Nat. Volatiles & Essent. Oils, 2021; 8(5): 10011 - 10017

NVEO
Natural Volatiles & Essential Oils

Effect of Stıtch on Composıte Plate

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Abstract

Experimental study is carried out on the stitching reinforcement of composite laminates. First, the tensile strength and stiffness are measured, and their dependence on stitching parameters such as stitching needle span, row spacing, edge distance and stitching type are analyzed. Next, the strain distribution and concentration are investigated analytically and experimentally for different stitching parameters, external load and edge location of the hole. It is shown that the results of stitching reinforcement are quite different for composite laminates with a circular hole, which could provide proper stitching parameters for designers. Resin and hardener are usually supplied two liquids in separate container. Here we conduct a various mechanical testing to define the material properties. Based on the property it can be used in spare parts on vehicle to increase the strength of the part. Later the material is experimented and values are noted.This material can be used in aerospace industries, automobile industries where the cost reduction can be achieved and quality can be increased.

Keywords: laminates, stitching parameters, composites, Mechanical characteristics, hardener

1. Introduction

In recent times laminate composites have been increasingly utilized in such lightweight and high strength structured as ground transportation vehicles, aerospace and space structure. However composite material suffers from some serious limitation. The most significant among them is their response to impact loading. A structure is subjected to an impact force when a foreign object hits it. For instance, the loads imparted by dropped tool on the bonnet cover of car body, bird hit and runway debris on an aircraft engine are typical example of impact loads.

A composite material is a combination of two or more materials which retain their identities as they act in concert. These materials are usually composed of reinforcement such as a fiber and a matrix such as a resin. Nylon, fiberglass and carbon fibers and polyester, acrylic and epoxy resins are the commonly used composite materials in prosthetics and orthotics. Several factors can greatly effect the strength and performance of composite materials. The adhesion at the interface between the resin and fiber, and the mechanical properties of the resin and fiber, greatly effect composite performance. The fiber length, orientation and ratio of fiber to resin, and processing techniques used to fabricate the composite also effect composite properties.

W. J. Cantwell, et al (2000) the influence of the ply stacking sequence on the impact resistance and subsequent 0-tension fatigue performance of carbon fiber laminates has been investigated. Drop-weight impact tests were conducted on a range of 16 ply carbon fiber laminates with either all non-woven plies or mixtures of woven and non-woven plies. Damaged coupons were tested in 0-tension fatigue for up to 106 cycles, scanned using an ultrasonic probe and then loaded in tension until failure. The impact resistance and subsequent fatigue performance have been found to be sensitive to the ply stacking sequence. The non-woven composites showed a marked sensitivity to impact loading, but increases in residual static strength were noted after cycling. The inclusion of a woven fabric served to improve the impact resistance of the laminates. Fatigue cycling resulted in considerably improved residual static strengths; by 106 cycles any effect of the impact damage had been removed.

Mehmet Aktas, et al (2008) in this study, the impact response of unidirectional glass/epoxy laminates has been investigated by considering energy profile diagrams and associated load–deflection curves. Damage modes and the damage process of laminates under varied impact energies are discussed. Two different stacking sequences, [0/90/0/90]s and [0/90/+45/_45]s, were chosen in tests for comparison. An alternative method, based on variation of the excessive energy (Ee) versus impact energy (Ei), is presented to determine penetration threshold (Pn). The penetration threshold for stacking sequence [0/90/+45/_45]s is found to be smaller than that of [0/90/0/90]s. The primary damage mode was found to be fiber fracture for higher impact energies; whereas, it was indentation resulting in delamination and matrix cracks for smaller impact energies. Contour plots of the overall damage areas are also depicted for several impact energies.

M. S. Found, et al (1997) Drop weight impact tests have been performed on thin CFRP panels stiffened with blade or T-stiffeners and comparisons made with similar plain panels. The change in structural response of the panels is governed by the amount of damage sustained during impact. The increase in panel stiffness is associated with the suppression of backface cracking but larger areas of delamination.

