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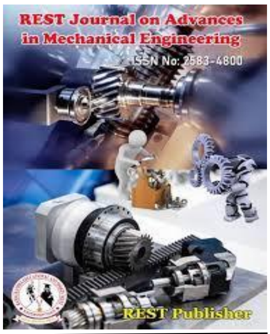

A Study on Mechanical and Drilling Properties of Carbon Nanotubes

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Abstract: *Tunnelling of composite laminates Difficult to manage Often causes disfigurement It is the strength of the structure reduces dramatically due to drilling induced damage on the mechanical parameters of affected composite materials Flexural strength has received less attention. Composite materials, in particular Glass fiber reinforced polymers (GFRP), in the construction of ships and submarines Traditional construction such as steel and aluminum have succeeded in changing things. In addition to being nonmagnetic and nonconductive, GFRP has found usage in the maritime industry due to its composite materials' comparatively low density, superior resistance to corrosion in marine environments, and strong fatigue resistance. Process variables considered in experiments Feed rate, spindle speed, hole diameter and incorporated into nanocomposite laminates is the wt% of carbon nanotubes. Thrust force and* ***delimitation*** *factor Factors that have the greatest impact on is feed rate and spindle speed.*

Key words: *carbon nanotubes, glass fiber reinforced Polymers, MWNTs, Composite materials*

1. INTRODUCTION

The word "mixture" means microscopic, mesoscopic or different at macroscopic scales having physical or chemical properties Refers to the combination of two or more elements. Including aviation, aerospace and defence in various industrial applications, alloys High strength-to-weight and stiffness-to-weight ratios Due to their superior qualities including are the main competitors for metals [1]. Of ships and submarines for construction, composite materials especially glass fiber reinforced Polymers (GFRP) can be modified, conventional building materials like steel and aluminium. In addition to being non-magnetic and non-conductive, GFRP has found employment in the maritime sector Other mixed and regular items It is more cost effective than GFRP composites are low density have been proven to contain, great maritime environment corrosion resistance, and strong fatigue resistance [2]. Particularly, GFRPs are frequently utilised in aircraft radomes and sporting goods like bicycle helmets and golf clubs. Following the discovery of fullerenes in the 1990s, carbon nanotubes (CNTs) emerged as a promising candidate [3] Carbon nanotubes, nanorods, onion, graphene oxide (GO), reduced GO, etc. Carbon family nanomaterials, dopants are widely used as fillers. in polymer composites to realize desired composite properties [4]. Due to their distinct mechanical characteristics, CNTs make excellent fillers that may be integrated into micrometer-sized fibres. To broaden the use of composite materials, integration with nano composites like carbon nano tubes (CNTs) is crucial [5]. Making polymeric composites is more difficult than making traditional materials because of the anisotropic and inhomogeneous nature of these materials. Component rejection can result from a variety of failure causes, including fibre breakage; fibre pull-out, **delimitation**, and matrix smear [6].

2. CARBON NANOTUBES POLYMER COMPOSITES

A seamless hollow cylinder consisting of a hexagonal network of carbon atoms is known as a carbon nanotube (CNT); the ends of the cylinder may or may not be covered by half of the fullerene molecule. The two main types of CNTs are SWNTs, which are typically individual cylinders with a diameter of 1-2 nm, and MWNTs, which can be thought of as several concentric graphene cylinders held together by weak van der Waals forces [7]. SWCNTs, or single-walled carbon nanotubes, can have metallic or semiconducting surfaces. The latter is more conductive than copper because it can carry electrons over long distances without much interference. Actually, the combination of a nanotube's mechanical and electrical capabilities makes them a great reinforcing agent in a variety of applications [8]. MWNTs have a length of tens of microns and a diameter that spans from 2 to 100 nm. To make MWNT, chemical vapour deposition is undoubtedly the most common method [9].

