

**EXPERIMENTAL ANALYSIS MADE ON HYBRID
COMPOSITE JOINT OF WOVEN RING TYPE****A. Karthik¹, G.Velukumar² S. A. Srinivasan³**¹Assistant Professor, Saveetha School of Engineering, Chennai²Assistant Professor, S.A. Engineering College, Chennai³Research Associate, National Institute of Technology, TrichyE-mail-ID: ¹karthik.3071988@gmail.com, ²velukumarmgp@gmail.com, ³sasrinivasan@gmail.com**Abstract**

The recent development of composite material provides excellent mechanical properties to fulfill the operating parameters in the field of aerospace, automobiles, robotics, architecture, etc. The repeated failure of joints in the aircraft structures is studied using the composite materials in the present investigation. A structure largely depends on their joint strength which is considered to be the weakest part to be improved. Joints are either made up of adhesive or riveted joints which do not satisfy the criteria. An inclusion of reverts, made up of aluminum enhance the strength of the bounded joint by arresting the propagation of the crack, and reduce the plane peel stresses thereby increasing the strength the life of the joint. The consequence of tensile tests gives results to predict the behavior of material under uni-axial tension. The correlation of tensile test results shows better quality of joint when compared to normal joint.

Keywords: Composite materials, Bounded joints, Riveted joint, Hybrid joint.

1. INTRODUCTION

The phenomenon of developing a good quality joining of composite structures has been difficult due to the complex nature of materials. The joint is the weakest part of any structure and improvements leads to better performance. The composite joints are categorized into adhesive joints and mechanical fastening.

In the aerospace industries, composite joints remain a critical aspect of designing structures. Bonded joints are made by gluing together, pre-cured laminates with the suitable adhesives and Pre cured laminates are riveted using suitable pin for the riveted joint.

The bonded joint distributes the load over a larger area than the mechanical joint, requires no holes, adds very little weight to the structure and has superior fatigue resistance. Bounded joints have many advantages over the riveted such as high strength-to weight ratio, electrical and thermal insulation, conductivity, corrosion and fatigue resistance.

In spite of recent development in Composite still required better study for optimum utilization and experimental methods need to be improved and validated. The literature on bond strength of composite materials is tested using the universal tensile machine which is capable of producing tensile

force. The Joint is region considered to more porous to stress due to varying environment of the aircraft and the static strength of the joint depends upon following factors such as the static strength, cyclic plasticity, frictional damping, and vibration levels associated with the structure [4].

A simple but effective design is considered to improve the joint strength of composite joints by laminates joined together with tongue and groove geometry. This leads to better performance [3].

In the riveted joint, the addition of a washer in designs by Structural Reaction Injection methods shows affected distribution of the bolt clamping force in hybrid composite joint. The hybrid joints have higher static strength and longer fatigue life than adhesive bonded joints for the studied material system. [6]

The article, therefore, aims to investigate and compare the three types of joints such as bonded, riveted and hybrid which are processed with some methods and predicts the failure mechanism of the parts through tensile testing and finally make a quantitative prediction of their ultimate strength on the basis of outcomes.

2. SAMPLE PREPARATION

The experimental work is done using Epoxy LY556/epoxy plain weave woven fabric composite made by hand lay-up method and the factors considered for making joint are the stacking sequence, fiber volume fraction, as well as the cure process.

The laminates used in this investigation are in type E-glass fiber form of woven glass mat (0/900). The merits while using epoxy resin are cohesive strength, lack of volatile reaction which minimizes shrinkage and low creep. Ratio epoxy and hardener is 10:1 is followed making resin at room temperature. The curing of epoxy plays a vital role in forming a hard surface in making composite laminate. The choice of both the resin and the hardener depends on the application, the process selected and the properties desired. Hand stirring with a suitable flat-sided stirring stick and scraping round the sides of the

container done for a period of not less than 1-2 minutes, depending on volume. Resins are impregnated using rollers impregnating resin into fibers which are in the form of stitched fabrics. Layers of fiber are placed in stacking sequence to make composite laminate and hardener HY951 used to incubate the curing process and constant load is supplied for 24 hours between the glass plates. Laminates are left to cure under standard atmospheric conditions. The edges of the infused panels are trimmed to the desired geometry, and the joint, the filler and the triangular fillets are applied and mounted manually. The laminates are manufactured and cut into required dimensions which are shown in table no 1.

Testing parameters	Sample 1	Sample 2	Sample 3
Gauge thickness (mm)	2	2	2
Gauge width (mm)	25	25	25
Area (mm ²)	50	50	50

Table: 1 Dimension of Sample

Bonded joints are performed by gluing together pre-cured laminate with the suitable adhesives. In this case the joint and the laminate is cured by epoxy itself. Riveted joints are made by using 3mm thick aluminium rivet to hold joint as a tight fit and proper caution should be taken to minimize damage to the laminate during hole-drilling and closing of the rivet. Hybrid joints have a combination of adhesive bonding and mechanical fasteners. In the present case, rivet has been used as the mechanical fastener. Both steps are repeated for hybrid joints. All the dimensions of three joints are made under the same dimension of joint length, thickness, width, of 35mm, 2mm, 5mm and shown in figure 1 and investigation of joint were made at room temperature.



Figure: 1 Samples

3. EXPERIMENTAL PROCEDURE

A universal tensile testing machine is used to perform a variation of three joint in tensile strength was Predicted and it is validated experimentally. It has enlarged ends specimen held up between the grip sections. The most important concern in a gripping method is to ensure the minimum bending and failure grip must be avoided. Universal testing machine is fully automated with a variable-speed electric motor and a gear reduction system which ensures the load was applied gradually and this motion loads the specimen in tension and compression. A feature of testing equipment is to control the speed of the machine accurately with microprocessor based closed loop servo system, controlled through a PC from load measurement to load control with the data acquisition system shown in the figure 2.

