Retraction

Retraction: Studies on Mechanical properties of hybrid fiber reinforced polymer matrix composites (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012092)

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IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Studies on Mechanical properties of hybrid fiber reinforced polymer matrix composites

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Abstract. Composite fibers are becoming one of the inevitable sources, the inculcation of synthetic fibers and natural fibers hold a pivotal position in the engineering technologies. The process of combining composites without reduction in their properties like mechanical and physical have significantly led to increase in the quality of the product. Some of the process that can be done pertinent towards the polymers are tensile test, impact test, shear test, etc. To synthesize the component, hand layup process is been implemented in this process. The composition of components that include jute, hemp, basalt, glass and epoxy resin which when added with SiC will also be providing superior properties.

Keywords: Composites, Tensile, Flexural, Shear, SiC

1.Introduction:

The composite materials are primarily used to minimise the density of a material while also increasing its strength. The first applications of composite materials were in aircraft materials, which required higher robustness and low mass per unit volume. Numerous number of tests have been executed to analyze and find out the properties of composite materials and to obtain the desired results and to determine if modification in fiber surface can be used to enhance the properties of fiber-reinforced composites. [1] have looked into the robustness of congenital fibres till its fracture and discovered that the alkaline treatment improves the fracture toughness of fibre composites even if more research is required in the future. Natural fibres are those that aren't synthetic or man-made, to put it simply [2]. They can come from either plants or animals [4]. Glass Fiber Polymers are a type of fibre reinforced polymer that is made up of a matrix which comprises of plastic and fine glass fibres. Due to its excellent properties, fibre glass—a weightless material, solid and durable, used in a variety of places [5]. While the material's strength and stiffness are less than carbon fibre, it is hard to break, and the cost of the raw materials are affordable and economic [6]. Natural fibre composite materials are now replacing glass and carbon fibre composite materials as it is easily available in the market and it is of low cost [8]. Since the field of application for natural fibres is expanding every day, particularly in the automotive industry, the use of natural fibres is improving dramatically. Several research works have been followed up in this area. Silva et al., and colleagues Because of its capacity to produce difficult shapes, economical for start-ups, its ability to adapt, and its ability to have minimal lead times, hand layup is an essential part of the composites production industry. The layup method normally begins with smooth, undamaged prepreg plies fractured to form materials which are continuous in structure [7]. It has a long history of use in applications which has absolute values of higher order.Materials that are made up of many different materials [3]. Composite materials are now widely used in high-volume civilian aerospace and automotive applications, according to [9] Advanced composite materials have a number of benefits that
have made them popular in a variety of high-performance applications. As a result, composites are being used in a wider variety of applications, including race vehicles, aeroplane parts, and sporting goods, as well as economical. As they are being used in each and every department, demand as increased which imposes a demand of higher quality while having the volumes high as well as being economical.

Composites performing in a higher level, have layers of fibers aligned and reinforced as a matrix material. These fibres offer outstanding tectonic properties to composites, but they also make them innately difficult as it should be step by step of layer production. [10] Hand layup is a process in which the specimen is manufactured by laying fibers layer by layer, which is carried out by labour that consists of layers of a reinforcement known as prepreg. It is made up of numerous layers of fibres that have been pre-infused with resin before being woven together or arranged in a single unidirectional ply. Each ply is hand-manipulated into shape before being firmly adhered to the preceding layer or mould layer, with the plies having zero air pockets. [11] Investigations were done on the impact activity of nano-silica in glass/epoxy fiber-reinforced composites and found that when 1.5 percent of nano-silica is combined with glass fibre, the maximum impact energy is achieved. Congenital fibres are exceptional fibres when compared to man-made fibres as supplements for polymer, composites as the bending modulus and collision capabilities is higher. They are environmentally friendly, abundant, sustainable, low-density, and biodegradable. Natural fibres contribute to a balanced world as biodegradable fabrics, and their low cost combined with outstanding performance enables companies to gain higher profits. Natural fibre-based polymer composites are used in a variety of items, including housing building materials, furniture, and automobile parts[12-15]. Natural fibres have become increasingly popular in composite applications over the past few years. As compared to synthetic fibres, these composites have a range of benefits, including less chances of tool failure[16,17]. Less dense, economical, easily available, and compostable are all advantages[18]. Bast fibres are most popular congenital plants used in applications. Natural fibres have a higher strength to weight ratio and almost a sable specific stiffness than glass fibre, which is one of the reasons for their increasing popularity. These natural fibres can potentially give desirable precise robustness at a economical cost due to the properties and cheaper sources.

