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PREDICTION ON THE WEAR RATE OF EPOXY COMPOSITES REINFORCED MICRO-FILLER OF THE NATURAL MATERIAL RESIDUE USING TAGUCHI – NEURAL NETWORK

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Abstract

The abrasive wear rate of epoxy composites reinforced with fillers sourced from recycled natural waste consisting of pollen of palm (PPW) and seashells (SSW) was studied.

Due to the importance of polymer composites used in the tribological couplings of machinery structures, as well as their possible use in brake pads as alternative materials for harmful components in environmentally polluted asbestos, the current research seeks to develop the tribological properties of composite materials reinforced with natural fillers and environmentally friendly. The research investigated the effect of two factors, the weight percentage of natural filler wt. % (0.5 %, 1 %, and 1.5 %) and testing loads (1000 g, 2000 g, 3000 g) upon the wear resistance of epoxy composites. The importance of developing epoxy composites is evident, especially since their work does not require lubricating conditions in various industrial fields, and therefore the development of their bonding properties will increase their operational life and achieve economic benefit for the industrial sector and the environment at the same time. The epoxy composites were subjected to abrasive wear tests under dry friction conditions using a pin-on-disc system. Signal-to-noise (S/N) analysis is adopted to study the influence of the two factors, wt. % and test loads, upon the tribological wear resistance of epoxy composites. A predictive model depending on the regression equation was developed to predict the wear resistance of epoxy composites. The results showed an improvement in the wear resistance of the composite material compared to the epoxy sample without filling by about 47 %. The optimum condition for wear resistance of epoxy composites has been achieved with a weight ratio of (1.5 %) and an applied load of 1000 g.

Keywords: epoxy composites, natural residue, abrasive wear rate, Taguchi, neural network.

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1. Introduction

The epoxy composites are good alternatives to many parts used in the machinery industry because of their reliability through their ability to work in joints that work in dry and lubrication-free conditions, in addition to other properties such as resistance to chemical solvents, climatic conditions, etc.

With the aim of developing the tribological properties of epoxy composites by strengthening them with natural waste materials, the current research efforts are complementary to the global research series at present. Recently, many papers focus on fillers from natural sources due to their environmentally friendly properties. There are various methods of reinforcing epoxy composites either in the form of micro-filler, fiber, or hybrid formula, with the aim of improving their mechanical and tribological properties, which is important at present [1]. Both the United States and Europe encourage researchers to use fillers from natural sources to reinforce epoxy composites in order to preserve the environment by reducing the sources of global warming.

The study aims to shed light on the availability of some lignocellulosic fibers in Brazil and in some developing countries that can be used as natural sources in the preparation of green composite materials as environmentally friendly and low-cost natural materials, in addition to their extraction methods, properties and applications [2].

There is a tendency for most car manufacturers to make their parts recyclable and biodegradable. Plant fibers as fillers and reinforcements for polymers are currently the fastest growing. Therefore, the study concluded that using a composite of wood and plastic enhances sustainability, improves durability and resistance to breakage, thus ensuring passenger safety and reducing production costs [3].

The present review provides a superficial overview of a limited number of natural fibers and polymer resins in commercial use. It also reviews the methods used to strengthen natural fibers and their mechanical properties. Specifically, the paper included biodegradable and environmentally friendly green composites, the method of processing composite materials and their various structural applications [4, 5].

