Indian Journal of Science and Technology, Vol 9(48), DOI: 10.17485/ijst/2016/v9i48/108468, December 2016
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Analysis of Lap Joints in Composite Materials

M. Rajmohan*, M. Balachandar and D. Kasinathan

Department of Mechanical Engineering, Sri Sai Ram Institute of Technology, Chennai - 600044, India;
rajmohan.mech@sairamit.edu.in, balachandar.mech@sairamit.edu.in, kasinathan.mech@sairamit.edu.in

Abstract

Objectives: To characterize the Lap joints prepared by the Glass fiber reinforced composite materials. **Methods/Statistical Analysis**: Composite plates were prepared with Glass fiber reinforced composite materials with Epoxy resin. Tensile specimens were prepared as per the ASTM standards for the tensile test using Water jet cutting. During manufacturing hand lay-up method was followed to simplify the work. Tensile test was carried out to characterize the materials. **Findings:** 3 types of specimens were analyzed and from the testing we found that the peak stress of 47.41 MPa and Young's Modulus of 14.3 Gpa were obtained. **Application:** The hand lay-up method used in Aerospace Industries, Mechanical Joints.

Keywords: Composite Materials, Glass Fiber, Lap Joint, Tensile Test

1. Introduction

Fiber architecture, a key factor for the final properties of the composite material includes their geometry (diameter and length or aspect ratio i.e., length/diameter), their arrangement (alignment and packing), their distribution (more or less uniform), their nominal quantity (volume fraction) in the composite[1]. High-performance composite components are usually made of layers each of them having directional properties. To predict the elastic properties of the component as a whole, each layer, despite being a composite, must be considered homogeneous. These plies, when stacked one over another form a laminate. The fiber direction for each ply might vary from one layer to the next to reduce anisotropy of certain mechanical properties within the component[2]. Composite materials consist of a matrix material containing reinforcements: These can be short and fibers, particles or flakes. The matrix can be ceramic, metallic, polymeric or the combination. Commonly reinforcement is expected to provide strength and stiffness, whereas the matrix holds the reinforcement in place, transfers load between fibers withstanding shear forces and provides environmental resistance[3].

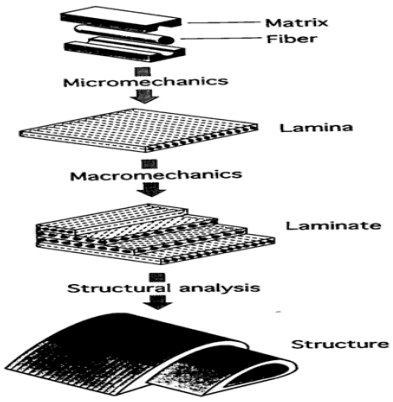

Figure 1. Fabrication of composites.

2. Materials and Methods

2.1 Materials

E-glass has been chosen because of the high density when comparing to the other fiber materials. And also tensile strength also is high while comparing with other fibers. Epoxy resin is most often used because it is almost totally transparent when cured. In the aerospace industry, epoxy is used as a structural matrix material or as structural glue.

*Author for correspondence

2.2 Preparation of Composites

The preparation involves the Fiber layer formation, matrix preparation, weight calculation, pouring of matrix to the fiber, rolling and curing processes. The necessary precautions should be taken care while fabricating a composite laminate: 1. The fiber layer should be properly placed without damage. 2. The fiber should be uniformly layered. 3. The ratio of fiber- resin should be maintained properly as per standards. 4. Rolling should be perfect to avoid air bubble inside the lamina[4].

Figure 1 shows the composite is cured under pressure by mounting the weight over it. The required number of layers to obtain the total thickness can be determined by taking in to account the density of the mat and the carbon-to-resin ratio by weight. The glass fibers are weighed and the resin is measured as 1:1 ratio to the weight of the fiber. Then hardener with 10% weight of the resin hardener is added. The hardener and resin is completely mixed which forms the matrix[5].

2.3 Preparation of Specimen

Figure 2 shows a lap joint is a technique for joining two pieces of material by overlapping them. For analysis of joints in composites Lap joints in composite materials are prepared. 5 Specimens for tensile testing have been prepared.

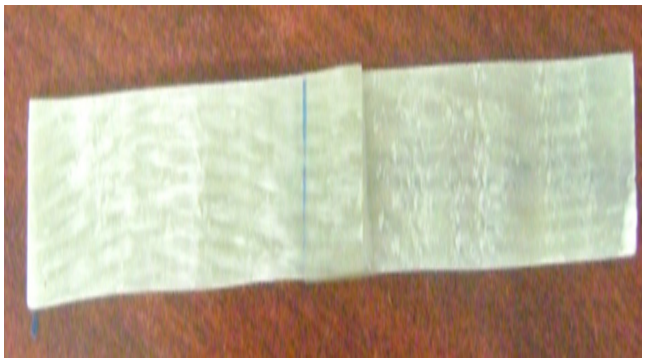

Figure 2. Lap joint specimen.