Mechanics of polymer composites Characteristics Used Manufacturing Affected by processing techniques. Solution casting is one of the most well-liked techniques for producing nanotube-polymer composites [10]. Carbon nanotubes are high for performance, multifunctional composites Recognized as the best carbon fibres Because of their high appearance rate small diameter, light weight, high mechanical strength, High electrical and thermal conductivity and high heat and wind stability [11]. These materials' anisotropy, inhomogeneity, and abrasiveness, drilling composites is a highly difficult process. Various kinds of harm can occur while drilling [12]. Core drilling of composites is a common procedure for making holes for testing and fitting connections, and is usually performed using a hollow core drill, which is a hollow cylinder with a diamond-grid abrasive on a circular cutting edge [13]. Since a high thrust force typically causes deformation, the drill will exit when approaching the aircraft during the drilling process various to reduce thrust force Drill bits were examined. Composites' tendency to distort can be somewhat reduced by employing a back-up plate and refining the cutting parameters [14]. The way the drilling fluid is used to complete specific operational duties determines how successful a drilling operation will be. Currently, the industry is facing material Related to petroleum drilling to overcome technical/environmental issues in designing high performance fluids Challenges in. However, it demonstrates certain functional requirements usually exclude the use of conventional macro-scale soil additives (needed to challenge drilling settings). But transparency features of nanoscale objects have shown to close this gap [15]. Nanoparticles have improved the performance of drilling fluids due to their specific kind of considerably enhanced physicochemical, electrical, thermal, and hydrodynamic characteristics. Nanoparticles' many uses in fields like biomedical technology, electronics, coatings, and material composition draw interest from a wide range of companies [16]. As a result, calculating the **delimitation** factor from merely looking at the upper and lower surfaces of the laminate in micrographs or pictures is a quick and easy technique to evaluate the perforation quality [17]. High spin speed and low feed rate are CNT reinforced on the **delimitation** factor in alloys have a positive impact [18]. According to analytical research, the cutting parameters determine F_t. One of the main issues with machining composite laminates is removal due to pitting, one of the many different types of material damage. The main argument for deletion has been identified as thrust force [20]. Deformation happens when the thrust force goes above a certain point, and **delimitation** gets worse when the thrust force is increased [21]. Surface roughness in machining process one of the most important variables Fully manufactured components Significantly affecting, particularly Contact with other parts or materials for receiving areas. Fatigue life of hole Affected by a weak pore surface [22]. Of fabric reinforced laminate composites Among the most important and desirable traits Has flexural strength. However Flexural loads are frequent in joint constructions fail. Because of this Excellent flexural strength for these materials Reach is important because of their flexibility Performance should always be improved [23].

3. ANALYSIS AND DISCUSSION

In this study, four parameters, namely Nano content, feed rate, spindle speed, and drill diameter, were selected as input factors and delaminating factor and residual flexural strength were considered as the main response factors.

TABLE 1. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.654	.256	4

Table 1 shows Cronbach's Alpha Reliability result. The overall Cronbach's Alpha value for the model is 0.654 which indicates 65% reliability. Reliability of this model can be considered good.

TABLE 2. Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Nano Content	16	1	0	1	6	.40	.407	.165
Feed Rate	16	.06	.04	.10	1.12	.0700	.02309	.001
Spindle Speed	16	315	315	630	7560	472.50	162.665	2.646E4
Drill Diameter	16	1	4	5	72	4.50	.516	.267
A	16	1.44	1.08	2.52	24.60	1.5375	.47871	.229
B	16	1.47	1.08	2.55	25.20	1.5750	.52664	.277
C	16	135.6	211.2	346.8	4446.2	277.888	40.9784	1.679E3
D	16	122.8	221.1	343.9	4462.9	278.931	41.7738	1.745E3

A- Delaminating factor observed: B-delimitation factor predicted; C-residual flexural strength observed; D-residual flexural strength predicted

Above table 2 shows the Descriptive Statistical Analysis of Nano Content, Feed Rate, Spindle Speed, Drill Diameter, delimitation factor observed, delimitation factor predicted, residual flexural strength observed, residual flexural strength predicted for the given composite.

