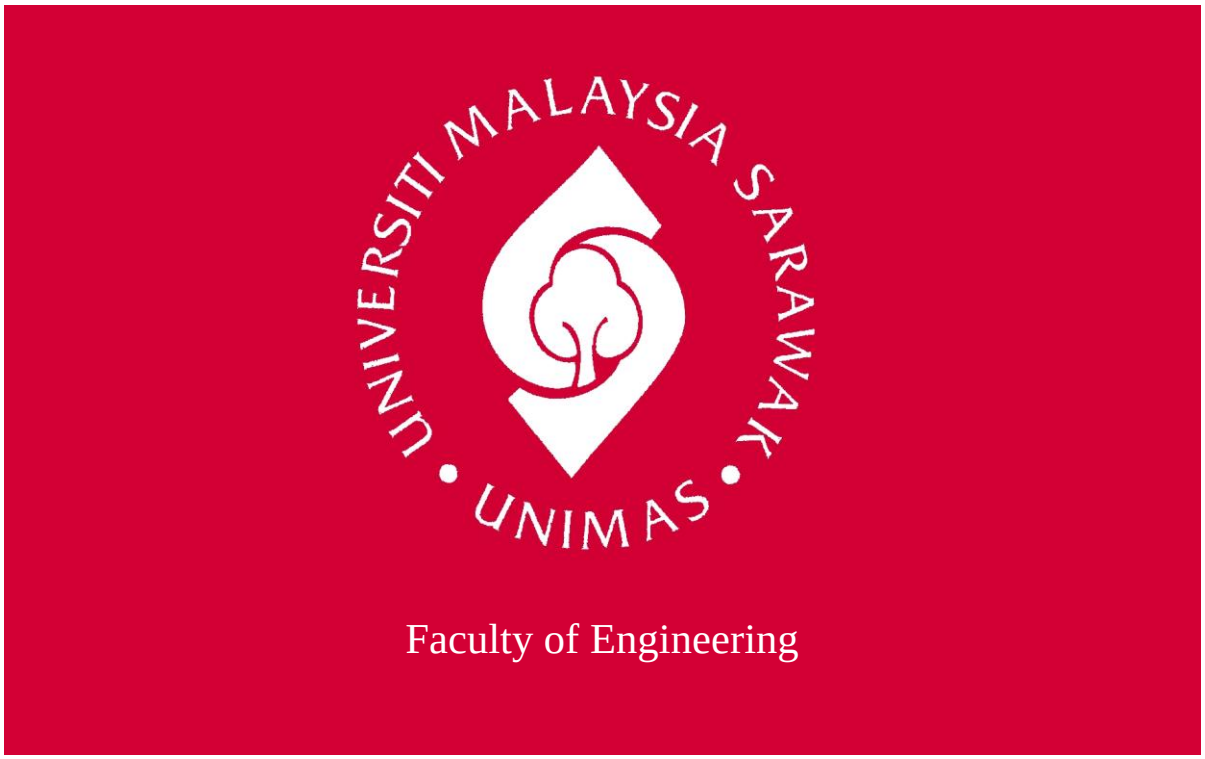

EVALUATION OF SHEAR STRENGTH OF SINGLE LAP JOINT

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ABSTRACT

Adhesive Bonding has become more useful in today's technology. The advantages of adhesive bond from other joining method such as welding have made adhesive bond become more demanding. Adhesives bonding have been use in aircraft, space structure and automotive industries. Because of the use of adhesive bonding has become more demanding, it is important for a research to find the shear strength of adhesive bonding. In this research, the testing was done to find the effect of different surface geometry on the bond strength. To obtain the shear strength values, testing were conduct on adhesive bonding according to America Society for Testing Material (ASTM) D- 1001 standard. In this project, the testing also involves using different type of adhesive and different surface geometry. There are five different type of surface geometry that will be tested. The specimens were fabricated to achieve the required geometry. After that, it will go through surface preparation. The testing was conducted after it has gone through all the process mention before.

