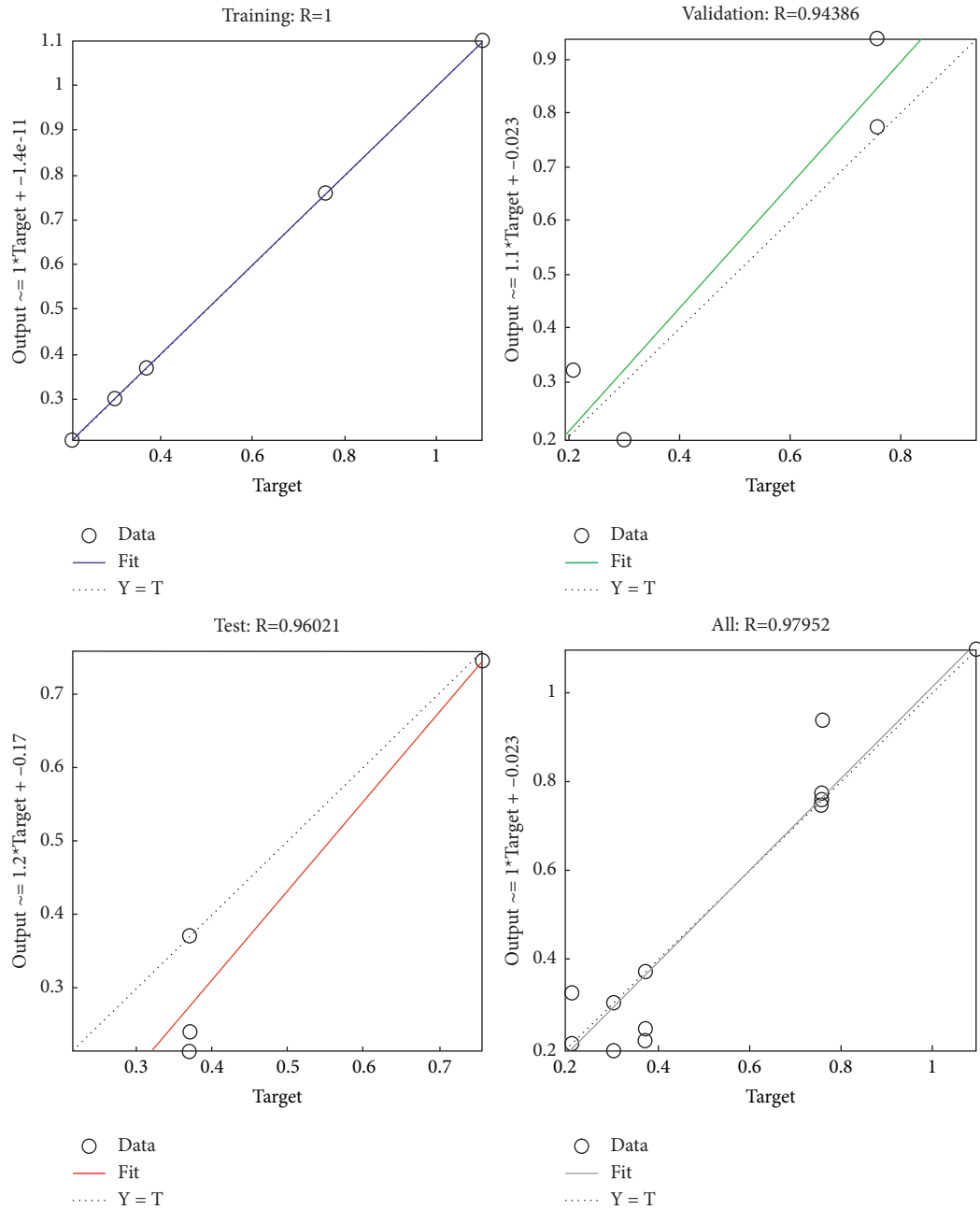
FIGURE 16: Prediction evaluation of sorptivity outcomes.

experimental results for sorptivity and acid resistance test of fiber reinforced FA-RHA blended geopolymer mortars, respectively. Figures 8–12 demonstrate that the outcomes for strength and durability evaluated through experimental and ANN methods were closely similar. According to the preceding statements, the established ANN (3-5-5-5) structure can be used to estimate the strength and durability features of FA-RHA-based geopolymer mortars comprising PF fibers with a low error percentage. Moreover, the strength values determined from experimental and predicted studies were limited by the ratios of RHA/FA, different molarities of NaOH solution, and percentage of polypropylene fibers added.