2. Materials and Methods:

2.1 Materials:
The major components of this experiment for fabricating the composite material are Jute(Corchorus), Hemp(Cannabis sativa), Basalt and Glass fibre(Glass). The following raw materials are bought from various online markets like “India Mart”. Covai Seenu Company in coimbatore, India has been our resource to get the Resin (Ly 556), Hardener (Hy-951) which is been our root product for the composite manufacturing. The incucelation of silica carbide helps in increasing the overall values of our component and also helps to withstand the shear force. The epoxy resin is mixed with Silica Carbide and then they are it is added accordingly in different weight percentage categories which are bought from a chemical shop named Astra Chemicals at Chennai India. Glass-Fiber is also included for the fabrication of the specimen.

2.1.1 Natural fibres. Natural fibres are a renewable resource and provide advantages like imparting the composite with good fibre aspect ratio, are biodegradable and readily available from nature. They are pertinent for the reinforcement of the fibre because of having high ratio strength, high ratio stiffness and significant low density. The fibres can be manufactured in multiple ways to increase the reinforcement of the elements having significant mechanical properties. Behind few years, there has seen a significant noticeable rise at the usage of the natural fibres hemp, jute, basalt, flax, coconut fibre and banana for preparing biodegradable composite materials. The recent studies have also proven that the reinforced composite fibre materials provides a great reasonable development in the properties of the materials and it shows a path to encourage the development of the environment. These congenital fibre specimens supports for extra strength, for being thermally stable, and they are also refabricated once it is being
completely used. But one of the major drawbacks is that, it possess strength which is very low and this is because they are completely biodegradable. The major properties of Jute, Hemp, Basalt is shown in Table 1.

| Physical property | Density (kg/m³) | Flexural modulus (Gpa) | Tensile strength (Mpa) | Strength Young’s Modulus (Gpa) |
|-------------------|-----------------|------------------------|------------------------|-------------------------------|
| Basalt            | 3.0             | 4.5                    | 14                     | 57                           |
| Jute              | 1.5             | 68.5                   | 300-700                | 5.8                          |
| Hemp              | 0.86            | 4.99                   | 47.2                   | 1.8                          |

2.1.2. Glass fibres. The Glass fibre is comprised of plastic matrix, reinforced by the fine-fibres of the glass. Glass fibre is adhesively well built structure but, less in weight. Though the strength properties are less when compared with the carbon fibre, the materials are less delicate and are less in cost. While weighing the properties with the other fine metals, the GFRP has high bulk resistant robustness and mass, and it is more easier to manufacture it by the moulding process. General uses of fibreglass include vehicles, external door skins, traffic lights, Waterpipes, Helicopter rotor blades. The properties of the glass fibre is mentioned in Table 2.

| Physical property | Density (kg/m³) | Flexural modulus (Gpa) | Tensile strength (Mpa) | Strength Young’s Modulus (Gpa) |
|-------------------|-----------------|------------------------|------------------------|-------------------------------|
| Glass             | 2.49            | 26.07                  | 4700                   | 86                           |

2.1.3. Silica carbide. In research studies done in the recent past, the component which is fabricated with the inclusion of nano particles is more better as it constitutes to added property of binding behaviour and also improves mechanical robustness; hence we have preferred the silica carbide, which is very economical and also exhibits a higher strength to composite material. Silica carbide nanoparticles exhibits characteristics such as extreme high thermal conductivity, high stability and purity and also very good wear resistance. The property of Silica Carbide is given in Table 3.

