DYNAMIC & STATIC FINITE ELEMENT ANALYSIS
OF NON-UNIFORM CROSS-SECTION
FUNCTIONALLY GRADED COMPOSITE BEAM
SUBJECTED TO THERMO-MECHANICAL LOADING

By

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APPROVAL

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A project dissertation submitted to the Faculty of Engineering and Quantity Surveying INTI INTERNATIONAL UNIVERSITY in partial fulfilment of the requirement for the Bachelor of Engineering (Hons) in Mechanical Engineering

Approved:

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April 2018
DECLARATION

I, the undersigned, hereby declare that this report is my own independent work except as specified in the references and acknowledgements. I have not committed plagiarism in the accomplishment of this work, nor have I falsified and/or invented the data in my work. I am aware of the University regulations on Plagiarism. I accept the academic penalties that may be imposed for any violation.

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Abstract

Material improvement is quite vital as it is the key driver of the world we live in, because all areas of human undertakings in this developed world rely upon material advancement for their execution. The development of materials from solid material to composite or alloy materials and the advancement of composite materials depends on the constraint of one class of materials that requires the improvement of other classes of materials. For the need to have two materials consolidated, and to have the capacity to work and hold their properties after being subjected to harsh working environments, functionally graded material (FGM) was introduced. Although FGM was at first created for thermal barrier application, nonetheless the use of this imperative enhanced material has been expanded and used to unravel various issues in the applications of engineering. This research is conducted to reveal insight into this imperative material. Chapter 1 - An introduction of functionally graded material is presented, together with a brief historical background of FGM with my research approach. Chapter 2 - Diverse sorts of functionally graded materials that are delivered today and their applications especially capitalizing on power energy sector. Chapter 3 - Methodology process whereby modelling non-uniform two layered composite material beam. Onward simulation analysis of static and thermal-static loadings whereby stage one results can be found in stage one report. Progressively, in stage two introducing FGM properties into the composite model with thermal-mechanical loading of static and dynamic. Chapter 4 – Results and discussion by comparing composite (2 layer) beam with FGM beams defined. Chapter 5 – Project conclusion and future work.
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First and foremost I am very grateful to God Almighty for without his grace and blessings, this study would not have been possible. As a token of gratitude to all who directly and indirectly contributed to the success of this project, we would like to extend our gratitude and thankfulness to the following people.

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Last but not least, I would like to extend my gratitude towards the ANSYS lab management staff of INTI International University for allowing me to use the lab whenever needed and special thanks to Assoc. Prof. Dr. Chua Keng Hoo, FEM ANSYS subject specialist for his expertise to several guidance.
DEDICATION

My Mother
A strong and gentle soul who taught me to trust in God, believe in hard work and I'll bear the fruits of my labour

My Uncle
For being my pillar of support, encouragement and guardian during my educational career

This thesis is also dedicated to my supervisor Mr. Abdolreza Toudehdehghan who encouraged me to build my motivation towards the world of Functionally Graded Materials (FGM)
Along with all hard working and respected Lecturers
# TABLE OF CONTENTS

DECLARATION ............................................................................................................. i
ABSTRACT .................................................................................................................. ii
ACKNOWLEDGEMENTS ............................................................................................... iii
DEDICATION ............................................................................................................... iv
LIST OF FIGURES ...................................................................................................... vii
LIST OF TABLES ........................................................................................................ xii
LIST OF ABBREVIATIONS ......................................................................................... xiii
NOMENCLATURE ........................................................................................................ xiii

**Chapter 1: INTRODUCTION** .................................................................................. 14

1.1. Background ........................................................................................................... 14

1.1.1. Brief History about Functionally Graded Materials (FGM) ......................... 14
1.1.2. Introduction to FGM and research approach ................................................ 14

1.2. Problem Statements ............................................................................................ 15

1.3. Objectives of the Research ................................................................................ 16

1.4. Scope of the Research ....................................................................................... 16

1.5. Project Flow Chart ............................................................................................ 19

**Chapter 2: LITERATURE REVIEW** .................................................................. 20

2.1. Functionally Graded Materials in nature .......................................................... 22

2.2. Types of Functionally Graded Materials (FGMs) ........................................... 24

2.3. Applications of Functionally Graded Materials (FGMs) ................................ 28

2.4. Application: Energy Sector ............................................................................. 29

2.5. Advantages & Difficulties of FGM ................................................................. 47

**Chapter 3: METHODOLOGY** ............................................................................. 48

3.0. Non-Uniform Beam Design ............................................................................ 48

3.1. Sigmoid Function (FGM) ................................................................................. 49

3.2. Work done ........................................................................................................ 50