At the present time, there is a tendency by car companies to use green fibers and fillings in car products as alternative materials in order to reduce carbon dioxide emissions [6]. Many recent studies seek to find alternatives to asbestos materials used in the manufacture of brake pads, as they are environmental pollutants. Therefore, there is an actual need to study and analyze the tribological behavior of composite materials [7]. The study aims to improve the abrasive wear rate of epoxy composites by reinforcing them with polyurethane waste by converted into a fine powder using heating and then reinforcing at various weight ratios (wt. %). The study used the linear regression equation and the ANN modeling for accurate results. The study concluded that increasing the heating temperature as well as the wt. % of the micro filler increases the composites' resistance to abrasive wear by about 41 % [8]. The effect of strengthening epoxy composites with waste from natural sources (seashells, palm pollen) on their mechanical properties was highlighted. The results showed that the addition of these fillers to the epoxy in the form of a micro-filler led to a significant improvement in the mechanical properties of the epoxy composites. The research also determined which micro-fillers have the greatest influence on the mechanical behavior of the composites, and found that the first rank is for epoxy composites reinforced with a weight ratio of 1.5 % of seashell fillers, followed by reinforced composites of palm pollen fillers [9]. The study presents the wear analysis of polymer composites reinforced with four types of bio-fillers using a pin on a disc. A hybrid filler of coconut shells, rice, peanuts, and a hybrid filler was used to prepare the epoxy composites. Some fillings were treated with malic acid to be ready for use, and their results were later compared with untreated fillings. Weight ratios of 20 % were used to stiffen the composites. Load variables, sliding distance, and sliding speed were adopted as test parameters. Where the results of the study showed a clear improvement in the wear behaviour of the composites that strengthen with the treated hybrid bio-fillers [10]. The researchers presented a study dealing with the effect of reinforcing polyester composites with agricultural waste on their traditional behavior using a pin-on-disk device. The results showed a significant improvement in the tribological properties of the composites, specifically in the friction coefficient and abrasive wear rates [11]. Coconut shell waste was also used as natural fillers to reinforce epoxy composites at different densities in order to improve their mechanical properties and increase their operational life under cyclic loading. Where the results showed a significant improvement in the performance of the composites [12].

Two studies aim to prepare composite materials with mechanical specifications that allow them to be used in various application engineering fields.

The first study used types of coconut shell powder as fillers for natural rubber. The results concluded that the mechanical and physical properties of the composites were improved [13], while the second study used coconut shell-reinforced polyethylene. The result was improved in the mechanical properties of the composites within the weight percentages of shells about 5–25 % [14].

The current study aims to improve the wear rate behaviour (WRB) of epoxy composites (EPC) used in thein the tribological couplings of machinery structures by strengthening them with environmentally friendly materials and low-cost.

Different wt. % and particle size were adopted as variables to prepare the epoxy composite. The optimal state for the wear rate of epoxy composites was also determined. To reach results with high accuracy, the research relied on the regression model and the neural network model for analysis, and then compared the results with practical data.

2. Materials and methods

2. 1. Materials

Prepare the fillers from natural waste: For prepare the micro filling from seashell waste, where the process begins with the collection of seashell, which comes from the shores of the Mediterranean Sea, then the stage of cleaning by the water well and drying by air. The grinding process begins, then leave the powder in a warm oven for drying. For granular sorting the Sieve 75 µm was used. Palm pollen is collected directly from the palm's tree before blooming the flowers, then leave in a pot under the sun to bloom, and to dry, then filtered through a 50 µm sieve, after which it becomes suitable for use as a filler.

Type of resin: Use epoxy resin with a hardener of type Sika Dur 3 at mixing ratios (2:1) and a density of 1.1 kg/L.

Preparation of epoxy composites: For the preparation of epoxy composites, different weight ratios of 0.5 %, 1 %, and 1.5 % of micro-fillers were mixed with epoxy resin at room temperature. Fillers consist of pollen of palm waste (PPW) 50µm and seashell waste (SSW) 75 µm in fine powder form. **Fig. 1** shows the stages of sample preparation of epoxy composites. For additional details on the material, see our previous publication [9].

