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EXPERIMENTAL INVESTIGATION OF EGLASS CARBON FIBER AND KEVLAR FIBERS WITH GRAPHITE POWDER REINFORCEMENT USING HAND LAYUP TECHNIQUE

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Abstract: Many researchers are searching for structural materials of high strength, less weight, and low cost. In generally, strong materials are relatively dense and light materials have less strength. In order to achieve high strength and less weight, we go for composite materials. Then the tensile strength and impact strength of specimens are determined using ultimate testing machine and impact testing machine. The structure of an autonomous underwater vehicle (AUV), usually composed of a cylindrical shell, may be exposed to high hydrostatic pressures where buckling collapse occurs before yield stress failure. In conventional submarines, welded stiffeners increase the buckling resistance, however, in small AUVs; they reduce the inner space and cause residual stresses. This study investigates the mechanical properties of composite materials by incorporating various fibers, namely E-glass, Kevlar and Carbon fiber, each combined with a 10% addition of graphite powder. Additionally, hybrid combinations of these fibers such as E-glass + Kevlar + 10% graphite powder, Kevlar + Carbon fiber + 10% graphite powder, Carbon fiber + E-glass + 10% graphite powder and Carbon fiber + E-glass + Kevlar + 10% graphite powder are explored. Polyester-resin is utilized as the matrix material to form the composite specimens, adhering to ASTM standards. The research focuses on evaluating the mechanical performance of the composite materials through comprehensive testing methods: tensile strength, flexural strength, impact strength. After that design of an AUV Pressure vessel, proposing the use of sliding stiffeners that are part of the structure used to accommodate the electronics inside it. Design of AUV pressure vessel using CATIA software and analysis using ANSYS software using two materials existing AL 6061 and after testing best composite material.

Keywords: *E-glass, Kevlar and Carbon fiber, resin, AUV, Pressure, composite material*

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I.INTRODUCTION:

A composite material is essentially a blend of two or more distinct components, each retaining its individual properties at a visible level. These components, known as the reinforcing phase and the matrix, are intermixed to form a unified structure. The reinforcing phase, which can take the form of fibers, particles, or flakes, serves to enhance specific properties of the composite. Meanwhile, the matrix, typically in a continuous form, surrounds and supports the reinforcing phase. Examples of composite systems abound, such as concrete fortified with steel and epoxy reinforced with graphite fibers.

These combinations offer tailored properties, leveraging the strengths of each constituent to create materials with diverse applications across industries. The technological development has increased on advances in the materials field. A random composite material is one, which consists of mixing the particles of the materials working together to produce new metal have properties which are dissimilar to the properties of singular material that they possess.

It contains the most important characteristic that the materials are not soluble to each other. Likewise, the random composite material assumes the role of the advancements designing material because of their fantastic mechanical properties while being low weight, minimal cost, and profoundly adaptable. Composite essentially comprises a matrix which around the reinforce in this way the strength and durability is existed that is important in a specific field of utilization. E glasss are arbitrarily situated, give good strand, great wet ability, and scattering, and show even strength thought every which way. A researcher examined the investigation of mechanical properties of E-Glass fiber E glasserial with epoxy resin nano clay composites; the point of this work is to dissect the impact of nanoclay effect on the mechanical conduct of chopped strand E-glass fiber, strengthened in the matrix of epoxy with filler of nano clay.

Figure 1 General formation of a composite

TYPES OF SYNTHETIC FIBERS: Rayon, Nylon, polyester, Acrylic, Acetate, etc...,

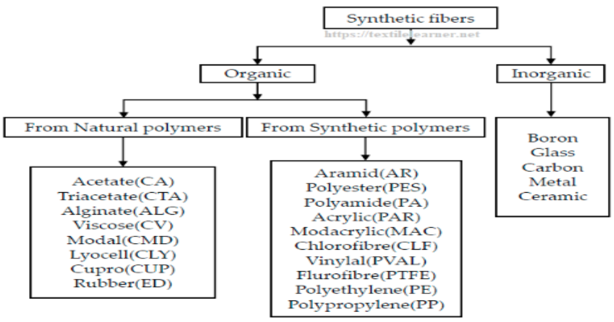

Figure 2: classification of Synthetic fibers

PROPERTIES OF SYNTHETIC FIBERS

- Synthetic fibers are cheaper than natural fiber.
- Synthetic fibers are stronger than natural fiber.
- Synthetic fibers are more durable than natural fiber.
- Synthetic fabrics are dried up in less time.
- Synthetic fibers are easy to maintain and wash

ADVANTAGES OF SYNTHETIC FIBERS

- Synthetic fibers are more durable than most natural fibers.
- Most of the synthetic fibers offer consumer-friendly functions such as stretching, waterproofing and stain resistance.
- Synthetic fibers are more water resistant and stain resistant than the natural fibers.
- Synthetic do not depend either on any agricultural crops or on animal farming.
- There are general cheaper than the natural fibers.
- Synthetic fibers are easily available and easy to maintain.

