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Experimental Investigation of Date Seed Filler Reinforced Bio-Polymer Composite

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To obtain the needed properties, hybrid bio-composites have recently been created by adding diverse natural materials as reinforcement and filler components. The creation of a new set of date seed natural filler-based polymer composites with reinforcements containing epoxy resin and natural filler loadings ranging from 5% to 30% by volume is described in the current work. The wear qualities of the composites are assessed after they are constructed using a hand layup procedure. To improve the interfacial response between the matrix and filler of the composite, different compositions using epoxy-based date seed fibre will be used, which will in turn improve the composite's wear analysis. We'll contrast the composite's wear with that of neat polymer. To measure the biopolymer composite's strength, tensile, flexural, and impact tests are performed.

Keywords: Hybrid Bio-Composites, reinforcements, layup procedure, seed fibre.

1. Introduction

Due to their lightweight nature and high specific stiffness and strength, composites are replacing metals in a variety of structural applications in the aerospace, construction, and automotive industries. Composites outperform metals at high temperatures, are lighter, and are more resistant to fatigue and fractures, which could be dangerous flaws in metals [1]. The utilisation of new and sophisticated composite materials that not only reduce weight but also absorb stress and vibration through customised microstructures has received significant emphasis in response to the requirement for lighter building materials and more durable constructions. In the automotive industry, the utilisation of composite materials is developing [2-4].

Composite materials have a lot of potential for lowering vehicle weight, improving fuel efficiency, and decreasing carbon dioxide emissions. Contrary to conventional materials (like steel), a composite material's qualities can be created while taking the structural characteristics and variable reinforcing matrix or filler content into account [5][21]. Both materials and structural design go into the creation of a composite structural component. Under the direction of the designer, composite qualities like stiffness and thermal expansion can be continually changed throughout a wide range of values. The properties of the product can be customised to practically any unique technical requirement through careful reinforcing type selection [6][18].

The use of composite materials is a clear choice, and the choice of material will be based on factors like the required working lifetime, the quantity of items to be produced, the complexity of the product shape, potential assembly cost savings, and the designer's experience and expertise in utilising composites to their full potential [7-9]. In compared to mineral fillers, using natural fillers to strengthen composite materials has the following benefits: robust and rigid structure; lightweight material; environmental friendliness; cost-effectiveness; and renewable and abundant resource. Natural fillers with exceptional potential as plastic reinforcing include coconut shell powder. Composites made from epoxy polymer and filled with up to 30% coconut shell fillers were shown to have higher tensile strength as the coconut shell content rose [3][10].

It has been found that adding date shell powder decreases the bio-dampening composite's property while significantly increasing its tensile strength and tensile modulus. The date shell is an agricultural by-product with no commercial use. But it is frequently employed as fertiliser in other agricultural purposes [11]. The agricultural sector as well as other industries will profit from finding new uses for agricultural garbage. This agricultural waste will find use and gain value through the creation of polyethylene composite from coconut shell powder. Because epoxy resin with hardener HY951 is inexpensive, readily accessible, has high mechanical qualities, and has applications in the transportation, maritime, and sporting goods industries, it was chosen as the study's matrix [1][12].

2. Literature Survey

Creating and testing natural-based composite materials focuses on creating composite constructions using resources from nature. Flax fibres were combined with bio-resin to create the natural fibres that were employed. Natural structures are compared to analogous artificial sandwiches made of fibre glass and epoxy resin. To learn more about the qualities of the coconut shell powder, it has undergone physical and chemical analysis. The characteristics of coconut shell powder vary depending on the mesh sizes [13-15]. Thermo-Mechanical Influences on Mechanical Polishing of Natural Fiber Composite, Faissal The composite surface has fewer surface flaws after dry polishing. As a result, the fiber/matrix interface is protected against brittle fracture. Surface roughness is affected by the polishing conditions, and dry polishing results in smoother surfaces than wet polishing.