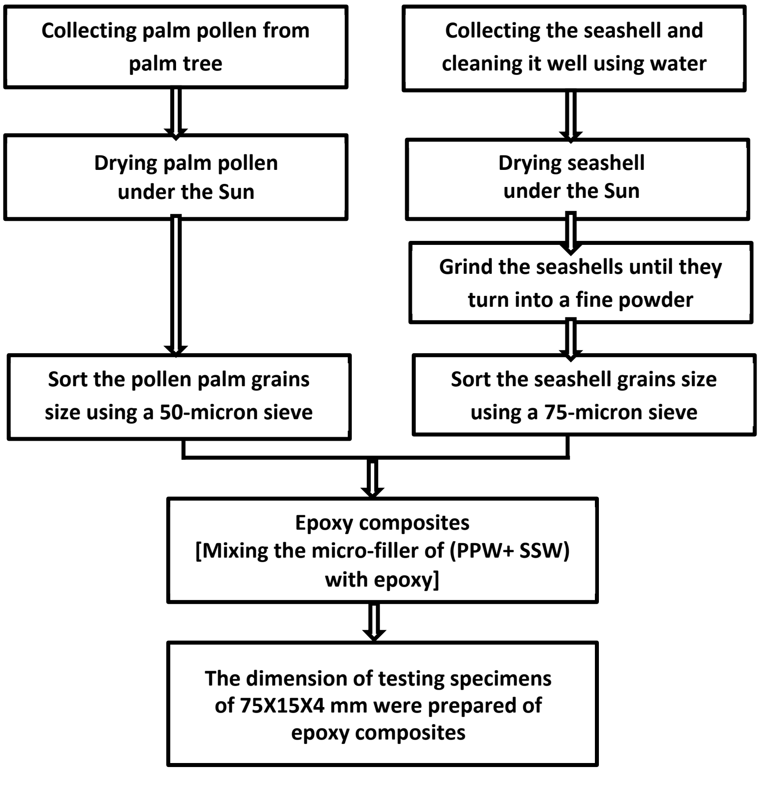


Fig. 1. Summary steps for casting epoxy composites

Table 1 shows the composition of epoxy composite samples. The composites that were prepared consisted of three sets of samples, the first set included hybrid fillings of pollen and seashell powder at various wt. %. While the composition of the samples in the second and third sets included fillings of palm pollen and seashell powder separately, respectively. In the first row of the same table, the wear rate of an unfilled epoxy sample is shown.

Table 1
Composition of epoxy composites samples

No. of sample		Samples compositions			Particle size (µm)
		Epoxy wt. %	Pollen palm wt. %	Seashell wt. %	
Unfilled (base case)		100	0	0	–
Group 1	(S+P) 0.5	99.5	0.25	0.25	75+50
	(S+P) 1	99	0.5	0.5	
	(S+P) 1.5	98.5	0.75	0.75	
Group 2	(PP) 0.5	99.5	0.5	0	50
	(PP) 1	99	1	0	
	(PP) 1.5	98.5	1.5	0	
Group 3	(SS) 0.5	99.5	0	0.5	75
	(SS) 1	99	0	1	
	(SS) 1.5	98.5	0	1.5	

2. 2. Methods

2. 2. 1. Experimental method

2. 2. 1. 1. The wear rate (WR) of composite strengthen with fillings of natural residues

Using a pin-on-disk device, the wear behavior at dry sliding conditions was studied against the surface of a steel disc. The tests included applying three loads of 1000 kg, 2000 kg, and 3000 kg to determine the composites' wear resistance as shown in **Table 2**.

At 25 degrees, all experiments were conducted with a relative humidity of 15 %, and a constant sliding velocity of 149.15 m/s along a circular path. A circle with a diameter of 13 cm and a constant sliding distance of 58.17 m was utilized for all tests. The electronic balance of the [HC-B precision Balances] type, with the description of a capacity of 500 g, resolution 0.001 g, and quantity 1 pcs, was used to measure the mass of the samples before and after the test load was applied for each case. In order to ensure uniform wear behavior during the tests, the vertical position of the test samples was kept on the rotating disc. It is worth noting that the samples, as well as the rotating surface, are cleaned with a piece of cloth moistened with acetone periodically after each test. In order to achieve accuracy in the results, the tests are repeated three times for each sample. Since there is a fixed weight attached to one end of the pin-on-disc device, the sample will be pressed against the rotating disc, and this process will cause the abrasive wear of the sample particles to begin, when the device starts rotating. The procedures of testing were achieved at sliding speed (149.15 m/s) for 3 minutes.

Before and after each test, the mass of the samples is recorded to determine the lost mass, and then the wear rate of the composites $W_{s(Exp)}$ in mm^3/N m was recorded using (1):

$$W_s = \frac{\Delta m}{\rho L P}, \tag{1}$$

where Δm represents the mass loss in (g), ρ denotes the density of the samples (g/cm^3). L is the abrading distance (m), and P signifies the normal load in (N).

