UNIVERSITY TEKNIKAL MALAYSIA MELAKA

(UTeM)

STRESS AND DEFORMATION ANALYSIS ON PCB DEPANELING

Thesis is submitted in accordance with the requirements of the Melaka Technical University of Malaysia for the Degree of Bachelor of Engineering Manufacturing (Design)

By

ANDREW ARIH

Faculty of Manufacturing Engineering

May 2007

DECLARATION

I hereby, declare this thesis entitled "Stress and Deformation Analysis on PCB Depaneling" is the results of my own research except as cited in the references.

Signature	:	……………………………………….
Author's Name	:	ANDREW ARIH
Date	:	8 MAY 2007

UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA

BORANG PENGESAHAN STATUS TESIS*

JUDUL: STRESS AND DEFORMATION ANALYSIS ON PCB DEPANELING

SESI PENGAJIAN: 2006/2007

Saya ANDREW ARIH (NO. KP) 840224135337 (NO.MATRIK) B050310183

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
√	TIDAK TERHAD	

Disahkan oleh:

(TANDATANGAN PENULIS)

(ENCIK SHAJAHAN BIN MAIDIN)

Alamat Tetap:
013, KAMPUNG TANAM,
96300 DALAT, MUKAH
SARAWAK

Cop Rasmi:
SHAJAHAN BIN MAIDIN
Ketua Jabatan (Rekabentuk Pembuatan)
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Ayer Keroh
75450 Melaka

Tarikh: 8 MEI 2007

Tarikh: 8 MEI 2007

* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

ABSTRACT

This paperwork contains the report of stress and deformation analysis on the application of shearing with support blocks method on Printed Circuit Board (PCB) depaneling. The aims of the study are to analyze the characteristic of the PCB model from manufacturer, determining the stress and deformation on the applied shearing force and identify the maximum shearing force used to cut the depanel tabs on the PCB using Universal Testing Machine (UTM). Depaneling method are selected based on the characteristic of the PCB model's depanel point. The dimensions of PCB model are taken to perform a solid modeling based on the PCB model. From that, the stress and deformation on the PCB model is analyzed using Finite Element Analysis (FEA). Both Solid modeling and analysis are performed using CATIA V5R16 software. There are three shearing force has been determined used in the study which are 100N, 500N and 1000N. From the FEA simulation, it has been observed that the value of stress and deformation (displacement) on the depanel tab proportional to the increase of shearing force applied. The use of support blocks has minimized the value of displacement on the shearing area. The experimental testing shows the maximum shearing force used to cut the depanel tabs is 131.7N. The location and the use of support blocks influence the low stress shearing condition on the PCB model.

DEDICATION

For My beloved Mum and Dad and for the rest of the families

ACKNOWLEDGEMENT

I would like to extend special appreciation to my supervisor, Encik Shajahan Maidin and Second Supervisor, Encik Ismail Abu Shah for this constant guidance over months, fkp technician, my beloved parents for their encouragement and all my friends for their help throughout the projects.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

DSB	Double Sided Board
IC	Integrated circuits
FR-2	Paper Phenolic resin
FR-3	Paper Epoxy resin
FR-4	Woven Glass Epoxy resin
FEA	Finite Element Analysis
FEM	Finite Element Model
NEMA	National Electrical Manufacturers Association
NC	Numerical control
PCB	Printed Circuit Board
SMD	Surface Mounted Devices
SSB	Single Sided Board
TAB	Tape Automated Bonding

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

A printed circuit board (PCB) consists of "printed wires" attached to a sheet of insulator. The conductive "printed wires" is called "traces". The insulator is called the substrate and is made of "Pertinax" (a phenol formaldehyde resin) or a fiberglass, reinforced epoxy composite material. Most PCBs have between one and sixteen conductive layers laminated (glued) together. In more complex PCBs, two or more of the layers are dedicated to providing ground and power. These ground planes and power planes detune accidental antennas, and provide efficient distribution of power multilayer board's enable construction of complex digital circuits. Most of the PCBs are designed with cavities in order to reduce cost and increase efficiency. Hence, PCBs need to be cut before undergo further processes. There are several ways of cutting or depaneling the PCBs. In currently used, there are five main depaneling cutting techniques which are hand break, pizza cutter, punch, router and saw. All depaneling methods cause a level of stress and deformation on the PCB.