ABSTRAK

Pelekatan menggunakan gam telah menjadi semakin berguna dalam teknologi terkini. Kelebihan yang ada pada kaedah ini berbanding cara pelekatan yang lain seperti pelekatan menggunakan skru telah membuatkannya lebih diperlukan. Pelekatan menggunakan gam telah digunakan untuk kapal terbang, kapal angkasa dan juga dalam industri automotif. Disebabkan kegunaannya yang semakin meluas, adalah penting untuk menjalankan kajian untuk mencari kekuatan pelekatan itu. Dalam kertas kerja ini, eksperimen telah dijalankan untuk mengkaji kesan penggunaan permukaan yang berbeza ke atas kekuatan pelekatan itu. Untuk menentukan kekuatannya, eksperimen dijalankan berpandukan "America Society for Testing Material (ASTM) D- 1001 standar".. Dalam projek ini juga, kajian dijalankan menggunakan bahan ujikaji yang mempunyai bentuk permukaan yang berbeza dan juga gam yang berbeza. Terdapat empat jenis bentuk permukaan yang berbeza yang dikaji. Bahan ujikaji akan dibentuk sehingga memperoleh ukuran yang diperlukan. Selepas itu, permukaan bahan uji kaji akan dibersihkan. Eksperimen dijalankan selepas bahan ujikaji telah memjalani semua proses yang dinyatakan sebelum ini.

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For my family, friends and myself…….

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LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 Introduction

Many techniques were use to joint two or more similar or non-similar materials together. The joining technique includes welding, brazing, mechanical fastening, and adhesive bonding.[5] Joining process is so important especially in manufacturing in order to combine part before final product can be produce. In this project, adhesive bonding will be use as the joint technique. Adhesive bond has become increasingly popular among engineers and designers because of several advantages compare to other joining method. Nowadays adhesive bond have been apply to many industries such as automobile, electrical, aircraft and medical. Because of the use of adhesive bonding has become more demanding and important, it is crucial for a research on the shear strength of adhesive bonding to be conduct. To obtain the shear strength values, testing were conduct on adhesive bonding according to America Society for Testing Material (ASTM) D- 1001 standard. In this project, the testing also involves using different type of adhesive and different surface geometry.

1.2 Adhesive in Modern days

In recent years, adhesive bond were apply successfully in many technologies. Adhesives bonding have been use in aircraft, space structure and automotive industries. Adhesives bonding in large and small commercial aircraft have been use widely in Europe. For example, sailplanes in Germany, SAAB 340 and EXTRA EA-400.Extensive adhesive bonding is being used in the United States for the assembly of newly emerging small all-composite aircraft structures (Cirrus SR20 and Lancair Columbia 300) [6]. Because adhesive has become more demanding, this research been done to produce adhesive with strengths higher than the strength of previous adhesive that have been develop.