DISADVANTAGES OF SYNTHETIC FIBERS

- The mono-fibers do not trap air pockets like cotton and provide poor insulation,
- Synthetic fibers burn more readily than natural,
- Prone to heat damage,
- Melt relatively easily,
- Prone to damage by hot washing,
- More electrostatic charge is generated by rubbing than with natural fibers.

II.LITERATURE REVIEW

[1] The purpose of this research is to establish stab proof material made up of shear thickening fluid (STF) and Kevlar fiber. In this research, silica / ethylene glycol suspension was prepared for the use as STF and it was evaluated by rheometer. From the results, it was seen that STF exhibited a reverse liquid- solid transition at a particular shear. Kevlar was treated as STF by 1 dip 1 nip method and mechanical and stab resistant properties were analyzed. After viewing both the results, STF impregnation comprehensively upgraded the stab resistance of Kevlar against the spike threats and the safety aspect of Kevlar was also increased comprehensively.

[2] The stab resistant coating was performed by considering one STF, fumed silica / ethylene glycol suspension of Kevlar fabric to enhance the performance of the material. From this research, extensive upgrades in puncture defiance were seen especially in excessive speed loading condition. It was seen that the addition did not change or deteriorate the flexibility of STF. From the results, we incurred that fumed silica/ Kevlar composite fabric woud be a fine material for body armored applications

[3] Moreover, multiple materials that are combined to produce an individual component. The two materials that were investigated were Kevlar poly (p-phenylene terephthalamide) and santoprene. Here in this investigation, the Kevlar fiber was used in two ways, the first type was, it was used without altering it and the second type was used after altering it.

[4]The Kevlar which was used without modifying strengthened the santoprene to quote an extent and it upgraded few properties of the composite, namely low strain modulus and tensile strength but it also had a drawback, lengthening at break reduced heavily. In order to overcome this, the Kevlar was modified and hence its surface was hydrolyzed maleic anhydride-grafted polypropylene (MA-g-PP). There were clear advantages of using the modified Kevlar over the stock one. The properties enhanced and the drawbacks were reduced to nil. This combination showed improved stress distribution due to better surface bonding between the fiber and matrix**.**

[5] Thereafter, Fluorinated and Oxy fluorinated Short Kevlar Fiber-Reinforced Ethylene Propylene Polymer This paper examines raw Kevlar and surface treated Kevlar. Examination on its thermal properties showed an increase in thermal stability and storage modulus due to gradual reinforcement of fibers. It is also noted that it continues to increase in the case of ox fluorinated and fluorinated Kevlar fiber-reinforced EP.

[6] Fluorinated and oxy fluorinated Kevlar fiber's tensile strength increased substantially. This concludes that fluorination and oxy fluorination had an impact on the surface morphology giving better adhesion of fibers and the matrix

[7] Moreover, comparison of properties like crystalline, thermal, mechanical of syndiotatic polystyrene composites with surface modified Kevlar fiber.

[8] In comparison to oxi-fluorinated Kevlar reinforced fiber, fluorinated Kevlar fiber reaches higher crystallization temperature. There is a significant increase in thermal conductivity in case of modified Kevlar fiber reinforcement. It also shifts to a higher value shown by differential scanning calorimeter and dynamic mechanical analysis. A strong adhesion between PS matrix and oxy-fluorinated Kevlar fiber was found and it seems to be better than other composites shown by atomic free microscopy. From this research it was found that it boosts up the thermal stability and storage modulus of the composite

[9] However, the properties of Kevlar polypropylene based on composite material under high strain rate loading using Split Hopkinson Pressure bar (SHPB). Flat laminated Kevlar composite of 16, 24 and 30 layer where comparison molded and laser machined to obtain cylindrical specimen of desired shape based on SHPB experiment. To report compressive material behavior as expansion of growing strain rate, the stress strain plots were obtain and analyzed. The studies suggest that for better performance of composite

[10] Laminates apply thin laminates. The 90% of thickness composite depend on the peak stress, strain and toughness. On the basis of high strain rate testing of 16, 24, 30 layered Kevlar polypropylene composite SHPB testing was done and the following conclusion was made. At low strain rates the growth

pattern of stress and strain are linear and further continue the same nature even at high strain rates. As per research the thin specimen are more useful than the thick specimen

[11] Moreover, laminated hybrid and unidirectional composites, and looks into the effects of Nylon to Kevlar ratio on mechanical properties. Bismaleimide (BMI) resin is reinforced from hybridizing 3-D braided Nylons and Kevlar fibers.

This braided Nylon/Kevlar showed higher flexure strength, which was expected. Linearity was noticed, but only on attaining peak values of loading. It attained maximum flexure strength when the Nylon to Kevlar ratio was 3:2. Addition of ductile fiber improved its impact properties significantly of all Nylon composites. As the volume of the relative Kevlar fiber increased, residual flexure and energy absorption also increased which were tested with the impact samples

[12]. Thereafter, finding an alternative for soft Kevlar that is more durable and safe

[13] This hybrid composite had a good tensile property. A seven layer Nylon fiber and a seven layer Kevlar was made for comparison. The performance of full Nylon fiber is lesser than the performance of full Kevlar. A low velocity impact test was given for all the above specimens. According to the results, the seven layer laminate only with stood an impact energy of 30 Joules. On the other hand, the hybrid had the mechanical properties and performance of full Kevlar and greater mechanical properties than Nylon fiber composites. By these tests we can conclude that the Kevlar-Nylon fiber hybrid composites can be used as an alternative

[14]Moreover, Nylon fibers having excellent contenders for establishing huge strength biomaterials and they have good stress transfer and electrical characteristics it can increase tissue forming. Since Nylon fibers possess these properties, tubular Nylon layered with poly (methyl-methacrylate) was studied as it can be adopted for internal fixation of bones. In order to make the Nylon ductile, ductile Kevlar was enumerated to the composite.