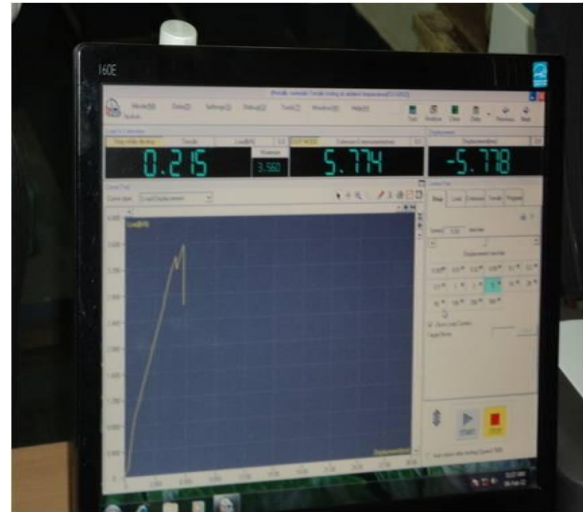


Figure: 2 Data Acquisition System

Clamping force was given even to all three joint predict outcomes in a standard manner and result are tabulated in table 2.

Sample type	Ultimate tensile strength (MPa)	breaking load (kN)
Bonded Joint	66.6	4
Riveted Joint	23.2	2
Hybrid Joint	100.26	5

Table: 2 Experimental Results

4. RESULTS AND DISCUSSIONS

Increase of tensile stress results in the peeling adhesive which results in breaking of joint and adhesive can be worn out after certain time period due to environmental action Figure no: 3 Load vs displacement for bonded joint.

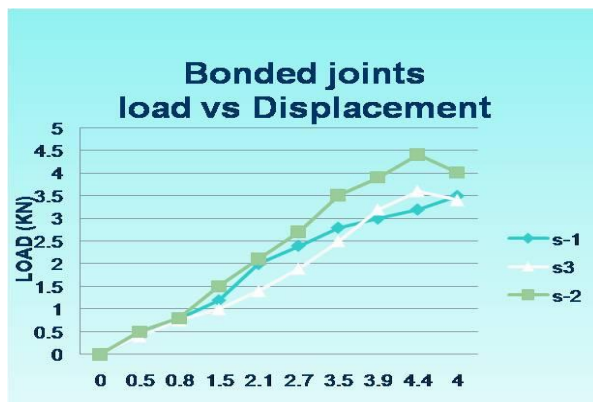


Figure: 3 Load vs Displacement for Bonded joint

The above graph displayed in figure 3 for all the three joint displacements for load pattern followed by hybrid joint was gradual and depicted a smooth curve when we compared to other two joint. This prevents the two major failures of composite joint, such as crack arrest in the fiber and riveted joint have low strength when we compare other two joints the uneven strain rate of this is also void in the hybrid joint. While making the riveted joint strength of composite materials is reduced due to the drilling of holes which incites crack propagation, but in case hybrid joint crack growth rate is arrested by adhesive which is one reason for uniform stress strain pattern curve. Another point of view in hybrid case rivet pin will prove the bonding effect which minimizes the peel stress of bonded joints which joint more effect efficient and high strength.

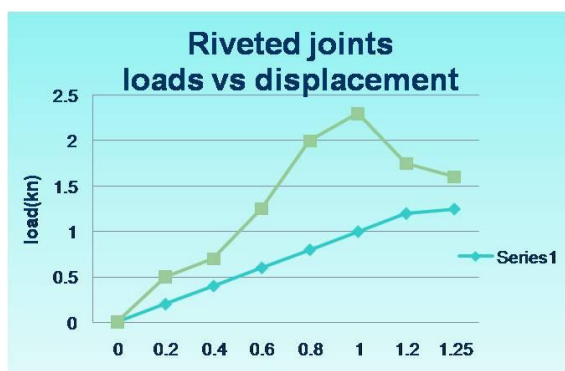


Figure: 4 Load vs. displacement for riveted joint

The average breaking load hybrid joint is 1.25 times higher than bounded joint and 2.5 times higher than riveted joint which indicates the increase of tensile

strength of joints. The Load vs displacement graph is shown in figure 5.

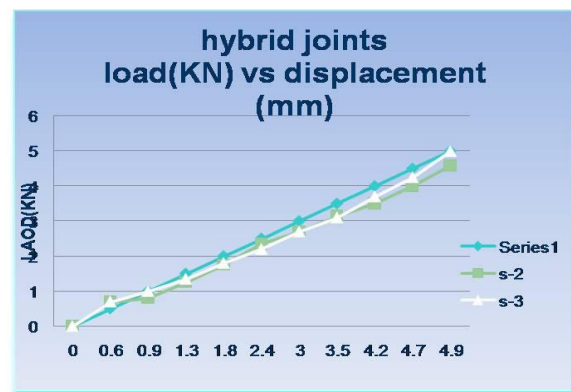


Figure: 5 Load vs. displacement for hybrid joint

This article focused on experimental study upon the tensile strength of hybrid composite joints when compared with conventional joint. This indicates, the hybrids joint will satisfy the expectation of current manufacturing industries and consumer point of view as the manufacturing assures the quality with low cost involved. Hence, the present study reveals that a well-designed hybrid joint is very efficient when compared to bonded or riveted joints in the case of repair situation in aircraft structures. We consider following criteria will design any composite joint, such as thickness of adhesive joint must be based of loading condition and length of the joint.

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full time research in NITT, India with research interest in the area of thermal backgrounded studies allied with material science.

A Brief Author Biography

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