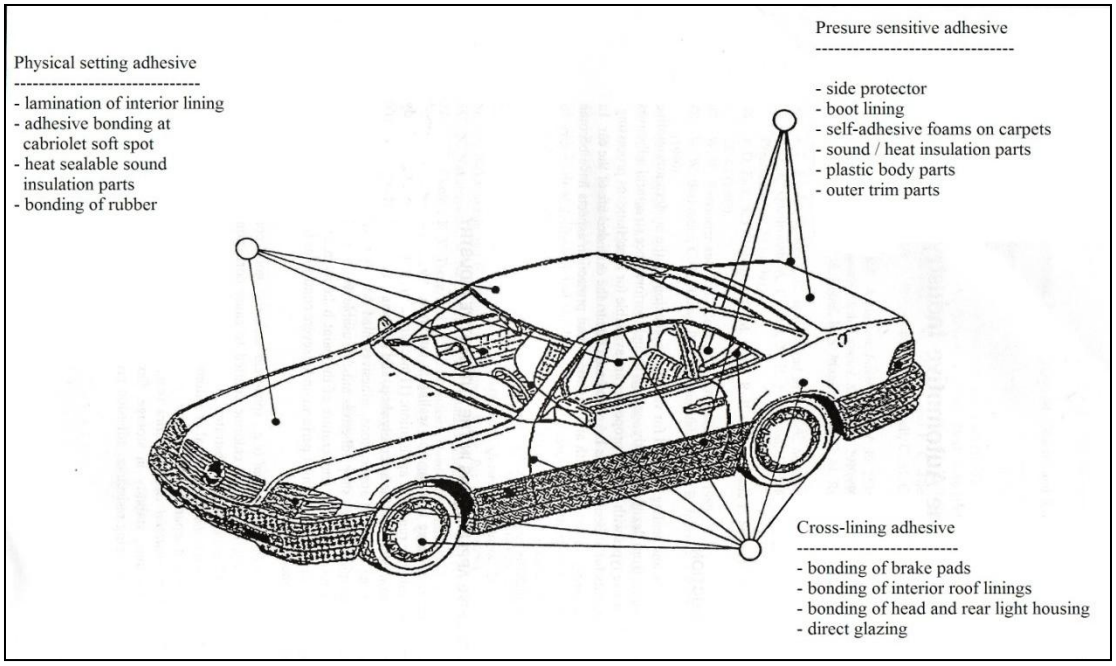

Figure 1.0**:** Adhesive bonding application in automobile industries [1]

1.3 Application of Adhesive in Industries

Adhesive have been use for many industries, the technology of adhesive is expected to grow and used in many other fields. The following are some of the industries using adhesive bonding. For example in the building industries adhesive been used as floor covering, and in electrical industries adhesive been used to fabricate capacitor and transformers.

1.4 Advantages of Adhesive Bonding

Nowadays adhesive is preferred to joint material because of a lot of advantages compared to other joint method such as rivet and welding. One of the major advantage of adhesive bonding compare to other joining method is it produce uniform distributed stress on the bonded area. Welding and mechanical fastener only bond at localize points. Welding and mechanical fastener will cause stress concentration that will shorten the life of the structure. Figure 1.1(a) and 1.1(b) below shows the different between adhesive bond and mechanical fasteners in stiffening effect and stress distributions.

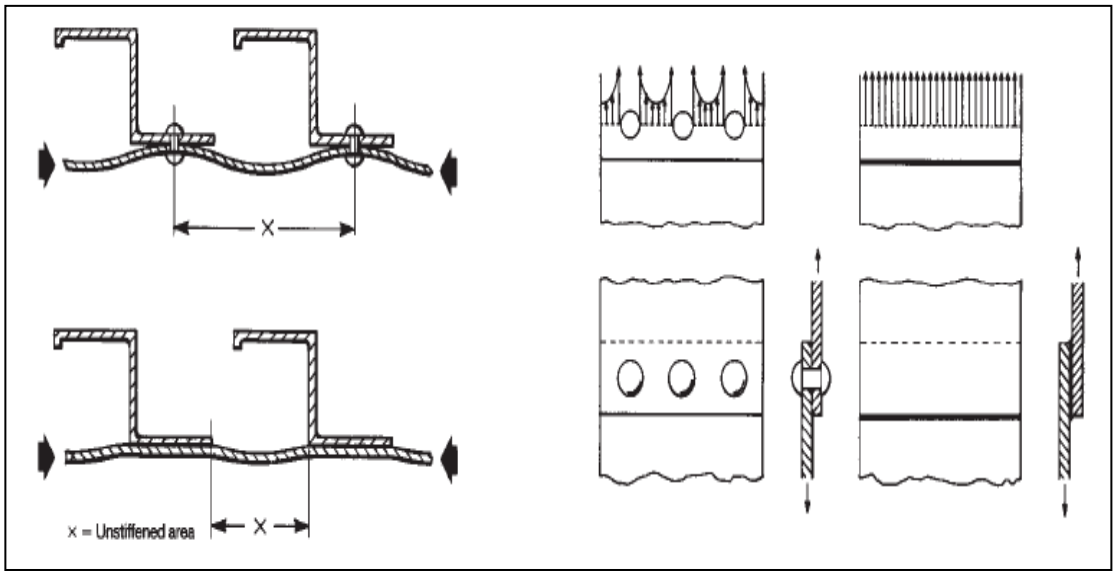

Figure 1.1 (a) Figure 1.1 (b)