[15] Tailor able braiding technology was adopted to make the tubular Kevlar by modifying fiber orientation in the composite. The results from the experiment revealed that with enhancing braiding criterion, mechanical properties near to bone characteristics can be made. Superior capability of stress distribution on composite was achieved since Kevlar braid's physical properties, fiber composite distribution and diameter consistency. Adding PMMA matrix and grapheme Nano plates together, it improved composite quality. Hence, it could be adopted as an implant

[16] In this work authors are reported about the execution and examine the characteristics of the novel auxetic Kevlar composite. This research was particularly based on fracture and impact characteristics. To analyses and differentiate, Kevlar interlinked composite was used along with polyurethane analysis and in the absence of it. Short nylon fibers of two distinguished fiber measurement and 3 distinguished fiber distinguished fiber densities were converged.

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III.COMPOSITION OF SPECIMEN MATERIALS

In our country India, there are far reaching particular blended packs of regenerative plants and trees with some fiber content. In them, some are created from the times and some are wild plants, creepers, and trees that create in woodlands and woods. It is a known fact that any material which is in stringy structure is more grounded than in the mass structure. Thus, these strong filaments are used. Pineapple and Agave Americana are energetically open in our country that has been used as a piece of their therapeutic structure. In any case, same business identified with this fiber is all that abundantly obliged when stood out from various filaments. This examination incorporates to explore the possible usage of filaments in making of new blended sack of composites for weight passing on structures. The propose of trademark filaments is to extend the quality. A vast bit of the ordinary composites are less costly than the produced fiber composites.

These typical fibers have a key part in long time past days. These individuals, in light of these fibers they make them for their private uses like range homes cruising strength etc. The examination has exhibited that, these built fiber advancements are offered by an impelled development, then again, these investigates are to upgrade the application, quality and effectiveness of customary fibers. These standard fiber composites have various inclinations of being strong, unassuming, and light, eco-friendlier and safer. Regardless, by using of these trademark fibers there are a couple of requests raised up that how such sort of materials are to be striven for sturdiness and quality. More works ought to be required before these regular fiber composites are used as a piece of asking for conditions. From these trademark fiber sustained plastics, Daimler Benz have used gateway sheets for their Mercedes G class cars besides they have courses of action to construct the material containing normal fiber fortified plastics for various portions. Once after developed, the advancement would be a dynamic making of a broad number of Eco-friendly things.

MATERIALS

On among different types of resins and hardener. Epoxy LY556 and hardener HY951 are chosen. The materials taken to fabricate the specimens are Nylon fiber, E-glass and Graphite powder. These are taken in the different ratios and different combinations. The six different composites are investigated the impact strength, tensile strength, flexural strength.

EPOXY

In present work epoxy LY556 is used as matrix material shown in figure.3.1 to fabricate hybrid fiber epoxy composites. Epoxy LY556 is chosen because it is a one such matrix which is extensively used because it exhibit low shrinkage, higher mechanical properties, easy fabrication, excellent chemical and moisture resistance, good wet ability. Epoxy resins are the most commonly used thermo set plastic in polymer matrix composites. Epoxy resins are a family of thermo set plastic materials which do not give off reaction products when they cure and so have low cure shrinkage. They also have good adhesion to other materials, good chemical and environmental resistance and good insulating properties.

Figure 1 Epoxy Resin LY556

HARDENER

Hardener used for present investigation for initiating gel formation is hardener HY951 which is shown in figure.3.2. The combination of epoxy LY556 and hardener which cures at room temperature, excellent adhesive strength, good mechanical and electrical properties. The ratio of the epoxy and hardener are taken 10:1 that is 10 grams of epoxy and 1 gram of hardener.

Figure 4 Hardener HY 951

KEVLAR

Kevlar has many applications, ranging from bicycle tires and racing sails to bulletproof vests, all due to its high tensile strength-to-weight ratio; by this measure it is five times stronger than steel. It also is used to make modern marching drumheads that withstand high impact. Synthetic fibers are used to improve naturally existing animal and plant fibers. There are hundreds of types of synthetic fibers; polyester and nylon are the two most common. Previously, most of the studies performed on the woven form of textile composites have been with synthetic fiber, rather than natural fiber. Several advantages of synthetic fibers are their low absorbency, thermoplastic, abrasion resistant, and availability. In comparison with natural fibers, synthetic fibers are much more durable, stronger, easier to maintain, and washable.

