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Performance Investigation of the Composite Made with Polymer Resin and Glass Fiber

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A B S T R A C T

Purpose: The majority of glass, carbon, ceramic, and aramid fibers, in addition to other man-made fibers, are used in the fabrication of polymer composites as fiber reinforcing materials. It has been suggested that one method for enhancing the properties of polymers is to include fillers into the matrix of the polymer. This would make the matrix more dense. The organic fiber (micro-level particles) reinforced polymer matrix (Epoxy Resin) has received substantially greater interest in comparison to pure polymers due to the extraordinary features that it contains. This is because pure polymers do not possess these qualities of composite materials. Research Methodology: In the present study, the initial step is to produce composite material by combining natural fiber as filler material with glass fibre sheet in an epoxy resin mixture. The product is then evaluated for its mechanical and wear qualities using ASTM standards. The results are confirmed using the Taguchi technique of experimental design. In addition, the analysis of variance test is utilized for this investigation. Research Findings: The primary findings of the study relate to the enhancement of the mechanical and wear properties of a composite material comprised of glass fibre and natural microparticles as filler for the same material. After conducting studies on the various test composite compositions, the best results were obtained when filler material was included in the composite components. Limitations: Like other research works, present investigation has also some limitations. In present investigation mechanical properties like tensile strength, micro hardness are measured and investigated with wear properties analysis for the all experiments but detailed micro structural analysis is not done due to lack of the measuring instruments availability. Importance of present work: the present work is provide the relation of the filler micro particles with glass fibre mixed in epoxy resin material to make the high strength composite material. In present study the filler particles are made of wood dust and glass fibre sheet is directory laminated with epoxy resin as matrix material. DOE is used to find the important relation of the input parameters with response parameters like tensile strength, wear rate of the composite material.

Keywords: Epoxy Resin, Natural micro particle, Glass fibre sheet, Composite, DOE

Introduction

Polymer matrix composite materials offer a strong potential for use in technical and residential applications due to their low weight, weight-to-size ratio, durability, good thermal properties, and economic soundness. Due to their reduced weight, increased strength, and flexibility, reinforced plastics are employed in a variety of items, such as aircraft, spacecraft, rockets, automobile body panels, and windmill blades. Significant improvements have been made to the workability, machinability, durability, and unique features of polymer matrix composites. Engineers and scientists from all around the world must work to boost the strength of composites.

When polymer composites require load-bearing capabilities, fibre strengthening is a typical approach that is applied in most of the composite materials. The reinforced fiber element shares the imparted load and transfers it to the matrix phase. Consequently, matrix stress might be minimized, allowing the composite to bear larger loads. When particular qualities, such as thermal stability, dielectricity, photoelectricity, and magnetism, are required, particle addition is not only a simple but also very effective method. The addition of particles to a polymer matrix composite provides the material with many dimensions. The matrix phase is the most vulnerable component of any composite because it is subject to external degradation factors such as mechanical force, impact damage, thermal force, chemical assault, and water absorption. These factors include selecting between thermoplastics and thermosetting plastics based on the matrix phase's properties.

The thermoplastic matrix phase has increased degrees of hardness, low brittleness, and great temperature stability due to its crystalline molecules. On the other hand, the thermosetting matrix exhibits increased brittleness, decreased toughness, and enhanced temperature stability. Long continuous fiber material and fiber cloth have the ability to operate as anisotropy reinforcing materials. These materials show axial and transverse stresses that are unique from one another. Some forms of composites, such as whisker, particle, flake, and chopped fiber, can show the behavior of isotropic materials because deformation can occur in all three dimensions. Using the law of mixtures, it is possible to evaluate the strength of composites by considering both the matrix and reinforcement strengths.