| PROPERTY                      | VALUE            |
|-------------------------------|------------------|
| Melting Point C               | 2200-2700        |
| Hardness (kg/mm²)             | 2800             |
| Density (g/cm²)               | 3.1              |
| Coefficient of thermal expansion (micron/m°C) | 4.0 |
Preparation of composite specimen:
The needed materials used in this experiment, is manufactured by using the process named "hand layup" (as portrayed in Figure 1) and fibres (Basalt, Hemp, Jute, Glass) were chopped into small strings shaped placed layer-by-layer to fabricate the specimen into five layers. The fibres were dried for about two-three days at humid/room temperature to prevent them from sunlight. The Silica carbide (1%, 2%, &3%) is mixed with epoxy-resin mixture and then, it is further stirred by using a all-purpose laboratory stirrer. Simultaneously the composition mixture of Silica carbide, the resin is further added with the hardener, at the ratio of (90:10”). Initially, the lubricant/wax is gradually applied at both the surfaces (bottom and top) of the plate of the mould for the removing process, on the other hand, the epoxy resin and hardener mixture is merged on the lower plate of the mould then glass fibre mat which is of is placed and then the resin is poured on top of the glass fibre using a simple all-purpose brush to make the application process easier. The process is repeated until the preceding layers, until the glass fibre composite layer. Finally apply the resin at the top of the glass fibre. Above plate of the mould is then further placed above the layers. Then the mould is further pressed under a mould press (heavy) machine for 1 h. Pressure is applied and is set to cure about 2-3 hours in the same position on the compress machine. The final step is that, the plate is cut accordingly to the basic (ASTM) standards.

3. Composites testing methodology:

3.1 Tensile test for Hybrid Composites. The article represents that H-composite (H-Hybrid) materials is prepared for required dimension (as mentioned in ASTM standards) for testing, with the help of saw cutter, edges, and emery sheet. ASTM D3039 standard testing is performed, by applying a tensile force to a specimen and measuring various mechanical properties of the specimen under the stress. By using ASTM D3039 the common specimen dimensions are implemented with the constant rectangular cross-section and gauge length. This testing process is conducted on a universal testing machine (UTM) and tensile force is act through the specimen until the material fracture, the numerical values would be noted. which depicts in the UTM machine. The first specimen consists of pure hybrid composites (included with jute, hemp, basalt & glass fiber) in the absence of Nano particles (silica carbide). Composition of
silica carbide content are added at (0%, 1%, 2%, & 3%) sequentially. Tests are executed for all the specimens and the outcomes are noted.

3.1.2 Flexural test for Hybrid Composites. This test measures the force required to bend a composites under the three-point loading methodology. ASTM D790 standards are followed to prepare the component. The preferred depth of flexural test under the standard is 3.4 mm. It measures the flexural properties of the material under the strain and deflection of the specimen until it fractures and breaks, by using a Flexural testing machine. Based on silica carbide percentage at 0% to 3% the flexural values may vary.

3.1.3. Impact test for Hybrid Composites. ASTM D 256 standard (65 X 13 X 3 mm) is followed to manufacture the specimen. Specimen is fixed in a test apparatus, straight through the pendulum notched side is placed to conducted a test. When it is released and allow to strike through the specimen the parameters were noted until failure occurs. By the addition of Nano materials at 0%, 1%, 2% & 3% respectively, the values of each specimen can be found easily. Using the test (Charpy), the power required to shatter a component can be studied and the hardness of the specimen too. The effect of shear rate on a material, ductile, test temperature, and absorbed energy of the material are verified.

4. Result & Discussion
Natural fibers are overtaking each and every other components in other fields due to its ability to increase the properties of materials. Four specimens were fabricated and mechanical tests like Tensile, Flexural and Impact tests were taken.

4.1 Tensile properties
The tensile test is being implemented on UTM machine for the four specimens of various compositions until they are fractured. The tensile strength of specimen with 2% Silica Carbide proved to have higher properties than the other manufactured composites. The specimen without Nano particles shows a decline in tensile strength when compared to the other composites while the other composites which has Silica Carbide (Nano particles) added to it showed higher tensile strength properties. The addition of Silica Carbide has definitely added up to the properties which shows in its values. The composite with 2% silica carbide has higher strength whereas the composite with 1% and 3% are somewhat good and closer to the strength compared to the higher value. Tensile test outcomes are presented in Table 4 and also a graph has been shown in Figure 2. The robustness of the composites with 0%, 1%, 2%, & 3% Silica Carbide are 79.31Mpa, 80.12Mpa, 83.16Mpa, and 83.91Mpa respectively. The outcome shows that the component with 2% of nano particles has shown higher properties than the other three composites and there has been gradual increase in tensile strength till 2% of Silica carbide is added and thereafter the values seems to take a gradual downward path.

