

**UNIVERSITI TEKNOLOGI MARA**

**EXPLOITING HIGH-SPEED AIR  
BAG MODELS TO QUANTIFY  
RELIABILITY IN NON-  
DESTRUCTIVE EVALUATION**

**MUHAMMAD NUR AIMAN BIN  
SUHAIMI**

Thesis submitted in fulfillment  
of the requirements for the degree of  
**Bachelor of Sciences (Hons.) Polymer Technology**

**Faculty of Applied Sciences**

**July 2019**

## **AUTHOR'S DECLARATION**

I declare that the work in this proposal was carried out originally with my own work otherwise indicated or acknowledged as a reference work.

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.

Name of Student : Muhammad Nur Aiman Bin Suhaimi  
Student I.D. No. : 2017413084  
Program : Bachelor of Science (Hons) Polymer Technology  
Faculty : Faculty of Applied Science  
Thesis : Exploiting High-Speed Air Bag Models To Quantify  
Reliability In Non-Destructive Evaluation

Signature of Student : .....

Date :

## ABSTRACT

The combination between high speed loading with Out of Position (OOP) of airbag are still not well understood though for high precision such as racing car, and others which could lead to the wrong deployment angle and catastrophic failure to the airbag housing. Rather than relying on the old design of airbag housing structure, the cooperation of high speed finite element with the addition of hinge features is an emerging strategy to achieve the required robust structure of airbag housing design. Here, we describe that the high value of strain rate during the high speed airbag deployment can altered by making a modification to the structure instead of using the sharp corner that could lead to the wrong angle of deployment by prepared the four variable of hinge design, as demonstrated by the design of airbag housing with hinge and without hinge in the method. The high speed of airbag deployment towards the housing resulting the high value of strain and different contact result. These result were study on the different design structure in order to overcome the fracture of airbag housing and wrong angle of deployment that lead to Out of Position (OOP). The airbag housing design with hinge exhibit low strain value about 0.0129 where the value is below than strain of Thermoplastic Olefin (TPO) material 0.069 which indicate the robust structure that will prevent the failure of airbag housing. While, the airbag design with no hinge exhibit higher of strain value about 0.0731 than 0.019 for Polypropylene (PP) combined with Ethylene Propylene Diene Monomer (EPDM) for design with no hinge. After the topology result, the high response displacement of structure was reviewed in order to remain the needed structure by removing the unnecessary material during the responses.

# TABLE OF CONTENTS

<b>CONFOMATION BY PANEL OF EXAMINERS</b>	<b>i</b>
<b>AUTHOR’S DECLARATION</b>	<b>ii</b>
<b>ABSTRACT</b>	<b>iii</b>
<b>ABSTRAK</b>	<b>iv</b>
<b>ACKNOWLEDGEMENT</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>viii</b>
<b>LIST OF FIGURES</b>	<b>ix</b>
<b>LIST OF NOMENCLATURES</b>	<b>xi</b>
<b>CHAPTER ONE: INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Problem Statement	3
1.3 Objective	3
1.4 Significance of Study	4
1.5 Limitations	4
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>5</b>
2.1 Introduction to Airbag	5
2.1.1 Out of Position Occupants	5
2.1.2 Out of Position of Airbags	6
2.1.2.1 The Airbag Design Testing	7
2.1.3 Incorrect Angle of Airbag Deployment	8
2.1.4 Airbag housing cross-section	10
2.2 Topology Optimization.	11
2.2.1 Variable Density Method	12
2.3 Material PP+EPDM and TPO-POE	14
2.4 Summary	15
<b>CHAPTER THREE: METHODOLOGY</b>	<b>16</b>
3.1 Introduction	16
3.2 Flow chart	17
3.2.1 Pre-Processing in Marc-mentat	18

3.3	Modification With Hinge Features	22
3.4	Types of Material	23
3.5	Pre-Processing in Hyperwork Analysis	24
3.6	Meshing in Finite Element Analysis	25
3.6.1	Load Collector	25
3.7	Set Up Optimization	27
3.7.1	Volume Response	28
3.7.2	Element Densities	28
	<b>CHAPTER FOUR: RESULTS AND DISCUSSION</b>	<b>29</b>
4.1	Dynamic Analysis	29
4.2	Sharp Corner Design (No Hinge)	31
4.2.1	No Hinge Design	31
4.2.2	No Hinge With Snap Fit Design	32
4.2.3	No Hinge Pattern Design	33
4.3	Airbag Housing With Hinge	33
4.4	Strain Time at 90°	38
4.5	Topology Optimization	40
4.6	Final Design Airbag Housing With Topology	43
4.6.1	Curve Design with Thin Hinge	43
4.6.2	Slanting Design with Thin Hinge	44
	<b>CHAPTER FIVE: CONCLUSION</b>	<b>45</b>
5.1	Conclusion	45
5.2	Recommendation	46
	<b>REFERENCE</b>	<b>47</b>
	<b>CURRICULUM VITAE</b>	<b>51</b>