UNIVERSITY TUN HUSSEIN ONN MALAYSIA

STATUS CONFIRMATION FOR UNDERGRADUATE PROJECT REPORT

EFFECT THERMAL AND PLY-ORIENTATION ON THE STRUCTURAL PERFORMANCE

ACADEMIC SESSION: 2016/2017

I. MUHAMMAD EKA NOVIANA, agree to allow this Undergraduate Project Report to be kept at library under following terms:

1. This Undergraduate Project Report is the property of the University Tun Hussein Onn Malaysia.
2. The library has the right to make copies for educational purpose only.
3. The library is allowed to make copies of this report for educational exchange between higher educational institutions.
4. ** Please Mark ( √ )

[ ] CONFIDENTIAL (Contains information of high security or of great importance to Malaysia as STIPULATED under the OFFICIAL SECRET ACT 1972)

[ ] RESTRICTED (Contains restricted information as determined by the organization/institution where research was conducted).

[ ] FREE ACCESS

Approved by,

[Signature]

(PERMANENT ADDRESS)

No2. TAMAN WIRA,
86400 PARIT RAJA
BATU PAHAT, JOHOR

Date: 18/6/2017

NOTE: ** If this undergraduate Project Report is classified as CONFIDENTIAL or RESTRICTED, please attach the letter from the relevant authority/organization stating reasons and duration for such classifications.
VALIDATION SHEET

This final project has been corrected and legalized by supervisor Faculty of Mechanical and Manufacturing Engineering University Tun Hussein onn Malaysia, and knowing by Head of Mechanical Engineering Department, and Secretary of International Program Automotive Engineering, University Muhammadiyah Surakarta:

Name: Muhammad Eka Novianta
NIM: D200102006

Surakarta, 24th July 2017
Admitted by:
Secretary of International Program

( Wijianto, ST.M.Eng.Sc )
EFFECT OF THERMAL AND PLY ORIENTATION ON THE STRUCTURAL PERFORMANCE

MUHAMMAD EKA NOVIANTA

A project report submitted in partial fulfillment of the requirement for the award of the Degree of Bachelor Engineering

Faculty of Mechanical and Manufacturing Engineering
University Tun Hussein Onn Malaysia

JUNE 2017
I hereby declare that the work in this project report is my own except for quotations and summaries which have been duly acknowledged.

Student : ..................................................
MUHAMMAD EKA NOVIANTA

Date : ..................................................
18/ JUNE / 2017

Supervisor : ..................................................
Dr. ALEMRAN BIN ISMAIL
DECLARATION OF RESEARCH AUTHENTICITY

Through this paper I am assert that the research on end title: EFFECT OF THERMAL AND PLY ORIENTATION ON THE STRUCTURAL PERFORMANCE as far as I know there is no plagiarism. All material in the text that referred to the other creations have been enclosed by citation sources and mentioned in references.

If someday, there is any untruth that found in my statement above, I will take responsibility about it.

Surakarta, 24 July 2017

The Writer

MUHAMMAD EKA NOVIANTA
D200102006
DEDICATION

This Final Project is dedicated to:

*My Parents who won’t feel tired to give education to me*

*My beloved sister Novi Dwi Mega Astuti*

*My Classmates in UMS Automotive Engineering*

*And for All Readers*
ACKNOWLEDGEMENT

Bismillahirrahmanirrahim. All Praises and thanks to Allah who gives me Mercy and Blessing to complete this final project. My appreciations are firstly dedicated to my supervisor who always take care to me and give me spirit to complete this thesis. Secondly, thanks to my brothers and sisters, without you come into my mind I would feel dispirited everyday. Thirdly, thanks to Dr. Al Emran Ismail, Dr KamarulAzhar Kamarudin, and En. Muhamad Khairudin Awang who always guide me patiently.