F. Aymerich ,et al(2006) This study examines the effect of stitching on the impact performance of a class of graphite/epoxy cross-ply laminates with the aim of investigating the ability of through- thickness reinforcement to improve the delamination resistance of laminates. Unstitched and stitched rectangular specimens (65 mm · 87.5 mm) were simply supported by a steel plate having a rectangular opening 45 mm · 67.5 mm in size and impacted at the center with energies ranging between 1 and 13 J. Stitched and unstitched laminates revealed similar structural performances in terms of force versus displacement response, energy absorption and residual indentation depth. It was also observed that whereas stitching does not appear capable of preventing the initiation and spread of delaminations, it induces a clear reduction of damage area when stitches bridge delaminations sufficiently developed in length.

Giovanni Belingardi, et al (2003) the low velocity impact behavior of carbon fiber- epoxy matrix laminates has been studied by experimental drop dart tests. The considered composite laminate is characterized by two different stacking sequences. Plates of three different values of the laminate thickness have been tested both by quasi-static and dynamic impact loading. The force–displacement curves, obtained during tests conducted with different impact velocities, are superimposed in order to point out that the considered material, in the considered loading conditions and impact velocity range, has no sensitivity to strain rate effect. The energy absorption capability is studied with respect to the different laminate lay-ups.Finally some considerations are developed on the dependence of the first damage force and maximum force values, of the saturation energy and of the plate flexural stiffness with respect to the laminate number of layers variable.

A.P. MouritzaS, et al (1997)this paper reviews over fifty studies into the effect of through- the-thickness stitching on the in-plane mechanical properties of fiber-reinforced polymer composites. Reviewed are the in-plane tensile, compressive, flexure, interlaminar shear, creep, fracture and fatigue properties, although little work has been undertaken on the last three properties. When comparing studies it is apparent that many contradictions exist: some studies reveal that stitching does not affect or may improve slightly the in-plane properties while others find that the properties are degraded. In reviewing these studies it is demonstrated that predicting the influence of stitching on the in-plane properties is difficult because it is governed by a variety of factors, including the type of composite (eg. type of fiber, resin, lay-up configuration), the stitching conditions (eg. type of thread, stitch pattern, stitch density, stitch tension, thread diameter), and the loading condition. The implications of these findings for the use of stitching in lightweight engineering structures are discussed.

V. Lopresto,et al (2006) low-velocity impact tests were carried out on stitched carbon fiber-reinforced plastic laminates of various thicknesses, whose behaviour was studied with reference to the overall force–displacement curve, first failure load, penetration, indentation and damage extent. The results obtained were compared with similar data available for 2D laminates. Apparently, the presence of stitches did not affect substantially the material behaviour in terms of force–displacement curve, first failure load, and indentation. However, the stitched laminates exhibited penetration energy about 30% lower than their 2D equivalent. Further, the advantage of stitching in terms of impact damage resistance was evident only for high thickness composites. The data generated suggest that the use of stitches could be unnecessary to hinder delamination in thin 2D laminates.

F. Aymerich, et al (2006) The impact response of stitched graphite/epoxy laminates was examined with the aim of evaluating the efficiency of stitching as a reinforcing mechanism able to improve the delamination resistance of laminates. The investigation, which focused on two classes of cross-ply stacking sequences ([03/903]s and [0/90]3s), showed that the role of stitches in controlling damage progression of laminates and their capability to reduce the impact sensitivity of specimens are greatly dependent on the impact behaviour of base (unstitched) laminates. In [03/903]s laminates, in particular, stitching is able to reduce damage area, on condition that the impact energy is higher than a threshold level and delaminations are sufficiently developed. In [0/90]3s laminates, on the other hand, stress concentration regions generated by the stitching process appear to promote the initiation and propagation of fiber fractures, thereby inducing a decrease in the penetration resistance of the laminate.

