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Effect of Chemical Treatment on Repaired Glass Fiber Laminate

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Abstract: The present study proposes a method for design optimization of external patched repairs. The compressive behaviour of notched specimens with patched repair was studied using hybrid patch with glass fiber. The optimal patch design can be characterized by volume fraction of jute (25%, 50% &75%) with glass fiber, treatment with NaOH and without treatment of hybrid patch.A fast and cost-effective surface treatment with hydrolysis treatments has been developed for the surface treatment of hybrid jute/glass composite faces to improve the adhesive bonding characteristics of lightweight repaired glass fiber composites. Treatment with 10 wt% NaOH solution produces carboxylate groups on the surface which increase rapidly up to treatment times of about 50 min at room temperature .After this maximum the carboxylate groups decrease and then level out. This behaviour can be explained by considering the increase as due to hydrolysis of the surface amide groups, competing with the decrease due to removal of the extensively hydrolysed, fragmented molecules into the treatment solution. Our result shows that mild conditions (10 wt% NaOH and room temperature) can be used for modifying the surface of the jute fiber without destroying the skin and thus increasing the mechanical properties of repaired composite.

Keywords: Glass fiber, hybrid patch, NaOH.

I. INTRODUCTION

The physical properties of common strands are for the most part dictated by the substance land physical synthesis, for example, the structure of filaments, cellulose content, edge of fibrils, cross-area, and by the level of polymerization. Just a couple of trademark esteems, however particularly the particular mechanical properties, can achieve tantamount estimations of customary strengthening strands. This physical structure can be altered by utilizing soluble base treatment and acetylation forms. Characteristic filaments appear to have little obstruction towards natural impacts.

This can be perceived in the composite and can be favourably used for the improvement of natural degradable composites with great physical properties.[1] Composites fabricating includes numerous wellsprings of vulnerability related with material properties variety and limit conditions inconstancy. In this examination, test and numerical outcomes concerning the factual characterisation and the impact of data sources inconstancy on the principle ventures of composites producing including process-instigated imperfections are displayed and broke down. Every one of the means of composite assembling acquaints fluctuation with the ensuing procedures, making solid related. [2]

The vast lion's share of polymeric composites are produced by hand lay-up, mostly because of its adaptability. Be that as it may, the mechanical properties are specifically affected by the stacking grouping, fiber volume portion and morphology, just as the fix procedure. This investigation mulls over an E-glass/epoxy plain weave woven texture composite made by hand lay-up. After the staking succession is finished, three arrangements of plates are chosen and everyone is restored in an unexpected way. The three chose fix forms are: fix on air, fix vacuum helped, and fix under pressure.

A change ponder dependent on firmness and quality from ASTM D 3039/3039 M malleable tests is performed to check the measurable contrasts brought about by the fix forms. Also, a minute investigation was performed to recognize the voids arrangement rate.

The coupling among full scale and smaller scale mechanical investigation is finished by a non dimensional coefficient which can catch the rate of imperfections created by each fix procedure. [3] Fiber strengthened polymer (FRP) composites are utilized in numerous essential basic applications inside the vehicle segment, for their capacity to give a decent trade off among lightweight and harm tolerant plan.

In any case, these materials, amid their working life, are frequently exposed to changes of their properties because of the ecological conditions to which they are uncovered. One such condition, ready to trigger extreme maturing marvels, is presentation to solvents, and water or dampness specifically.[4]

II. EXPERIMENTAL WORK

A. Material

1) *Glass Fiber:* Glass fiber has generally equivalent mechanical properties to different strands, for example, polymers and glass fiber. Although not as rigid as glass fiber, it is a lot less expensive and essentially less brittle when utilized in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass". The work is carried out with 600 GSM (Grams per Square Meter)
2) *Jute Fiber:* Jute is a natural fiber popularly known as “Golden Fiber”. Jute fiber comes from the stem of a herbaceous annual plant corchorus.
3) *Epoxy Resin:* Epoxy resins traditionally are made by reacting epichlorohydrin with bis-phenolA, which are linear polymers that cross link, formation epoxy resin (araldite LY 556)
4) *Hardener:* In the present work hardener (araldite) HY 951 is used. This has a viscosity of 10-20 poise at 250^{0}C