Thanks to Muslim sisters and brothers to the student who give me to support to completed this project. Finally, I hope the result of this project in the future to serve as reference materials for students, so the students can afford to give all their knowledge towards industry as well as in campus activity.
ABSTRACT

In this application for structure material many research to develop the structures and materials, with stress – strain, impact, ductile materials and etc. In the improving of the vehicles for strength of material, used for highway safety, for protection industrial accidents, personal safety, and used for packaging. In the typical problem areas in engineering finite element method included structural The analysis of the material itself, at the micro level and the analysis of the structure made of metal, composite and hybrid materials. Comparison of thermal 125°C and 250°C specimen with modelling ASTM E8 from metal material to the effect of angle orientation, from composite materials with 2 ply-orientation, 4 ply-orientation, 6 ply-orientation and Hybrid steel coated composite with 2 ply-orientation, 4 ply-orientation, 6 ply-orientation. The comparison between all of specimen with the effect of thermal working on the body of all specimens. The relationship between phenomenom stress-strain that work in all specimens except metal with the ply orientation.
ABSTRAK

# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td>i</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>DECLARATION OF RESEARCH AUTHENTICITY</td>
<td>iii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iv</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vi</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF SYMBOLS AND ABBREVIATIONS</td>
<td>xix</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>xxi</td>
</tr>
</tbody>
</table>

## CHAPTER 1 INTRODUCTION

1.1 Introduction  
1.2 Problem Statement  
1.3 Objective  
1.4 Problem Limitation  
1.5 Scope  
1.6 Benefit  

## CHAPTER 2 LITERATURE REVIEW

2.1 Composite Material  
2.2 Classification of Composite Material  
2.3 Type of Composite Fiber  
2.4 Direct Stress  
2.5 Direct Strain  
2.6 Modulus Elasticity  
2.7 Tensile Test  
2.8 Temperature
CHAPTER 3 METHODOLOGY

3.1 Introduction 22
3.2 Flow Chart 23
3.3 Design of Models 24
3.4 Material Properties 25
3.5 Variable of Models 25
3.6 Ansys Model and Simulation 27
3.6.1 Engineering Data Materials 27
3.6.2 Model 28
3.6.3 Mesh Refinement 29
3.6.4 Analysis Setting 31
3.6.5 Force 32
3.6.6 Thermal Condition 33
3.6.7 Solution 33
3.7 Validation 33

CHAPTER 4 RESULT AND DISCUSSION

4.1 Introduction 36
4.2 Tensile Test Metal Steel 125°C 36
4.3 Tensile Test Metal Steel 250°C 37
4.4 Tensile Test Composite 2 Ply-Orientation 125°C 38
4.5 Tensile Test Composite 4 Ply-Orientation 125°C 40
4.6 Tensile Test Composite 6 Ply-Orientation 125°C 45
4.7 Tensile Test Composite 2 Ply-Orientation 250°C 46
4.8 Tensile Test Composite 4 Ply-Orientation 250°C 48
4.9 Tensile Test Composite 6 Ply-Orientation 250°C 52
4.10 Tensile Test Hybrid Composite 2 Ply-Orientation 125°C 53
4.11 Tensile Test Hybrid Composite
   4 Ply-Orientation 125°C  55
4.12 Tensile Test Hybrid Composite
   6 Ply-Orientation 125°C  59
4.13 Tensile Test Hybrid Composite
   2 Ply-Orientation 250°C  61
4.14 Tensile Test Hybrid Composite
   4 Ply-Orientation 250°C  63
4.15 Tensile Test Hybrid Composite
   6 Ply-Orientation 250°C  67
4.16 Deformation of All Specimens  69

CHAPTER 5 CONCLUSION  36
   5.1 Conclusion  72
   5.2 Suggestion  73

REFERENCES  75
APPENDICES  78
LIST OF TABLES

3.1 Size model of specimens 24
3.2 Properties Material of Steel 25
3.3 Properties Material of Carbon/Epoxy 25
3.4 Variable of Model 26
3.5 Result of Mesh 31
3.6 Material properties of AZ31B Magnesium Alloy 34
LIST OF FIGURES