3.3. Material Properties ......................................................................................... 52
Chapter 4: RESULTS & DISCUSSIONS ............................................................... 53
  4.1. Static Simulation Analysis ............................................................... 53
  4.2. Static Thermal Simulation Analysis ............................................. 66
  4.3. Dynamic Simulation Analysis ...................................................... 75
  4.4. Factors or Sensitivity Analyses ..................................................... 83

Chapter 5: SUMMARY ........................................................................ 85
  5.1. Conclusion ................................................................................. 85
  5.2. Future Work ............................................................................... 87

References ......................................................................................... 88
Appendix ............................................................................................ 91
LIST OF FIGURES

Figure 1.1: Single layer metal structure (A), 2 layered composite material (B).........16
Figure 1.2: Bonding of layered Functionally Graded Material (FGM) into 2 material structures..........................................................................................................................17
Figure 1.3: Distributed load with boundary conditions for static and dynamic FEA simulations (a) 1 Fixed end, (b) 2 Fix ends, (c) 1 Fixed & 1 Pin support, (d) 2 Pin supports, (e) 1 Pin & 1 Roller support..............................................................17
Figure 1.4: Project flow chart .......................................................................................19
Figure 2.1 Description of Modern Material Hierarchy [2]..................................................20
Figure 2.2: Schematic diagram of (a) Composite functionally graded material (b) traditional laminate composite material [29]..........................................................................................21
Figure 2.3: (a) Traditional Composite → final properties (b) Functionally graded materials → final properties........................................................................................................22
Figure 2.4: Schematic diagram of human bone showing FGM structure.[29]..................23
Figure 2.5: Organic and artificial illustrations for FGM - Jha et al. (2013) .................23
Figure 2.6: Porosity Gradient Functionally Graded Material schematic diagram........24
Figure 2.7: Schematic diagram of graded microstructure [29].......................................25
Figure 2.8: Schematic diagram of cylindrical part subjected to flow of (a) liquid metal and (b) cooling water........................................................................................................26
Figure 2.9: Some area of applications utilizing FGM.......................................................28
Figure 2.10: Some commercial heat sinks made by longitudinal plate fins (top: computer component, bottom: mainframe)...........................................................................30
Figure 2.11: A schematic of longitudinal fin with uniform profile and its dimensional parameters[16]............................................................31
Figure 2.12: Comparison of the temperature profiles, 0(ξ), between FGM and H.M longitudinal fins along the dimensionless normal axis, ξ, of the fin for (a) Γ=2.0, (b) Γ=5.0 with power-law class [16].................................................................32
Figure 2.13: Predicted fin tip temperature, 0(1), for FGM longitudinal fin and comparison with H.M fin data for different dimensionless thermo-geometric parameters in the range of 0≤Γ≤3, (power- law class) [16].........................33
Figure 2.14: Predicted FGM longitudinal fin efficiency, $\eta$, and comparison with H.M data for different dimensionless thermo-geometric parameters in the range of $0 \leq \Gamma \leq 8$, [16] ................................................................. 33

Figure 2.15: Comparison of the effective fin efficiency, $\eta_{eff}$, of FGM longitudinal fin at different dimensionless thermo-geometric parameters in the range of $0 \leq \Gamma \leq 8$, [16] 34

Figure 2.16: 3D wear profiles of: a) uncoated steel, b) Cr-25Al2O3, c) Cr-25Al2O3+5Re, d) Cr-40Al2O3+5Re  ............................................................................................................. 36

Figure 2.18: Left side shows the Main features of a flat-plate PVT collector (Chow, 2010) & right shows Schematic illustration of the hybrid solar roofing panel with a functionally graded layer (Yin et al., 2013) ............................................................................. 39

Figure 2.19: Cross section of residential system (Yin et al., 2013) ................................................................. 39

Figure 2.20: Solar panel testing setup [24] .......................................................................................................... 41

Figure 2.21: Position of thermal couples and water flow direction [24] ................................................................. 42

Figure 2.22: Equilibrium temperatures of each point at conditions of (a) irradiation: 850 W/m², water flow rate: 33 ml/min, (b) irradiation: 1100 W/m², water flow rate: 66 ml/min [24] ............................................................................................................ 43

Figure 2.23: FEM Model and grid generation for (a) whole of solar Panel, (b) side view of the cross section, and (c) close up of a water tube and material that are used in the finite element simulation. [24] ............................................................................. 43