Hybrid composites are formed by combining many distinct phases of materials. The matrix and reinforcement phases are also viable hybridization locations. The hybrid matrix composite is the combining of two or more matrix components (polymers). Matrix hybridization is performed when there is a high demand for base polymers and the objective is either to improve the mechanical and thermal characteristics of the base polymers or to minimize their production costs. It is conceivable for the matrix hybridization to incorporate both identical and dissimilar components. Mixing thermosetting and thermoplastic polymers is common practice. Hybrid reinforced polymer matrix composites are generated when two or more reinforcements are combined with a single polymer matrix.

In composites, the kind and size of reinforcing can vary. Hybrid composites are those that are reinforced by more than one type of fiber. Hybrid reinforcement composites are composed of both fiber and particle. When certain circumstances are satisfied, the material's quality can be enhanced by incorporating two or more particles into the matrix. When a polymer matrix is reinforced with a continuous-fiber woven fabric, the resultant material can possess higher mechanical characteristics. When particles of ferric oxide are spread throughout the matrix of a composite, the material's mechanical and magnetic characteristics are increased. Electrical and thermal characteristics can be altered by the presence of particles. There are a variety of uses for multifunctional hybrid composites. The matrix phase, reinforcement phase, or both might offer the environment for hybridization to occur.

Hand lay-up is the simplest and oldest open moulding method for composites. It's a low-volume, labor-intensive process ideal for boat hulls. Glass or other reinforcing fabric is physically placed in an open mold, then resin is poured, brushed, or sprayed over it. Air trapped in laminates is manually removed with squeegees or rollers. Most matrix resins are room-temperature-curing polyesters and epoxies. A catalyst in the resin system hardens fiber-reinforced resin without heat. A coloured gel coat can be applied to the mold surface for a high-quality component surface. Fig. 1.6 shows the hand lay-up method step-by-step in detailed view.

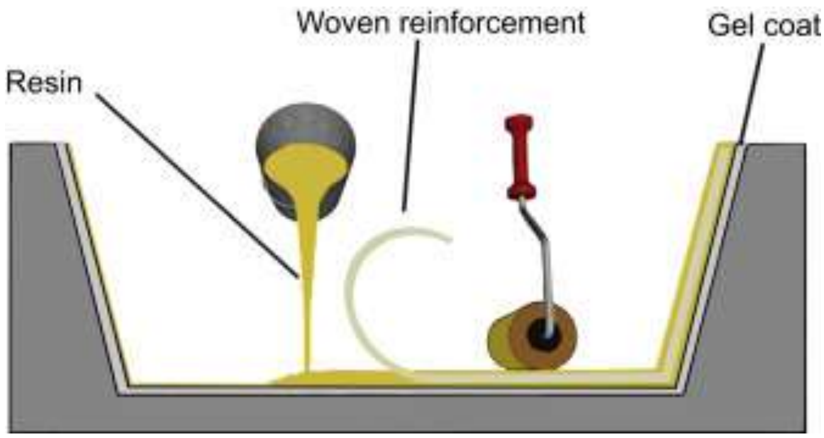

Figure 1 Hand lay up method for making the composite material [06]

Need of the present study on Hybrid Composite

In comparison to conventional composites, hybrid polymer matrix composites provide a number of advantages. Although GOFERs are best suited for specialized applications, hybrid PMC output does offer multi-directional capabilities. GOFERs are comprised of matrix and second phase additions. These days, composites mix a lot of different properties. A conventional PMC that utilizes glass fibre as the reinforcing element has the potential to improve the mechanical and impact behaviour of the material, whereas a hybrid GOFER that makes use of E-glass fibre and ferric oxide particle has the potential to improve the mechanical and magnetic properties of the material. There are a lot of different permutations that may be employed to get the desired characteristics. The purpose of this study is to investigate the mechanical properties and wear resistance of an epoxy polymer that has been reinforced with E-glass fibre and natural fibres such as wood dust, cow dung dust, plant dust, and so on. Combinations of fibres and particles could make the aforementioned features even better. The Tribological characteristics of epoxy thermosetting polymers can be improved by the addition of natural fibre particles, whereas the mechanical properties of epoxy thermosetting polymers can be improved by the addition of E-glass fibre.