2.1 Types of Materials used in Boeing 787 series 5
2.2 Classification of composite materials 6
2.3 Laminated Composite 7
2.4 Fibrous composite material 8
2.5 Particulate composite materials 8
2.6 Woven Fiber Composite 9
2.7 Continuous Fiber Composite 9
2.8 Direction of Discontinuous Aligned Fiber Composite 10
2.9 Direction of Off-Axis Aligned Continuous Fiber Composite 10
2.10 Direction Randomly Continuous Fiber Composite 11
2.11 Hybrid Fiber Continuous 11
2.12 Direct Strain on the Object 12
2.13 Stress-strain curve Composite 14
2.14 Instron Machine for Tensile Test 15
2.15 The engineering stress-strain curve 16
2.16 Tensile Test Carbon Fiber Material to Failure 17
2.17 Al 1100 and C1010 solution and atmospheric Conditions 19
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.18</td>
<td>Effect different temperature on the specimens</td>
</tr>
<tr>
<td>3.1</td>
<td>Research Produce Flow Chart</td>
</tr>
<tr>
<td>3.2</td>
<td>Modeling for Specimens Using ASTM E8 Standard</td>
</tr>
<tr>
<td>3.3</td>
<td>Engineering data selected in software Ansys</td>
</tr>
<tr>
<td>3.4</td>
<td>Design model of specimen using software Solid Work 2014</td>
</tr>
<tr>
<td>3.5</td>
<td>Set a Layer section in Composite and Hybrid Model</td>
</tr>
<tr>
<td>3.6</td>
<td>Mesh Refinement on specimen</td>
</tr>
<tr>
<td>3.7</td>
<td>Result of the mesh on the body</td>
</tr>
<tr>
<td>3.8</td>
<td>Result of the mesh on the body of Hybrid specimen</td>
</tr>
<tr>
<td>3.9</td>
<td>Analysis set up before Run Simulation</td>
</tr>
<tr>
<td>3.10</td>
<td>Set up Force on the body of specimen</td>
</tr>
<tr>
<td>3.11</td>
<td>Thermal condition on the body of specimen</td>
</tr>
<tr>
<td>3.12</td>
<td>Size of KS B0810 13 Bflat dog bone specimen</td>
</tr>
<tr>
<td>3.13</td>
<td>Result of Simulation by software Ansys</td>
</tr>
<tr>
<td>3.14</td>
<td>Comparison Result From Ansys and Theory</td>
</tr>
<tr>
<td>3.15</td>
<td>Uniaxial Tension Test</td>
</tr>
<tr>
<td>4.1</td>
<td>Tensile Test von Mises Stress of Steel 125°C.</td>
</tr>
<tr>
<td>4.2</td>
<td>Stress- Strain Curve Metal Steel at Temperature 125°C</td>
</tr>
<tr>
<td>4.3</td>
<td>Tensile Test von Mises Stress of Steel 250°C</td>
</tr>
<tr>
<td>4.4</td>
<td>Stress- Strain Curve Metal Steel at Temperature 250°C</td>
</tr>
<tr>
<td>4.5</td>
<td>Tensile Test von Mises Stress Composite (2-Ply [0/0]) 125°C</td>
</tr>
<tr>
<td>4.6</td>
<td>Tensile Test von Mises Stress Composite (2-Ply [45/-45]) 125°C</td>
</tr>
</tbody>
</table>
4.7 Tensile Test von Mises Stress Composite (2-Ply [90/90]) 125°C
4.8 Stress- Strain Curve Composite 2 Ply-Orientation at Temperature 125°C
4.9 Tensile Test von Mises Stress Composite (4-Ply [0/45-45/0]) 125°C
4.10 Tensile Test von Mises Stress Composite (4-Ply [0/45/45/0]) 125°C
4.11 Tensile Test von Mises Stress Composite (4-Ply [90/45/-45/90]) 125°C
4.12 Tensile Test von Mises Stress Composite (4-Ply [0/90/90/0]) 125°C
4.13 Tensile Test von Mises Stress Composite (4-Ply [90/45/45/90]) 125°C
4.14 Tensile Test von Mises Stress Composite (4-Ply [0/-45/-45/0]) 125°C
4.15 Tensile Test von Mises Stress Composite (4-Ply [90-45/-45/90]) 125°C
4.16 Tensile Test von Mises Stress Composite (4-Ply [45/-45/-45/45]) 125°C
4.17 Stress- Strain Curve Composite 4 Ply-Orientation at Temperature 125°C
4.18 Tensile Test von Mises Stress Composite (6-Ply [0/90/45/45/90/0]) 125°C
4.19 Tensile Test von Mises Stress Composite (6-Ply [0/90/-45/-45/90/0]) 125°C
4.20 Tensile Test von Mises Stress Composite (6-Ply [0/90/45/-45/90]) 125°C
4.21 Stress- Strain Curve Composite 6 Ply-Orientation at temperature 125°C
4.22 Tensile Test von Mises Stress Composite
(2-Ply [0/0]) 250°C 46

