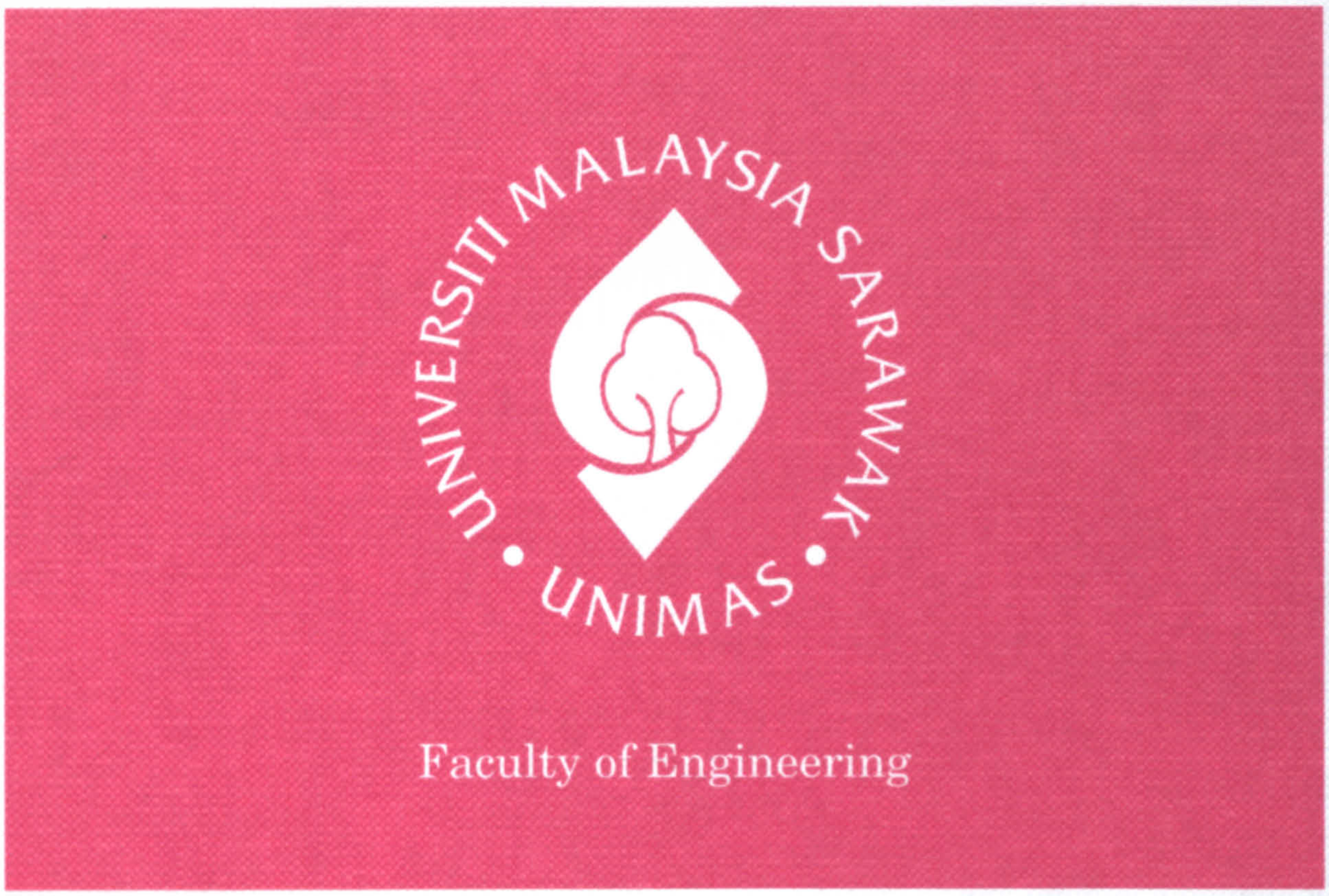

SURFACE PREPARATION AND ADHESIVE JOINING

Mohamad Asrul Bin Mustapha

Bachelor of Engineering with Honours
(Mechanical Engineering and Manufacturing System)
2005