Literature Review

(Choudhary et al, 2019 [07]) This article addresses the production and evaluation of glass fiber-reinforced epoxy composites with and without marble dust waste. Under controlled circumstances, the composites were produced utilizing VARTM (vacuum-assisted resin transfer molding). The composite contained 0–30% marble dust by weight. This research shown that increasing the amount of filler enhanced composite density, void content, hardness, and crystallinity. Regardless of filler amount, the storage modulus and loss modulus of unfilled and particulate-filled composites increased up to 60 degrees Celsius, then decreased.

(Naheed Saba et al, 2014 [08]) described the impact of nanofillers and natural fibres on the polymer matrix. With the inclusion of nanoscale filler and natural fibre, the mechanical and thermal characteristics of composites were enhanced. They observed that surface-modified filler improved filler-to-polymer adhesion. Surface modification of the filler resulted in enhanced mechanical, thermal, and water-absorption capabilities of the material.

According to the findings of (Navaneetha Krishnan et al, 2015) [09], the mechanical characteristics of epoxy composites were enhanced by the inclusion of CNT-Fe2O3 solgel particle and 50 percent E-glass fibre. The hybrid composite demonstrated tensile strength of 250 MPa, flexural strength of 540 MPa, flexural modulus of 26 GPa, and impact strength of 2.6 KJ/m Izod. They concluded that the incorporation of particles improved the fibre-matrix bridge connection.

(Navaneetha Krishnan et al, 2014) [10] studied the hybrid wear of ZnO and E-glass fiber-reinforced HDPE (2014). According to them, it was successful to improve the wear qualities of E-glass fibre by adding 10 percent ZnO. Using E-glass fibre coupled with ZnO particle, a homogenous transfer film was created. The ZnO epoxy composite with E-glass fibre reinforcement was found to have a lower friction coefficient than the other composites.

(Rahmanian et al, 2014) [11] examined the use of carbon nanotubes in carbon fibre epoxy. The hybrid shape enhanced the load transmission of carbon fibre and epoxy. Carbon nanotubes acted as the bridge's load bearing material. The use of carbon nanotubes into carbon fibre epoxy composites enhanced the material's rigidity and durability. Carbon nanotubes can increase the material's storage modulus, impact resistance, and flexural properties.

(Júlio C Santos et al, 2015) [12] studied the composites' mechanical and thermal characteristics after adding PDDA-functionalized micro- and nano-silica particles to glass-epoxy composites. They observed that adding more surface-functionalized nanosilica to a glass fiber-reinforced epoxy composite increased the composite's tensile and flexural strengths. This improvement was the consequence of enhanced nanosilica dispersion inside the polymer matrix. The use of PDDA enhanced both dispersion and mechanical characteristics. When the particle concentration exceeded 2%, clusters formed, which diminished the mechanical and thermal properties.

Utilizing carbon nanotubes and E-glass fibre, (Nevin Gamze Karsli et al, 2014) [13] enhanced the characteristics of polypropylene composites. They worked on carbon nanotubes with changed surfaces (CNTs). In the matrix, CNTs treated with 3-aminopropyltriethoxysilane dispersed effectively. The mechanical and thermal characteristics of CNT/E-glass fiber-reinforced polypropylene with a modified surface have been greatly improved. As a result of surface-modified carbon nanotubes, tensile and flexural testing performance was improved by 2%. Agglomeration decreased the mechanical characteristics of the material as CNT loading increased.

(Jalali M et al, 2011) [14] studied the electromagnetic shielding capacities of metallic nanoparticles on carbon fiber-epoxy composite (2011). The addition of 50 nanometer-sized iron nanoparticles to a carbon fiber-reinforced polymer nanocomposite boosted its X-band shielding effectiveness by 15 dB. A carbon fiber-reinforced polymer composite containing iron particles was shown to be the most efficient type of microwave shielding. Iron particles diminished both the electrical and magnetic components of microwave radiation.