In figure 1.1(a), adhesives form a continuous bond between the joint surfaces. Rivets and spot welds pin the surfaces together only at localized points. Bonded structures are consequently much stiffer and loading may be increased. [13]

In figure 1.1(b), the riveted joint on the left produce highly stressed area near the rivets. A similar distribution of stress occurs with spot welds and bolts. Adhesive bond on the right produce uniform distributed stress. [13]

1.5 Objective

The objectives of this project are:

(a) To evaluate the shear strength of adhesive bonded lap joint due to different surface geometry of the substrates.

(b) To compare shear strength between two kind of adhesive which are epoxy resin and polyester resin

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Adhesive bonding has a broad application in modern society, from used in daily life, to high technology industry. That is why many type of testing were done using various adhesive to various materials, in order to know their properties. By knowing their properties such as shear strength, designers or engineers can develop and used it for various applications. Before the testing were done many process has to be considered such as shear strength, design type in adhesive bonding, and adhesive selection. In this chapter the information gather to conduct this project will be explain. The information comes from books, journals and websites.

2.2 Stress

Stress occurs when assembly product cannot hold the load subject on it. Stress can be measure by knowing the force in the component relative to the cross-section area over which the force is applied. For example, if a person wearing spike- heeled shoes, the stress applied by the person can be high enough to damage the floor. If the same person wearing flat heel loafers, there will be no damage on the floor because of low stress. In this case the force did not change but the area over which the force was applied was significantly increase by using flat heel loafers. This also prove the equation of stress, where stress, σ is denoted by force, *F* over area, *A*. [3]

$$\sigma = F/A$$

When the force applied perpendicular to the plane, the stress is call shear stress, when the force applied is perpendicular to the plane the stress can be either tensile or compressive stress, depending on the force direction. Adhesive bond can be subjected to a wide range of stresses such as tensile, compressive, shear or peel. Adhesives bond perform best in shear, compression and tension but perform relatively poorly under peel and cleavage. That is why adhesive bonding needs to be designed so that the loading stresses will be directed along the lines of the adhesive's greatest strengths where it can perform at its best.