2. 2. 2. Theoretical methods

2. 2. 2. 1. Taguchi-design analysis

In order to reduce the number of experiments and the time required to obtain optimal results, the experimental design technique was employed to investigate the impact of two variables:

filler content (wt. %) and the applied load test on the abrasive wear rate of composites. Taguchi's design was utilized to examine the influence of three levels associated with two control factors on the abrasive wear of epoxy composites (EPC). Furthermore, this method converted loss into a signal-to-noise ratio (S/N). Three quality characteristics within the Taguchi method were employed: larger-better, smaller-better, and nominally-better. The objective of the *S*/*N* analysis was to minimize the wear response of the composites (EPC). The L27(3^2) orthogonal matrix was chosen based on the Taguchi design. In the current research, the analysis was conducted based on the criterion of smaller being better (2):

$$\text{smaller-the-better}: S/N = -10\lg\left(\frac{1}{n}\sum_{j=1}^{n} y_{ij}^2\right), \tag{2}$$

where *S*/*N* denotes the signal-to-noise ratio; *n* denotes the reapetable time of each variable combination y_{ij}; denotes the observed data of evaluation index; *i* denotes a different evaluation index, and *j* is the test number from 1 to *n*.

2. 2. 3. Artificial neural network

The prediction of the wear rate of epoxy composites (EPC) was undertaken in the present study using a three-layer feedforward network with a backpropagation model. The ANN was constructed utilizing MATLAB software. The input layer, comprising two neurons, was associated with the testing load and micro-filler content (wt. %), while the output layer consisted of one neuron representing the abrasive wear resistance of composites. In this study, a hidden layer of 12 neurons was opted for. To accurately train the system for predicting the wear rate (WR) of composites reinforced with PPW and SSW, it relied on data derived from practical results. The distribution of experimental data for training, testing, and validation was set at 70 %, 15 %, and 15 %, respectively. During the training phase, the network acquired knowledge regarding the relationship between input and output parameters across all test domains. Subsequently, this acquired knowledge was applied during the test phase to predict the wear resistance (WR) response, with the remaining data being utilized for result validation.

3. Results and discussion

3. 1. The results of studying wear rate (WR) using experimental and predictive methods

Table 2 shows the abrasive wear resistance results for epoxy composites strengthen with natural waste micro filler. The average wear rate $W_{s(av)}$ was found for the unfilled epoxy sample and the rest of the other filled samples under three test loads for the purpose of comparing the results. In the same table, the results showed that the unfilled epoxy sample had the highest wear rate to be 5.1763×10^{-4} mm^3/N m compared to other epoxy samples. When comparing the average wear rate of the unfilled epoxy sample with the highest recorded value in composites reinforced with PPW and SSW fillers, it was observed that the abrasive wear rate (WR) of epoxy composites EPC was increased by 47 % in sample (SS1). The objective was to investigate the influence of the research factors (test load, weight %) on the wear rate of composites.

The data in **Table 2** was reorganized into three levels, two factors, and 27 experimental data, as shown in **Table 3**, to be suitable for the Taguchi L27 orthogonal array formulation. For the purpose of result analysis, the experimental data was transformed into the *S*/*N* ratio. Control factor settings that minimize the effects of the noise factors are identified by higher values of the signal-to-noise ratio (*S*/*N*). It is found that the value of average wear rate and *S*/*N* ratio of composites strengthened by the waste powder consisting of (SSW) and (PPW) are 2.1589×10^{-4} mm^3/Nm and –5.444 dB respectively. The Minitab-19 software is used to perform Taguchi analysis of composites. **Fig. 2** shows the optimal combination of parameters for a lower wear rate of composites at A1B3, mean Maximum load with 1000 g and 1.5 wt. %. Also, from **Fig. 2**, it can be observed that the wear rate is low at lower loads and the higher weight ratio of micro filler (wt. %).

«The effect of the factors on the wear rate is depicted in **Table 4**, where the response is analyzed through the *S*/*N* ratio for each of the three levels. The response value indicates that factor A has the most pronounced influence on the abrasive wear behavior of epoxy composites, with factor B ranking second».