(Krishnasamy Jagadeesan et al, 2014) [15] thoroughly investigated the EMI shielding advantages of hybrid composite (2015). With the addition of conductive textiles (stainless steel) and conductive particles, the EMI shielding provided by epoxy resin was greatly enhanced (copper). In the 18 GHz frequency region, the EMI shielding offered by a hybrid conductive fabric and particle was increased by 80 dB.

(Tehrani et al, 2013) [16] evaluated the impact of introducing carbon nanotubes to an epoxy composite on the composite's structure. The addition of SiO2 particles to treated carbon fibre resulted in a damping coefficient that was greater than that of an epoxy composite reinforced with carbon fibre. The addition of carbon fibre to the epoxy resin enhanced the composite's mechanical qualities, while the inclusion of SiO2 particles enhanced the composite's damping capabilities.

(Patil et al, 2016) [17] found that increasing the number of graphite (20 microns) and bronze (47 microns) particle as well as the volume of sub-micron particle inclusion to 15 percent improved the load absorption and flexural strength of epoxy resin. Adding five percent graphite, fifteen percent bronze, and fifteen percent E-glass fibre boosted the flexural strength of the composite by twenty percent. In addition, the researchers observed that adding more than 5 volume percent of particles reduced the flexural strength and modulus of the material due to van der Waals attraction.

(Amaresh Kumar et al, 2015) [18] found that the addition of calcium sulphate (250 nm) and silicon carbide (300 nm) to a fibre-reinforced epoxy resin containing 50 volume percent E-glass raised the tensile strength from 93 MPa to 152 MPa. With the addition of 10% SiC, the impact resistance increased to 0.22 J/mm2. The inclusion of tiny SiC particles and reinforced E-glass fibre substantially improved the mechanical characteristics of the epoxy resin.

According to study by (Ekram A Ajaj et al, 2013) [19], increasing the number of SiO2 nanoparticles (12 nm) in an epoxy-chopped glass fibre composite boosted both the fatigue strength and the fatigue life. The fatigue load applied to the composite material was a 5 Hz sinusoidal wave with a resistance value of -1. The SN curve demonstrates that the fatigue life of the composite with 10% SiO2 was 19000 cycles more than that of the composite with chopped glass fibre and epoxy. By filling the crevices between epoxy molecules, SiO2 particles improved the material's fatigue resistance.

(Suresha et al, 2003) [20] studied the 20 millimeter-long wear of SiC particle in an epoxy resin composite. The SiC-filled E-glass fibre-reinforced epoxy composite demonstrated 14 percent more wear resistance than the unfilled composite at a distance of 6000 metres. The coefficient of friction of an E-glass fibre epoxy composite with SiC filler is lower than the coefficient of friction of an empty composite.

Material and Method

The procedure for making an E-glass fiber-reinforced wood dust particle added epoxy hybrid composite is depicted in the figure labeled "Figure 2," which provides an illustration of the procedure. Graphical representations of this process are provided. After adding a constant quantity of treated E-glass fiber to the resin at a volume percentage of 25, along with varying volume percentages of surface-modified wood dust particles (up until approximately 10 volume percent), and stirring the mixture thoroughly until the degassing process was finished, the mixture was stirred at room temperature. After the method of stirring was discontinued, a continuous amalgamation of the particle and the resin was produced. After that, the curing agent triethylenetetramine (hardener) was added to the mixture in the precise weight ratio that had been estimated in advance (resin to curing agent), and the mixture was agitated until it became homogenous. After that, the mixture was ready to be used. After pouring the viscous colloidal solution into a rubber mold that had been treated with wax, the epoxy resin matrix was then covered with a 25% volume percentage of an E-glass woven fiber mat that was three plies thick. This process was repeated until the matrix was completely covered. With the use of a cotton roller, the air bubbles that had become trapped in the material were able to be removed. The extra resin was wiped away by hand using a wipe, and it was all done by itself. The curing process was carried out for a length of twenty-four hours at a temperature of room temperature. The designations of hybrid composites are listed below in Table 1, along with the ingredients that make up such hybrid composites.

