

**UNIVERSITI TEKNOLOGI MARA**

**FINITE ELEMENT  
IMPLEMENTATION TO PREDICT  
FAILURE OF COMPOSITE  
LAMINATE**

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Thesis submitted in fulfilment  
of the requirements for the degree of  
**Master of Science**

**Faculty of Mechanical Engineering**

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## **CONFIRMATION BY PANEL OF EXAMINERS**

I certify that a Panel of Examiners has met on the 21<sup>th</sup> August 2015 to conduct the final examination of Mastura Binti Abdul Rahim on his Master of Science thesis entitled “Finite Element Implementation to predict Failure of Composite Laminate” in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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## AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi Mara, regulating the conduct of my study and research.

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## ABSTRACT

The engineering applications using composite materials are widely growth due to the high strength to weight ratio. It is crucial to understand the failure of composite laminates to enhance the full potential of composite materials. Nevertheless, performing experiments to obtain the strength of failure is tedious and expensive procedure. Thus, a reliable failure prediction tools are needed. This study aims to develop finite element model of laminated composite plate subjected to the uniaxial and biaxial tension load to predict failure. A significant feature of the methodology is it rely on customized user-subroutines of FE programme (MATLAB) and on the analysis capability of the FE software (ANSYS) to predict failure of composite laminates. High Order Shear Deformation Theory (HSDT) is employed to model deformation and stress of laminated composite plate. The stress obtained is used in the failure criteria (Maximum stress theory and Tsai Wu) to predict the first ply failure (FPF) and last ply failure (LPF) of laminated plates. Two case studies were carried out using analytical method in order to validate the FE programme (MATLAB). Four numerical case studies are performed as numerical assessment and the results of FE computational approaches (MATLAB and ANSYS) are compared with available experimental results which the maximum errors were found 23.42% (ANSYS), 22.72% (MATLAB) and 8.45% (ANSYS), 8.09% (MATLAB) for Case study 1 and 2, respectively. The results of numerical assessment have shown that the FE programme (MATLAB) gives a better prediction in failure analysis for the laminated composite plate. It proves that the FE programme using MATLAB has the ability to perform failure analysis of composite laminates more accurate compared to the FE software package (ANSYS). This study is significant and contributed to enhance knowledge about the failure behaviour of laminated composite plate.

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