The cumulative coefficient of correlation (R) for compressive strength results at the stage of training, validation, testing, and the association of three levels in the ANN framework was measured as 1, 0.97189, 0.95547, and 0.97808, as seen in Figure 13. For flexural outcomes, the calculated R values throughout training, validation, testing, and the combination of three-phased convergence were computed from Figure 14 as 0.98670, 0.99819, 0.98673, and 0.97317, respectively. Figure 15 illustrates the R values for water absorption results at the time of training, testing, and association of three stages as 0.99076, 0.98675, 0.95312, and 0.97874, respectively. Consequently, Figures 16 and 17 demonstrate the regression evaluation and efficiency of
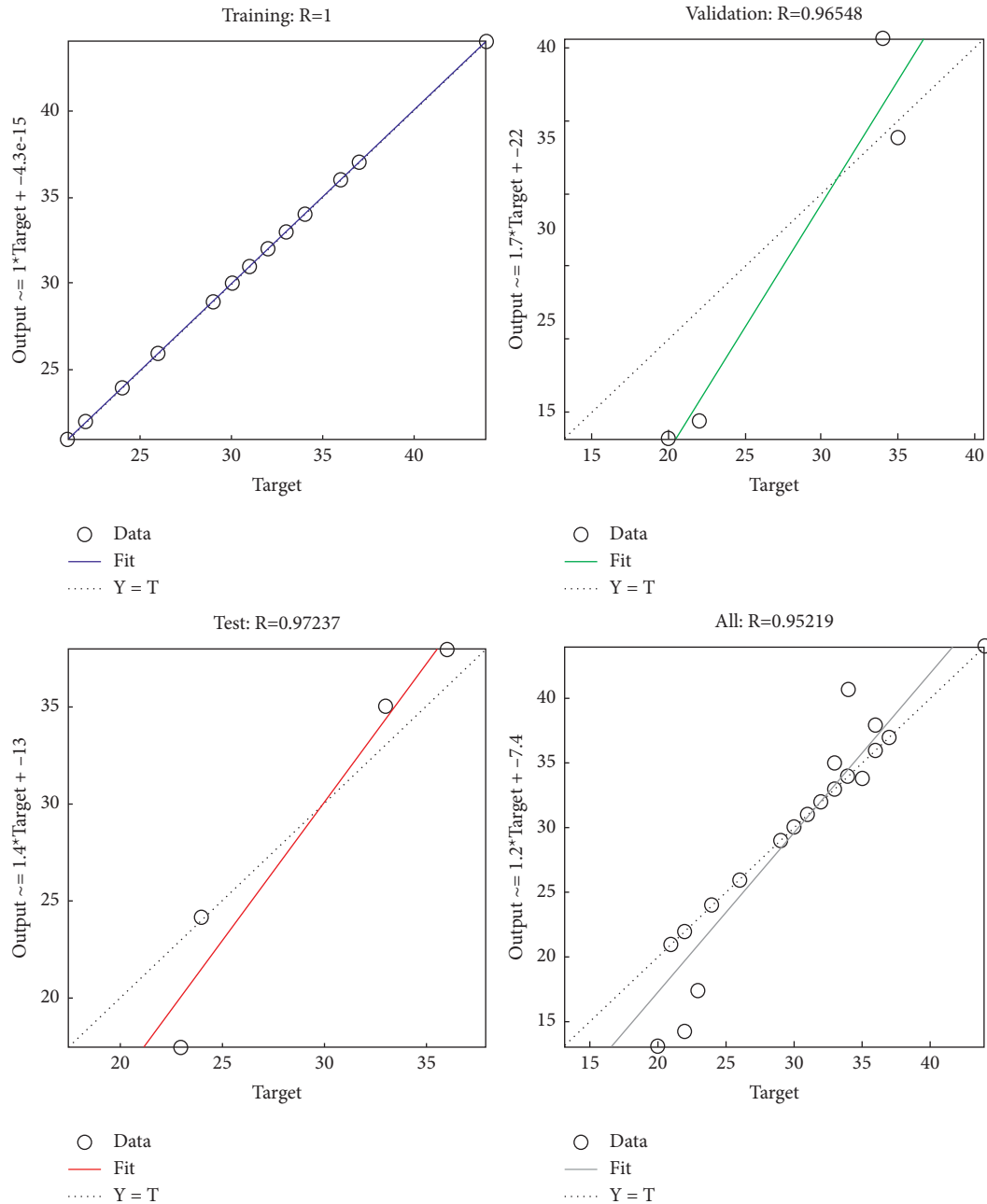
Figure 17: Assessment of predicted acid resistance results.

the water sorptivity and acid resistance results in the form of *R* values.

R values larger than 0.9 explicitly indicate a strong association among the observed and simulation outcomes across all instances [37, 38]; the developed ANN structure, which has been performed using measured data, precisely anticipated the intended outputs.

6. Conclusions

The following are the conclusions compiled from the experimental and predicted test results based on the influence of RHA substitution levels, concentration of NaOH solution, and fiber content in FA-based geopolymer mortars:

(i) The geopolymer mortars (G5 and G8) containing 10 M concentration of sodium hydroxide solution produced the maximum compressive strength results of 62 MPa.

(ii) Geopolymer mortar strength decreases with rice husk ash addition (20%). However, the replacement of fly ash by rice husk ash geopolymer mortar strength is higher than the control mortar.

(iii) Geopolymer mortar with and without fiber does not vary much in compressive strength, whereas

higher residual compressive strengths were obtained after the exposure of 10% of sulfuric acid.

(iv) The flexural strength characteristics of the FA-RHA based geopolymer mortar increase with higher PP fiber (0.3%) proportions.

(v) Water absorption and water sorptivity increase with an increment in rice husk ash substitution levels.

(vi) Sustainable geopolymer mortar can be developed from source materials like FA and RHA, which are obtained as industrial byproducts.

(vii) Mechanical and durability strength properties of RHA-FA-based geopolymer mortar could be predicted with the application of ANN framework using experimental results.

(viii) The ANN structure constructed in this investigation for assessing the mechanical and durability characteristics of fiber influenced FA-RHA blended geopolymer mortar was proved to be efficient as the predicted results are in comparison with the actual results.

Data Availability

The data used to support the findings of this study are included within the article. Should further data or information be required, these are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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