Figure 2.24: Temperature space distributions of the panel at (a) 1100 W/m² irradiation without water flow, (b) 1100 W/m² irradiation with water flow of 66 ml/min [24] ............................................................................................................ 44

Figure 2.25 Temperature variation with time diagram for (a) irradiation: 850 W/m², water flow rate: 33 ml/min, (b) irradiation: 1100 W/m², water flow rate: 66 ml/min ............................. 45

Figure 2.26: FEM simulation and experimental data of the temperature distribution under (a) 850 W/m² irradiation and 33 ml/min water flow rate (point 4), and (b) 1100 W/m² irradiation and 66 ml/min water flow rate (point 4) [24] ............................................................................. 45

Figure 3.0: Schematic drawing of top view 2 layered (Metal-Ceramic) & FGM: ..... 48

Figure 3.1: Schematic drawing of side view Ceramic-Metal (2 layer) .................................................................... 48

Figure 3.2: Schematic drawing of side view FGC-sg (FGM 17 layers) ................................................................. 49

Figure 3.3: Schematic drawing of side view H-FGC-sg (FGM18 layers) ............................................................. 49

Figure 3.4: 2 layered Metal-ceramic (left) & FGM 17 layers for both $n=5$ & $n=0.5$ (right) defined on Ansys ................................................................................................................................. 51
Figure 3.5: FGM 18 layers for both $n = 5$ & $n = 0.5$ (top) & the thermal heat introduced for static thermal analysis for all beams (bottom) ........................................51

Figure 4.1: Parameter set for boundary condition 1 on the five different beams. .....53

Figure 4.2: Analysis on total deformation was set along the horizontal axis at the midsection of its thickness. (Red indicates maximum value and blue minimum value) ........................................................................................................53

Figure 4.3: Analysis on stress and strain along the vertical axis (Z-axis) through the thickness of the beams. .................................................................................................................................53

Figure 4.4: Graph of Deflection along the Horizontal Length of the five different beams with B.C. 1 ..................................................................................................................................................54

Figure 4.5: Graph of Stress along the Thickness of the five different beams with B.C. 1 ..................................................................................................................................................55

Figure 4.6: Graph of Strain along the Thickness of the five different beams with B.C. 1 ..................................................................................................................................................55

Figure 4.7: Parameter set for boundary condition 2 on the five different beams. .....56

Figure 4.8: Total deformation shows maximum deflection occurs at midsection of the beams. ..................................................................................................................................................56

Figure 4.9: Graph of Deflection along the Horizontal Length of the five different beams with B.C. 2 ..................................................................................................................................................56

Figure 4.10: Graph of Stress along the Thickness of the five different beams with B.C. 2 ..................................................................................................................................................57

Figure 4.11: Graph of Strain along the Thickness of the five different beams with B.C. 2 ..................................................................................................................................................58

Figure 4.12: Parameter set for boundary condition 3 on the five different beams – left pin end. ..................................................................................................................................................58

Figure 4.13: Total deformation shows maximum deflection occurs at midsection of the beams. ..................................................................................................................................................59

Figure 4.14: Graph of Deflection along the Horizontal Length of the five different beams with B.C. 3 ..................................................................................................................................................59

Figure 4.15: Graph of Stress along the Thickness of the five different beams with B.C. 3 ..................................................................................................................................................60