Tien-Wei Shyr, et al (2003) this paper presents an investigation into the damage characteristics and failure strengths of composite laminates at low velocity impact tests. Three E-glass fabrics, non-crimp fabric, woven fabric, and nonwoven mat, were selected as reinforcements for the composite laminates. Impact tests were conducted using a guided drop-weight test rig in ascending energy to 24 J/layer nominal impact energy. Metallographic microscopy was used to observe the damage characteristics of the perpendicular cross- section of the impacted laminates after a micro powder polishing treatment. When the load–time and the energy– time histories were compared with the fractographics, it was found that fiber breakage had occurred prior to the major damage. When the impact energy increased over the threshold energy of the major damage, matrix cracking, delamination, and fiber breakage were observed at the back surface, below a nearly undamaged zone, which were attributed to the bending stresses. The main objective of the composite plate are to study and analysis the characteristics of stitched and unstitched plate .The laminates are stitched to with stand the load more than the unstitched laminates .The stitched laminates must be more flexible and strong enough than unstitched laminates.

2. Materials and Methodology

2.1 Materials

In this research work stitched fibers are used to develop the laminated composite plate. Using Cotton yarn has a reinforcement and Epoxy is used as matrix material to develop the composite material. The stitched fiber are shown in Figure 1.

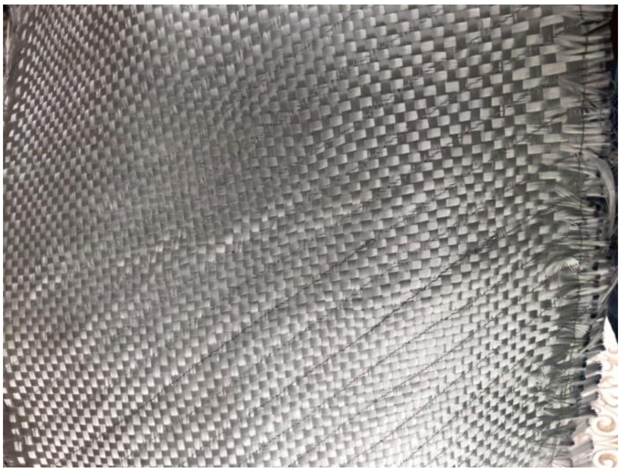


Figure 1. Stitched Fiber

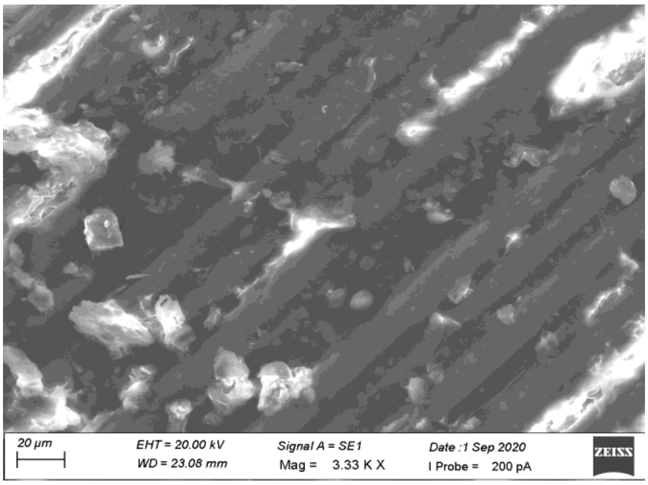
2.2 Fabricate of Composite Laminate

The laminate size is 300mm × 300mm x 4 mm**.** Laminate is a symmetric because the no of layer is 6. The stitching direction is Inclined to the fiber direction of the 45˚ surface layers of the laminates. An ensuing volume fraction of stitch threads material of about 0.3%. In order to reduce fibred distortion in the interior of the laminate. A modified lock stitch adopted for stitching by easing the tension of the needle thread.

