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INVESTIGATING TENSIL PROPERTIES OF HYBRID LAMINATES

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ABSTRACT

Impact damage and post-effect tension strength behaviour are examined in this research, and the impact of laminate stacking sequence is quantified. In this work, three configurations of hybrid woven Carbon and Glass composite laminates are investigated and compared in order to better understand their performance. It's also worth noting that tensile testing have long been the most widely used method for characterising the mechanical reactivity of composite materials. In spite of this, there is currently no viable direct way for conducting tensile testing on composite laminates at lower temperatures. At low temperatures, determining the tensile characteristics of composites, particularly the ultimate strength, is not simple. High tensile and shear strength, for example, was to blame. Polymer matrix composites' tensile tests at low temperatures have showed noticeable irregularities in terms of strength ratings. Low-temperature testing issues can include specimens dropping out of the test holder during the test.

KEYWORDS Tensile test, hybrid composites, Residual tensile strength, Fibre polymer.

INTRODUCTION

They are employed in a wide range of applications because they have diverse mechanical qualities and are low in weight. Automobiles, aeroplanes, tyres, sporting equipment, and even the military have all used composite materials extensively. Polymer matrix composite materials may be used in a variety of ways depending on the kind of reinforcing material used. However, fiberglass-reinforced polymer composites are less expensive to produce than carbon or aramid fiber-reinforced polymer composites because of their higher density and lower strength. We wanted to find out more about the tensile qualities of these hybrid materials so that we might use them in sports and engineering. Hand layup process was also used to distinguish woven glass and jute materials in novel stacking sequences. A comparison and validation of the experimental tensile findings with those obtained from the finite element analysis (FEA) was performed. Fractography was also used to examine the interfacial properties of materials.

LITERATURE REVIEW

YUANHENG YAO ET.AL (2022) Chemical properties such as carbon fibre reinforcement and basalt fibre reinforcement make these materials popular in the automotive and naval industries. It was shown that CFRE, BFRE and their combinations were sensitive to changes in strain rate. Quasi-static strain rate: 0.0017s1; dynamic state: 0.1s1; 10, 100, and 150 strain rates were used. The shattered specimens were examined in detail. All of the hybrid composites tested demonstrated stacking sequence sensitivity, according to the findings. Peak forces of two hybrid constructions were found to be between those of BFRE and CFRE, with H1 and H2 each improving by 3 and 29 MPa, respectively, compared to BFRE in the quasi-static condition of the test. BFRE and CFRE have better mechanical characteristics in the static condition than any of the three hybrid constructions. Strain rates affected the hybrid composites as well. Five structures' peak forces rose significantly when loading speed shifted from a quasi-static to a dynamic condition. However, the strain rate sensitivity of the three structures (BFRE, H1, and H2) rose as the stretch speed increased in the dynamic range. Straining revealed stratification in all five structures. There were fewer microcracks in the cross-section after dynamic stretching compared to the cross-section after quasi-static stretching. The sequence sensitivity of three hybrid structures might be explained by the tight mix of fibres and resin.

ANANT JOSHI ET.AL (2021) The main goal of this article is to comprehend the importance of hybrid laminates reinforced with various types of synthetic and natural fibres on mechanical and fracture toughness properties with a clear understanding of their applications in the structural, aerospace, automotive, offshore, and packaging industries, among others. ;. The importance of natural fibres in enhancing the mechanical characteristics of hybrid composites is explored using a variety of hybrid composites made using a variety of approaches. The numerous experiments performed to evaluate the mechanical and fracture behaviour of hybrid composites made from Flax, Sisal, Kenaf, Jute, and Banana fibres have been thoroughly reviewed methodically. Researchers all across the world have taken notice of the profusion of natural fibres with low cost, environmentally beneficial, and biodegradable qualities.

