SYNOPSIS
OF
THE THESIS ENTITLED

TO STUDY THE PHYSICAL AND MECHANICAL PROPERTIES OF TEXTILE COMPOSITE'S LAMINATES PRODUCED BY ORIENTING FABRIC LAYERS DIFFERENTLY.

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SYNOPSIS

The thesis entitled **"To study the physical and mechanical properties of textile composite's laminates produced by orienting fabric layers differently."** comprises of six chapters.

Chapter 1: Introduction

Textile composite structure has emerged as huge category of composite materials which is known for its adaptability and ease of making due already available traditional methods of manufacturing. Composite materials are replacing day by day the conventional metallic materials due to their light weight, high strength, design flexibility and long life. Textile structures are engineered and fabricated to meet worldwide structural applications. The use of textile materials like fibers, fabrics as reinforcement in designing and generating improved materials for different applications has increased due to its outstanding properties in terms of easy handling, shapability, adaptability and structural complexity. The demand for lightweight products that consume less energy in aviation, wind energy, motor vehicles etc. have added to this. [1]

Chapter 2: Literature survey

Today with the advancement of technology a need is created for versatile product development. A single material cannot satisfy this demand, so existence of composites became possible. Composites are the most sought materials in terms of their utility, properties, adaptability and applications. [2] Composites due to their high strength to weight ratio, excellent chemical resistance, superior electrical and thermal conductivity and many other properties has increased its use in an ever-growing number of applications. Textile reinforcement structure can be made of fibers, yarns or fabrics (woven, braided, knitted or non-woven) and are generally flexible. The application of traditional textile technology to organize high performance fibers for composite material applications has provided a route to combining highly tailored materials with enhanced process ability. [3]

Composite materials have been used quite successfully for decades within industry sectors such as aerospace, maritime, transportation, infrastructure and consumer goods. These materials consist of high-performance fibers such as carbon, glass and aramid, which are bound together within a matrix of polymer material such as epoxy, polyester, etc. [4-6] The physical properties of composites will vary with location and orientation of the principal axes. These materials are termed anisotropic, which means they exhibit different properties when tested in different directions. [7] Composite is made of two components: reinforcement material and matrix. [8-9] Composite Material are two inherently different materials that when combined produce material with properties that exceed the constituent materials. Composite materials are made by combining two or more materials to give a unique combination of properties. [5,8-10]

Textile reinforced structure can be classified as (1) Dimension (2D and 3D) (2) Method of manufacturing (woven, knit, braid and nonwoven) [2] (3) Linearity of reinforcement (linear or nonlinear) (4) Direction of reinforcement (1,2,3 or multi) (5) Integration (Laminated or integrated) [10]

The different types of Laminates are: 1. Symmetric laminates: A symmetric laminate has both geometric and material symmetry with respect to the mid-surface. 2. Asymmetric Laminates: This laminate is characterized by having its layers arranged in an asymmetric fashion with respect to the mid-surface as shown in figure 1.

Composites have found their application in commercial aircraft, submarines, submarines, powerboats, racing yachts, and laminated sailcloth & interiors like overhead luggage compartments, sidewalls, partitions, cargo liners, panels, marine structure like boat, ships, submarines and aerospace structures like aero plane, airport pavements, military structures etc. [11-13]

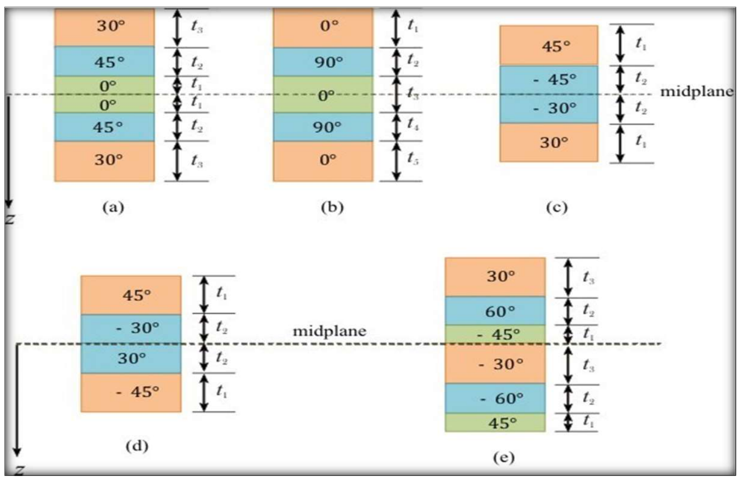

Figure 1: (a) Symmetric laminate (b) Cross-ply laminate (c) Angle-ply laminate (d) Anti-symmetric laminate and (e) Balanced laminate [11]

Composites consist of carbon, or glass, reinforcing an epoxy polymeric matrix. The carbon fiber is one of the most used materials for the preparation of large varieties of composites. They present unique advantages in terms of strength weight relation, and can influence the physical and mechanical properties through the form, orientation, and content modification [14]. Epoxy resin has been important to the engineering community for many years. Components made of epoxy-based materials have provided outstanding thermal and electrical properties [15]. Due to their high mechanical properties, the Multi-axial multi-ply fabric (MMF) composites are becoming increasingly popular as reinforcing materials in high performance composites. [16]

The main objective of this work is to study the effect of laying the different layers of fabrics differently during the composite preparation. Here, the fabric is laid at different angles as fabric being anisotropic in nature exhibit different behavior in terms of properties in different directions. These properties varies with different orientation with principal axes. An attempt has been made to curb this variable behavior for better properties enhancement.