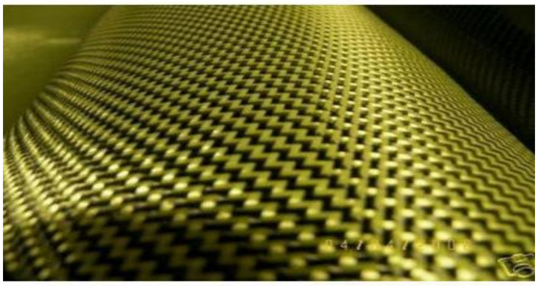

Figure 5 Kevlar fiber

CARBON

Carbon fiber is a material made from thin filaments of carbon atoms bonded together in a crystalline structure, which results in an exceptional strength-to-weight ratio. The manufacture of carbon fiber material involves several complex steps that transform carbon-rich precursors into spools of fibers.

Figure 6 Carbon fiber

E GLASS

This product is especially suited for compression molded laminates, as well as electrical and non-electrical laminates. It is also very suitable for pultrusion, infusion or injection procedures (e.g., RTM S-RIM or Matched Die Molding). Contains an insoluble binding agent for unsaturated polyester, epoxy and polyurethane compatibility in unfilled or filled resin systems. Available as powder or emulsion mat. Both products offer a wide range of control regarding stiffness, adaptability, handling and tensile strength. Fiberglass combination - stitched is a sandwich construction made of roving and non-oriented strands. It reduces the confection and impregnation expenditure and is suitable for larger and thicker laminates. Fiberglass combination - stitched can be cut with the single fibers staying together.

Figure : 7 E Glass fiber

GRAPHITE POWDER

Raw graphite is first extracted then crushed into smaller, more workable fragments. Reducing the size is vital since you cannot efficiently work with large pieces of graphite. Raw graphite is broken down by specialized crushing machines into coarse pieces. The machines use pressure in this step to transform big blocks into tiny particles. This helps the material to be handled in the future stages of production simpler. Crushing the graphite uniformly is crucial since uneven particles can complicate the later grinding process and reduce its efficiency for your uses.

Figure 8 graphite powder

FABRICATION OF COMPOSITE SPECIMENS (HAND LAYUP)

Hand lay-up technique is the simple and cheapest method of composite processing. The infrastructural need for this technique is also minimal. The standard test procedure for Mechanical properties of fiber-resin composites; ASTM-D790M-86 is utilized to according to the measurements. The mold is prepared on smooth clear film with 2-way tape to the required measurement. At that surface mold is prepared keeping the 2-way tape on the clear film.

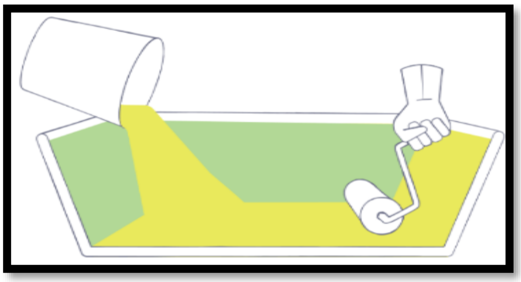

Figure 9 Hand layup technique

The reinforcement in the form of long fiber is cut as per the mold size and placed on the surface of thin plastic sheet. Then the thermosetting polymer in liquid form is assorted thoroughly in appropriate proportion with a recommended hardener (curing agent) and poured on the surface of clear. The polymer is uniformly spread with the help of brush. Then second layer of fiber is placed on the polymer surface and another layer of polymer is applied after this is closed with another thin plastic sheet after squeezer is moved with a gentle pressure on the thin plastic sheet to remove air .The consequential mold is cured for 24 hours at room temperature.

After fabrication specimens are cut form sheets according to the ASTM statndards165mm long, 12.5mm in width and 4mm in thick are fabricated for tensile testing. 100mm long, 25mm width and 4mm in thick are fabricated for flexural testing. 63.5mm long, 12.36mm width and 6mm thick are fabricated for impact testing...

STEPS INVOLVED IN THE FABRICATION OF SPECIMEN:

The Carbon with 10% of graphite powder, Kevlar with 10% of graphite powder, E Glass with 10% of graphite powder, Carbon/ Kevlar with 10% of graphite powder, E Glass/ Kevlar with 10% of graphite powder, Carbon/ E Glass, Carbon/ Kevlar/ E Glass with 10% of graphite powder specimen was fabricated with carbon powder in all compositions by hand layup technique. In this process 8 sheets of 300GSM E-glass fibre along with E glass (230/300mm) and 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen is 4mm for tensile test and flexural test. Thickness of the specimen that obtained by 2 sheets of 300GSM of E-glass fibre is around 1mm. For obtain 4mm thickness eight sheet of E-glass are used. And the thickness of specimen for impact test is 6mm.

CARBON FIBRE reinforced Epoxy Composite specimen was fabricated by hand layup technique. In this process 8 sheets of 300GSM Carbon with 10% of graphite powder (230/300mm) and 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen is 4mm. Thickness of the specimen that obtained by 2 sheets of 300GSM of Carbon with 10% of graphite powder is around 1mm. For obtain 4mm thickness eight sheet of Carbon with 10% of graphite powder are used. And the thickness of specimen for impact test is 6mm for obtain these 12 sheets of Carbon with 10% of graphite powder are used.