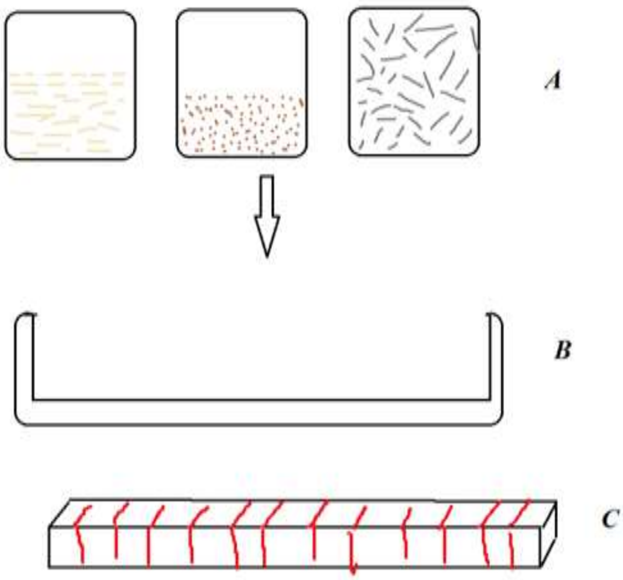

Fig. 2 Fabrication of Hybrid Composite a. ingredients b. silicon mould c. final object

TABLE 1 Composition of the Hybrid Composite made with E-Glass, Wood Particle and Epoxy Resin

Designation	Epoxy (in Vol %)	E-Glass (in Vol %)	Wood Dust (in Vol %)	Remarks
ER	100	0	0	Neat Epoxy Resin
ERGF	75	25	0	25% E-glass fibers in ER
GOFER-I	72.5	25	2.5	Mixed micro level wood particles in epoxy and e glass fiber
GOFER-II	70	25	5.0	
GOFER-III	67.5	25	7.5	
GOFER-IV	65	25	10.0	

Factor and Levels

In the current body of study, selecting appropriate factors and the range of those factors was of the utmost importance. The values of the factors depend on a number of characteristics, including the ones that are listed below:

A. Evaluate the machine's usable range to determine the level of precision it is capable of producing

B. The "design of experiment" approach choice significantly impacted the range selection process.

C. A local industrial survey was also considered for the level selection of the variables. This was done in an area where a testing machine was used for commercial purposes.

D. In the most recent published material, the emphasis was also placed on selecting the ultimate stages.

As was said in point one, the levels depend on the testing equipment; hence, appropriate pilot trials are necessary to locate the final levels for the various input parameters. In this particular investigation, the researchers used three types of response parameters. Within the scope of this specific analysis, the Researcher has decided to look at three different input parameters. The load placed on the object, the rotating disk's sliding distance, and the filler percentage make up these parameters. The process of deciding which levels to employ involves using the pilot experiments discussed in the previous section.

TABLE 2 FACTORS AND LEVELS FOR WEAR ANALYSIS

Factors/Levels	Filler Particle	Normal Load	Sliding Distance
	In %	N	m
I	2.5	10	350
II	5.0	15	450
III	7.5	20	550
IV	10.0	25	650

TABLE 3 ORTHOGONAL ARRAY DEVELOPED FOR WEAR ANALYSIS

Run	Filler in %	Load	Sliding Distance
1	2.5	10	350
2	2.5	15	450
3	2.5	20	550
4	2.5	25	650
5	5	10	450
6	5	15	350
7	5	20	650
8	5	25	550
9	7.5	10	550
10	7.5	15	650
11	7.5	20	350
12	7.5	25	450
13	10	10	650
14	10	15	550
15	10	20	450
16	10	25	350

Total 16 experiments were generated using Taguchi method for wear analysis f the composite made with Epoxy Resin and E-Glass fiber with different wood dust filler particles. In present investigation the rotation of the disk was set to 300 RPM and E-glass fiber was set to 25% of Total weight of the Object. Remaining was the Epoxy Mixture (Part A+Part B).