4.23 Tensile Test von Mises Stress Composite
(2-Ply [45/-45]) 250°C 46

4.24 Tensile Test von Mises Stress Composite
(2-Ply [90/90]) 250°C 47

4.25 Stress- Strain Curve Composite
2 Ply-Orientation at temperature 250°C 47

4.26 Tensile Test von Mises Stress Composite
(4-Ply [0/45/-45/0]) 250°C 48

4.27 Tensile Test von Mises Stress Composite
(4-Ply [0/45/45/0]) 250°C 48

4.28 Tensile Test von Mises Stress Composite
(4-Ply [90/45/-45/90]) 250°C 49

4.29 Tensile Test von Mises Stress Composite
(4-Ply [0/90/90/0]) 250°C 49

4.30 Tensile Test von Mises Stress Composite
(4-Ply [90/45/45/90]) 250°C 49

4.31 Tensile Test von Mises Stress Composite
(4-Ply [0/-45/-45/0]) 250°C 50

4.32 Tensile Test von Mises Stress Composite
(4-Ply [90/-45/-45/90]) 250°C 50

4.33 Tensile Test von Mises Stress Composite
(4-Ply [45/-45/-45/45]) 250°C 50

4.34 Stress- Strain Curve Composite
4 Ply-Orientation at temperature 250°C 51

4.35 Tensile Test von Mises Stress Composite
(6-Ply [0/90/45/45/90/0]) 250°C 52

4.36 Tensile Test von Mises Stress Composite
(6-Ply [0/90/-45/-45/90/0]) 250°C 52
4.37 Tensile Test von Mises Stress Composite
(6-Ply [0/90/45/-45/90/0]) 250°C

4.38 Stress-Strain Curve Composite
6 Ply-Orientation at temperature 250°C

4.39 Tensile Test von Mises Stress Hybrid Steel
coated Composite (2-Ply [0/0]) 125°C

4.40 Tensile Test von Mises Stress Hybrid Steel
coated Composite (2-Ply [90/90]) 125°C

4.41 Tensile Test von Mises Stress Hybrid Steel
coated Composite (2-Ply [45/-45]) 125°C

4.42 Stress-Strain Curve Hybrid Steel Coated
Composite 2 Ply-Orientation at temperature 125°C

4.43 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [0/45/-45/0]) 125°C

4.44 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [0/45/45/0]) 125°C

4.45 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [90/45/-45/90]) 125°C

4.46 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [90/90/90/0]) 125°C

4.47 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [90/-45/-45/90] 125°C

4.48 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [0/-45/-45/0]) 125°C

4.49 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [90/-45/-45/90]) 125°C

4.50 Tensile Test von Mises Stress Hybrid Steel
coated Composite (4-Ply [45/-45/-45/45] 125°C

4.51 Stress-Strain Curve Hybrid Steel Coated
Composite 4 Ply-Orientation at Temperature 125°C
4.52 Tensile Test von Mises Stress Hybrid Steel coated Composite (6-Ply [0/90/45/-45/90/0]) 125°C