KEVLAR FIBRE reinforced Epoxy Composite specimen was fabricated by hand layup technique. In this process 8 sheets of 300GSM Kevlar with 10% of graphite powder (230/300mm) and 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen is 4mm. Thickness of the specimen that obtained by 2 sheets of 300GSM of Kevlar with 10% of graphite powder is around 1mm. For obtain 4mm thickness eight sheet of Kevlar with 10% of graphite powder are used. And the thickness of specimen for impact test is 6mm for obtain these 12 sheets of Kevlar with 10% of graphite powder are used

E GLASS reinforced Epoxy Composite specimen was fabricated by using hand layup technique. In this process 4 sheets of 300GSM E Glass with 10% of graphite powder (230/300 mm) the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen for tensile test and flexural test is 4mm which is shown in figure 3.8. The thickness of specimen for impact test is 6mm.

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KEVLAR+CARBON FIBER reinforced Epoxy Composite specimen are fabricated by hand layup method. For this hybrid epoxy and hardener. In this process 4 sheets of 300GSM Carbon/ Kevlar with 10% of graphite powder (230/300 mm) and 4 sheets of 300GSM Carbon/ Kevlar with 10% of graphite powder are used to obtain the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) is used as matrix in the composite. The thickness of the specimen for tensile test and flexural test is 4mm. The thickness of specimen for impact test is 6mm to obtain these thickness 6 sheets of 300GSM.

E GLASS/ KEVLAR fibre reinforced Epoxy Composite specimen are fabricated. For this hybrid E Glass/ Kevlar with 10% of graphite powder composite is added to the epoxy and hardener. The thickness of the specimen for tensile test and flexural test is 4mm. The thickness of specimen for impact test is 6mm to obtained this thickness 6 sheets of 300GSM E Glass/ Kevlar with 10% of graphite powder fibre and 6 sheets of 300GSM E Glass/ Kevlar with 10% of graphite powder are used.

E GLASSE+CARBON For this hybrid composite Carbon/ E Glass with 10% of graphite powder is added to E glass, epoxy and hardener. In this process 4 sheets of 300GSM Carbon/ E Glass with 10% of graphite powder fibre (230/300 mm) and 4 sheets of 300GSM Carbon/ E Glass with 10% of graphite powder are used to obtain the 4mm thickness. And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556). The thickness of the specimen for tensile test and flexural test is 4mm. The thickness of specimen for impact test is 6mm to obtain these thickness 6 sheets of 300GSM Carbon/ E Glass with 10% of graphite powder 6 sheets of 300GSM are used.

CARBON/ KEVLAR/ E GLASS For this hybrid composite Carbon/ Kevlar/ E Glass with 10% of graphite powder is added to E glass, epoxy and hardener. In this process 8 sheets of 300GSM Carbon/ Kevlar/ E Glass with 10% of graphite powder (230/300 mm), And 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556). The thickness of the specimen for tensile test and flexural test is 4mm. The thickness of specimen for impact test is 6mm to obtained this thickness 6 sheets of 300GSM Carbon/ Kevlar/ E Glass with 10% of graphite powder fibre 6 sheets of 300GSM are used

Figure 10 Complete sequential process for fabrication (1) Measuring mass of Epoxy resin (2) Measuring Graphite powder 10 grams (3) Taking appropriate proportion of Hardener (4) mixing hardner and epoxy with graphite powder (5) fibers (6) Applying pressure on mold (7) layering with epoxy resins and powders (8) Marking on specimen removing air bubbles

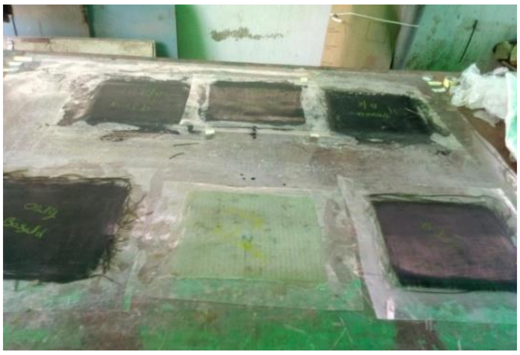


Figure 11 BEFORE CUTTING THE SPECIMEN

MECHANICAL CHARACTERISTICS OF COMPOSITE The properties of the Carbon with 10% of graphite powder, Kevlar with 10% of graphite powder, E Glass with 10% of graphite powder, Carbon/ Kevlar with 10% of graphite powder, E Glass/ Kevlar with 10% of graphite powder, Carbon/ E Glass, Carbon/ Kevlar/ E Glass with 10% of graphite powder reinforced epoxy hybrid composites with of fiber under this investigation are presented in below Table have taken each composite for each test. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The mechanical properties of Synthetic fiber reinforced composites are largely depends on the chemical, structural composition, fiber type and soil conditions and also on atmospheric conditions at the time of fabrication of the specimens.

The results of various characterization tests are reported here. This includes evaluation of tensile strength, flexural strength, and impact strength and hardness test. Has been studied and discussed. Based on the tabulated results, various graphs are plotted and presented in figures for composites.