2.4 Experimental Tests on Lap Joints

Figure 3 shows that uni-axial tension tests are conducted in order to quantify the tensile properties such as tensile strength, tensile modulus of the laminates in accordance with ASTM D3039[6] using Universal Testing Machine (UTM) AG-IS-100 KN. The sample is loaded in tension at a cross head speed of 2 mm/min and gauge length of 100 mm for carrying out the test[7]. Tensile test has been done in BISS (Bangalore Integrated System Solution) which is in Bangalore. The machine used for the testing is INSTRON UTM which has the capacity of 100KN.

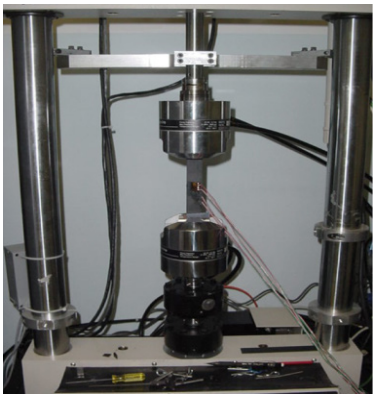

Figure 3. Instron UTM.

3. Results and Discussion

Tensile test of hand-layup samples were performed shown in Figure 4 and Figure 5 to evaluate the tensile strength and tensile modulus of Lap joint made up of Glass fiber reinforced with Epoxy resin composite in Table 1-3.

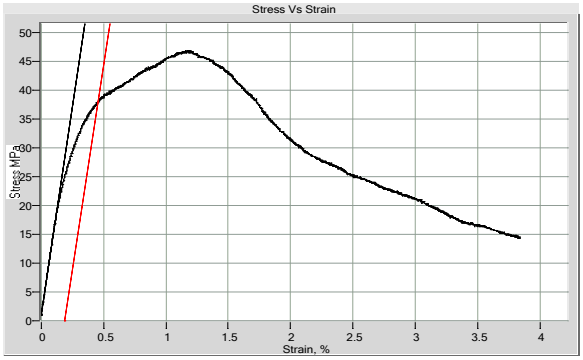

Figure 4. Stress strain curve oaf lap joint of sample 1.

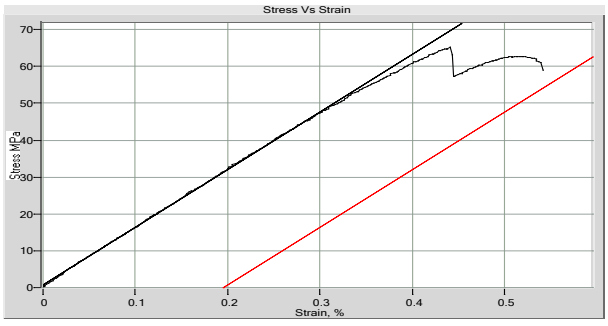

Figure 5. Stress strain curve oaf lap joint of sample 1.

Table 1. Sample 1 results

Peak stress	**47.41 Mpa**
Peak load	5.345 KN
Yield Strain	0.466 %
Yield Load	4.49 KN
Modulus	14.3Gpa

Table 2. Sample 2 results

Peak stress	**69.41Mpa**
Peak load	9.1 KN
Yield Strain	0.52 %
Yield Load	6.44 KN
Modulus	15.24 Gpa

Table 3. Tensile test result of 5 samples

Type	Gauge Length (mm)	Rate Mm/min	Cont. Area (mm)	Area (mm^2)	Peak Stress (Mpa)	Peak Load (KN)	Yield Strain (%)	Yield Load (KN)	Modulus (Gpa)
Lap joint	175	2	25	133.1751	68.22	9.085	0.519	6.436	15.232
Lap joint	175	2	25	132.561	47.49	5.545	0.456	4.492	14.29
Lap joint	175	2	25	133.210	69.51	9.101	0.521	6.445	15.310
Lap joint	175	2	25	134.012	67.92	9.201	0.524	6.320	15.215
Lap joint	175	2	25	133.251	68.48	9.109	0.527	6.320	15.328

4. Conclusion

The glass/epoxy lap joint will give a maximum peak stress of 69.41 MPa with Modulus of 15.31 Gpa.

5. References

1. Davallo M, Pasdar H, Mohseni M. Mechanical properties of unsaturated polyester resin. International Journal of chem Tech Research. 2010; 2(4):2113–7.
2. Composite Materials. Available from: https://en.wikipedia.org/wiki/Composite_material Date Accessed: 10/10/2016.
3. Gibson RF. A review of recent research on mechanics of multifunctional composite materials and structures. Composite Structures. 2010; 92(12):2793–10.
4. Smith GF. Design and production of composites in the automotive industries. Composite Manufacturing. 2011; 1(2):112–6.
5. Rajmohan M, Yuvaraj M, Naveen G, Mohanraj S. Mechanical characterization of Basalt based composite materials. IOSR. 2014; 70–6.
6. Liu PF, Zheng JY. Recent developments on damage modeling and finite element analysis for composite laminates: A review. Material and Design. 2010; 31(8):3825–34.
7. Dolhalit LB, Salam NBA, Mutalib AB. A review on Persuasive Technology (PT) strategy in awareness study. **Indian Journal of Science and Technology**. 2016; 9(34):1–6.