Table 2
Experimental data of abrasive wear

No.	Composite material		Wt. %	Experimental data of W_s 10^{-4} under loading (mm^3/N·m)			$W_{s(av)}10^{-4}$ (mm^3/N·m)
				1000 g	**2000 g**	**3000 g**	
	Unfilled		**0**	**4.5001**	**5.2450**	**5.7840**	**5.1763**
1		SS(0.5)	0.5	0.9996	2.1526	3.6877	2.2800
2	Group 1	SS(1)	1	1.2522	2.6339	4.3275	2.7378
3		SS(1.5)	1.5	0.5945	1.6770	3.2007	1.8240
4		P(0.5)	0.5	0.8087	2.1245	4.2812	2.4048
5	Group 2	P(1)	1	1.1349	2.2347	4.5816	2.6504
6		P(1.5)	1.5	0.7035	2.2213	3.9041	2.2763
7		S+P(0.5)	0.5	0.7397	0.1873	3.5854	2.0662
8	Group 3	S+P(1)	1	0.7400	1.7199	3.5769	2.0123
9		S+P(1.5)	1.5	0.9951	2.1608	4.7000	2.6331

Table 3
Abrasive wear rate results of micro filler-reinforced epoxy composites

Experimental run	Composite material	A (test load) (g)	B (wt. %)	$W_{s(Exp.)}$ 10^{-4} (mm^3/N.m)	S/N ratio (dB)
1	SS(0.5)	1000	0.5	0.9996	1.3457
2	PP(0.5)	1000	0.5	0.8087	1.3457
3	S+P(0.5)	1000	0.5	0.7397	1.346
4	SS(1)	1000	1.0	1.2522	–0.548
5	PP(1)	1000	1.0	1.1349	–0.548
6	S+P(1)	1000	1.0	0.7400	–0.548
7	SS(1.5)	1000	1.5	0.5945	2.1261
8	PP(1.5)	1000	1.5	0.7035	2.1261
9	S+P(1.5)	1000	1.5	0.9951	2.1261
10	SS(0.5)	2000	0.5	2.1526	–6.252
11	PP(0.5)	2000	0.5	2.1245	–6.252
12	S+P(0.5)	2000	0.5	1.8735	–6.252
13	SS(1)	2000	1.0	2.6339	–6.957
14	PP(1)	2000	1.0	2.2347	–6.957
15	S+P(1)	2000	1.0	1.7199	–6.957
16	SS(1.5)	2000	1.5	1.6770	–6.168
17	PP(1.5)	2000	1.5	2.2213	–6.168
18	S+P(1.5)	2000	1.5	2.1610	–6.168
19	SS(0.5)	3000	0.5	3.6877	–11.739
20	PP(0.5)	3000	0.5	4.2812	–11.739
21	S+P(0.5)	3000	0.5	3.5854	–11.739
22	SS(1)	3000	1.0	4.3275	–12.431
23	PP(1)	3000	1.0	4.5817	–12.431
24	S+P(1)	3000	1.0	3.5770	–12.431
25	SS(1.5)	3000	1.5	3.2010	–12.000
26	PP(1.5)	3000	1.5	3.9000	–12.000
27	S+P(1.5)	3000	1.5	4.7000	–12.000

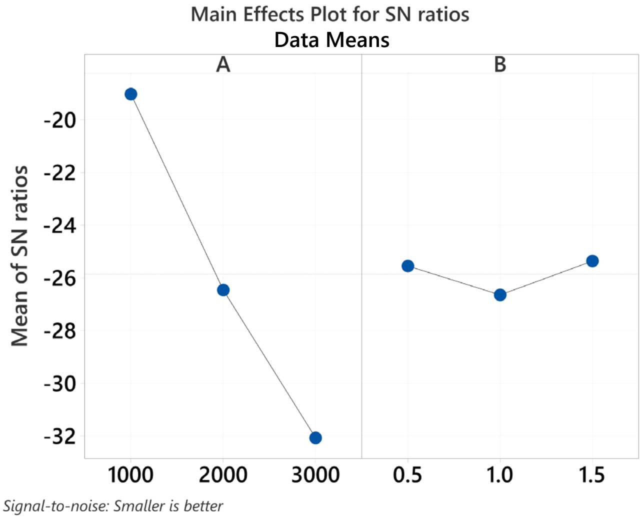


Fig. 2. Effect of control factors on wear rate of epoxy composites

Table 4
Response Table for Signal to Noise Ratios Smaller is better

Level	A (load)	B (Wt %)
1	–19.03	–25.55
2	–26.46	–26.65
3	–32.07	–25.36
Delta	13.05	1.28
Rank	1	2