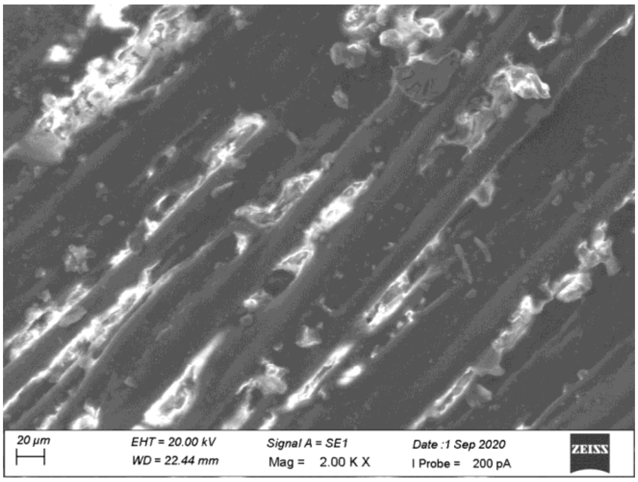
2.3 Mechanical Characteristics

2.4 Scanning Electron Microscopy (SEM)

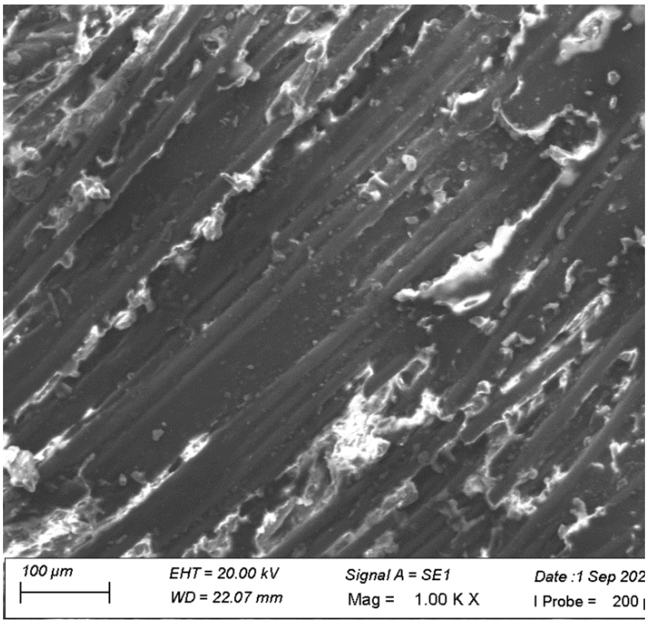
A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The SEM images are shown in Figure 2. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. Resin flow and impregnation of the glass fibers can be observed in the SEM micrographs.



(a)



(b)