Table 4. Tensile test values

| Sample                        | Tensile strength(Mpa) |
|-------------------------------|-----------------------|
| Hybrid composite0% silica carbide | 79.31                |
| Hybrid composite1% silica carbide | 80.12                |
| Hybrid composite2% silica carbide | 83.16                |

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Figure 2. Comparison of tensile strength to various weight% of Silica Carbide

4.2 Flexural properties

The four composite specimens with different compositions undergo flexural testing and the maximum value is found to be 31.26 Mpa. The result exhibits that the composite specimen with 2% of Silica Carbide is found to have higher properties compared to the other specimens which has 0%, 1% and 3%. From testing, it shows that when silica carbide is not added the properties are a bit low when compared to that of specimen with some percentage of silica carbide. Hence putting in of silica carbide has gradually increased the properties. Flexural test results are given in Table 5 and in graph in Figure 3. The bending strength of the composite specimens with different weight percentages of 0%, 1%, 2% and 3% are 29.5 Mpa, 31.02 Mpa, 31.26 Mpa, 30.16 Mpa respectively. The outcome shows that there has been gradual increase in flexural strength till 2% whereas there is a depreciation in flexural strength when Silica Carbide is added more.

Table 5. Flexural test values

| Sample                          | Flexural strength (Mpa) |
|---------------------------------|--------------------------|
| Hybrid composite 0% silica carbide | 29.5                     |
| Hybrid composite 1% silica carbide | 31.02                   |
| Hybrid composite 2% silica carbide | 31.26                   |
| Hybrid composite 3% silica carbide | 30.16                   |
4.3 Impact properties

Impact test is being done on four composite specimens of different compositions. Charpy test is being carried out here. The values are noted from the reading displayed from the Charpy impact machine. The outcome shows that natural and synthetic composite specimen with 1% of Silica Carbide exhibits higher impact properties compared to the other specimen and as usual the specimen with 0% Silica Carbide has shown the least properties. The impact test values are shown in Table 6 and also through graph in Figure 4. The properties of the composite specimen with 0%, 1%, 2%, and 3% Silica Carbide are 2.32 J, 3.19 J, 2.98 J, and 2.89 J sequentially. The hybrid composite specimen with 1% of silica carbide has shown higher impact properties followed by the composites 2%, 3% and 0% respectively.

Table 6. Impact test values

| Sample                        | Impact energy (joules) |
|-------------------------------|------------------------|
| Hybrid composite 0% silica carbide | 2.32                   |
| Hybrid composite 1% silica carbide | 3.19                   |
| Hybrid composite 2% silica carbide | 2.98                   |
| Hybrid composite 3% silica carbide | 2.89                   |
Figure 4. Comparison of impact energy with different weight% of Silica Carbide

5. Conclusion

The hybrid composites comprising of Jute, Basalt, Hemp, Glass with Silica Carbide undergo tensile test, flexural test and impact test. The conclusion is based upon the outcome obtained and it follows as,

- Tensile strength of composite without addition of Silica Carbide is 79.31 MPa but when 2 wt% of Silica Carbide is added, the tensile strength showed an increase to 83.16 MPa respectively.
- Flexural strength of composite without addition of Silica Carbide is 29.5 MPa but when 2 wt% of Silica Carbide is added, the flexural strength showed an increase to 31.26 MPa respectively.
- Impact strength of composite specimen without addition of Silica Carbide is 2.32 J but when 1 wt% of Silica Carbide is added, the impact strength showed an increase to 3.19 J respectively.

Considering all the specimens, the composite specimen with 2 wt% of Silica Carbide has proved to increase the overall properties and has enhanced the the properties to another level.

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