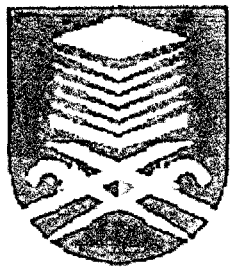

THE OPTIMIZATION OF ANTI-SYMMETRIC LAMINATE

WAN MOHD TAJUDDIN BIN WAN OSMAN

(2001194739)

A thesis submitted in partial fulfillment of the requirements for the award of Bachelor Engineering (Hons) (Mechanical)

Faculty of Mechanical Engineering

Universiti Teknologi MARA (UiTM)

APRIL 2005

ACKNOWLEDGEMENT

In the name of Allah, the most merciful and most benevolent. We are very grateful to Allah S.W.T for giving us the chance to have the determination and strength to complete this final year project. It is because Allah shows the way in completing this project and eventually gaining priceless knowledge for the past 18 months enabling for future use directly and indirectly to our degree, career and life.

We would like to express our most special gratitude to our project advisor, Mr. Jamaluddin Bin Mahmud for his advice, guidelines and patience to us throughout the process of completion for this project. We hope that all his priceless guidelines and knowledge that he had provided will give so much benefit to us in the future.

In addition we sincere thanks to our beloved father, mother and all our family for their encouragements in our studies in this so called UiTM. Also, special thanks greatest appreciation to my kindly friends, Hamedan Bin Ibrahim, Ahmad Zuwairi Bin Abdul Latif, Hasnal Bin Tamjehi, Fadzli Haizam Bin Hamzah, Ahmad Fauzi Jantan and Ahyaulazam Bin Ngah Rawi, for their cooperation and great ideas.

Last but not least, we would like to express our most gratitude to all our classmate and friends for their supports and opinions. Finally to those who involved and spend their time and effort directly and indirectly this is only that we could say, Thank You.

ABSTRACT

The main objective of this project is to simulate the failure of plates under sinusoidal transverse loading. Based on the simulations, the optimization analysis is performed on the anti symmetric laminates. Higher Order Shear Deformation plate theory is utilized to predict the deformation of the plates. To determine the mode of failure for composite plates, a failure criterion with the existence of coupling terms is employed. The selection of this criterion is made, because of its uniqueness that it includes the coupling terms, which relate the interaction between the longitudinal stress and the transverse stresses. Therefore, it allows the interaction between the fiber properties and the matrix properties in terms of the strength of the material, which other failure criteria have neglected. A program based on a finite element method is utilized to determine the lamina stresses. These stresses are then used in the present failure model to determine the First Ply Failure of the anti symmetric laminates. Finally, the First Ply Failure results for various lay up and ply thickness composite plates are analysed to determine the optimum composite plate based on the best lay up and ply thickness. Firstly, for different lay up of lamina, based on optimization analysis, results are generated to find the best lay up for Carbon Epoxy plates. Secondly, for different ply thickness, for Carbon Epoxy results are generated to find the best ply thickness Carbon Epoxy plates. The results shown that the lay up and ply thickness of (5t,t,t,t) at orientation (0,30,-30,0), (0,45,-45,0), (0,60,-60,0), (0,75,-75,0), (0,90,-90,0) and (t,t,t,3t) at orientation(0,0,0,0) are anti symmetric laminates that could withstand or resistance maximum sinusoidal transverse loading.

TABLE OF CONTENTS

CONTENTS		PAGE
PAGE TITLE		i
ACKNOWLEDGEMENT		ii
ABSTRACT		iii
TABLE OF CONTENTS		iv
LIST OF TABLES		vii
LIST OF FIGURES		vi
LIST OF ABBREVATION		xiii
CHAPTER I	**INTRODUCTION**	
1.0	Introduction	1
1.1	Objective of the project	2
1.2	Methodology	2
CHAPTER II	**ANTI SYMMETRIC COMPOSITE LAMINATES**	
2.1	Composite Materials	6
2.2	Classification of composite materials	6
2.3	Laminated composite	7
2.4	Anti symmetric Laminates	7
2.5	Symmetric Laminates	8
	2.5.1 Types of symmetry	9
2.6	Cross-Ply Laminates	10
2.7	Angle-Ply Laminates	11

2.8 Balanced Laminates 11
2.9 Quasi-Isotropic Laminates 12

CHAPTER III COMPUTATIONAL BACKGROUND FOR COMPOSITE MATERIALS

3.1 Lamination theory 13
3.2 Elastic properties of a Lamina 14
3.3 Failure model 14
3.3.1 Failure Criteria for a Laminate 14
3.3.2 Fiber mode failure in tension 15
3.3.3 Matrix mode failure in tension 16
3.4 Kinds of Elements 17
3.4.1 Element shape function 17

CHAPTER IV PROBLEM DESCRIPTION

4.1 Computational Model 19
4.1.1 Nodes and Elements 20
4.2 Composite materials properties 21
4.3 Lay up 21
4.4 Ply thickness 22
4.4 Loading type 26

CHAPTER V RESULTS AND DISCUSSION

5.1 Results for Carbon Epoxy Plate Analysis 28

CHAPTER VI CONCLUSION

Conclusion 85