Flexural Behavior of Hybrid Nano Filled Kevlar Reinforced Composites

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Abstract- **Polymer Matrix Composites (PMC) is gaining significant importance due to their unique feature of high to weight ratio, lower wear loss, better tensile strength etc. Behaviour of different fibre reinforced polymer composites are studied with respect to their composition and the applications are discussed. The Kevlar reinforced composite usually withstand impact and the fibers resists propagation of crack. Kevlar's exhibit good mechanical properties like tensile strength, stiffness, low weight and density. Impact and shock applied components are being produced using these materials. The experimental assessment studies the impact properties of Kevlar composites focussing on varying combinations. The addition of ceramic filler material such as nano Silicon Carbide and alumina would further improve its overall mechanical and wear characteristics. The purpose of the experiment is to understand the influence of nano Silicon Carbide and Alumina on woven Kevlar fabric. It provides an orientation to optimise the present day Kevlar materials and a platform to explore and investigate new combinations.**

Keywords: Kevlar fiber, Epoxy resin, Nano fillers, Flexural Strength, Fracture study

I.INTRODUCTION

Polymer Matrix Composites (PMC) is being increasingly applied for engineering applications due to their versatile adaptability related to mechanical and tribological behaviors. Fibre reinforced polymers also known as polymer composite is a homogenous combination of a polymer oriented matrix coupled with reinforcements in the form of fibre. Carbon, Aramid, Glass etc are the few of widely used fibres [1]. Lots of such fibres are extremely investigated for their mechanical and aerospace applications [2]. Polymer Matrix Composites are increasing their presence in the domains automotive, marine, aerospace sectors. It's also gaining prominence in the domain of infrastructure and construction industries. Composites are getting wider acceptance to their strength and stiffness which enhances the matrix properties substantially. The purpose is to explore the variations and produce component which satisfies the design and manufacturing requirements [3,4]. Filler materials combined with fibres also enhances the intrinsic properties of fracture strength, fatigue, wear, creep, abrasion and stability due to thermal conditions [5] Kevlar fibre in particular is getting a lot of prominence for its excellent mechanical properties. It exhibits better impact resistance when compared to glass and carbon fibres [6]. It is being increasingly used in sports and marine application in recent times for its ability to withstand impact loads and fracture reduction [7]. The investigation present study is to investigate the fracture properties of Kevlar based epoxy based laminate composite and the influence of Silicon Carbide filler to enhance the fracture strength of the laminate [8].

The materials are easy to fabricate using techniques such as hand lay-up and also advanced processing methods directed to vacuum bagging, resin transfer mechanism, injection molding and are incorporated on large scale. It is relatively cost effective and offers wider options to process different types of matrix, reinforcements and fillers to cater to various automotive and aerospace applications [3].

II. EXPERIMENTAL

2.1. Materials

Aramid based fibre specific to Kevlar 49 fabric is selected in the mat or the woven form was used as the reinforcement. The previous experimentation and studies indicate its stability and blending with epoxy resin. Hardener to resin ratio has been considered in 1:10 ratio. The specimens are prepared using hand layup technique under dry conditions. The curing was done at a required load of 4-5 MPa and was done at ambient condition of temperature for an entire day. Nano Alumia Oxide particle reinforcement was incorporated into Kevlar Epoxy matrix and is as indicated table 2.1

Table 2.1: Details of the prepared test samples

Sample code	Matrix	Reinforcement	Al_2O_3 (wt%)
1	Epoxy	Kevlar fiber	0%
2	Epoxy	Kevlar fiber	1%
3	Epoxy	Kevlar fiber	2%
4	Epoxy	Kevlar fiber	3%

2.2. Fabrication procedure for preparing test specimens
Fibre reinforced polymer composites are produced by various manufacturing methods. Kevlar-Epoxy specimens used in our experimentation are obtained by a suitable production process i,e hand lay-up. Curing under controlled environment was successfully done. The specimens need to be protected from any corrosive conditions and are cleaned to remove any residual particles. Hand Lay-up process involves designing a mould to cure the final product to a thickness of up to 4mm in requirements of the ASTM specifically to ASTM D 638 standards. LY-556 is the epoxy resin and K6 is the hardener used based on the type of epoxy resin. It has low viscosity, good thermal stability and curable at room temperature. The curing is frequently monitored for its temperature and pressure conditions. To prevent the formation of voids the specimens are frequently rolled maintaining suitable pressure. Issues of porosity and impregnation are handled and ensured to result in specimen with uniform thickness and density which is desirable to achieve accuracy while testing

2.3: Flexural testing procedure
The procedure for conducting the mechanical testing under the impact category is followed as per the ASTM D- 256 norms. The procedural standards require the specimen to have a notch. This is done in order to facilitate the accumulation of stress at that point. The specimens are loaded vertically. A pendulum hammer needs to be set at an angle which ensures the specimen is fractured in a single swing. The absorption of force before breakage is recorded and tabulated in terms of joules and the values of the combinations are made note. Subsequent trails are conducted to understand the effect of nano filler and its ability to improve the mechanical behavior.

III. RESULTS AND DISCUSSIONS

The Flexural energy data of the Kevlar- Epoxy, Kevlar-Epoxy+1% filler, Kevlar- Epoxy+2% filler, Kevlar-Epoxy+3% filler composite is given in Table 3.1. The results indicate an increase in the impact energy based on the percentage enhancement of the nano filler. Kevlar-Epoxy+3% filler showed the best results for impact energy as indicated in the table. Closer investigation reveals the mode of failure to be a fibre pullout. The surface examination indicates a brittle fracture and the distribution of fillers are found to be uniform on the surface of crack. The matrix-fiber distribution has been compatible with no voids or internal cracks.

Table 3.1: Results from impact test for samples

Specimen Code	**Specimens**	**Flexural Stress (MPa)**
1	K-E	55
2	K-E + 1% Al_2O_3	43
3	K-E + 2% Al_2O_3	61
4	K-E + 3% Al_2O_3	79

IV. CONCLUSION

The impact properties of Kevlar-Epoxy incorporated with nano fillers has been investigated. Based on the observation, the 3% Al_2O_3 based reinforced thermosetting composites displayed higher impact strength. The higher impact energy has established that impact energy showed improvement based on the addition of ceramic fillers. The hybridization has enhanced mechanical properties and wear characteristics. Based on the requirement of the particular components, the obtained inferences can be incorporated in industries for manufacturing and applying components under the specified conditions of environment. Further studies can be used to improvise the applications of these materials.

V. REFERENCES

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