MUHAMMAD YASIR KHALID ET.AL (2021) There has been an ongoing need in the aircraft sector for materials with outstanding mechanical qualities, reduced density, and greater fuel economy. For the time being, Fiber Metal Laminates (FMLs) are the most popular material for use in aerospace. Material behaviour under projected loading circumstances is critical for the precise design and fabrication of aviation components. Primary objective was to determine how well the FMLs with aluminium 7075-T6 sheets in them tensile behaved. Surface de-greasing, mechanical abrasion, and anodizing were also used to finish the composites once they were made. Various strain rates of 210-4 s1, 510-4 s1 and 810-4 s1 were used to conduct mechanical characterization. Because of this, we used a procedure known as vacuum-assisted resin transfer moulding (VARTM). The findings showed that FMLs based on diverse combinations of fibre and metal elements showed a low degree of strain rate-sensitivity. CARALL saw a 1.7% rise in tensile strength, bringing its tensile strength from 741 MPa to 754 MPa. There was a great degree of strain rate-sensitivity in ARALL and GLAS laminates, on the other hand, This pattern is seen when strain rates are raised from 2104 s-1 to 5 and 8 104 s-1. 389 MPa, 411 MPa, and 475 MPa for GLARE laminates, and 253 MPa, 298 MPa, and 352 MPa for ARALL laminates, respectively.. Tensile strengths of ARALL and GLARE laminates were found to rise by 39% and 22%, respectively.

MOHAMMED HISHAM, ET.AL (2019) This research focuses on the Kevlar fibre composite, which is becoming more popular due to its low weight and outstanding mechanical qualities. It is possible to make fibre composites from a wide variety of natural and synthetic fibres. One of the best composite materials is Kevlar, which is readily accessible. Resilience, hardness, and heat stability are just a few of the qualities of Kevlar. Kevlar composite characteristics may also be improved by using various hybridization and treatment processes. This study's goal is to examine the various hybridization and treatment options that may be used to improve the mechanical characteristics of Kevlar composites.

S.RAJESH ET.AL (2018) It is increasingly necessary to use novel materials to create more dependable and smart components in today's technology. Composite materials top the list of innovative engineering materials that can be used in all disciplines of engineering and technology because of their features. Kevlar composites with four layers of Kevlar laminate are the focus of this article, which examines their tensile properties. Scanning Electron Microscope was used for morphological analysis to examine the internal structure of the composite fibres after testing. The study found that Kevlar has a high tensile strength, which makes it an excellent alternative to traditional materials in many technical applications.

MATERIALS AND METHODS

Materials

In the automotive, aerospace, and other industries, hybrid composite materials reinforced with metal fibre are a novel form of laminated composite that is gaining in popularity for structural purposes. It was discovered that the MEKP catalyst and the cobalt napthenate accelerator were used to accelerate the reaction of isopthalic polyester resin, woven steel, and nylon bi-directional fibre mesh in this study. Medium viscosity polyester resin was used as the matrix material because of its low setup costs and the ability to alter its characteristics to individual needs. Reinforcements included a bi-directional fibre mesh of steel and nylon woven together.

Test Setup

In line with ASTM regulations, the tensile and compressive specimens were fed into a computer-controlled universal testing machine and tested. At a displacement rate of 1.27 mm/min, the specimens were held in pin-loaded grips and subjected to monotonic uniaxial strain. We kept a tight eye on the experiments, which were done at room temperature. It is difficult to find the initial damage point in laminates, hence these values represent the maximum stress that a hybrid composite specimen can sustain before it fails completely. The critical load for each specimen has been used to compute the notched tensile strength.

Fabric - Hybrid

composites Hybrid fabric advancements are the most common result of textile industry research and technical advancement. For the development of big turbine blades, Hillermeier exhibited novel hybrid fabric performance. Fabric reinforcing layers (fabric) as shown in Fig. 1b were piled onto a mould and infused with epoxy resin under vacuum in the present investigation of carbon/glass hybrid composites, as illustrated.

RESULT

The next sections detail the findings and the effect of various factors on the physical and mechanical characteristics of experiments carried out to characterise the proposed composite material under various loading circumstances and with varied specimen configurations.

Physical Properties of Hybrid Laminates

Density: The ASTM D792 standards were used to gauge the laminates' densities. 100mm X 20mm X 10mm rectangular samples with thickness and breadth variations of 0.25mm and 0.20mm, respectively, were employed in this study. The mass was measured using a digital balance with a 10-4 g precision and distilled water was utilised as the immersion fluid. A total of fifteen specimens from each group were analysed to determine the average density.