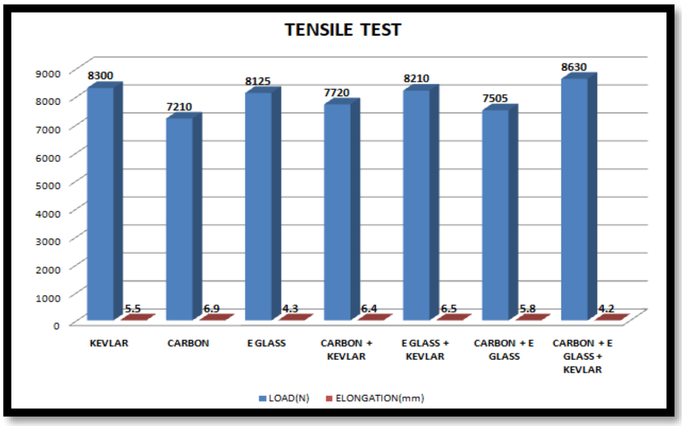
S.NO	COMPOSITE	TENSILE TEST(MPa)		FLEXURAL TEST(MPa)		IMPACT TEST	HARDNESS TEST
		LOAD(N)	ELONGATION(mm)	LOAD(N)	ELONGATION(mm)	Joules	Number
1	KEVLAR	8300	5.5	1050	8	9.1	143
2	CARBON	7210	6.9	980	8.5	7.6	98
3	E GLASS	8125	4.3	1005	6.2	8.8	138
4	CARBON + KEVLAR	7720	6.4	1010	7.4	8.3	133
5	E GLASS + KEVLAR	8210	6.5	1000	8.9	8.6	142
6	CARBON + E GLASS	7505	5.8	995	5.3	7.8	134
7	CARBON + E GLASS + KEVLAR	8630	4.2	1095	4.9	9.3	149

Table 1 Specimens testing results

S.NO	COMPOSITE	TENSILE TEST			
		LOAD(N)	ELONGATION(mm)	TENSILE STRESS (MPa)	ELONGATION(mm)
1	KEVLAR	8300	5.5	1.143	3.35
2	CARBON	7210	6.9	0.993	4.2
3	E GLASS	8125	4.3	1.119	2.62
4	CARBON + KEVLAR	7720	6.4	1.063	3.9
5	E GLASS + KEVLAR	8210	6.5	1.13	3.96
6	CARBON + E GLASS	7505	5.8	1.033	3.53
7	CARBON + E GLASS + KEVLAR	8630	4.2	1.188	2.56

Table 2 Tensile testing results for 7 composites

After successful completion of the tensile strength we are getting maximum values for the Carbon/ Kevlar/ E Glass with 10% of graphite powder at 8630 N with minimal deformation of 2.56 mm, shows better results than remaining compositions.

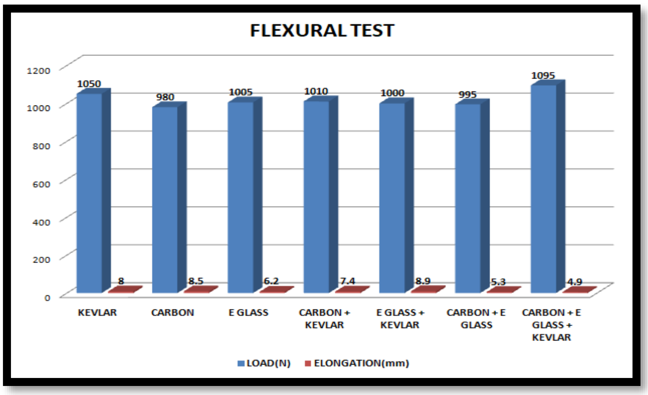


Graph 1 Tensile test result graph

S.NO	COMPOSITE	FLEXURAL TEST			
		LOAD(N)	ELONGATION(mm)	FLEXURAL STRESS (MPa)	ELONGATION(mm)
1	KEVLAR	1050	8	272.625	4.87
2	CARBON	980	8.5	257.25	5.18
3	E GLASS	1005	6.2	263.812	3.78
4	CARBON + KEVLAR	1010	7.4	265.125	4.51
5	E GLASS + KEVLAR	1000	8.9	262.5	5.42
6	CARBON + E GLASS	995	5.3	261.187	3.23
7	CARBON + E GLASS + KEVLAR	1095	4.9	287.437	2.98

Table 3 Flexural testing results for 7 composites

Based on the flexural strength finally concluded that Carbon/ Kevlar/ E Glass with 10% of graphite powder possess high flexural strength compared to remaining composite as shown in figure 6.2.