B. Alkaline treatment for Jute fiber

The natural fibers were cut to 50 cm of length and were soaked in a 5% NaOH solution at 30°C maintaining a liquor ratio of 15: 1. The fibers were kept immersed in the alkali solution for 2, 4, 6 and 8 h. The fibers were then washed several times with fresh water to remove any NaOH sticking to the fiber surface, neutralized with dilute acetic acid and finally washed again with distilled water. Final pH maintained was 7. The fibers were then dried at room temperature for 48 h followed by oven drying at 100°C for 6 h.

C. Laminate Plate Fabrication

The laminated plate fabrication prepared, pre weight the reinforcement schedule. They should target 50:50 glass fiber to resin ratio for our laminate plate. so once our have weighed our reinforcement, measure out the same weight resin. Add catalyst or hardener and mix the resin as instructed. Typically we are using 6 to 8 layers. A squeegee or roller work well for this.

Hand Lay Method

It is a mainstream system for assembling composite material with open form. In which a pigmented gel coat is first coated to the form by spray gun for an astounding surface. At the point when the gel coat has turned out to be tasteless, fiber glass support is physically put on the shape. The base resin is applied by pouring, brushing. Squeegees or rollers are utilized to merge the laminate to remove the trapped air. Numbers of layers are added as per our thickness required. Catalysts and accelerators are added to the resin to cure without external heat.[5]

D. Specimen Cutting

Laminated materials consist of two or more layers of materials, joined together by an adhesive. The materials can be same, as in glass fiber is sandwiched between sheets of plastic. The principal problem when cutting laminated materials with water jet is that the water can get between the layers of materials and force them apart, as a process called delamination. The Figure 1 and Figure 2 shows the specimen before and after abrasive jet machining.

Fig 1. Before AWJM Cutting

Fig 2. After AWJM Cutting

E. Patch On Repair Lamination

The present study proposes a method for design optimization of external patched repairs. The tensile behaviour of notched specimens with patched repair was studied using finite element analysis and compared with experimental results. The damage initiation site and its propagation depend on the patch in-plane stiffness. The optimal patch design can be characterized strength ratio $R^{/}$.The overall design of the patch repair can be considered using a dimensionless design parameter K.

Fig 3. Interlayer Mat

Fig 4. Patched Specimen

F. Compression Testing

The objective of this paper is to evaluate the IITRI Compression Test Method for measuring the axial compressive modulus and strength of composite materials possessing a high degree of anisotropy in the axial direction. The influence of material anisotropy and test specimen geometry on the data reduction scheme used to characterize the axial compressive modulus and ultimate strength is examined. The findings demonstrate that ASTM D3410 specimen geometries, recommended for the IITRI and Celanese compression test methods, may not always be appropriate for materials that are highly anisotropic in nature. The significance of the findings on appropriate specimen design for thick section laminates is also discussed. An error investigation is included which demonstrates to what extent the experimentally determined compressive modulus may be affected if careful consideration of the specimen geometry is not made. This investigation utilizes the finite element method and an elasticity solution based on Saint-Venant's principle for an upper bound estimate on stress decay length in a parametric study involving combinations of specimen geometries with varying material anisotropy. The figure 5 represents the compression testing done on specimen.