4.53 Tensile Test von Mises Stress Hybrid Steel coated Composite (6-Ply [0/90/45/45/90/0]) 125°C

4.54 Tensile Test von Mises Stress Hybrid Steel coated Composite (6-Ply [0/90/-45/-45/90/0]) 125°C

4.55 Stress-Strain Curve Hybrid Steel Coated Composite 6 Ply-Orientation at Temperature 125°C

4.56 Tensile Test von Mises Stress Hybrid Steel coated Composite (2-Ply [90/90]) 250°C

4.57 Tensile Test von Mises Stress Hybrid Steel coated Composite (2-Ply [0/0]) 250°C.

4.58 Tensile Test von Mises Stress Hybrid Steel coated Composite (2-Ply [45/-45]) 250°C.

4.59 Stress-Strain Curve Hybrid Steel Coated Composite 2 Ply-Orientation at Temperature 250°C

4.60 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [0/45/-45/0]) 250°C

4.61 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [0/45/45/0]) 250°C

4.62 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [90/45/-45/90]) 250°C

4.63 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [0/90/90/0]) 250°C

4.64 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [90/45/45/90]) 250°C

4.65 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [45/-45/-45/45]) 250°C

4.66 Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [0/-45/-45/0]) 250°C
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.67</td>
<td>Tensile Test von Mises Stress Hybrid Steel coated Composite (4-Ply [90/-45/-45/90]) 250°C</td>
</tr>
<tr>
<td>4.68</td>
<td>Stress- Strain Curve Hybrid Steel Coated Composite 4 Ply-Orientation at Temperature 250°C</td>
</tr>
<tr>
<td>4.69</td>
<td>Tensile Test von Mises Stress Hybrid Steel coated Composite (6-Ply [0/90/45/45/90/0]) 250°C</td>
</tr>
<tr>
<td>4.70</td>
<td>Tensile Test von Mises Stress Hybrid Steel coated Composite (6-Ply [0/90/45/-45/90/0]) 250°C</td>
</tr>
<tr>
<td>4.71</td>
<td>Tensile Test von Mises Stress Hybrid Steel coated Composite (6-Ply [0/90/-45/-45/90/0]) 250°C</td>
</tr>
<tr>
<td>4.72</td>
<td>Stress- Strain Curve Hybrid Steel Coated Composite 4 Ply-Orientation at Temperature 250°C</td>
</tr>
<tr>
<td>4.73</td>
<td>Total Deformation of Steel Model Specimens</td>
</tr>
<tr>
<td>4.74</td>
<td>Total Deformation of Composite and Hybrid 2 Ply-Orientation Model Specimens</td>
</tr>
<tr>
<td>4.75</td>
<td>Total Deformation of Composite and Hybrid 4 Ply-Orientation Model Specimens</td>
</tr>
<tr>
<td>4.76</td>
<td>Total Deformation of Composite and Hybrid 6 Ply-Orientation Model Specimens</td>
</tr>
</tbody>
</table>
LIST OF SYMBOLS AND ABBREVIATIONS

D, d - Diameter
r - Radius
L - Length
A - Cross-sectional Area
t - Thickness
m - Mass
F - Force
P - Pressure
\(\sigma\) - Stress
\(\sigma_e\) - Von Mises equivalent Stress
\(\varepsilon\) - Strain
\(m\) - Matrix
\(E_f\) - Modulus Elasticity of Fiber
\(E_m\) - Modulus Elasticity of matrix
\(V_f\) - Fraction of Fiber Volume
\(V_m\) - Fraction of Matrix Volume
\(l, \delta L\) - Change in Length
\begin{itemize}
\item \textbf{E} \, - \, Modulus Elasticity
\item \textbf{G} \, - \, Gauge length
\item \textbf{W} \, - \, Width
\item \textbf{R} \, - \, Radius of Fillet
\item \textbf{B} \, - \, Length of grip section
\item \textbf{C} \, - \, Width of grip section
\item \textbf{CAD} \, - \, Computer Aided Design
\item \textbf{KS} \, - \, Korean Standard
\item \textbf{ASTM} \, - \, American Society for Testing And Material
\end{itemize}
# LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Table 1.1 Result of Steel and Composite at Temperature 125°C</td>
<td>79</td>
</tr>
<tr>
<td>B</td>
<td>Table 1.2 Result of Composite at Temperature 250°C</td>
<td>80</td>
</tr>
<tr>
<td>C</td>
<td>Result of Hybrid Composite at Temperature 125°C</td>
<td>81</td>
</tr>
<tr>
<td>D</td>
<td>Table 1.4 Result of Hybrid Composite at Temperature 250°C</td>
<td>82</td>
</tr>
</tbody>
</table>