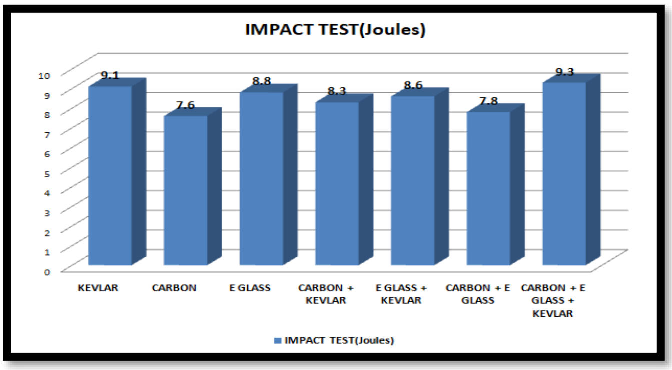


Graph 2 Flexural test graph

S.NO	COMPOSITE	IMPACT TEST
		Joules
1	KEVLAR	9.1
2	CARBON	7.6
3	E GLASS	8.8
4	CARBON + KEVLAR	8.3
5	E GLASS + KEVLAR	8.6
6	CARBON + E GLASS	7.8
7	CARBON + E GLASS + KEVLAR	9.3

Table 1 Testing of impact strength on all materials

And finally concluded the Carbon/ Kevlar/ E Glass with 10% of graphite powder possess high impact strength compared to remaining compositions

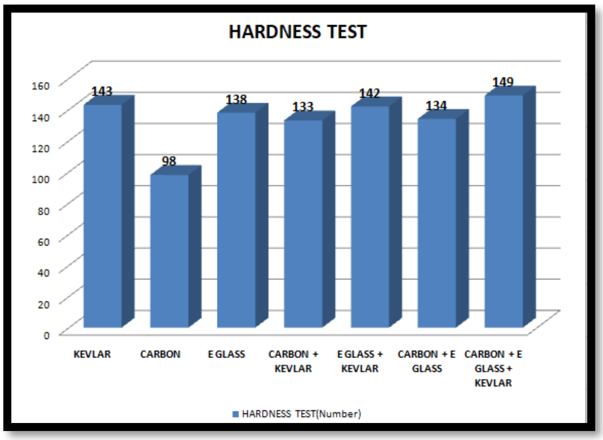


Graph 3 Impact strength result graph

S.NO	COMPOSITE	HARDNESS TEST
		Number
1	KEVLAR	143
2	CARBON	98
3	E GLASS	138
4	CARBON + KEVLAR	133
5	E GLASS + KEVLAR	142
6	CARBON + E GLASS	134
7	CARBON + E GLASS + KEVLAR	149

Table 5 hardness testing results

Brinell hardness vs. experiment number graph of the composite. Figure reveals the graph indicating Brinell hardness values corresponding to the experiment number. The graph shows, experiment with Carbon/ Kevlar/ E Glass with 10% of graphite powder gives the higher value of Brinell hardness.



Graph 4 Hardness number result graph

IV.CONCLUSION

The present work has been done with an objective to explore the use of Carbon with 10% of graphite powder, Kevlar with 10% of graphite powder, E Glass with 10% of graphite powder, Carbon/ Kevlar with 10% of graphite powder, E Glass/ Kevlar with 10% of graphite powder, Carbon/ E Glass, Carbon/ Kevlar/ E Glass with 10% of graphite powder are manufactured using hand lay-up method. Epoxy is used as matrix in the reinforced composite and investigated the mechanical properties like tensile, flexure, impact and hardness number of composites.

This work is focused to find the best composite among the seven combinations. After all the tests has performed on the specimens the Carbon/ Kevlar/ E Glass with 10% of graphite powder shows a best result in the tensile strength impact strength, hardness test and as well as flexural strength . For the above investigations we are proposed the Carbon/ Kevlar/ E Glass with 10% of graphite powder having good mechanical properties when comparing with other results.

V.FUTURE SCOPE

- The extension of this thesis work can be done by considering the following points:
- The fiber can also take in the form of powder to fabricate the specimen which may increases the strength.
- Different type reins can be used to find the mechanical properties like strength, wear resistance
- By considering different process parameter and different composites which improves the properties of composites.

VI.REFERENCES

[1] Thakur VK and Singha AS. Physico-chemical and mechanical characterization of natural fiber reinforced polymer composites. Iran Polym J 2010; 19: 3–16.

[2] Singha AS and Thakur VK. Effect of fiber loading on urea-formaldehyde matrix based green composites. Iran Polym J 2008; 17: 861–873.

[3] Thakur VK, Singha AS, Kaur I, et al. Silane Functionalization of saccaharum cilliare fibers: thermal, morphological, and physicochemical study. Int J Polym Anal Charact 2010; 15: 397–414.

[4] Singha AS and Thakur VK. Synthesis, characterization and study of pine needles reinforced polymer matrix based composites. J Reinf Plats Compos 2009; 29: 700–709.

[5] Manshor MR, Anuar H, Nur Aimi MN, et al. Mechanical, thermal and morphological properties of durian skin fiber reinforced PLA bio composites. Mater Des 2014; 59: 279–286.

[6] Abral H, Kadriadi D, Rodianus A, et al. Mechanical properties of water hyacinth fibers – polyester composites before and after immersion in water. Mater Des 2014; 58: 125–129.

[7] Sahari J, Sapuan SM, Zainuddin ES, et al. Sugar palm tree: a versatile plant and novel source for biofibers, biomatrices, and bio composites. Polym from Renew Resour 2012; 3: 61–78.

[8] Sapuan SM, Kho JY, Zainuddin ES, et al. Materials selection for natural fiber reinforced polymer composites using analytical hierarchy process. Indian J Eng. Mater Sci 2011; 18: 255–267.

