THE EFFECT OF FIBER ORIENTATION ON PROGRESSIVE FAILURE OF COMPOSITE PLATES

ZAHARUDDIN BIN MUHAMMAD

(2001194547)

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Faculty of Mechanical Engineering

Universiti Teknologi MARA (UiTM)

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ABSTRACT

The objective of this thesis is to analyze the effect of fiber orientation on progressive failure of composite plates. A mathematical model and computational model are presented for the analysis. Higher Order Shear Deformation Theory is utilized to predict the deformation of the plates. A failure criterion with the existence of coupling terms to determine the mode of failure for composite plates is employed to predict the failure. 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. A program based on a finite element method is utilized by using Fortran-90 to determine the lamina stresses. These stresses are then used in the present failure model to determine the First Ply Failure and Last Ply Failure. From the analysis, it is found that the fiber orientation affected the progressive failure of the composite plates. Fiber orientation due to different lay-up will give different progressive failure load to constitute First Ply Failure and Last Ply Failure of the plates. From the results, we found that the best lay-up for this orientation is (0/45/45/0). The analysis has been proved by comparing the results of failure curves. In conclusion the objective of this research is successfully achieved. Perhaps in future, this thesis can offer better prediction of failure to engineers and designers in their designing work of composite structures.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

1.1 Background of the Project

Composite material is becoming popular nowadays. It is material that has advantages like high strength to weight ratio and as well as high stiffness to weight ratio. These advantages are crucial to many applications especially in spacecraft and aircraft; where the structures are very weight-sensitive.

In composite materials, failure is distinguished by its mode of failure. In fiber reinforced composite plates, failure in one direction of any single layer implies neither total failure of that layer, nor the whole structure. Load carrying capacity still exists not only in the structure, but also in the layer itself (J. Mahmud, 2000). Fiber orientation in composite material is one of the main factors that affect the progressive failure. The load constitutes First Ply Failure (First Ply Failure) and Last Ply Failure (LPF) changes throughout the orientation. Therefore, the most common way to deal with failure of a composite laminate is by using definitions of First Ply Failure (FPF). First Ply Failure