In this project of "Stress and Deformation Analysis of Loaded Printed Circuit Board", the focus on stress and deformation analysis will be done using a simulation of FEA of the PCB model from the manufacturer. The factor influences the stress and deformation on the PCB are its own characteristic such as types of panel design, density of component loaded which relative to solder paste distribution on the PCB, the thickness of the PCB board, PCB material and types of depaneling line on the PCB. The study on the characteristic of the PCB model given is important to identify the suitable depaneling method that will be used to break the PCB depaneling line.

Analysis will be done using a Finite Element Analysis on stress and deformation analysis function on the PCB model drawn based on the actual model. The analysis will be performed using CATIA V5R16 software where this software is capable to simulate and measure the stress based on von mises stress value on the modeled element. All data collected will then used for actual depaneling practice based on the types of depaneling method selected to depanel the model to identify the value of force at which the joint or depanel tabs fractured.

1.2 GOAL

The goal of this study is to get better understanding and exposure on loaded PCB deformation and stress analysis and to suggest the low stress PCB depaneling condition using depaneling method selected for the PCB model. To achieve this goal, the study and understanding on PCB characteristics is important before apply the method to depanel the loaded PCB into each individual unit. In this study, the low stress depaneling condition is evaluated by considering the value of the stress and deformation (displacement) shown by FEA model in the CATIA V5R16.

1.3 PROBLEM STATEMENT

Depaneling unloaded PCBs are norm for PCB manufacturers. However, to depanel a loaded PCB using manual jig to break PCBs breakaway has resulted stresses produced on the PCBs components and this cause difficulties to control the product quality consistency. The crack on the loaded PCB usually occurred on the traces and SMDs component on the PCB. During depanel the breakaway line on the PCB; the force applied from the breaking will put the closes component to the depaneling line at risk of cracking. In this project, the PCB model from manufacturer will be analyzed to identify its characteristic before selecting the suitable depaneling method used through the study to break the PCB model.

1.4 OBJECTIVES OF PROJECT

The specific objectives for this project are:

i) To analyze and understand the printed circuit board characteristics.
ii) To analyze the stress and deformation on depanel tab of PCB model using Finite Element Analysis (FEA).
iii) To identify the maximum force used to depanel the breakaway tabs on the PCB model.

1.5 SCOPE OF PROJECT

1. Analyze the loaded printed circuit board characteristic from manufacturer.
2. Select depaneling method for the PCB model.
3. Stress and deformation (displacement) analysis on the Finite Element Model which modeled based on actual model.
4. Analyze collected data from Finite Element Analysis and apply the depaneling method on the PCB model.

CHAPTER 2
LITERATURE REVIEW

The literature review is conducted to achieve the objectives for this research. The literature is included information on Stress and Deformation concept, Printed circuit board characteristics; number of layers, board material, base material properties, number of sides and device types, the current printed circuit board depaneling method, Optical Beam Comparator and CATIA software. All of this information served as guideline in the course of the study.

2.1 STRESS AND DEFORMATION

2.1.1 STRESS

A stress is a force divided by an area. If an object receives an external force from the top, it internally generates a repelling force to maintain the original shape. The repelling force is called internal force and the internal force divided by the cross-sectional area of the object (a column in this example) is called stress, which is expressed as a unit of Pa (Pascal) or N/m^2. (Ian Sinclair, 2001)

2.1.1.1 Shear Stress

Figure 2.1: Shear Stress

Shear Stress is the concentration of force per unit area, acting tangent to dA. In other words, it is the stress component that acts in the plane of the sectioned area. Consider the effect of applying a force P, to a bar as shown in the figure on the left. (http://gnatchung.tripod.com/Mechanics/id4.html)

Figure 2.2: Effect of rigid supports against Force P

If the supports are considered rigid, and P is large enough, the material of the bar will deform and fail along the planes AB and CD.