Result and Discussion

In the present study, a composite material has been made by mixing glass fiber and wood dust particles with epoxy resin. Mechanical testing and wear testing have been performed for this composite material.

In the present chapter, different types of mechanical testing analysis have been performed under section one. First of all tensile strength analysis is discussed then impact energy analysis is discussed for all composites in this section. Flexural strength analysis was also performed in this section. The harness testing of composite material is also discussed in this chapter. To measure the hardness, the hardness testing machine available in the college is used. Design of Experiment has been used to study the friction of composite materials.

In this present chapter, three types of composites are made by mixing pure epoxy, epoxy and fiberglass, and finally epoxy fiberglass with wood dust particle. Tensile strength analysis of all these composites is discussed in the section of this chapter. As per previous public literature, addition of glass fiber improves tensile strength, but once those dust particles are added, the tensile strength decreases slightly but is still better than pure epoxy. In the present chapter, when the glass is mixed inside the epoxy, its surface is roughened by metal wire, the surface of the glass fiber is created more rough surface by metal wire, and the length of the fiber is not more than 20 mm. Due to the roughness created inside, the strength of the normal epoxy mixed composite is better than the rough Eglass fiber made composite, which is presented in this tensile strength analysis.

TABLE 4 Tensile Strength analysis of the all Cases made with Pure ER, with GF and with Wood Dust particles

Designation	**Epoxy (in Vol %)**	**E-Glass (in Vol %)**	**Wood Dust (in Vol %)**	**Tensile Strength (MPa)**
ER	100	0	0	69
ERGF (Normal)	75	25	0	98
ERGF (Metal Wire made Rough)	75	25	0	107
GOFER-I	72.5	25	2.5	104
GOFER-II	70	25	5.0	101
GOFER-III	67.5	25	7.5	97
GOFER-IV	65	25	10.0	94

As can be seen, the tensile strength of pure epoxy resin made composite is 69 MPa, but as soon as glass fiber is mixed inside it, the tensile strength of the composite becomes 98 MPa. Unlike glass fiber which is roughened by metal wire, it develops a tension strength of 107 MPa, which was highest among all test objects made by ER base matrix material.

But when wood dust was mixed with a mixture of glass fiber and epoxy resin to make a composite, a drop in tensile strength has been recorded. The tensile strength of the composite made with 10% wood dust, is 94 mega pascals. Due to the addition of percentage of wood dust, there has been a drop in the tensile strength, which is due to the organic nature of the wood dust as shown in figure 3. In present study the maximum tensile strength was shown for 2.5% wood dust in ER+GF mixture.