This work aimed to study the effects of variable parameters including fiber contents, numbers of plies, and layer orientations on basic properties of the composite structure.

Accordingly, the primary purpose of this work was to prepare carbon fiber/epoxy MMF composites on laboratory scale. The effects of number of plies, angle-ply laminates, and fiber contents on the physical and mechanical properties of resulting MMF laminate composites were investigated.

Chapter 3: Manufacturing of fabric

The initial part of the work was aimed at manufacturing of the reinforcement material. Here, it was decided to use carbon as the main reinforced material as it being the most emerging high-performance yarn. The process of manufacturing selected was weaving as it the most widely used textile manufacturing technique and accounts for nearly 70% of the two-dimensional fabric produced. The weaving process is suited to produce panels and woven fabric textiles have been used for several years in two dimensional laminated composites. [3] The economy of textile composites can be increased by deploying the already available weaving looms for high performance yarn like carbon, glass and kevlar etc. This can lead to easier and quicker manufacture of a finished product and product development.

This chapter deals with manufacturing of carbon fabric on CCI SL8900 Evergreen rigid rapier sample weaving loom. This is multi- functional machine producing a variety of woven samples including industrial fabrics, upholstery and apparel. The existing set up of the loom was not suitable for weaving flat yarn like carbon as the parts and accessories of the loom were more suitable for spun and filament yarn. For fabric manufacturing through weaving, three primary motions are required namely shedding, picking and beat up. During weaving carbon warp breakage occur due to may be either by an increase in tension or by a decrease in strength. Tension in warp is controlled by operational parameters like high friction between warp and machine parts. Again, if there are nicks, cuts and roughness on surfaces to which yarn comes in contact then this problem aggravates. There is uneven distribution of load overall the warp threads. During shedding the main tension arises for carbon yarn by the cyclic variations in tension which is caused by periodically changing the shed. Tension compensators can be used but due to dynamic variation going on continuously, it is not possible to eliminate the variation completely. This lead to damage on to the carbon yarn onto the machine parts like heald eye, lease rods and front rest. This lead to ephemeral erratically occurring variation in carbon yarn, leading to cuts on the yarn surface and weakening it. This also adds to the problem of fly. Thus, it was observed that though yarn being flat but it behaves as filament yarn during weaving where the fibers separates and breaks when abraded.

It was found that for weaving carbon on the loom successfully, requires modifications in the basic structure and surface of the parts like healds, reed, temple and front rest on sample loom. Some processes also require modification like take up motion. The surface finish of the metallic parts used where the yarn is in direct contact also require care to avoid damage due to continuous rubbing onto the rough surface. After modification carbon-carbon, carbon-HDPE fabrics were weaved with different weaves on this loom successfully.

Chapter 4: Preparation of Textile composite structure

The next step to the work was to prepare the correct composition of the matrix material. For this thermoset epoxy resin was selected as it makes up most of the current market for advanced composites resins. For resin preparation the exact combination of resin, hardener and releasing agent was used. After a series of experiments, with various trial and errors this combination was achieved. The carbon fabric was cut according to different angles like 0,30,45,60,90 using proper cutting technique to avoid the fraying of fibers out of fabric. The hand layup method was used to prepare the composite structure with proper compression used with the help of calculated weights. The resin was applied on each fabric sample and different stacking arrangements were followed to prepare the samples. The effect of different stacking sequence, laying angles, fabric weaves and constituent reinforced material is to be studied and analyzed.

Chapter 5: Result and Discussion

The physical and mechanical properties of prepared textile composite structure were evaluated. The effect of angle stacking was measured and analyzed. The Tensile, flexural and impact properties were analyzed using different testing instruments. The results indicate maximum tensile strength is attained along 90 degrees as compared to other stacking sequence.

The angle-ply of the composites showed the greatest effect on the mechanical properties compared with number of plies and layer orientations. The significant improvements in mechanical properties of the composites were further supported using scanning electron microscopy (SEM). The SEM images of tensile failure of the sample with angle orientation as (0,90,90,0) is shown in figure 2. Morphologies of the tensile fracture surfaces of composites revealed that the presence of fiber pulled out results in the creation of voids between the fibers and matrix polymer. This causes the mechanical properties of the composites to be reduced. Finally, the enhancement of mechanical properties of composites clearly confirmed that angle-ply layer (0,0,0,0) had the most significant reinforcing effect among other parameters evaluated.

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Figure 2: SEM images of tensile failure of sample with orientation angles as (0,90,90,0)

Chapter 6: Conclusion

The conclusions will be summarized in chapter 6.

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