Data demonstrating the impact of the time spent milling coconut shell nanoparticles with a vibratory disc on their microstructural properties (CS-NPs). SEM equipment was used to test the impact of milling duration on morphological features. It has been demonstrated that coconut shell may be utilised as reinforcement material and has good mechanical qualities [16][24]. Flexural properties of thin-walled ferrocement beams with various types of core materials and mesh reinforcing Extruded foam core (EFC) ferro cement beams typically had the lowest ductility index, whereas light weight concrete core and autoclaved aerated lightweight brick core (AAC) beams had the highest ductility indexes (LWC) [2][17]. Expanded metal mesh (EMM)-reinforced specimens have higher ductility, while fibre glass mesh (FGM)-reinforced specimens have lower ductility. Pultruded flax fabric reinforced cement (PFRC) composite had an increase in compression strength that was between two and four times greater than that of control cement. In comparison to normal cement, the use of PFRC increased impact crack resistance by 1.1–2.3 times.

Doum-plam leaves particle reinforced PVC composite: microstructural and mechanical characterisation as pipe materials [18][23]. A doum palm particle reinforced PVC composite with significantly less expensive components and good mechanical qualities for piping material has been created. Compression moulding is the method used. When the weight proportion of the reinforcement increases, the density and elastic modulus of the composite change. Impact characteristics of shock waves on flax fibre reinforced composites Shock testing of flax/polypropylene and flax/epoxy composites in both unidirectional and cross-ply orientations reveals that cross-ply specimens have greater impact resistance than unidirectional specimens and hence have better impact strength [19][20].

A comparison of the physical and mechanical characteristics of cement panels with and without processed coconut fibre addition A cement panel reinforced with untreated coconut fibre gains even more compressive strength after being added. When the amount of coconut fibre in a cement panel was increased, the moisture content of the panel grew along with it, however when the amount of coconut fibre in a cement panel was increased along with it, the water absorption increased [21]. The major goal of this research is to create materials that are stiff, light, and strong while also having good mechanical qualities, To make sure that all of the natural resources are used up and that nothing is wasted, To replace synthetic fibre and produce a non-toxic environment, A natural fibre reinforcement and a matrix are what make up a natural polymer composite, Natural products that are wasted can be used to generate useful products or, alternatively, can be added to composites to strengthen them and give off superior qualities [22].

3. Proposed Work

The hand lay-up technique, which is an easy and efficient process, is employed to produce the hybrid composites. The steps involved in a hand lay-up are as follows. To prevent the base plate of the mould from sticking to it, first a layer of release agent, such as wax, is distributed evenly across the plate. Next, a layer of epoxy is applied to the base plate. Following the application of epoxy, a cut-to-size okra mat was placed on top of the foundation plate, and dates seed powder was equally distributed on top of the okra mat. To ensure adequate dispersion of the epoxy and avoid the production of air bubbles, a second coat was then poured and spread with the aid of a roller. To create the hybrid composite plate, three further layers of dates seed powder, epoxy, and okra fibre were successively applied. Once the materials had been laid up, the mould was sealed by pressing down on the top plate, and the setup was permitted to cure for 48–72 hours. Hybrid composite was created using the method previously described.

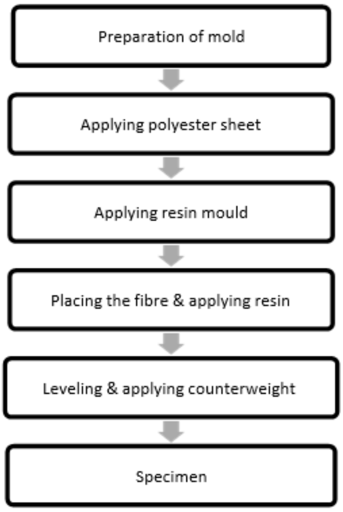

Figure 1 Block Diagram

4. Selection Of Materials

A. Dates Seed Powder

Strong interfacial bonding is formed because of the strong polarised hydroxyl groups that are present on the surface of lignocellulosic fillers. Due to the absence of interfacial adhesion, lignocellulosic fillers exhibit poor mechanical characteristics in polymer composites. Alternately, surface modification of the filler can improve the interfacial adhesion between the filler and matrix. The interfacial adhesion between lignocellulose filler and polymer matrix is currently promoted in a variety of ways, including alkalization, esterification, silane treatment, using compatibilizers, and treatment with other chemical compounds, when appropriate modifications and production procedures are used.