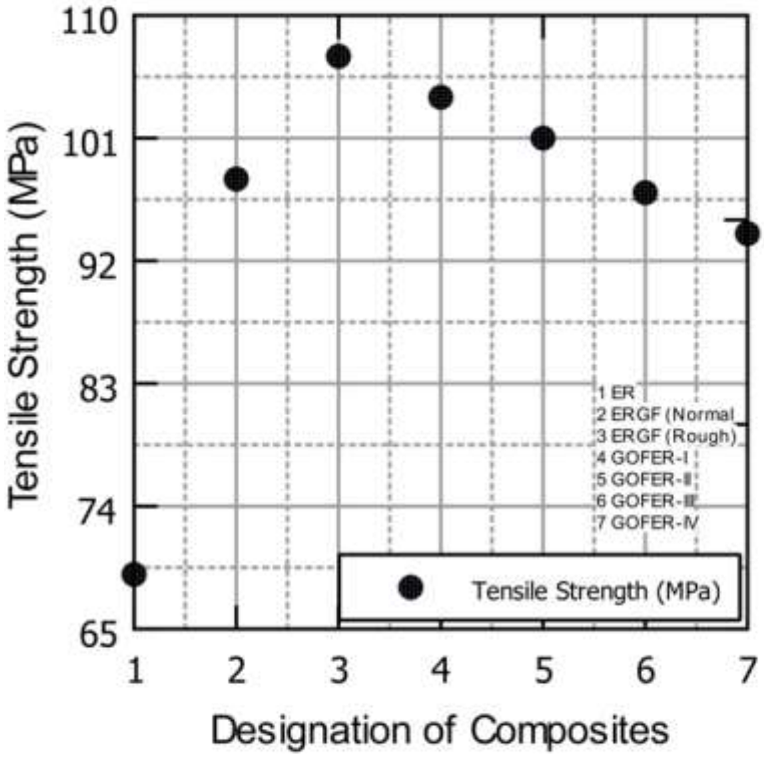

Fig.3. Tensile Strength analysis for Composite made with (ER, GF and WD)

As the percentage increment in wood dust was going to increase the tensile strength was also going to reduce due to the formation of wood dust particles clusters in the composite. The reason to make the clusters of the particles were the high viscous nature of the ER matrix fluid.

TABLE 5 Tensile Strength improvement of the all Cases made with Pure ER, with GF and with Wood Dust particles

Designation	**Epoxy (in Vol %)**	**E-Glass (in Vol %)**	**Wood Dust (in Vol %)**	**Tensile Strength (MPa)**	**% Improvement**
ER	100	0	0	69	-
ERGF (Normal)	75	25	0	98	29.59

Designation	**Epoxy (in Vol %)**	**E-Glass (in Vol %)**	**Wood Dust (in Vol %)**	**Tensile Strength (MPa)**	**% Improvement**
ERGF (Metal Wire made Rough)	75	25	0	107	35.51
GOFER-I	72.5	25	2.5	104	33.65
GOFER-II	70	25	5.0	101	31.68
GOFER-III	67.5	25	7.5	97	28.86
GOFER-IV	65	25	10.0	94	26.59

Impact Strength Analysis

Epoxy, epoxy combined with fiberglass, and finally epoxy fiberglass combined with a little amount of sawdust are the three types of composites that will be manufactured in this section. The impact strength analysis of each of these composites is discussed in this section of the chapter. According to past research that was made publically available, the addition of glass fiber to a material results in an increase in that material's impact strength. The impact resistance of the same substance, however, is reduced slightly when dust particles are introduced, although it is still more than that of epoxy in its purest form. In the present chapter, the surface of the glass is made more textured by the addition of metal wire before it is merged within the epoxy. In addition, the length of the glass fiber is limited to no more than 20 millimeters, and it has a surface that has been made to have a more abrasive texture by the use of metal wire. According to the findings of this study on impact strength, the composite made by roughly cutting up Eglass fibers has a lower impact strength than the composite made by regularly mixing epoxy. This is due to the fact that the rough Eglass fiber manufactured composite has a smoother interior compared to the conventional epoxy mixed composite's rough interior.

TABLE 5 Impact Strength analysis of the all Cases made with Pure ER, with GF and with Wood Dust particles

Designation	**Epoxy (in Vol %)**	**E-Glass (in Vol %)**	**Wood Dust (in Vol %)**	**Impact Strength (kJ/m^2)**
ER	100	0	0	4.3
ERGF (Normal)	75	25	0	9.3
ERGF (Metal Wire made Rough)	75	25	0	10.7
GOFER-I	72.5	25	2.5	8.1
GOFER-II	70	25	5.0	7.8
GOFER-III	67.5	25	7.5	7.3
GOFER-IV	65	25	10.0	6.7

It can be observed that the impact strength of a composite made completely of epoxy resin is 4.3 kJ/m2, but as soon as glass fiber is added into it, the impact strength of the composite jumps to 9.3 kJ/m2; this is because glass fiber reinforces the epoxy resin. When EG fibers were roughened by metal wires, it created a flexural strength of 10.7 kJ/m2, which was the highest among all test items generated by ER base matrix material. This was the strongest among all test items. In contrast to this is glass fiber, which has a rough surface due to the presence of metal wire.

