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MECHANICAL BEHAVIOUR STUDY OF KEVLAR / BASALT / ALUMINIUM REINFORCED EPOXY MATRIX COMPOSITES

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Abstract:

Kevlar is a revolutionary material that utilized for making automobile, marine, aerospace, body and vehicle armors for past few decades. It has better mechanical properties like higher strength to mass ratio, resistance to wear, tear, penetrations and high strength, modulus, toughness and thermal stability. Whereas basalt fiber is well known for its commercial applications and properties like dimensional stability, outstanding electrical resistance, and durability. This proposed work focuses and studies flexural and impact response of Kevlar and basalt fiber with aluminium core reinforced epoxy matrix hybrid composites made by traditional hand layup process.

Key Words: Kevlar, Basalt, Impact Response & Hand Layup Molding

Introduction:

Polymer matrix composites possess enhanced mechanical properties like tensile and impact strength, strength to weight ratio. Due to its low weight nature fiber reinforced polymer matrix composites are utilized over past few decades as an alternative for traditionally used automotive materials for achieving better fuel efficiency. Fiber reinforced composites has a significant impact in production of engineering materials. It occupies huge percentage in the total fabrication due to its admirable mechanical properties like strength to weight ratio and cost-effectiveness.

Recent researchers focusing on use fiber reinforced metal laminates for various automobile applications such as bonnets, frames, and floorings. Kevlar fibers are widely used in defence, aerospace and marine industries due to its specific nature of higher energy absorption and impact load resistance. 80% of the body armour and vehicle armors in the military contains major contribution of kevlar fiber. The polyamide aromatic structure of the kevlar possess ultimate endurance to the kevlar configuration

In this proposed research Basalt/Kevlar/Al plate were fabricated by compression moulding process and its mechanical studies were studied.

Materials And Methods:

Materials:

Thermoset epoxy matrix (LY 556) supplied by Covai Seenu Ltd, Tamilnadu, was used as an base matrix and W152 LR hardener mixed with resin in the ratio of 67/33. Kevlar and basalt fibers are woven fabrics with 230 gm^2 areal density supplied by Hindustan composites, Mumbai, were utilized as a reinforcement. Properties of kevlar and basalt fibers are depicted in Table 1.

Table 1: Properties of Reinforcement Materials

Property	Kevlar	Basalt
Tensile strength (MPa)	2900-3450	3100-3800
Elastic Modulus (GPa)	230-800	72.5-75.5
Elongation at Break (%)	0.5-1.5	4.7
Maximum Working temperature (°C)	650	380

The volume fraction of a resin-fiber configuration is measured by the following relationship.

$$Vf = \frac{Wf/\rho f}{Wm/\rho m + Wf1/\rho f1 + Wf2}$$

Where,
f = Fiber, m = Matrix, W = Weight, ρ = density

Table 2 portrays the various volume fraction composition of fiber resin configuration used for this proposed research work.

Table 2: Volume fraction in %

Specimen	Kevlar	Basalt	Matrix
1	40	30	30
2	30	40	30
3	35	35	30

Laminate Preperation:

Three fiber metal laminates containing major contribution of Kevlar and basalt fibers with various volume fractions as portrayed on table 2 were fabricated (300mm X 300 mm plate) for the present investigation. All the three laminates arranged in the order of K-B-K-B-Al-K-B-K-B. The required specimen size obtained with abrasive machine cutting.

Characterization:

The three point bending flexural test provides the stress - strain relationship of kevlar/basalt/aluminium laminates. As per ASTM 790 standard (80mm x 13mm x 3mm) flexural specimens were prepared and tests were done using Instron 4486 with short head speed 4mm/min.

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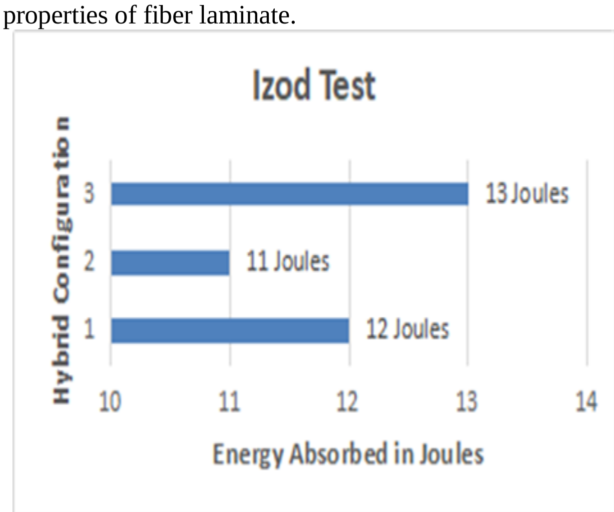
For izod Impact testing ASTM D256 and charpy testing ASTM D6110 standards were followed and AIT-300N impact pendulum is utilized for testing (strike velocity 5.6 m/sec, hammer wt. 18.70 kg, pendulum dia. 1600 mm). The prepared hybrid laminates were tested and results are reported. Figure 3 (a) and (b) shows the tensile and flexural test machines.