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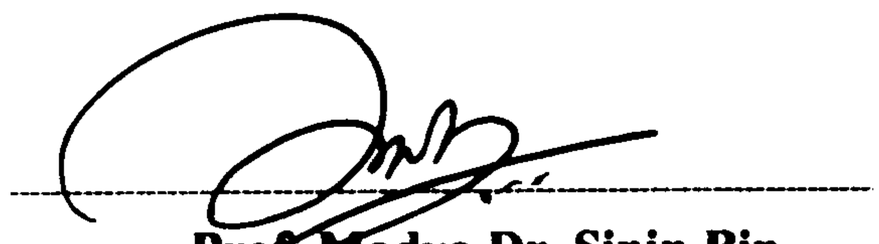
This project report, which entitled "Surface Preparation and Adhesive Joining" was prepared by Mohamad Asrul Bin Mustapha as a partial fullfilment for the Bachelor's Degree of Engineering with Honours (Mechanical Engineering and Manufacturing Systems) is hereby read and approved by:



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SURFACE PREPARATION AND ADHESIVE JOINING

MOHAMAD ASRUL BIN MUSTAPHA

This project is submitted in partial fulfilment of
the requirements for the degree of Bachelor of Engineering with Honours
(Mechanical and Manufacturing Systems)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2005

Dedicated to my beloved family and love one

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ABSTRACT

This project investigates the surface preparation effect on the strength of the adhesive joint. Strength of new invented adhesive namely sago glue also be compared with other wood adhesive available in market. In this research, abrading with sand paper is used as the surface preparation. 3 types of grit; grit 60(coarse), grit 120(fine), grit 180(super fine) choose to differ the surface roughness effect. The specimen materials are Belian wood (*Eusideroxylon Zwageri*) and Meraka Wood (*Shorea Albida*). The other adhesive used in this project are: High Solid Polyvinyl adhesive, White Wood Glue, and Kangaroo Glue.

Result shows that the surface preparation is always needed in bonding procedure. Abrading with sandpaper drastically increase the bonding strength. Results revealed that each adhesive has a different surface preparation or different degree of roughness needed to achieve the maximum bonding strength.

Analysis of stress – strain graph shows that the wood adhesives available in the market are brittle kind of characteristic. Load to failure graph shows that the sago glue can still be accepted as the wood adhesive event though it cannot resist load more than 1700 N average. Kangaroo glue cannot be accepted as a wood adhesive because of the tensile load to failure is very low.

ABSTRAK

Projek ini mengkaji tentang kesan penyediaan permukaan terhadap kekuatan sambungan bahan lekatan. Kekuatan gam yang baru dicipta yang dikenali sebagai gam sagu dibandingkan dengan gam kayu yang lain yang terdapat di pasaran. Dalam kajian ini, penggosokkan kertas pasir dilakukan sebagai penyediaan permukaan kayu. 3 jenis grit kertas pasir iaitu grit 60(kasar), grit 120(sederhana), grit 180(halus) dipilih untuk membandingkan kesan pengasaran permukaan. Spesimen yang digunakan adalah daripada Kayu Belian (*Eusideroxylon Zwageri*) dan Kayu Merakak (*Shorea Albida*). Gam – gam lain yang digunakan dalam kajian ini adalah: High Solid Polyvinyl Adhesive, White Wood Glue, dan Kangaroo Glue.

Data menunjukkan penyediaan permukaan seharusnya dilakukan dalam proses pelekatan. Penggosokkan menggunakan kertas pasir menunjukkan peningkatan yang drastik terhadap kekuatan sambungan. Data juga menunjukkan setiap gam mempunyai tahap kekasaran yang tertentu bagi mencapai kekuatan sambungan yang maksimum.

Analisis terhadap graf stress – strain menunjukkan gam yang terdapat di pasaran mempunyai sifat rapuh. Graf had beban menunjukkan gam sagu masih boleh diterima sebagai gam kayu walaupun tidak dapat menampung beban lebih daripada 1700 N purata. Gam kangaroo tidak dapat dispesifikasikan sebagai gam kayu disebabkan ketahanan bebanan yang boleh ditampung adalah sangat kecil.

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F	Applied force in Newton
A	cross-sectional area of the adhesive bonding in mm^2
Δl	change in displacement in mm
L	original length in mm

CHAPTER 1

INTRODUCTION

1.1 Introduction

The strength of a joint strongly depends on the condition and environment of the surface bonding. The purpose of the surface preparation is to produce clean bonding surface and improve its strength. Improper preparation will result in an interfacial failure in the joining.