At a constant rotational speed, the formation of a triple protective layer on the sample surface is initiated by low loads, resulting from the entrapment of displaced wear debris between the sliding surfaces. This layer serves the purpose of protecting the surface from additional wear. Conversely, higher loads lead to an elevated wear rate as the aforementioned protective layer undergoes breakdown. As speed and loads increase, frictional forces escalate, causing an elevation in the sliding surface temperature. This, in turn, results in thermal softening at the surface interface, leading to the disintegration of composite material elements and subsequently increasing the wear rate of the composites.

3. 2. The results of the wear rate (WR) by regression model

The prediction of the wear rate of the composites can be accomplished through the derivation of a linear regression model (3) utilizing MINITAB 19. The foundation of the linear regression analysis rests upon establishing a mathematical relationship between the response variable, wear rate (WR), and the factors critical for minimizing the wear rate (WR), denoted as A (load) and B (wt. %):

$$W_{s(regre)} = -0.771 + 0.001548A - 0.009B. \tag{3}$$

The residual plots for the abrasive wear rate of the PPW and SSW micro-filler/epoxy composite, as obtained using equation (3), are displayed in **Fig. 3.** The normal probability curve illustrates the normal distribution of the residuals, affirming their proximity to a linear relationship as per the developed models. This attests to the suitability of the fitting model and its inherent characteristics.

In the in-versus-fits plot, the plots exhibit the variance of residual values across the three levels of factors A and B, showcasing a consistent distribution of residuals among all three levels. This, in turn, demonstrates the equality of variance across these levels. The normality probability plot demonstrates that the residuals closely align with the diagonal line, indicative of an ideal normal distribution, thus confirming the normality of the data. It is noteworthy that a majority of residuals in the histogram plot register frequencies in the 0–1 range, underscoring the significance of the experimental design. The remaining values also exhibit deviations both above and below the mean line, aligning with the planned design of experiments comprising 27 tests.