TABLE 3. Statistics

		Nano Content	Feed Rate	Spindle Speed	Drill Diameter	A	B	C	D
Std. Error of Mean		.102	.00577	40.666	.129	.11968	.13166	10.2446	10.4434
Median		.30	.0700	472.50	4.50	1.4850	1.4500	269.400	267.900
Mode		0[a]	.04[a]	315[a]	4[a]	1.09	1.08[a]	211.2[a]	221.1[a]
Sum		6	1.12	7560	72	24.60	25.20	4446.2	4462.9
Percentiles	25	.02	.0450	315.00	4.00	1.1150	1.1275	243.900	246.750
	50	.30	.0700	472.50	4.50	1.4850	1.4500	269.400	267.900
	75	.88	.0950	630.00	5.00	1.7850	2.1100	314.450	321.600

A- Delimitation factor observed: B-delimitation factor predicted; C-residual flexural strength observed; D-residual flexural strength predicted

Above table 3 shows the statistics analysis of delimitation and flexural properties in drilling of carbon Nanotube/polymer composites**.** Here

TABLE 4. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sum of Squares	F	Sig.
A	.940[a]	.884	.842	.19056	3.038	20.916	.000[a]
B	.905[a]	.820	.754	.26110	3.410	12.507	.000[a]
C	.730[a]	.532	.662	32.7206	13411.473	3.132	.020[a]
D	.745[a]	.556	.694	32.5138	14547.138	3.440	.007[a]

A- Delimitation factor observed: B-delimitation factor predicted; C-residual flexural strength observed; D-residual flexural strength predicted

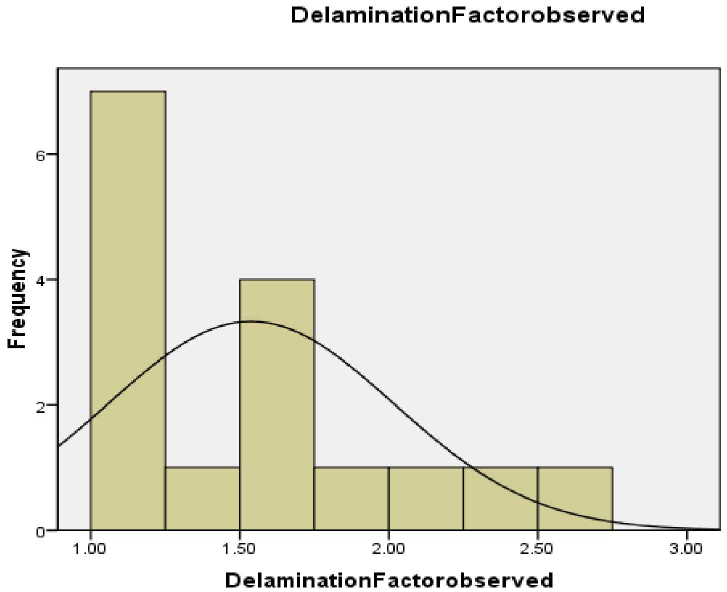

FIGURE1. Frequency for delimitation factor observed

Figure 1 shows the histogram plot for frequency of **delimitation** factor observed, where it can be seen that it's slightly skewed while other than some values from 1.00 to 1.50 all the values are under normal curve so the sample substantially follows the normal distribution.

Table 4 shows the reliability analysis of delimitation and flexural properties in drilling of carbon Nanotube/polymer composites. Overall value for R square is above average (0.5) and sum of squares for delimitation factor is less than ten and sum of squares for residual flexural strength is far above ten .F value for delimitation factor is above ten but F value for residual flexural strength is less than five. The sig. value is less than 0.05 for both delimitation factor and residual flexural strength. So this model can be considered to analyze.

