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Evaluating Surface Roughness of Aluminum Wire Meshed Pineapple Fiber Epoxy Composite Laminate with Plain Pineapple Fiber Epoxy Composite Laminate

MV. Hyvanth and T. Sathish*

Department of Mechanical Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

***Correspondence to:**
T. Sathish
Department of Mechanical Engineering,
Saveetha School of Engineering,
Saveetha Institute of Medical and Technical Sciences,
Saveetha University,
Chennai, Tamil Nadu, India.
E-mail: sathisht.sse@saveetha.com

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Abstract

The goal of this study is to quantify the surface roughness (SR) of drilled holes in a novel sandwich composite made of pineapple fiber reinforced with aluminum wire mesh and compare their performance to that of plain epoxy. Composite made from pineapple fiber. Group 1 specimen is prepared by using pineapple fiber reinforced and epoxy composite (PERC) whereas the group 2 specimens additionally reinforced with aluminum wire mesh. Sample size calculated was 20 per group total samples 40. ASTM D 4417 standard followed for the sample's preparation and testing. The samples drilled in the CNC vertical milling centre and roughness measured and compared. Cut rate (in millimeters per revolution), RPM, and drill diameter (in millimeters). Results acquired in T-independents PSS-based statistical analysis was $p = 0.000$ ($p < 0.050$) and the observations are found statistically significant. The aluminum mesh reinforcement in the composite improved the SR from 3.10 μm to 3.57 μm. In the scope of this investigation, the proposed novel AWMC increased the SR on drilled holes by 15.16%.

Keywords

Pineapple fiber, Sandwich composite, Novel aluminum wire mesh, Surface roughness tester, ASTM D 4417, Sustainable

Introduction

Pursuing smoother surfaces in PFRC is the driving motivation behind this study by means of reinforcing the novel aluminum wire mesh and compare performance with plain PFRC [1]. Samples reinforced with sustainable composite of novel aluminum wire mesh and without wire mesh in the CNC drilling operation using coated drill [2, 3]. The composite production has enhanced the machining of their materials based on their properties for manufacturing [4]. The large number of composite manufactures are moved to PFRC [5]. because of its soft nature and wear produced by the tool is also less when compared to other polymer materials [6]. Pineapple fibers are widely employed throughout multiple industries including the automotive sector, the construction business, and the glass packaging sector [7].

Over the previous few years, there have been about 6780 articles published in GS and 7650 published in SCI [8]. Such research was made by conducting the epoxy used for the polymer matrix preparation because of its less hazardous nature and ease for handling. The milling operation was conducted on the natural fiber composites for identifying its SR using a tungsten carbide drill. Venkategowda et al. [9] has done an investigation on pineapple fiber cellulose for identifying its mechanical properties in the slotting machine and obtaining a lower surface finish by comparing it with plain epoxy coated natural fiber [10]. It was investigated that pineapple fiber has better surface finish when drilled with carbide coated drill and found the better wear resistance and temperature produced in drill [11-14]. The author also found that machining at high drilling speed and cutting rate will produce better surface finish [13]. It was investigated that the micro friction effects between the cutting tool and composite material in fiber by using the numerical modeling and experiments and [15] was also considered as the best study for this research [16].

The fiber metal composites investigated in this research are novel and their machining characteristics not yet documented by academic sources. The influence of drilling parameters on output responses of these laminates are unanswered in the survey. This study relies heavily on the theoretical and experimental understanding of composite laminate fabrication. The purpose of this study is to examine the relationship between hole SR and other variables of the PFRWNAWMA between pineapple layers as if there were a layer of pineapple in between (Pineapple + aluminum + pineapple + aluminum + pineapple) using a tungsten carbide drill, make 20 holes in the composite.

Materials and Methods

Drilling and milling are performed at University campus, Chennai. There is no need for ethical review because this study does not involve any human subjects. Sustainable pineapple fiber epoxy composite (Group A) sample. Samples from group B are an environmentally friendly composite of pineapple fiber epoxy and aluminum wire reinforcement. Sample size for each group was 20. SD of 0.323547 and the MN value of 1.9654 [17].