The adhesive joining is preferred rather than the mechanical fastener due to its higher stiffness, more uniform load distribution, and more over no holes drilled in adherents. The study of adhesive is also important to determine the right adhesive for a substance. Combination of good surface preparation and adhesive may produce high strength of joining. This study will be beneficial for engineering industry especially for aerospace application by manipulating one of adhesive joining advantages, that is eliminating the usage of drilling holes for nuts and bolts thus improve the aerodynamic design.

Although in many applications no form of pretreatment is employed for the substrate materials prior to adhesive bonding, to attain the maximum joint performance some form of surface pretreatment for the substrate materials being joined is almost always necessary [1].

1.2 The selection of substance

The selection of substance depends on application been used in engineering industry. For the study, wood been chosen. Wood had been used in engineering industry since long time ago until metal took place, due to the strength higher than wood. Although metal replace wood, the used of wood still on demand especially in furniture and aerospace industry.

When kept under dry conditions, wood and wood bonds are very durable, but some wood is normally subjected to significant environmental changes that greatly reduce the integrity of the bonded assembly [2].

Based on the demand and the properties of wood, the selection of wood as a substance in this study is valuable.

1.3 The surface preparation

Bonding strength develop through joint design are useless if the surface to be bonded is not prepare carefully for its requirement. The types of surface preparation depends on the required bonded strength, as discuss by R.D Adams et al [3], surface treatment of an adherend prior to adhesive bonding can bring about one or a combination of the following effects:

1. remove material
2. modify the chemistry of the surface
3. change the surface topography

Since the substance may be wood, the surface preparations that can be done is abrasion treatment.

Abrasion Treatment

This method removing the surface of the material or specifically to remove the weak boundary area of the surface materials. Abrasive papers, grit and shot blasting are kind of equipments use in abrasive methods. This kind of treatments can remove up to 10 of μm from the surface.

Solvent Cleaning

Solvents are in liquids or in vapor degreasing. Its act very effectively in removing oils and greases especially from metals. Safety precaution must be taken seriously due to its toxicity behavior.

Chemical Etching

Chemical etching is one of the widely used procedures. It had been used because of its superior durability in wet conditions. Solutions that usually had been used are chromic, chromic and sulfuric, or phosphoric acids. Chemical etching normally used for metal surface preparation like aluminium.

1.4 Scope and Objective

The main objectives of this project are as stated below:

1. Investigate the surface preparation effect on the strength of the adhesive joint.
2. Strength comparison of sago glue with other wood adhesives available in market.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Stress distribution in adhesive is one of the important parameter to be considered before applying an adhesive to a selective substance. The stresses in the adhesive occur when the adherent cannot hold the excess loading applied on it. Although the strength of adhesive joint still far behind from other method of joining, the research for the reliable and high strength for adhesive joint still on demand.

R.D Adam et al in book Structural Adhesive Joint in Engineering [3] stated that it is convenient now to define an adhesive as a polymeric material which, when applied to surface, can joint them together and resist separation. A structural adhesive is one used when the load required to cause separation in substantial such that the adhesive provides for the major strength and stiffness of the structure. The structural members of the joint, which are joined together by the adhesive, are the adherends, a word first used by de Bruyne (1939).

2.2 Type of Stress

Type of stresses that usually involve in adhesive bonding are tensile stress, shear stress, cleavage stress and peel stress. Beside than these, as stated by A.J Kinloch [1], adhesive often operate with some additional stress in the joint arising from shrinkage of the adhesive relative to the substrate. R.D Adams, et al [3] stated that the maximum adhesive stress always occur near the end of the bond line.