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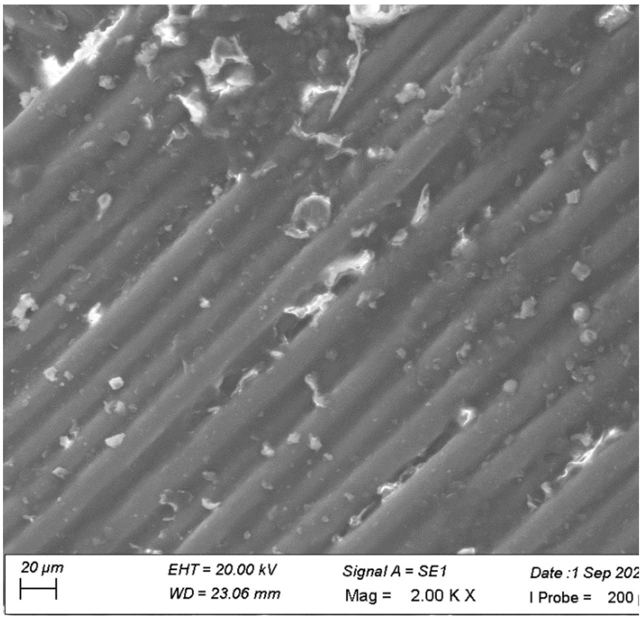
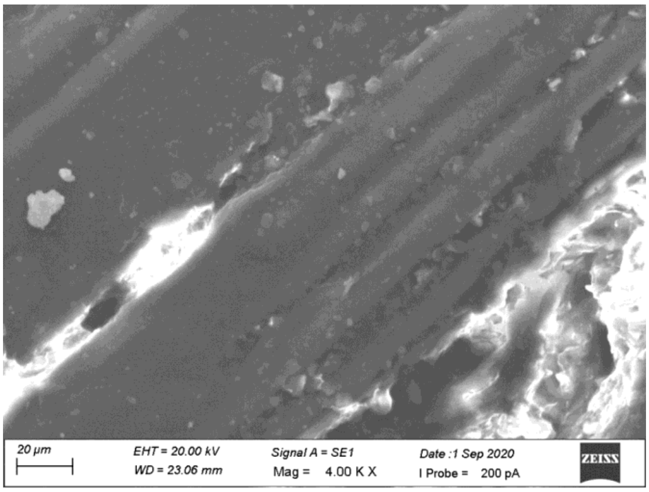


(d)



(e)

Figure 2. SEM images

3. Results and Discussions

3.1. Tensile Properties

Using Universal Testing Machine stitched and unstitched tensile specimens are tested. The graph are shown in Figure 3 and 4. Unstitched composite shows less tensile strength when compare to the stitched plate. From the graph it revealed that Stitched composite plate can withstand a load of 25.75 KN while Unstitched plate can withstand a load of 17.42 KN. This indicates better tensile characteristics is achieved in Stitched composite. Stitched composite can transfer large amount load in the material.