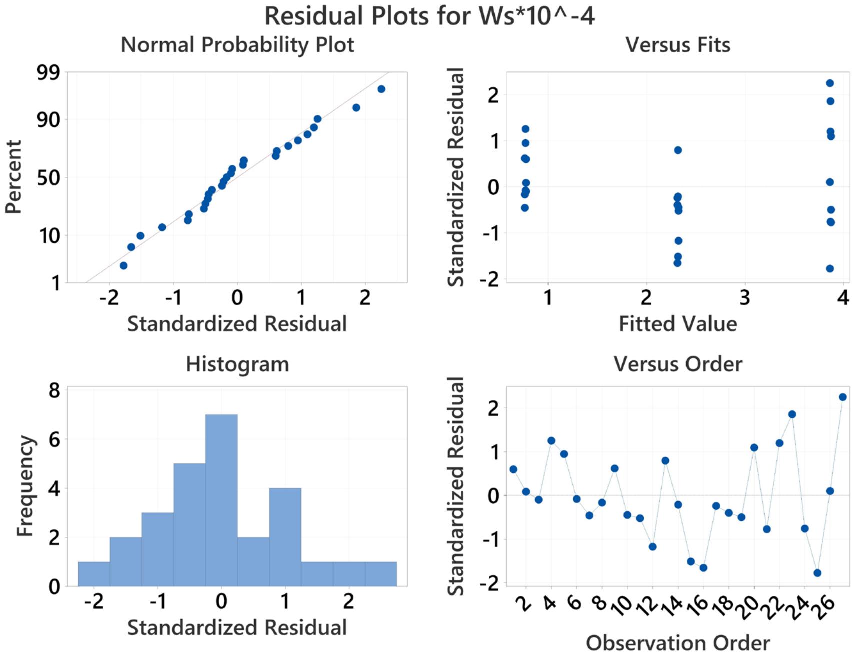
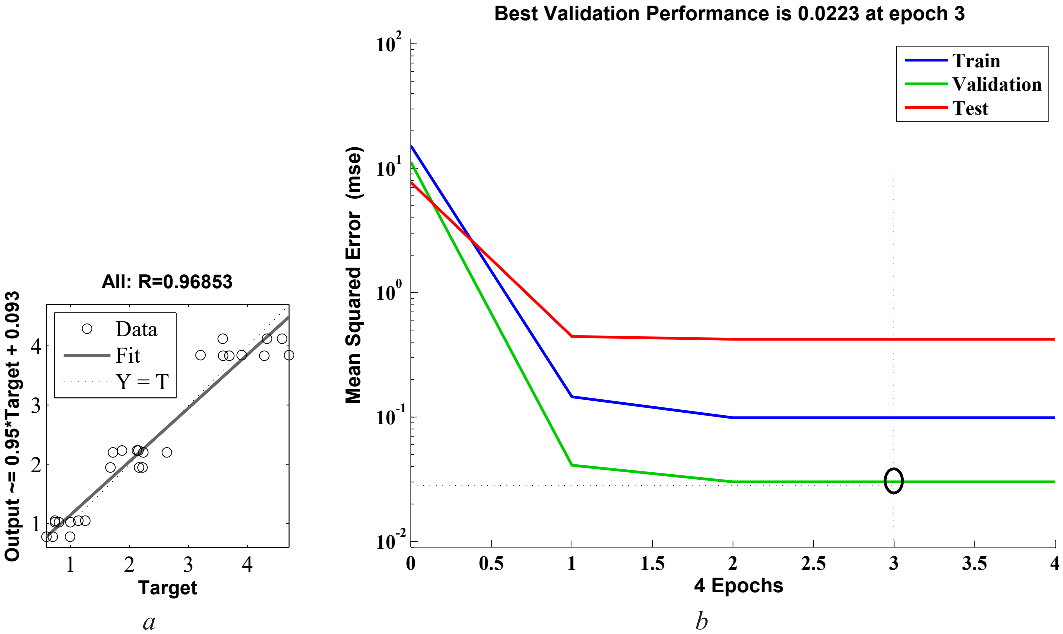


Fig. 3. Residual plots for wear rate of epoxy composites (EPC)

3. 3. The results of the wear rate by artificial neural network

Fig. 4 displays two plots, with the first one at (*a*) depicting the mean square error during the validation, testing, and training phases, while the second one at (*b*) portrays the regression plot of the trained network.



a *b*

Fig. 4. The efficiency of the artificial neural network (ANN) model shows:
a – mean squared error; *b* – regression plot of the trained artificial network

The acceptability of the current proposed model is reflected in the value of R, which signifies the alignment between the results derived from experimental data and those produced by the neural network. As the R-value approaches 1, this alignment becomes more apparent. In **Fig. 4, *a***, R-value of 0.96853 is recorded, indicating a robust convergence of results and the potential for its utilization in predicting experimental outcomes. In **Fig. 4, *b***, the best validation performance is observed to be 0.0223 at the epoch 3.

Table 5 presents a comparison between the experimental values, the neural network predictions, and the values predicted by the linear regression model for the wear rate of micro-filler-reinforced epoxy composites, considering both SSW and PPW.