2.1.1.2 Bending stress

Bending stress is the normal stress that is induced at a point in a body subjected to loads that cause it to bend. When a load is applied perpendicular to the length of a beam (with two supports on each end), bending moments are induced in the beam.

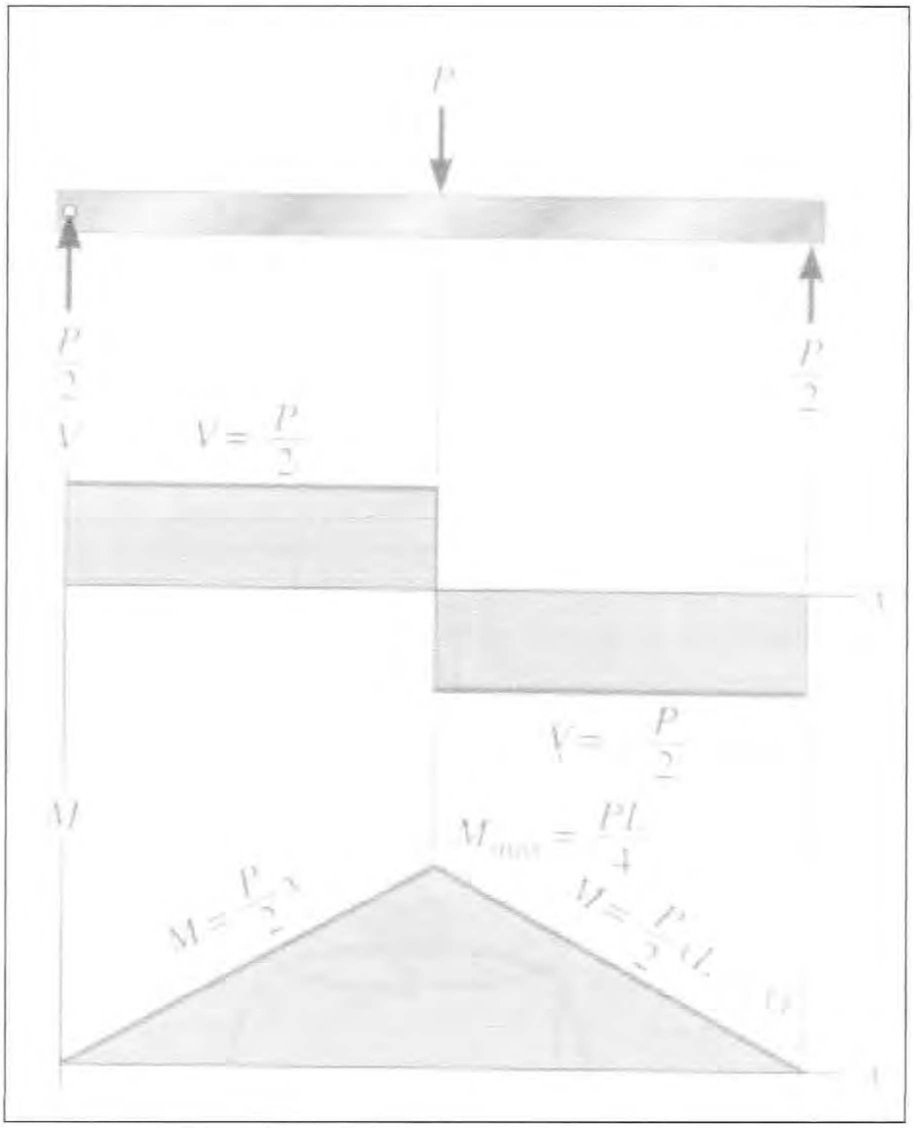

Figure 2.3: Bending stress