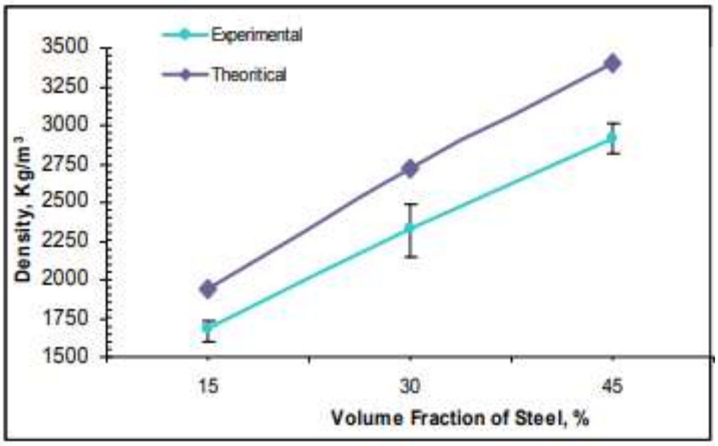

Fig.1. Density as a Function of Steel Content for 00 /900 Fiber Orientation Laminates.

There is a disparity in density illustrated in Fig. 1 between the theoretical densities of the laminates. Micro voids are to blame for the discrepancy between the theoretical and observed densities of the material. Thus, it is essential that the proportion of voids in the samples processed be accurately accounted for.

Mechanical Properties of Hybrid Laminates

Analyzing the behaviour of the substance under various mechanical stresses is the fundamental goal of any material characterisation. In the following sections, we'll go through the findings of our testing of steel reinforced composite material under various loading circumstances and with varied specimen configurations.

Tensile Tests

The ISO 527 standard specifies how to conduct tensile testing. With a constant displacement rate of 1.5 millimetres per minute, an Instron universal testing machine with a 100-kilogram load cell was employed throughout the test. Mechanical extensometers of 50 mm gauge length were clamped immediately on both sides of the test specimen to measure the strain in the material. Strain gauge amplifiers were used to process the outputs of the extensometers. An image of the test apparatus and specimen is shown in Fig. 3a before and after the test. The tensile characteristics of each series of laminates were measured using about 10 specimens. Table 1 displays the average tensile strength values for hybrid and non-hybrid composites.

Table 1 Tensile properties - hybrid and non-hybrid composites

Sl. No.	Laminate	Volume fraction (%)	Thick (mm)	Tensile modulus (GPa)	Tensile strength (MPa)	Strain to failure (%)
		Hybrid Laminates				
1	Carbon/glass/ epoxy (Fabrics)	17.8 (C) 32.0 (G)	3.4	58	920	1.5
2	Carbon/glass/ epoxy (Filament wound)	20.6 (C) 37.8 (G)	3.0	72	966	1.3
		Non-Hybrid	Laminates			
3	Glass/epoxy	58.7	2.9	48	1023	2.4
4	Carbon/epoxy	53.1	3.4	110	1337	1.2

The stress-strain diagrams here exhibit the comparison of the tensile loading performance of hybrid and non-hybrid laminates. There is a back calculation for carbon and glass fibre modulus based on the tensile data of non-hybrid composites, as detailed in section 2.1, which results in 242GPa and 82.7GPa for the modulus provided by the material supplier. Thus, the modulus of glass fibre is virtually identical to the value supplied by the supplier, however the modulus of carbon fibre produced is lower than the value supplied. The degree of graphite structural alignments at microstructure level may influence the carbon fibre modulus.

CONCLUSION

A preliminary investigation of the performance of hybrid and non-hybrid composites is presented in this work, along with a comparison. It has been shown that filament wound laminates perform better than hybrid textiles in compression loading, but in tensile loading, both types of composites perform equally well. The tensile strength and modulus of the glass fiber-epoxy-nanoclay ternary nanocomposite are increased by the addition of nanoclay, while the tensile strain is reduced. There are several ways to measure mechanical qualities, but the tensile test is one of the most used. Researchers in the field of material engineering have expressed worry about the lack of consistency in data values for tensile characteristics while using it to study certain mechanical behaviours of composite material (CSMFRP) laminates. The following may be deduced from the experiment carried out.

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