Unidirectional sustainable pineapple fiber hand stitched by fiber region, Chennai, India. For forming the composite epoxy LY-556 and hardener LH-556 which was used in 10:1 ratio which is collected from Hayavel aerospace india pvt ltd, Chennai, India. For group 1 sample preparation, The innovative aluminum wire mesh is used in the hand layup process to reinforce the composite material [18]. The composite's dimensions are 150 × 150 and the density of the composite is 5 mm. Polished wax is applied over the mold to remove the sample after fabrication with ease. Fabricating one sample, (80%) of epoxy is used in (40%) of pineapple fiber and novel aluminum wire mesh. After fabrication, The setup is given 24 h to settle with the proper weights on top of it for its curing time for good bonding strength.

For group 2 sample preparation, the same procedure is repeated. In this group, novel aluminum wire mesh is not used. Only orientation angle of the unidirectional pineapple fiber as per ASTM D 4417 standard and the curing time takes up to 24 h. The samples were drilled using the specified machining parameters, such as feed rate (mm/min) and speed (rpm). To establish whether the group possesses superior surface quality, we measured the roughness of their respective surfaces using the roughness testing machine seen in figure 1.The material is machined in accordance with ASTM D 4417 specifications. To measure SR of the composite material drilling operation is performed. To show the variation on the machining parameters like feed rate (mm/min) and speed rate (rpm) so that we can show a variety of values in SR of drilled holes. Coated tungsten carbide drill bit of 8mm diameter is used in drilling the holes in reinforced composite material.

Figure 1: SR testing machine.

Statistical analysis

Considering the data analysis SPSS V26 was used to determine the range, RE, MN, and SD. Clinical sample size calculator software used for sample size calculations. In this project work, The speed, diameter of the drill bit, and the rate of feed are the independent factors, and the dependent variable is SR (μm). A random selection The significance of using and not using a new aluminum wire mesh in PFRC was examined using a t-test [19].

Results

Group 1 (responsibly sourced PFRC laminate) and group 2 (responsibly sourced pineapple fiber reinforced with innovative aluminum wire mesh composite laminate) undergo CNC drilling with different speeds, feed rates, and drilled diameters in mind. Samples of pineapple fiber reinforced with aluminum mesh had a mean thickness of 2.6663 m, while samples without the reinforcement had a mean thickness of 1.7428 m. Table 1 displays the values for groups 1 and 2 of SR. Table 2 displays the independent t-test statistics for each group. As can be seen in table 3, Levene's test for equality of variances yielded a result of $p < 0.001$ ($p < 0.050$). After CNC drilling and SR, a sample from group 1 (PFRC laminate) is displayed in figure 2. In figure 3, we see the CNC-drilled and surface-roughness-measured sample from group 2 (Pineapple fiber reinforced with new aluminum wire mesh composite laminate). Observation means in groups 1 and 2 are compared graphically in figure 4.

Discussions

SR of the PF is obtained up to 3.57μm on aluminum mesh pineapple composite [20]. The 3.10 μm mean SR was found in pineapple fiber without aluminum mesh. The results show

Table 1: Degrees of surface abrasion.

Exp. No.	D (mm)	V (m/min	F (mm/rev)	SR (μm)	
				PFRC laminate	Pineapple FR with novel aluminum WMCL
1	10	16	0.03	3.18	3.26
2	10	32	0.06	3.12	3.6
3	10	48	0.09	3.07	3.28
4	10	54	0.12	3.1	3.88
5	10	16	0.06	3.09	3.66
6	10	32	0.03	3.21	3.73
7	10	48	0.12	3.16	3.92
8	10	54	0.09	2.98	3.78
9	10	16	0.09	3.11	3.72
10	10	32	0.06	3.08	3.41
11	10	48	0.12	3.04	3.25
12	10	54	0.03	3	3.87
13	10	16	0.03	3.19	3.91
14	10	32	0.09	3.2	3.61
15	10	48	0.03	3.01	3.59
16	10	54	0.06	3.03	3.82
17	10	16	0.12	3.14	3.27
18	10	32	0.12	3.17	3.37
19	10	48	0.06	3.15	3.22
20	10	54	0.09	3.02	3.35

Table 2: Group data from a totally separate T-test.