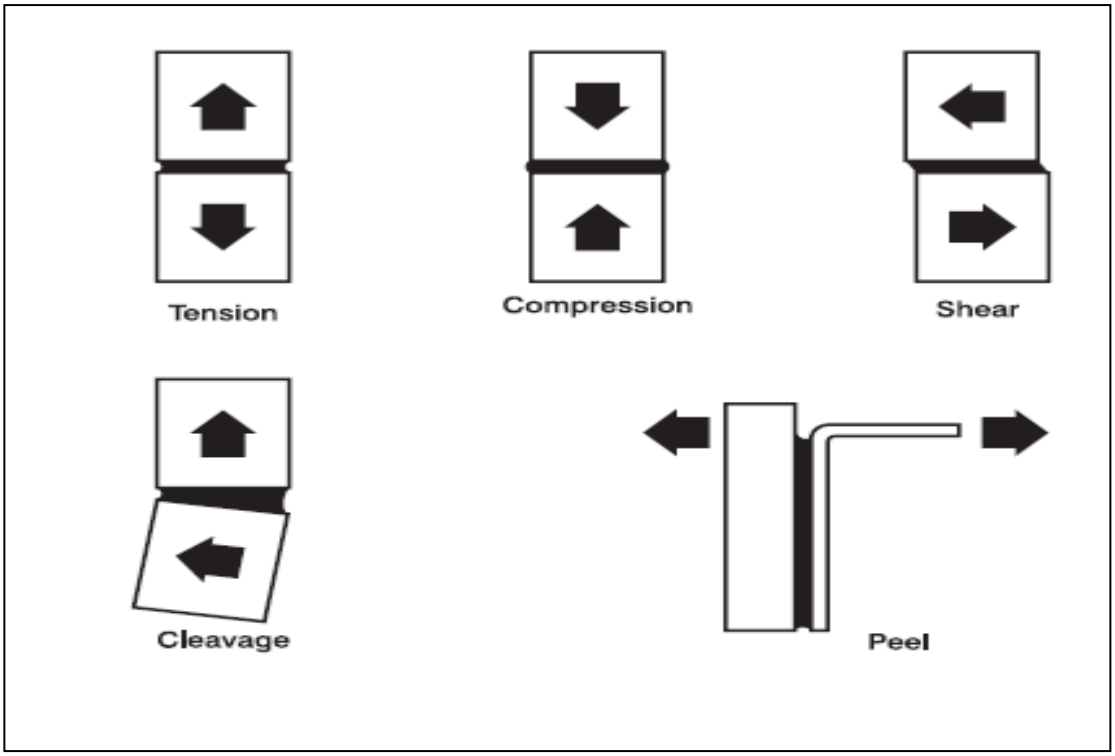

Figure 2.1: Type of stress [13]

Figure 2.1 shows type of stress. Stress on material cannot be eliminated but scientist and experts had done many researches to reduce the stress. Stress can happen anytime without any warning, which is very dangerous. That is why testing were done on material to determine its elastic limit when subjected to stress. The testing method will be discussed further in the next section of this chapter.

2.2.1 Shear Properties

Shear loading is a common application of metals in engineering design. The shear strength is the stress where material subject to shear load will fail. Shear test can be conduct using tensile machine. Shear strength of adhesive bond single lap joint can be performed according to ASTM D 1001. Usually polymer and ceramics were use as specimen for shear strength testing. Based on Huber Von Mises Henkey distortion energy theory for ductile material failure, the relation between shear yield strength and tensile yield strength can be summarized as:

$$\text{Shear yield strength} \approx 57.7\% \text{ tensile yield strength}$$

Material will behave elastically when subjected to shear. For example, torsion bars used for automotive suspensions behave as elastic springs that are energized by twisting. The stresses from the torsion load are shear stress. [3]

2.3 Tensile Test

Tensile test is use to record the materials response when subjected to stress. In other word the tensile testing measured the strength of a material. The test was standardized for metals but the same principles apply to polymers, ceramics, and composites. When the materials is subjected to tensile, compressive, and shear force, the value can be measured using universal testing machine, usually referred as tensile tester. To measured tensile strength, this machine will pull the sample. To measure compressive strength, the machine will push on the sample. For shear strength in of lap joint, the two substrates overlap and are bonded to each other. They are then loaded in tension until the bond fail. [3]

The choice of specimen geometry and size depend on the product form in which the material is to be use or the amount of materials available for sample. Flat specimen geometry is preferred when the end product is thin plate or sheet. Round cross section specimens are prefer when the products such as extruded bars, forgings and castings. The testing on the material were done by placing one end of the material at the gripper that is attached to the stationary end of the testing machine while the other end attached to actuator or moving portion of the testing machine. The actuator will move at fix rate and apply load to the specimen. The actuator will continue moving until the specimen fracture.

In early stage of the testing, that sample will behave elastically. Which mean if the actuator stop and return to it original position, the material will return to its original shape. As the test continues, the transition to nonlinearity occurs at a point known as proportional limit. As the stress continue to increase in the sample, the sample will elongate until it reach at a point where permanent plastic deformation occur which can be referred as plastic deformation. The point where the material transforms from elastic deformation to plastic deformation is call elastic limit or yield point. As the test continues, the material becomes stronger but the cross section area decreases. This will result of reducing load carrying capacity of test specimen. The force reaches peak and begin to drop off with further elongation of material. The stress at peak load is called the ultimate tensile strength of material. As test proceed the specimen or material will fractures into two halves.