Fig 5. Compression testing

III. RESULT AND DISCUSSION

A. Influence of vol. Fraction of hybrid patch

In this paper the compressive of glass fiber-reinforced epoxy prepreg (GFRP) were conducted in order to investigate the influence of volume ratio and fiber orientation. CFRP/Al7075 laminate hybrid composite (CARALL)consists of alternating Al7075-T6 sheets and glass epoxy prepreg (epoxy 121°C#2560). The fiber orientations of GFRP were applied to the extent of 0/90° and±45°. The GFRP layers are 1ply, 3plies and 5plies in case of 0/90°, and 1ply and2plies in case of ±45° of glass fiber direction, respectively. The tensile strength decreased with the volume ratio of GFRP in both the cases of fiber orientation0/90° and ±45°. The fatigue life is lower in large volume ratio of GFRP than in small volume ratio in both the cases of fiber orientation 0/90° and ±45°.

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Table 1. Evaluation of compression testing

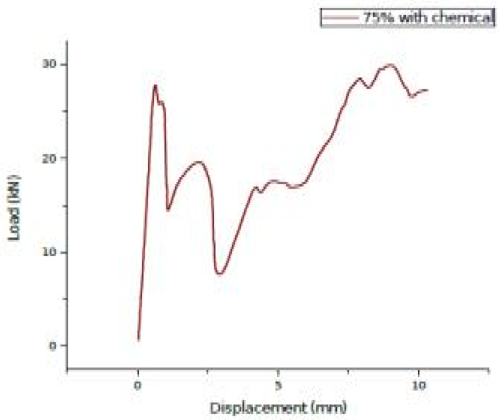
Specimen	S1	S2	S3	S4	S5	S6	S7	S8
Type of the specimen	75% with chemical treatment	50% with chemical treatment	25% with chemical treatment	75% without chemical treatment	50% without chemical treatment	25% without chemical treatment	Plain glass fiber laminate	Plain glass fiber laminate with hole
Load(KN)	29	26	24	27	23	20	35	22

B. Load Vs Displacement

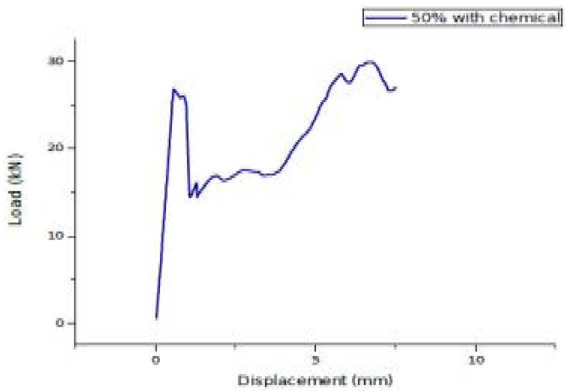
The fig.(a-c) represents the load Vs displacement curve for a glass fiber containing 75% ,50% & 25% of chemical coating respectively. Compressive loading was enhanced in 75% vol.fraction with chemically treated repair composite due to polar components was improved in the surface of repairing.

The fig.(d-f) represents the load Vs displacement curve for a glass fiber without containing 75% ,50% & 25% chemical coating respectively. In the without chemical treatment test the 75% composition is having maximum load to withstand.

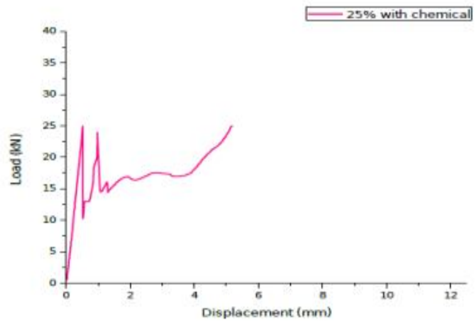
The fig.(g-h) represents the load Vs displacement curve of a plain glass fiber laminate without and with hole respectively. Here the pain laminate has maximum withstanding load capacity.