Table 5
Comparison of the results of the wear rate of composites obtained experimentally, ANN, and regression model

No.	Composites	$W_{s(Exp)}$ (mm^3/N.m)	$W_{s(regre)}$ (mm^3/N.m)	*Error %*	*ANN*	*Error %*
1	SS(0.5)	0.999	0.7765	22.325	0.739	26.002
2	PP(0.5)	0.808	0.7765	3.988	0.739	8.5344
3	S+P(0.5)	0.739	0.7765	–4.972	0.739	–0.002
4	SS(1)	1.252	0.771	38.428	0.937	25.134
5	PP(1)	1.134	0.771	32.065	0.937	17.396
6	S+P(1)	0.740	0.771	–4.182	0.937	–26.676
7	SS(1.5)	0.594	0.7655	–28.757	0.764	–28.555
8	PP(1.5)	0.703	0.7655	–8.808	0.764	–8.637
9	S+P(1.5)	0.995	0.7655	23.074	0.764	23.195
10	SS(0.5)	2.152	2.3255	–8.029	1.999	7.136
11	PP(0.5)	2.124	2.3255	–9.460	1.999	5.906
12	S+P(0.5)	1.873	2.3255	–24.122	1.999	–6.697
13	SS(1)	2.633	2.32	11.919	2.196	16.618
14	PP(1)	2.234	2.32	–3.812	2.196	1.725
15	S+P(1)	1.719	2.32	–34.888	2.196	–27.692
16	SS(1.5)	1.677	2.3145	–38.013	1.918	–14.417
17	PP(1.5)	2.221	2.3145	–4.193	1.918	13.620
18	S+P(1.5)	2.161	2.3145	–7.103	1.918	11.208
19	SS(0.5)	3.687	3.8745	–5.064	3.687	0.00068
20	PP(0.5)	4.281	3.8745	9.499	3.687	13.863
21	S+P(0.5)	3.585	3.8745	–8.063	3.687	–2.853
22	SS(1)	4.327	3.869	10.595	4.161	3.829
23	PP(1)	4.581	3.869	15.555	4.161	9.164
24	S+P(1)	3.577	3.869	–8.163	4.161	–16.349
25	SS(1.5)	3.201	3.8635	–20.696	3.950	–23.413
26	PP(1.5)	3.900	3.8635	0.935	3.950	–1.294
27	S+P(1.5)	4.700	3.8635	17.797	3.950	15.947

The results of **Table 5** specifically show in the fifth and seventh columns that the average error rate for experimental data and predicted data (ANN) is within the range ±13 %, while the average rate of error between the experimental and regression model is within ±15 %, so the results of the neural network method are the most efficient.

The difference between the average error rate in the ANN model and the regression is 13 % for the current research, while in the research of Abed and Ray [8, 15] who adopted the same methodology as the current research it was as follows 15 % and 50 %, respectively.

The non-convergence of the average error rate values between the neural network data and the regression model for the three researches above makes the task of finding a fixed difference in the average error rate between the two methods not possible.

3. 4. Limitations and directions for developing this study

All tests and sample preparation were carried out at a temperature of 25 °C.

Adopting the wt. % and particle size of seashell (75 µm) and palm pollen fillers (50 µm) when preparing epoxy composites.

Epoxy was used with hardener (2:1), type Sika-Dur32, with a density of 1.1 kg/L.

Under the sun, the fillings were dried.

Properties of the basic components of natural materials.

Under dry friction conditions and using a pin-on-disc system, the epoxy composites were subjected to abrasive wear tests.

Directions for developing this study:

– highlighting how much the surface of the counterbody and the edge shorten in abrasive wear;

– adopting wider ranges of weight and particle size, as well as the loads applied to each of the fillings and their effect on friction behaviour.

4. Conclusions

In the current study, it was observed that the wear of epoxy composites (EPC) is significantly influenced by the load factor and the percentage of natural material residue filler (wt. %). The wear rate resistance (WR) of epoxy composites reinforced with (PPW) and (SSW) showed an increase of 47 % when compared to the unfilled epoxy sample:

– the optimal combination of parameters for the lowest wear rate of composites A1B3, Maximum load is at 1000g and 1.5wt. %;

– a favorable convergence between the experimental data and the ANN data was observed, with an error margin of less than +13 %, in contrast to the regression model error which remained within 15 %. Upon comparing the results of the two models, it was determined that the (ANN) is deemed more acceptable than the regression model;

– the process of finding a percentage that determines a fixed difference between the values of the average error rate of the experimental data and the neural network data on the one hand and the regression on the other hand cannot be predicted due to the existence of a discrepancy and this is evident by comparing the above percentages in three researches.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

The study was performed without financial support.

Data availability

Manuscript has no associated data.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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