T-test				
Numbers in a group				
SR	N	MN	St D	St ER
Without Al	20	3.10	0.07196	0.01609
With Al	20	3.57	0.25116	0.05616

PFWAM has higher SR as compared to PPFC. As the p value obtained as $p < 0.001$ and it is less than 0.05 the observations are statistically significant [17].

The drilling of pineapple fiber with aluminum mesh with epoxy to produce low friction exterior surfaces, the best SR depends on CS and FD [21]. Pineapple fiber with plastic composite with carbide drill has a SR of 0.60μm then without plastic composite. Stating that the statistical investigation has revealed that machining parameters have a significant impact on variance in machined surface finish and force produced while cutting [22]. The SR was revealed toa minimum by employing the aluminum mesh with 55% value fraction of pineapple fiber with drill tool of 8 mm at SS of 150 and FR of 2.5 [23]. The chemical treatment can be improved by drilling. The delamination that occurred during machining and the absence of voids and cracks in the delaminated zone [24-26]. Hence as the future scope, the alternate fabrication process such as compression moulding method can be adopted to avoid formation of voids, cracks, and blow holes between the inter laminar layers and improve bonding strength and prevent delamination.

Conclusions

Within the boundaries of the present investigation, the pineapple fiber RC without aluminum mesh has produced a mean SR of 3.10 μm and the pineapple fiber samples reinforced composite with addition of aluminum mesh has produced mean SR of 3.57 μm. Using SPSS's independent T-test, we can get an average statistical significance of pineapple fiber reinforced composite samples was $p < 0.001$ and it is less than 0.05. The samples of pineapple fiber reinforced with aluminum mesh were found to have significantly more SR than the samples of unreinforced pineapple fiber plain pineapple fiber samples reinforced composite with an improvement of 15.16%

Table 3: Contrast for unrelated samples differences between groups are statistically significant based on the findings of levene's test for equality of variances, which reveals a significance value of 0.001 and is less than 0.05.

Independent samples test									
	A comparison of variances using the levene test		t	df	Sig. (2-tailed)	Comparison of means using the T-test		Estimated 95% CI for the dissimilarity	
	F	Sig.				MD	Sd. Er D	L	U
EVA	36.099	0.040	8.088	22.098	0.000	0.47250	0.05842	0.35138	0.59362
Equal variances not assumed	-	-	8.088	38	0.000	0.47250	0.05842	0.35424	0.59076

Figure 2: Group 1 (Pineapple fiber with aluminum mesh).

Figure 3: Group 2 (Pineapple fiber without aluminum mesh).

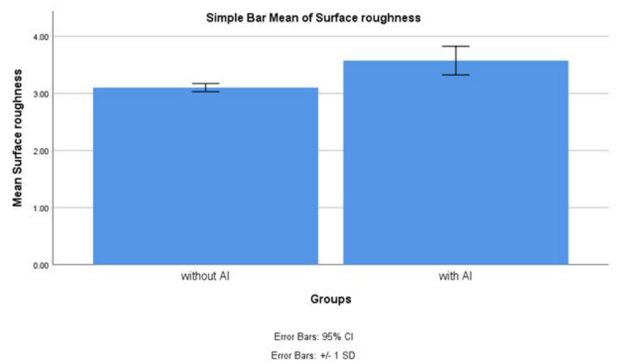

Figure 4: A bar chart depicting the average SR of pineapple fiber samples reinforced with and without aluminum mesh is displayed above. The findings show that the SR of pineapple fiber reinforced with aluminum mesh is greater than that of pineapple fiber without mesh. Compared on the x-axis are pineapple fibers with and without an aluminum mesh, in terms of their average SR. Group means 1 standard deviation with 95% confidence intervals plotted along the y-axis.

in SR.

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None.

Conflict of Interest

None.

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