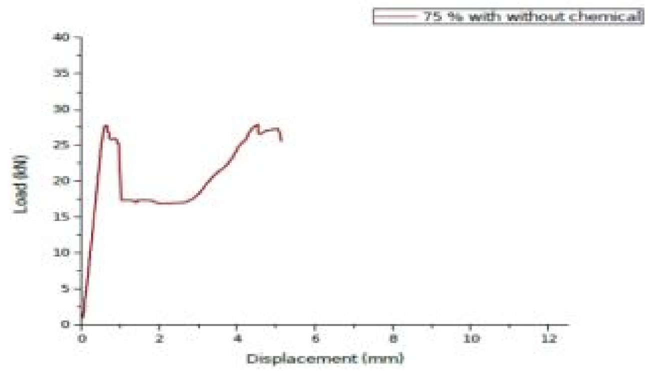
(a) 75% with chemical treatment



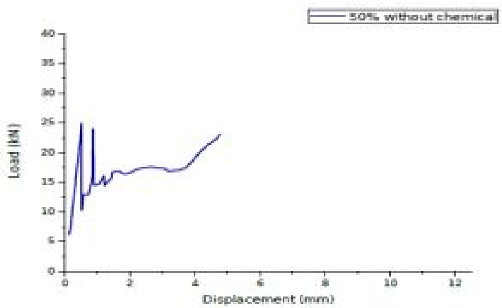
(b) 50% with chemical treatment



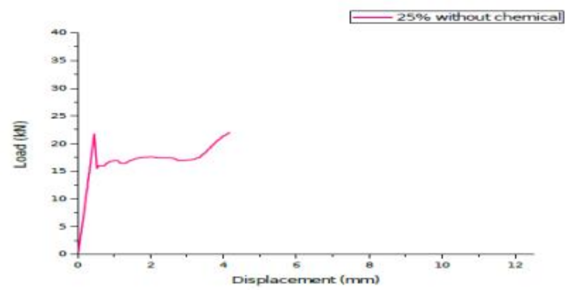
(c) 25% with chemical treatment



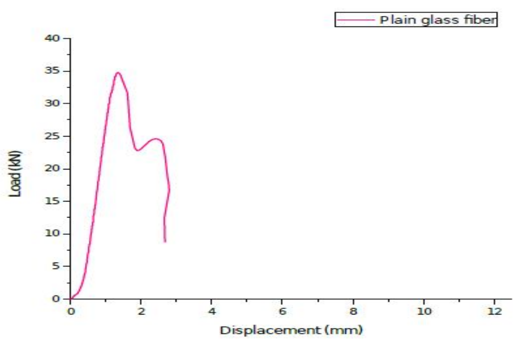
(d) 75% without chemical treatment

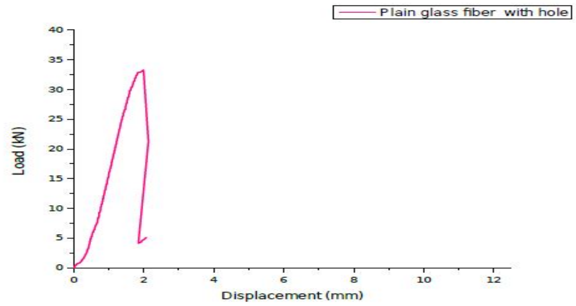


(e) 50% without chemical treatment



(f) 25% without chemical treatment





(g) Plain glass fiber laminate (h) Plain glass fiber laminate with hole

Fig (a-c) with chemical treatment, (b-f) without chemical treatment ,(g-h) plain glass fiber laminate

IV. CONCLUSION

A cost-effective surface treatment method for the adhesive bonding of repaired Glass/epoxy composites with hybrid patch adhesive has been treated using NaOH treatment. The compressive effects of hydrolysis treatment on the repaired glass/epoxy composite were studied in terms of the surface energies of composite surfaces and the adhesion strengths of composite joints. It was found that nano scale surface roughness was generated on the patch composite surface, which improved the compressive strength of the glass laminate. From the experimental observation 15% compressive strength was increased with treatment compared with without treatment of hybrid patch.

