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A Review of Strength Analysis of Adhesively Bonded Single Lap Joint

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Abstract – *Structural adhesive bonding technology is widely utilized in various applications in modern automotive and aviation industries. Adhesive bonding technology offers great design as it can be easily integrated into almost all available flat plates is the most common due to its simplicity and efficiency. In this paper, the effect of single lap joint, micro-surface texture pattern, different adherence and adhesive thickness, is to be investigated. The various experiments investigations to be objectives that enhance the shear strength of adhesive bonded lap joint.*

Key Words: shear strength, static testing, fatigue testing, universal testing machine,

1. INTRODUCTION

Adhesively bonded joints are increasingly used in aerospace and automotive industries. Use of adhesive bonding in mechanical fasteners for reduces weight and cost. Years ago, everything was made by industry in component pieces and these have to be fixed together. Mechanical connections are chosen, such as screws, rivets, bolts or spot welds etc. However, day by day variety of joining techniquedeveloped and one of the best techniques which is used is adhesively bonded single lap joints (SLJ) or double lap joints (DLJ). Adhesively bonded joints are metal to metal or composite material joints [1]. The advantages adhesively bonded joints are:-

- Improved product performance and durability
- New and modern materials can be joined
- Uniform stress distribution
- Vibration is less
- Good damping

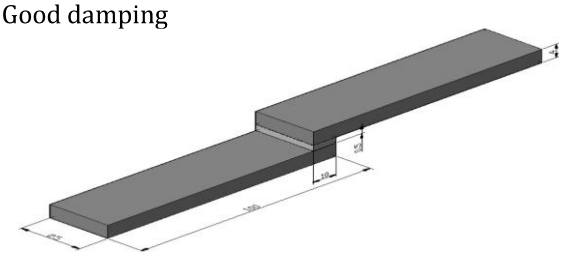

Fig. 1 Geometrical parameters of the single lap joint

Adhesive bonding technology offers great design flexibility as it can be easily integrated into almost all available industrial sequences of single piece of work or mass production. Bonding has long been recognized as a high performance joining technique. The substrates correspond to aluminum alloy measuring 100*25*2mm [9]. Fig. 1 shows the single lap joint with the respective dimension.

1.1 Choice of Adhesive

As polymer chemistry has advanced, the term of specific adhesives developed that bind very strongly to materials. The selection of adhesive is dependent on the materials being joined, the environmental conditions, the manufacturing requirements and the required performance. The number of combination of adhesive and adherent materials is large and before any application, it is considered.

1.2 Adhesive Bonding

Adhesive bonding is a material joining process in which an adhesive, placed between the adherent surfaces, solidifies to produce an adhesive bond. When components are bonded together, the adhesive first thoroughly wets the surface and fills the gap between, then it solidifies. When solidification is completed the bond can withstand the stresses of use. Adhesives come in several forms thin liquids, thick pastes, films, powders or solids, which must be melted. The adhesive can be designed with a wide range of strengths, all the way from weak temporary adhesives for holding papers in place to high strength structural systems that bond cars and airplanes.

2. LITERATURE REVIEW

D.M.Gleich et al., The optimum bondline thickness is 0.05-0.5mm, but in many practical applications are very difficult to achieve. Study was various parameters find the optimum bondline thickness, such as 0.05, 0.1, 0.2, 0.3, 1, 2, 3 mm and adherend thickness 2 mm and overlap length 25 mm. The result that optimum thickness is unclear. It is possible that for very thin bondline an optimum distribution of stresses over the bondline very difficult to achieve [2].

E.A.S. Marques et al., Adhesively bonded patches are mostly used to aircraft because aircraft face damage from impact with objects or birds or due to fatigue cracks. Two adhesives are selected a very stiff and brittle epoxy AV138 and Araldite2015. The mixed adhesive technique was used with a very brittle adhesive in the middle of the joint and ductile adhesive at the ends of the patch. AA6063 aluminum with T6 heat treatment were used with different taper angle 60^0, 45^0, and 30^0. The single adhesive joint strength is increased upto 45^0 but mixed adhesive is uniformly stress distibution and strength is increased [4]

L.D.R. Grant el al.,for four point bending tests, the loading point were kept at a constant distance. For three point bend tests, the distance between the inner loading point which is always the middle of the overlap, and the outer supports could be from 30 to 75 mm. Both testing were overlap length is 15, 30, and 45 mm. The materials are used to mild steel 0.95 mm thick and adhesive ESP110 from Permabond. The joint strength in the three-point bend tests is independent of the adhesive thickness. An increase in adhesive thickness causes the joint overlap section to be stiffer, but the bending moment is still the same at the edge of the overlap [11].