Figure 4.16: Parameter set for boundary condition 4 on the five different beams – both pin ends. ..................................................................................................................................................61
Figure 4.17: Total deformation shows maximum deflection occurs at midsection of the beams..........................62
Figure 4.18: Graph of Deflection along the Horizontal Length of the five different beams with B.C. 4..........................62
Figure 4.19: Graph of Stress along the Thickness of the five different beams with B.C. 4.....................................................63
Figure 4.20: Graph of Strain along the Thickness of the five different beams with B.C. 4.....................................................63
Figure 4.21: Total deformation shows maximum deflection occurs at midsection of the beams.....................................................64
Figure 4.22: Graph of Deflection along the Horizontal Length of the five different beams with B.C. 5..........................64
Figure 4.23: Graph of Stress along the Thickness of the five different beams with B.C. 5.....................................................65
Figure 4.24: Graph of Strain along the Thickness of the five different beams with B.C. 5.....................................................66
Figure 4.25: Total deformation shows maximum deflection occurs at right edge for all beams.....................................................66
Figure 4.26: Graph of Deflection along the Horizontal Length of the five different beams with B.C. 1 thermal..........................66
Figure 4.27: Graph of Stress along the Thickness of the five different beams with thermal B.C. 1.....................................................67
Figure 4.28: Graph of Strain along the Thickness of the five different beams with thermal B.C. 1.....................................................68
Figure 4.29: Total deformation shows maximum deflection occurs at midsection for all beams.....................................................68
Figure 4.30: Graph of Deflection along the Horizontal Length of the five different beams with thermal B.C. 2..........................69
Figure 4.31: Graph of Stress along the Thickness of the five different beams with thermal B.C. 2.....................................................69
Figure 4.32: Total deformation shows maximum deflection occurs at right section closer to right edge for all beams.....................................................70
Figure 4.33: Graph of Deflection along the Horizontal Length of the five different beams with thermal B.C. 3..........................70
Figure 4.34: Graph of Stress along the Thickness of the five different beams with thermal B.C.3 .............................................................. 71
Figure 4.34: Total deformation shows maximum deflection occurs at midsection for all five beams ........................................................................ 71
Figure 4.35: Graph of Deflection along the Horizontal Length of the five different beams with thermal B.C. 4 ........................................................................ 72
Figure 4.36: Graph of Stress along the Thickness of the five different beams with thermal B.C.4 ........................................................................ 73
Figure 4.37: Total deformation shows maximum deflection occurs at midsection for all five beams ........................................................................ 73
Figure 4.38: Graph of Deflection along the Horizontal Length of the five different beams with thermal B.C. 5 ........................................................................ 74
Figure 4.39: Graph of Stress along the Thickness of the five different beams with thermal B.C.5 ........................................................................ 74
Figure 4.40: Mode 1 - Bending ........................................................................ 75
Figure 4.42: Mode 3 – Sliding ........................................................................ 75
Figure 4.44: Mode 5 – Torsion ........................................................................ 75
Figure 5.0: Graph of amplitude against frequency of 2 layered (ceramic-metal) .......... 77
Figure 5.1: Graph of amplitude against frequency of FGM 17 (n=0.5) .................... 77
Figure 5.2: Graph of amplitude against frequency of FGM 17 (n=5) .................... 78
Figure 5.3: Graph of amplitude against frequency of FGM 18 (n=0.5) .................... 78
Figure 5.4: Graph of amplitude against frequency of FGM 18 (n=5) .................... 79
Figure 5.5: Graph of amplitude against frequency of 2 layered (ceramic-metal) .......... 79
Figure 5.6: Graph of amplitude against frequency of FGM 17 (n=0.5) .................... 79
Figure 5.7: Graph of amplitude against frequency of FGM 17 (n=5) .................... 80
Figure 5.8: Graph of amplitude against frequency of FGM 18 (n=0.5) .................... 80
Figure 5.9: Graph of amplitude against frequency of FGM 18 (n=5) .................... 80
Figure 5.10: Graph of amplitude against frequency of 2 layered (ceramic-metal) .......... 81
Figure 5.11: Graph of amplitude against frequency of FGM 17 (n=0.5) .................... 81
Figure 5.12: Graph of amplitude against frequency of FGM 17 (n=5) .................... 81
Figure 5.13: Graph of amplitude against frequency of FGM 18 (n=0.5) .................... 82
Figure 5.14: Graph of amplitude against frequency of FGM 18 (n=5) .................... 82
LIST OF TABLES

Table 2.1: Hardness results for FGM systems .......................................................... 37
Table 2.2: Dimension and properties of each material used in FEM simulation [24]. 44
Table 2.3: Energy and efficiency summary and comparisons [24] ......................... 46
Table 4.1: Table of Natural frequencies of 5 different modes with 5 different Boundary Conditions. ......................................................................................... 76
LIST OF ABBREVIATIONS

FGM  Functionally Graded Material
FEA  Finite Element Analysis
HM  Homogeneous Material
Cr-(Re)  Chromium
Al2 O3  Aluminium Oxide
CFB  Combustion Fluidal Boilers
HDPE  High Density Polyethylene
Al-HDPE FGM  Aluminium High-Density Polyethylene Functionally Graded Material
PV  Photovoltaic

NOMENCLATURE

Symbol

$\theta (\xi)$  Temperature profile
$\xi$  Dimensionless normal axis
$\Gamma$  Dimensionless thermo-geometric parameters
$\beta$  Inhomogeneity indices
$P_t$  Young Modulus (top)
$P_b$  Young Modulus (bottom)
n/h  Thickness of FGM layer and material parameter respectively.
z  layer thickness