Sl.no.	Chemical composition%	Date seed shell
1	Cellulose	26.6
2	Hemicelluloses	21
3	Lignin	29.4
4	Pentosans	27.7
5	Solvent extractives	4.2
6	Uronic anhydrides	3.5
7	Ash	0.6

Table 1 Composition of Date Seed Shell

Figure 2 Dates Seed Powder

S.NO	Dates seeds with natural fiber Vol %	Epoxy matrix Vol %
1	5%+20%	75%
2	10%+20%	70%
3	15%+20%	65%
4	20%+20%	60%
5	25%+20%	55%
6	30%+20%	50%

Table 2 Composition of Composite

5. Design Calculation

For the preparation of the composite, we calculate the volume fraction percentage ofbiomedical waste and epoxy resin.

The densities of,

i) Date seed filler with okra fiber = 2.56 × 10-3 gm/mm3

ii) Epoxy resin = 1.05 × 10-3 gm/mm3

Total Volume = Length × Breadth × Height

= 300 × 300 × 3

= 270000 mm3

for 10% with 20 % fiber &70% matrix

Volume of Matrix = 270000 × (90/100)

= 243000 mm3

Mass of Matrix = Volume × Density

= 243000 × 1.05 ×10-3

= 255.15 gm

Volume of Matrix = 270000 × (10/100)

= 27000 mm3

Mass of Matrix = Volume × Density

= 27000 × 1.05 ×10-3

= 28.35gm

6. Results And Discussion

This section presents the experimental study's findings and a discussion of them. Table displays the mechanical behaviour that was noticed. The greatest tensile stress that a material can withstand before failing is known as its tensile strength. The flat form of specimen is most frequently used for tensile tests. A uniaxial force is delivered via both ends of the specimen during the test. According to ASTM D638, this test is performed. The specimen's dimensions are (165x20x3) mm, and the results are given in table 3 Shows the specimen's tensile strength

Sample no.	volume %		Tensile strength (MPa)
	Filler with fiber %	Epoxy resin	
1	**5%+20%**	75	14.14
2	**10%+20%**	70	16.77
3	**15%+20%**	65	18.41
4	**20%+20%**	60	21.61
5	**25%+20%**	55	20.13
6	**30%+20%**	50	17.44

Table 3 Tensile Strength of Specimens

Flexural strength is the capacity of a material to withstand deformation under load. It is a 3-point bend test, which frequently encourages inter-laminar shear failure. The ASTM standard D790 is followed when conducting this test. The specimen measures (130x12.7x3) mm. The findings are summarised in table 4.

Sample no.	volume %		Flexural strength (MPa)
	Filler with fiber %	Epoxy resin	
1	**5%+20%**	75	22
2	**10%+20%**	70	24
3	**15%+20%**	65	27
4	**20%+20%**	60	31
5	**25%+20%**	55	29
6	**30%+20%**	50	28

Table 4 Flexural Strength of Specimens

The capacity of a material to absorb and dissipate energies during impact or shock loading is represented by its impact characteristics. In actuality, the impact circumstance could be anything from the unintentional dropping of hand tools to high-speed collisions, and the reaction of a structure could be anything from little damage to complete collapse. The ASTM standard D256 is followed when conducting this test. The specimen's dimensions are (65.5x12.7x3). The results are tabulated in the table 5.

Sample no.	volume %		Impact strength j/mm2
	Filler with fiber %	Epoxy resin	
1	**5%+20%**	**75**	1
2	**10%+20%**	**70**	1.5
3	**15%+20%**	**65**	1
4	**20%+20%**	**60**	1.5
5	**25%+20%**	**55**	1.5
6	**30%+20%**	**50**	1

Table 5 Impact value of Specimens

7. Conclusion

Date seed powder with okra reinforcement in the epoxy resin polymer is used to create a new class of organic fiber/filler-based polymer composites. Analysis was done on the effects of adding different volumes of filler or fibre to the epoxy on the tensile, flexural, and impact properties. The results of the mechanical tests indicate that the mechanical properties of the composite, such as its tensile, flexural, and impact strength, will increase with the addition of 15% filler and 20% fibre. The result of composite tensile strength fraction shows additional filler diminish the mechanical 15% filler with 20% fibre with filler property because the 15% filler with 20% fibre% date seed filler is not distributed uniformly throughout the epoxy matrix. It also demonstrates that the addition of filler and fibre to a specific location of the testing sample results in a high impact value when compared to other compositions.

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