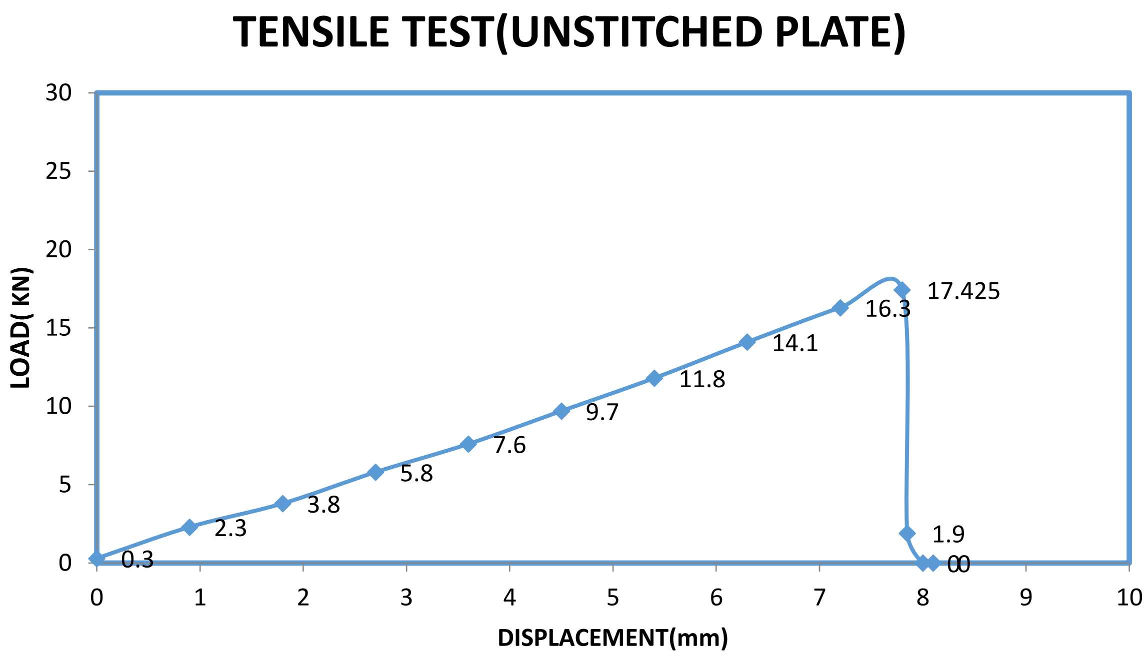


Figure 3. Tensile Properties of Unstitched Plates

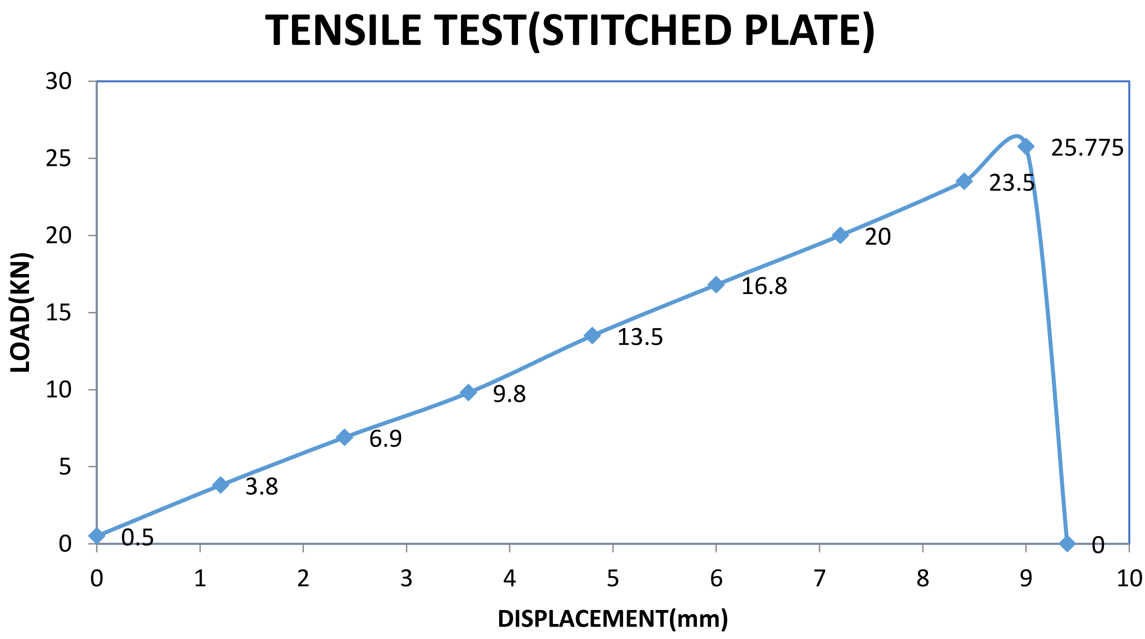


Figure 4 Tensile Properties of Stitched Plates

3.2 Impact strength

Charpy impact test were carried out on all the specimen. As per ASTM standards the specimens are prepared and test were performed. Stitched laminate have an impact strength of 10 J compare to 6 J.

4. CONCLUSION

Tensile, Fluxural and impact tests were carried out on unstitched and stitched glass fibre epoxy laminates. A cotton polyster thread was used to stitch prepare layers in fiber direction with stitch density of 6 stitches/cm2.The specimens were tested at different Test as discussed above. The Strength and breaking Loads and displacement was evaluated by using back lighting technique. The following conclusions were drawn on the impact response of the unstitched and stitched laminates.

For the above said cases impact force have been evaluated experimentally by drawing a graph between Load vs. Deformation for both stitched and unstitched laminates.From the graph it is found that the peak force of unstitched laminate is more than the stitched laminates.

Stitching of the laminate will further improve the delamination resistance,

Also from the above obtained results, we may conclude stitched laminate is more strengthening than the un-stitched laminates.

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