Lucas F.M. da Silva et al.,in this experiment, three adhesive, adhesive thickness, adherend thickness were selected. In this Taguchi method three factor and three level was selected. the single lap joint was tensile test and follow the procedure of Taguchi method. The result is shear strength increases as the adhesive thickness decreases[5].

Lucas F.M. da Silva et al., this study by the adhesively bonded patches, bending effect and thickness effect but disadvantages of this study many times of practically test and time is also more, then after that Taguchi method is grown up and product of quality is improve, testing time is less and proper sequence of procedure of testing. Three adhesive were selected, a very ductile two component toughened methacrylate adhesive Araldite 2021, a very brittle two component epoxy adhesive Araldite AV138/HV998 and intermediate one component epoxy adhesive Araldite AV118. The experiment and then results adherend yield strength is 19.7% contribution, adherend thickness 20.3% contribution, adhesive thickness decreases 8.8% contribution, overlap 20% [9]

3. Selection of Material

3.1 Adhesives

These adhesives a very stiff and brittle epoxy (AV138 and AV118) used in aerospace applications and a more flexible and ductile epoxy adhesive (Araldite 2015).

Table -1: Adhesives property

	AV138/HV998	Araldite 2015	AV118
Yield strength (MPa)	25	17.9	45
Shear strength (Mpa)	30.2	17.9	67
Shear failure strain (%)	5.50	43.9	40.1
Young Modulus (Mpa)	1559	487	305

3.2 Aluminum Alloy Material

Aluminum alloy AA6082 in the T6 condition was used for all substrates. The properties of the selected aluminum are shown in table .2

Young's modulus (GPa)	69.5
Poisson's ratio	0.346
Tensile yield strength (Mpa)	245.1
Tensile strength (Mpa)	305.6
Tensile failure strain (%)	16.5

4. Surface Preparation for Adhesives

The preparation of the surface of the substrate is of extreme importance in the implementation of a bonded joint. The joint strength depends on the surface roughness and adhesives to be depends on applications [7].

4.1 Abrasion

The surface prepared by mechanical abrasion using 'Emery' paper. These methods readily remove paints oxides and scale deposits.

4.2 Degreasing

The surface is prepared by applying solvent vapour or hot alkaline solution. These methods readily remove oil, grease and other containment's.

4.3 chemical treatments

Chemical etching and anodizing are commonly used for preparing the surface of metals where maximum strength is required. Most of the times is used for the cleaning and degreasing of the surface of the substrates, methyl ethyl ketone (MEK) was used.

5. EXPERIMENTAL SET-UP

5.1 Static testing

The single lap joint specimens were tensile tested in a universal testing machine. The specimen were tested under a head displacement rate of variable mm per minute is depends on the room temperature. The universal testing machine is specimen is hold between two balls and gradually load is applied and to investigate the specimen is strength is increased and where it is used. [1]

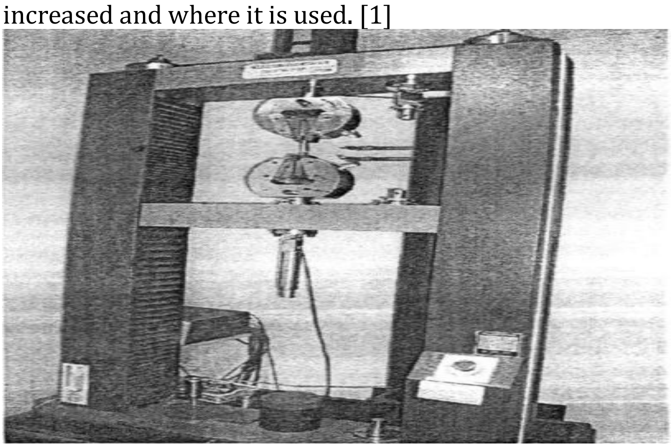

Fig. -2 :- Universal Testing machine

5.2 Fatigue testing

The specimens were carried out at different speed of revolution under cyclic loads. During testing thermocouples were placed at various points on the surface on the surface of the specimens in order to investigate thermal effects. The specimens were tested for each load level.

Fig. -2 :- Hydraulic press

6. CONCLUSIONS

In present study, the optimum bondline thickness of strength cannot be measured, sometimes adherence thickness change the bending strength also changed, taper angle effect at different loads due to some effect of lap joint. The adhesive bonded lap joint most of the plane surface bonded and strength is decreased, contact area is less, then new research is developed the adherence surface on the micro-texture pattern can be generate because of contact area is increased and ultimately shear strength is increased. The testing of lap joint at different parameters the Taguchi methods will be apply because of optimum results, time is less, cost low.

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