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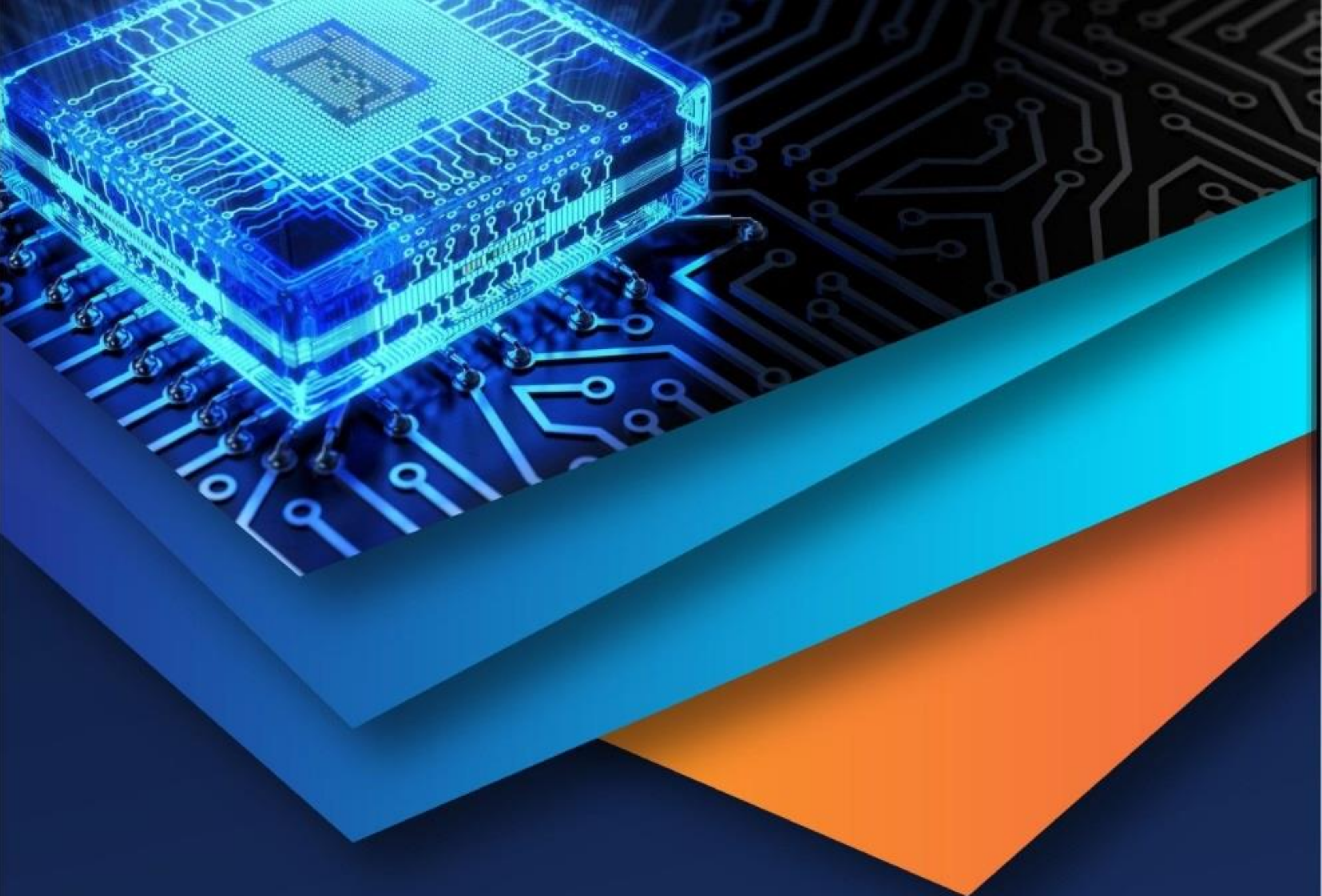

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