From the testing, the stress strain curve can be obtained. The stress corresponding to elastic limit is called yield strength. Corresponding strain is called yield point strain. The highest stress reaches during the test is ultimate tensile strength or tensile strength. Corresponding strain is called uniform strain. After this point necking occur. During necking, strain accumulation is limited to the region of the neck and is non-uniform. The yield point is difficult to determine precisely, that is why engineer consider it to occur at an offset strain of 0.2%. ASTM also designated the stress at 0.2% offset strain as yield stress or yield strength. [4]

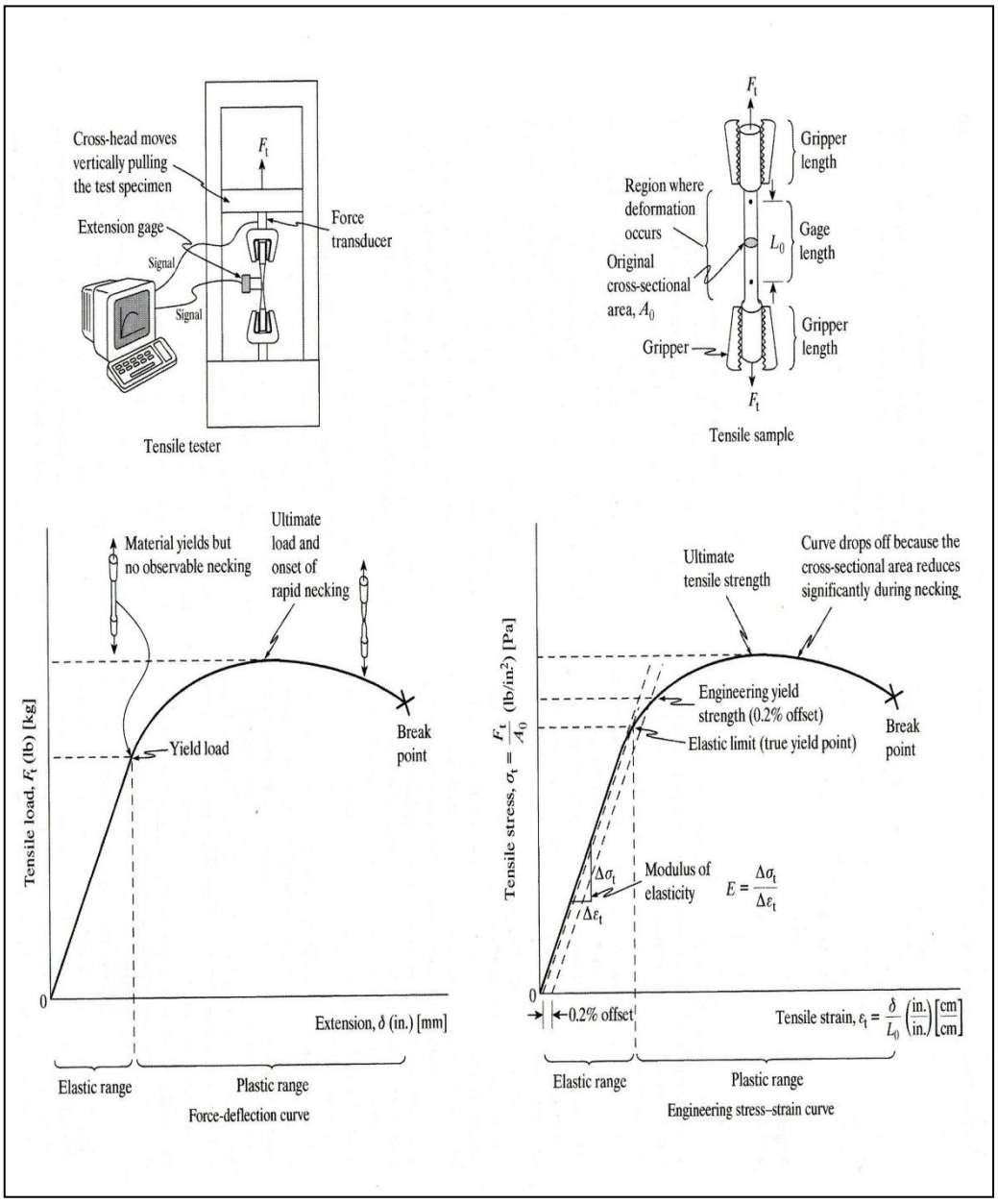

Figure 2.2: Tensile test method and resultant data. [3]