Figure 3: Flexural and bending test machines

Results and Discussions:

The average impact strength or energy absorption rate of kevlar/basalt/aluminium hybrid laminates with various volume configurations are depicted in figure 4 and 5.

As portrayed in table 2 (Volume fraction % configuration) specimen 3 (Kevlar 35%, basalt 35%, Resin 30% and Aluminium) shows more (nearly 20%) energy absorption than other two volume configurations. This is because of inter facial bonding between basalt and kevlar fibers in equal proportions shows good associative nature. This configuration possess considerable changes in mechanical properties of fiber laminate.



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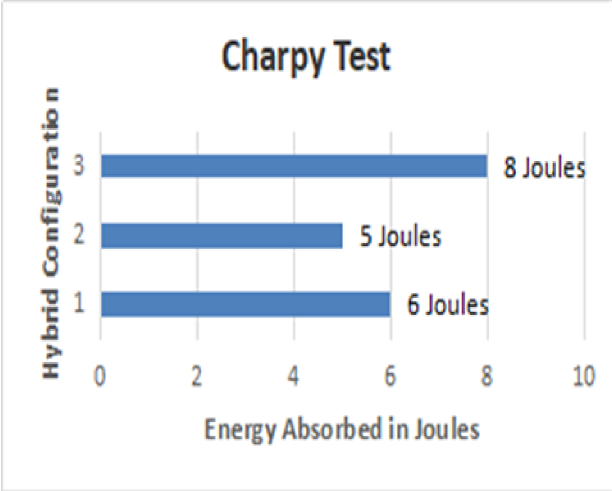

Figure 4 & 5: Izod and Charpy Impact test results

The three point bending flexural test results reveals that specimen 2 (kevlar 30%, basalt 40%, Epoxy 30%) exposes greater strength than other two configurations. It is noted that 10% increase of basalt fiber composition results in higher flexural and modulus strengths in fiber laminates. The stress - strain and force - displacement curves of higher flexural strength specimen is depicted in Figure 6 and 7.

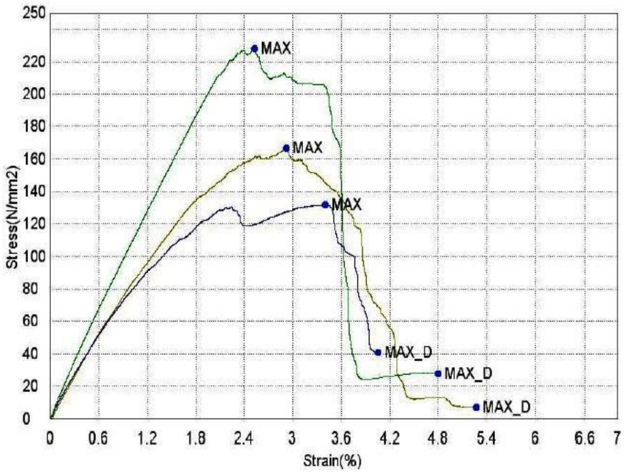

Figure 6: Stress - Strain Relationship

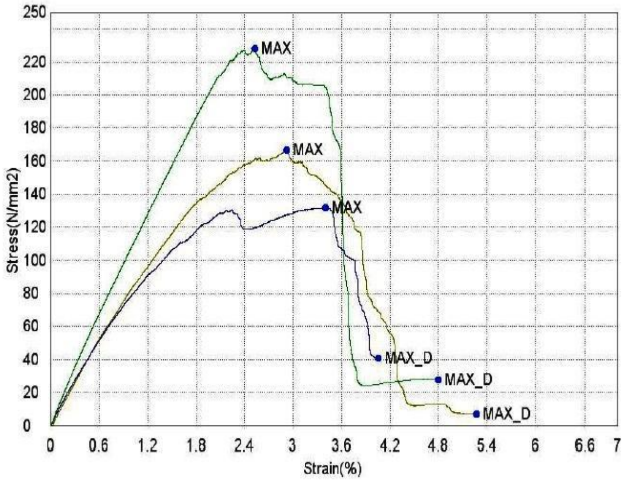

Figure 7: Force - Displacement Relationship

Conclusion:

Kevlar and E-Glass reinforced epoxy LY 556 composites were fabricated by hand lay-up process and mechanical characterizations were done for obtaining optimized hybrid configuration. Results indicates that equal proportion of basalt/Kevlar/Aluminium reinforced sample shows higher energy absorption, resistance towards catastrophic failure and 10% higher reinforcement of basalt results in good flexural strength. The targeted output preferably suitable for automobile front cross member, bonnets and fenders.

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