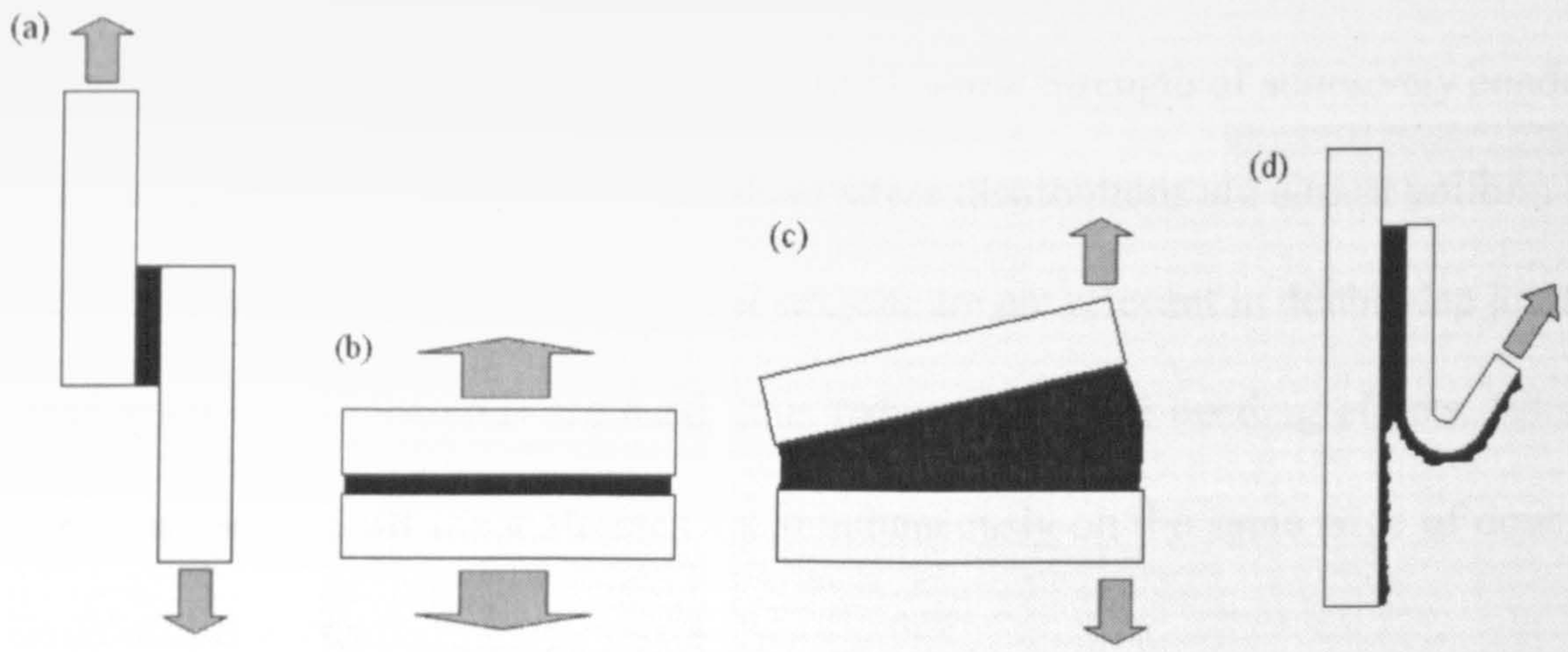


Figure 2.2 : Types of stress to which an adhesive joint may be subjected: (a) Tensile Shear; (b) tensile loading; (c) cleavage; (d) peel

Definition for each of 4 main stresses in adhesive bonding [4] :

a. **Tensile stress :** Exerted equally over the entire joint straight and away from the adhesive bond

b. **Shear stress :** Always across the adhesive bond. The bonded materials are being force to slide each other.