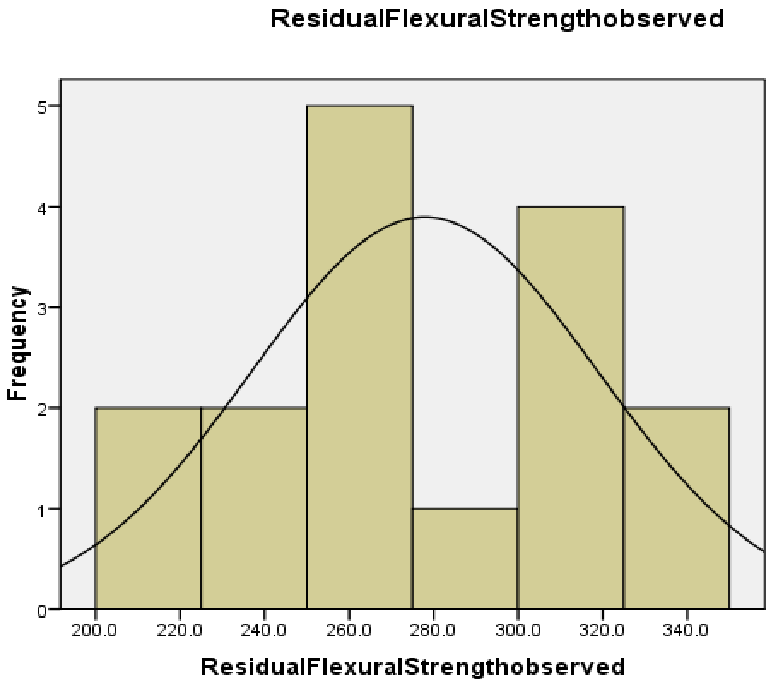

FIGURE 2. Frequency of residual flexural strength

Figure 2 illustrates the frequency of residual flexural strength observed, where it can be seen that above histogram is slightly skewed and most of the value are under the normal curve and sample for the most part follows normal distribution.

TABLE 5. Correlation

	Nano Content	Feed Rate	Spindle Speed	Drill Diameter	Delimitation Factor observed	Residual Flexural Strength observed
Nano Content	1	.000	.000	.000	.280	.569*
Feed Rate	.000	1	.000	.000	.768**	-.456
Spindle Speed	.000	.000	1	.000	-.458	.026
Drill Diameter	.000	.000	.000	1	-.070	.020
Delimitation Factor observed	.280	.768**	-.458	-.070	1	-.307
Residual Flexural Strength observed	.569*	-.456	.026	.020	-.307	1

Table 5 shows the correlation among parameters. Nano content is having lowest correlation with delimitation factor and having greatest with residual flexural strength. Feed rate correlates best with delimitation factor and worst with residual flexural strength. Spindle speed has best correlation with correlation with residual flexural strength and worst correlation with delimitation factor. Drill diameter correlates the best with residual flexural strength and worst with delimitation factor. Delimitation has greatest correlation with nano content and lowest with drill diameter. Residual flexural strength is having greatest correlation with nano content and having lowest correlation with feed rate.

4. CONCLUSION

Fiber-reinforced composite materials One of the must-haves, and they are Aerospace, Construction, Transportation, Automotive, As unique as sporting goods Widespread in engineering fields Widespread in engineering fields.Polymer composites are lightweight, stiff, corrosion resistant Desired like high resistance and improved strength Attributes are efficient. Many In engineering applications, polymer composites replacing traditional materials; so, this Machining behavior of composites is an excellent production to be examined for context. Understanding machining features and using a reliable tool to optimise parameters are crucial for a productive machining environment. In polymer nanocomposites relatively Modern GO modified epoxy and carbon Mechanical properties of fiber present are highlighted in the paper. Nano content Constant feed rate, in delimitation factor that makes the biggest impact the findings show. However, spin Speed and nano content residual flexibility they have a huge impact on residual flexibility strength.

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