Signal to Noise Ratio Analysis

In all 16 of the tests that were carried out using hybrid composites, a signal-to-noise ratio analysis was carried out for the wear rate. Within the hybrid composite, the glass fiber was immobilized within the epoxy resin; the sole variable was the percentage of wood dust particle contribution, which varied based on the experiment table. The choice "smaller is better" was chosen for this study's signal-to-noise ratio analysis, and the individual S/N ratios for the wear rate are presented in table 5.11 for wear rate. The present study aimed to determine the optimal signal-to-noise ratio. As seen in table the S/N ration values were calculated using Minitab Software. After calculation of individual S/N ratio, the delta of the S/N ratio was calculated using average value of the S/N ratio of wear rate.

TABLE 6 S/N RATIO ANALYSIS OF WEAR RATE

Run Order	**Wood Dust**	**Load**	**Distance**	**Wear Rate**	**S/N Ratio**
	%	**N**	**m**	**mm^3/m**	
1	2.5	10	350	0.029	30.71
2	2.5	15	450	0.027	31.43
3	2.5	20	550	0.023	32.67
4	2.5	25	650	0.030	30.42
5	5	10	450	0.028	31.17
6	5	15	350	0.031	30.20
7	5	20	650	0.031	30.11
8	5	25	550	0.029	30.81
9	7.5	10	550	0.024	32.27
10	7.5	15	650	0.034	29.31
11	7.5	20	350	0.041	27.74

Run Order	Wood Dust	Load	Distance	Wear Rate	S/N Ratio
	%	N	m	mm^3/m	
12	7.5	25	450	0.070	23.09
13	10	10	650	0.029	30.72
14	10	15	550	0.025	32.21
15	10	20	450	0.073	22.74
16	10	25	350	0.074	22.63

TABLE RANK OF FACTORS USING S/N RATIO ANALYSIS

Level	Wood Dust	Load	Distance
1	31.31	31.22	27.82
2	30.57	30.79	27.11
3	28.11	28.31	31.99
4	27.07	26.74	30.14
Delta	4.24	4.48	4.88
Rank	**3**	**2**	**1**

The wood dust increase the wear rate of the hybrid composite, the reason behind is the mixing of wood dust particles can make the strength weak compare to normal composite and also make clusters due to high viscosity rate of epoxy resins. Both reasons create the wear rate increment when mixing percentage of the wood dust increased in the composite. The same profile like wood dust, the Increment in the normal load applied to the composite object can increase the wear rate of the composite, but in last parameter sliding distance the zig zag profile was shown because it was not directly impact the hybrid composite,

Conclusion

I. Tensile strength testing was performed for Pure Epoxy, Epoxy mixed with Glass Fibre and Glass Fiber with Rough surface and in last the Wood dust particle. The tensile strength of the pure composite was equal to 69 MPa, but as the E-glass fiber is mixed with pure epoxy then Tensile strength improved to 98 MPa. In present study the glass fiber was roughened by metal wire and then mixed with Pure epoxy and the tensile strength was increased to 107 MPa. In the last for making the hybrid composite the micro wood dust particles were mixed in epoxy and glass fiber. By mixing the wood particle in epoxy resin decrease the tensile strength from Glass fiber mixed Composite but still more then normal epoxy composite. The reason to decrease the tensile strength was making the cluster of wood particles in the composite and the natural lower properties of the wood dust particles. The maximum increment in the tensile strength was present in ERGF (metal wire made rough). And the maximum flexural in wood dust mixed hybrid composite was in GOFER-I.

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