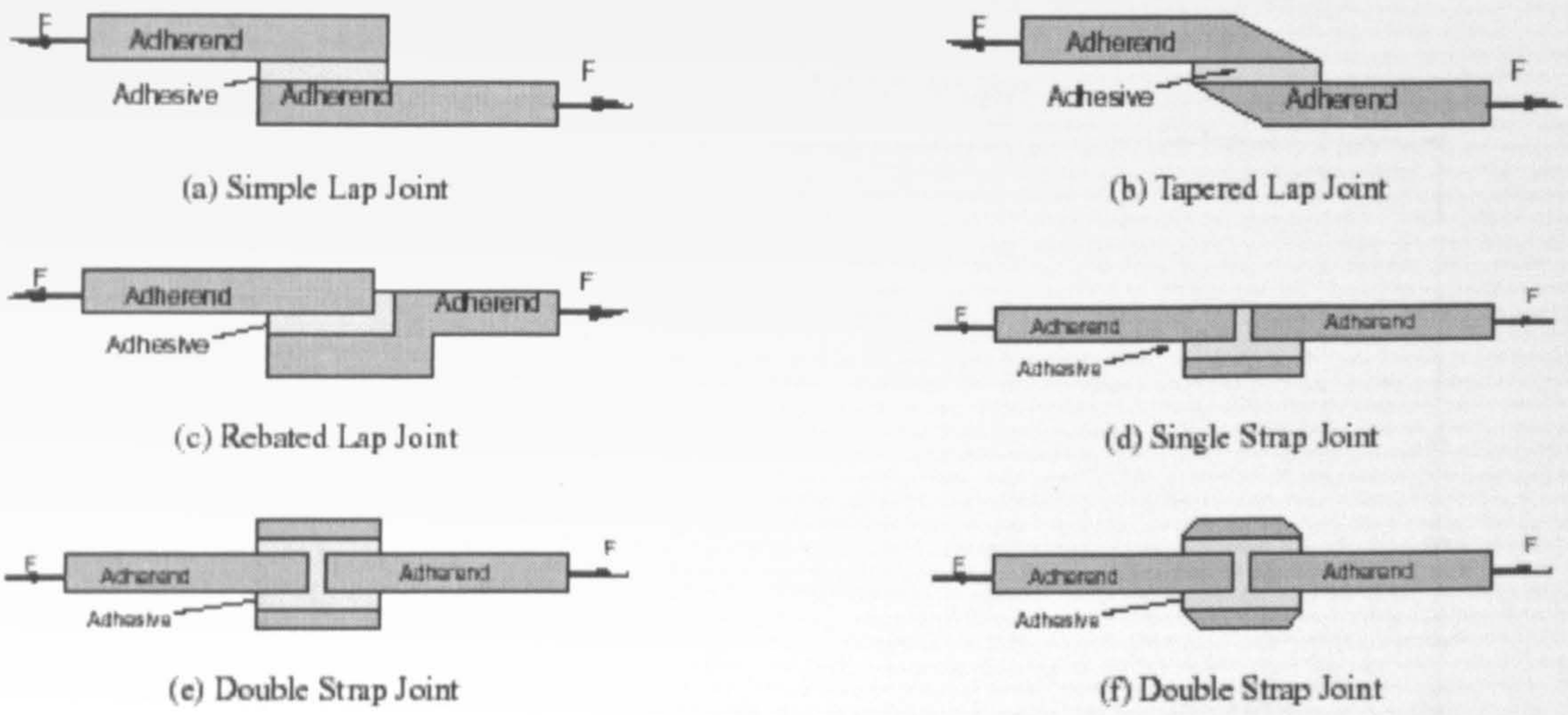
c. **Cleavage stress :** Always concentrated at one edge and exerts a prying force on the bond.

d. **Peel stress :** concentrated along a thin line at the bond's edge. One surface is flexible. Most applications combine stresses.

All the stress mentioned above should be though as the design consideration before designing the structure of the adhesive joint. The structure design should be able to minimize the 4 main stresses mentioned. From the observation of A. B. Pereira and A. B. de Morais [5] in their research about Strength of adhesively bonded stainless steel joints, they found that , shear stress distributions are almost uniform in the double lap joints and belief that peel stresses are not relevant in double-lap joints, even when thick adherends are used, thus reducing internal bending effects. While both peel and highest shear stresses act simultaneously on the same edge of double lap joint specimens.

2.3 Variation in Adhesive Bonding

A lot of research has been done in designing the adhesive bonding. Each of the design has been produce to suit the application of the materials. Each design has its own advantages and disadvantages in dealing with the adhesive stress that has been discuss earlier.



(a) Simple Lap Joint

(b) Tapered Lap Joint

(c) Rebated Lap Joint

(d) Single Strap Joint

(e) Double Strap Joint

(f) Double Strap Joint

Figure 2.3a: some common engineering adhesive joint [6]

From all the design above, the simple lap joint or also known as single lap joint is the joint that may need an adherend surface preparation before been bond. The tensile stress test will be investigated for this study.

R.D. Adams at al [3], in book of structural adhesive joint in engineering stated that some design are stronger than others, but none is simpler to make than the single – lap. However, the bevel, step and butt – strap have the advantage of presenting at least one external smooth surface. Scarfing or tapering is of limited benefit since Thamm (1976) has shown that the adherends have to be tapered to a fine edge if significant benefit is to be achieved, and this is usually impracticable.