

**Advances**  
**in**  
**Aircraft Structures**

**Editor**

**Jaffar Syed Mohamed Ali**

**Erwin Sulaema**



**IIUM Press**

Published by:  
IIUM Press  
International Islamic University Malaysia

First Edition, 2011  
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

ISBN: 978-967-418-148-2

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM  
(Malaysian Scholarly Publishing Council)

Printed by :

**IIUM PRINTING SDN. BHD.**

No. 1, Jalan Industri Batu Caves 1/3

Taman Perindustrian Batu Caves

Batu Caves Centre Point

68100 Batu Caves

Selangor Darul Ehsan

## CONTENTS

<b>Preface</b>	i
<b>Contents</b>	ii
<b>Contributing Author</b>	iv
<b>Aircraft Structural Design and Testing</b>	
1 Design of IIUM Aircraft Fuselage Using Composite Material (5168/20218)	1
2 Fabrication and Testing of IIUM Aircraft Fuselage Structure Made of Composite Laminate Material (5168/20223)	8
3 Design and Fabrication of Fuselage Model for Laboratory Purpose (5168/20225)	16
4 Simulation of Fuselage Model for Laboratory Purpose (5168/20228)	24
5 Propeller Blade Stress Analysis using CATIA (4625/20230)	30
6 Lateral Crushing of Composite Fuselages (4625/20232)	37
7 Corrosion Detection in Aircraft Structures by Ultrasonic Method (4980/20233)	45
8 Fatigue Damage Characterization of Aluminum Alloy Plates (4980/20235)	55
<b>Composite Structures</b>	
9 Determination of Mechanical Properties of Corrugated Hybrid Composite (5168/20237)	63
10 Composite Failure Mechanism of Corrugated Hybrid Composite Subjected to Bending Loading (5168/20239)	70
11 Study of Energy Absorption of Foam-Filled Honeycomb Structure (5168/20241)	79
12 Experimental Study of Indentation on Composite Structure (5168/20245)	86
13 Simulation Study of Composite Structure Subjected to 3 Points Bending Load (5168/20246)	93
14 Experimental Study of the Strength of Sandwich Structure with Honeycomb Core (5168/20248)	101
15 Buckling of Composite Columns (4625/20249)	107
16 Buckling of Composite Perforated Plates (4625/20253)	117
17 Structural Analysis of an Active Beam (4625/20254)	125
18 Characterization of Composite Materials using Full Field Data (6377/20256)	131

19	Application of Virtual Fields Method to Composite Plate Bending Problem	(6377/20262)	137
20	Mode I Delamination Simulation using LS-DYNA	(3563/20263)	143

### Structural Instability

21	Buckling of Long Column	(4625/20264)	150
22	Buckling of Thin Walled Sections	(4625/20265)	158
23	Effect of Boundary Conditions on the Buckling Behavior of Perforated Plates	(4625/20266)	167
24	Effect of Cutout Shape on the Critical Buckling Load of Perforated Plates.	(4625/20267)	174
25	Experimental Determination of Critical Buckling Load for a Perforated Plate	(4625/20268)	182
26	Accurate Geometric Stiffness Matrix Formulation of Beam Finite Element	(6327/20269)	190

### Structure Analytical Methods

27	The Constitutive Equation Gap Method	(6377/20270)	198
28	The Equilibrium Gap Method	(6377/20271)	202
29	The Reciprocity Gap Method	(6377/20272)	206
30	The Virtual Fields Method	(6377/20273)	210
31	Numerical Construction of Piecewise Virtual Fields	(6377/20274)	215
32	Numerical Model of Noise Effect in Full Field Data	(6377/20274)	221
33	Optimized Virtual Fields with Noise Minimization	(6377/20276)	227
34	Axial Stiffness Matrix of Non-Uniform Bernoulli-Euler Bar Elements		233
35	Finite Element Model Updating	(6377/20277)	240

## Chapter 16

# Buckling of Composite Perforated Plates

Jaffar Syed Mohamed Ali, Wan Najihah Wan Abdullah, Alina Binti Aminuddin,

### Abstract

*The buckling behaviour of homogeneous and composite plates with cutouts under axial compression is investigated numerically by using ANSYS software. The influence of material orientation and the length to width ratio on the buckling response of the plates is examined.*

**Keywords:** *Buckling, plate, ANSYS, composites, cutout.*

### 1. Introduction

Composite materials (or composites for short) are engineered materials made from two or more constituent materials with significantly different physical or chemical properties and which remain separate and distinct within the finished structure.

The most primitive composite materials comprised straw and mud in the form of bricks for building construction while the most advanced examples perform routinely on spacecraft in demanding environments. Usually, composite materials will consist of two separate components, the matrix and the filler. The matrix is the component that holds the filler together to form the bulk of the material.