UNIVERSITI PUTRA MALAYSIA

FINITE ELEMENT ANALYSIS OF COHESIVE ELEMENT FOR GLASS EPOXY COMPOSITE FUSELAGE MODEL

NG WEI SIM

FINITE ELEMENT ANALYSIS OF COHESIVE ELEMENT FOR GLASS EPOXY COMPOSITE FUSELAGE MODEL

NG WEI SIM

MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

2011

FINITE ELEMENT ANALYSIS OF COHESIVE ELEMENT FOR GLASS EPOXY COMPOSITE FUSELAGE MODEL

By

NG WEI SIM

Thesis Submitted to the School of Graduate Studies Universiti Putra Malaysia in Fulfilment of the Requirement for the Degree of Master Science

January 2011

This work is dedicated

To my family

Parents, brother and sister

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master Science

FINITE ELEMENT ANALYSIS OF COHESIVE ELEMENT FOR GLASS EPOXY COMPOSITE FUSELAGE MODEL

By

NG WEI SIM

January 2011

Chairman: **Faizal Mustapha, PhD**

Faculty: **Engineering**

In this research, a numerical simulation on a newly introduced fabrication miniature composite fuselage structure - a glass epoxy composite laminated with adhesively bonded butt joint under axial compression loading is presented. A FEA via ABAQUS/Explicit is utilized to capture the complete compressive response to predict the crushing behaviour and mechanical strength from initial compression loading up to the final failure is demonstrated. A woven C-glass fiber/epoxy 200 g/m^2 composite laminated with the orthotropic elastic material properties is modeled as continuum composite lay-up in the proposed numerical model. The adhesively bonded joint progression is modeled using cohesive elements technology that allows the correct accounting for the energy involved in the crushing process and investigates the capability of the bonded joint to withstand the axial crushing impact from debonding failure. An experiment of Double Cantilever Beam (DCB) according to the ASTM

Standard D5528 is performed to determine the adhesive Mode I critical toughness. The crushing load and collapse modes under axial compression loading from FEA results indicate good correlation with the experimental test. The discrepancy of the peak load is found to be at 1%.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

ANALISIS UNSUR TERHINGGA PADA UNSUR KOHESIF UNTUK MODEL FUSLAJ KOMPOSIT EPOKSI KACA

Oleh

NG WEI SIM

January 2011

Pengerusi: **Faizal Mustapha, PhD**

Fakulti: **Kejuruteraan**

Dalam kajian ini, simulasi berangka pada fabrikasi baru untuk miniatur komposit fuslaj struktur - komposit epoksi kaca lamit dengan ikatan pelekat akibat beban mampatan paksian ditunjukkan. Analisis Unsur Terhingga (FEA) dengan menggunakan ABAQUS/Eksplisit untuk mengkaji tindak balas mampatan bagi meramalkan perilaku hancuran dan kekuatan mekanik dari mampatan awal sehingga kegagalan akhir dikenal pasti. Gentian kaca C/epoksi 200 g/m^2 komposit berlapis belitan yang bersifat elastik orthotropik dimodelkan sebagai kontinum komposit dalam model berangka yang dicadangkan. Ikatan pelekat dimodelkan dengan menggunakan teknologi unsur kohesif untuk pengiraan tenaga yang tepat dalam proses mampatan dan menyiasat kemampuan ikatan pelekat untuk menahan kesan paksian mampatan daripada kegagalan. Ujian mengikut penilaian ASTM D5528 Double Cantilever Beam (DCB) dijalankan untuk menentukan pelekat kritis kekuatan mod I. Daya dan mod hancuran mampatan paksian

hasil daripada keputusan Analisis Unsur Terhingga menunjukkan korelasi yang baik dengan eksperimen. Perbezaan daya puncak didapati sebanyak 1%.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to Dr. Faizal Mustapha for his encouragement, valuable advice, and guidance through my years as a master student. It is a pleasure and an honour to be his student.

I would like also to express my sincere gratitude and deep thanks to my supervisory committee member, Dr. Rizal Zahari for his kind assistance, advice, encouragement, and suggestions throughout this work and during the preparation of this thesis. I would like to thank Mr. Saifol for helping me to carry out the experiment. Last but not least, thanks to all who have helped me in this endeavor.

Ng Wei Sim

I certify that a Thesis Examination Committee has met on 28 January 2011 to conduct the final examination of Ng Wei Sim on her thesis entitled "Finite Element Analysis Of Cohesive Element For Glass Epoxy Composite Fuselage Model" in accordance with Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohd Ramly bin Ajir, PhD, Lt, Col, (R)
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Mohd Khairol Anuar bin Mohd Ariffin, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Mohd Sapuan bin Salit @ Sinon, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal examiner)

Zainal Ariffin Ahmad, PhD
Professor
School of Materials and Mineral Resources Engineering
Universiti Sains Malaysia
(External Examiner)

BUJANG BIN KIM HUAT, PhD

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 24 March 2011

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Faizal Mustapha, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Rizal Zahari, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

_____

HASANAH MOHD GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.

NG WEI SIM

Date: 23 January 2011

TABLE OF CONTENTS