[9] Singha AS, Thakur VK, Mehta IK, et al. Surface-modified hibiscus sabdariffa fibers: physicochemical, thermal, and morphological properties evaluation. Int J Polym Anal Charact 2009; 14: 695–711.

[10] Thakur VK and Thakur MK. Processing and characterization of natural cellulose fibers/thermoset polymer composites. Carbohydras Polym 2014; 109: 102–117.

[11] Thakur VK, Thakur MK, Raghavan P, et al. Progress in green polymer composites from lignin for multifunctional applications: a review. ACS Sustain Chem Eng. 2014; 2: 1072–1092.

[12] Thakur VK, Thakur MK and Gupta RK. Review: raw natural fiber–based polymer composites. Int J Polym Anal Charact 2014; 19: 256–271.

[13] Khalil HPSA, Hanida S, Kang CW, et al. Agro-hybrid composite: the effects on mechanical and physical properties of oil palm fiber (EFB)/glass hybrid reinforced polyester composites. J Reinf Plats Compos 2007; 26: 203–218.

[14] Devi LU, Bhagavan SS and Thomas S. Dynamic mechanical analysis of pineapple leaf/glass hybrid fiber reinforced polyester composites. Polym Compos 2010; 31: 956–965.

[15] Noorunnisa Khanam P, Abdul Khalil HPS, Jawaid M, et al. Sisal/Nylon fiber reinforced hybrid composites: tensile, flexural and chemical resistance properties. J Polym Environ 2010; 18: 727–733.

[16] Gujjala R, Ojha S, Acharya S, et al. Mechanical properties of woven jute-glass hybrid-reinforced epoxy composite. J Compos Mater. Epub ahead of print 11 September 2013. DOI: 0021998313501924.

[17] Kumar MA, Reddy GR, Bharathi YS, et al. Frictional coefficient, hardness, impact strength, and chemical resistance of reinforced sisal-glass fiber epoxy hybrid composites. J Compos Mater 2010; 44: 3195–3202.

[18] Davoudi MM, Sapuan SM, Ahmad D, et al. Mechanical properties of hybrid Nylon fiber/glass reinforced epoxy composite for passenger car bumper beam. Mater Des 2010; 31: 4927–4932.

[19] Sapuan SM, Lok HY, Ishak MR, et al. Mechanical properties of hybrid glass/sugar palm fiber reinforced unsaturated polyester composites. Chinese J Polym Sci 2013; 31: 1394–1403.

[20] Yahaya R, Sapuan SM, Jawadi M, et al. Effects of Nylon fiber contents and fiber orientation on physical, mechanical, and morphological properties of hybrid laminated composites for vehicle spall liners. Polym Compos 2014. DOI: 10.1002/pc.23053.

[21] Zhang J, Chaisombat K, He S, et al. Hybrid composite laminates reinforced with glass/Nylon woven fabrics for lightweight load bearing structures. Mater Des 2012; 36: 75–80.

[22] Pothan LA, Mai YW, Thomas S, et al. Tensile and flexural behavior of sisal fabric/polyester textile composites prepared by resin transfer molding technique. J Reinf Plast Compos 2008; 27: 1847–1866.

[23] Khan GMA, Terano M, Gafur MA, et al. Studies on the mechanical properties of woven jute fabric reinforced poly(l-lactic acid) composites. J King Saud Univ -Eng. Sci 2013.

[24] Jawadi M, Abdul Khalil HPS and Abu Bakar A. Woven hybrid composites: Tensile and flexural properties of oil palm-woven jute fibers-based epoxy composites. Mater Sci Eng. A 2011; 528: 5190–5195.

[25] Ahmed KS, Vijayanagar S and Rajput C. Mechanical behavior of isenthalpic polyester-based untreated woven jute and glass fabric hybrid composites. J Reinf Plast Compos 2006; 25: 1549–1569.

[26] Amico SC, Angrizani CC and Drummond ML. Influence of the stacking sequence on the mechanical properties of glass/sisal hybrid composites. J Reinf Plast Compos 2010; 29: 179–189.

[27] Saw SK, Sarkhel G and Choudhury A. Effect of layering pattern on the physical, mechanical, and thermal properties of jute/bagasse hybrid fiber-reinforced epoxy novolac composites. Polym Compos 2012; 33: 1824–1831.

[28] Romanzini D, Lavoratti A, Ornaghi HL, et al. Influence of fiber content on the mechanical and dynamic mechanical properties of glass/ramie polymer composites. J Mater Des 2013; 47: 9–15.

[29] Ramesh M, Palani Kumar K and Reddy KH. Mechanical property evaluation of sisal–jute–glass fiber reinforced polyester composites. Compos Part B Eng 2013; 48: 1–9.

[30] Summer scales J, Dissanayake N, Virk A, et al. A review of bast fibers and their composites. Part 2 – Composites. Compos Part A Appl Sci Manuf 2010; 41: 1336–1344.

[31] Ozturk S. Effect of fiber loading on the mechanical properties of Nylon fiber and fiberfrax fiber-reinforced phenol formaldehyde composites. J Compos Mater 2010; 44: 2265–2288