UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FE Modelling Of Tensile Behaviour for Composite Material Using Altair HyperWorks

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Automotive Technology) (Hons.)

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DECLARATION

I hereby, declared this report entitled "FE Modelling of Tensile Behaviour for Composite Material Using Altair HyperWorks" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Mechanical Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Automotive Technology) (Hons.). The member of the supervisory is as follow:

……

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ABSTRAK

Dalam era globalisasi, penggunaan composit sangat meluas digunakan dalam bidang jurutera terutama sekali untuk dalam bidang pembuatan. Untuk menguji sesuatu benda baru seperti composit yang ingin digunakan akan memekan masa yang panjang seterusnya menelan belanja yang besar untuk melakukan ujian berulang kali. Selain itu, memeberi kesan terhadap masa dan juga keselematan semasa menjalankan ujian pada bahan composit. Kajian projek in membentangkan peneyelesaian dengan menjalankan dua keadah iaitu kajian sebenar dan juga simulasi di mana hasilnya akan sama atau hampir sama iaitu 90 peratus. Dimana kajian sebenar unidirectional fiber composite akan di susu mengikut 3 parameter penting iaitu ketebalan, orentasi dan susunan corak. Ketiga-tiga parameter ini akan dilakukan mengikut piawaian ASTM D3039. Seterusnya parameter tadi akan pindahkan dan analisis akan dijalankn dengan menggunakan applikasi Altair HyperWorks untuk membuktikan bahawa ujian sebenar lebih kurang atau sama dengan simulasi. Berdasarkan objektif kajian ini, jangkaan hasilnya adalah untuk membuktikan hasil ujian simulasi adalah sama atau 90 peratus sama dengan ujian sebenar sekaligus dapat menggantikan ujian sebenar kepada simulasi.

ABSTRACT

In this globalization era, the use of composite is very widely used in the field, especially for engineers in the field of manufacturing. To test a new object that you want to use as composite will take a long time so costly to do the test repeatedly. In addition, the impact of time and also the safety of carrying out tests on composite materials. This research project presents a solution by running two methods of actual research and simulation in which the result will be the same or almost the same at 90 percent. Where the actual study will use material such as unidirectional fibre composite where got three important parameters which are thickness, orientation and stacking sequence of the pattern. All three of these parameters will be conducted by according to the ASTM D3039 standards. The next parameter that will transfer to analysis and will be conducted using Altair HyperWorks application to prove that the actual test is nearly same or equal to the simulation. Based on these research objectives, the expected result is to prove the results of the simulation tests are similar or equal to 90 percent at the same time can replace the real test to simulate a actual test.

DEDICATION

To my beloved parents and family.

Mr. Ahmad bin Lananti and Mrs Milah binti Achmad.

To all my friends that involve, my supervisor and all my lecturer.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

FEA	-	Finite element analysis
CAE	-	Computer-aided engineering
MBD	-	Multibody dynamics
CAD	-	Computer-aided design
FE	-	Finite element
UTS	-	Universal Tensile Testing Machine
E	-	Young's modulus
FEM	-	Finite element method

CHAPTER 1
INTRODUCTION

1.0 Introduction

Finite element analysis is now being used routinely in the design of complex composite structures in other field such as automotive, aerospace and boating industry. Where the composite is a combination between two or more materials are consolidated on a naturally visible scale they frame a composite. A run of the mill illustration of composite material is ply wood, where slight layers of wood are stuck together with the wood grain of the layers in deferent points to pick up quality and stiffness in more than one course.

1.1 Project Background

For this research about **FE Modelling of Tensile Behaviour for Composite Material Using Altair HyperWorks**, it conducted by using two methods which is simulation and actual experiment. For the real specimen it will be made by using composite and tensile test will be perform. While, in simulation FE model will be created by creating a composite model which is the characteristic of thickness, orientation and stacking also same with the real specimen. FE model will be also apply with tensile test in simulation to get the same result with actual test. Hence the test done and result appeared, it should be same about the result. After make the comparison, further improving existing FE model based on the results of experiments performed.

Composite basically whenever two or more materials are consolidated on a naturally visible scale they frame a composite. A run of the mill illustration of composite material is ply wood, where slight layers of wood are stuck together with the wood grain of the layers in deferent points to pick up quality and stiffness in more than one course. Another case is concrete, where total particles are blended with a coupling material, which sticks the totals together. The greatest point of interest of present day composite materials is that they are light and also solid. By picking a proper mix of grid and fortification material, another material can be made that precisely meets the necessities of a specific application. Composites additionally give plan adaptability on the grounds that a large number of them can be formed into complex shapes. The drawback is regularly the expense. Despite the fact that the subsequent item is more effective, the raw materials are frequently costly.

Buts to create any composites materials it will be need some test or experiment and its maybe take a long time and also could be too dangerous when it running. So for this research try to prove about the problem was comes during test or experiment can be avoid by simulation method. David Sturrock (Strurrock, 2010) is in charge of design, development, support, and administration for Simio reproduction and booking items had explain about his suggestion about reasoning to eliminate simulation projects. Among the proposition set forward by him is a minimize cost spent. Simulate to guarantee that the truly require what are acquiring. An incessant aftereffect of re-enactments proposed to legitimize buys is to find that the buys are not advocated and truth be told the destinations can be met utilizing existing hardware better. A re-enactment may spare many times its expense with quick payback. Furthermore to upgrade utilization of what have. Simulation is a demonstrated approach to discover bottlenecks and recognize frequently minimal effort chances to enhance your operation. Besides that, the reason is want to control change. Simulation helps us to find concealed associations that can bring about enormous issues. Distinctive is not generally better. Simulate first to maintain a strategic distance from costly mistakes.

For this research also wants to focus in simulation which is want to replace the actual testing in to the simulation to make easier the designer or developer to made new thing without waste any cost, time, reduce risk and etc. In simulation, many elements or parameters can be change after run a test because it only simulation not an actual testing, regarding this situation improvement and optimization can be done by using simulation. Furthermore, in simulation give advantages in replacing part which is in meshing process where The Part Browser has full representation administration, it got a few diverse cross sections for every part and relying upon the reproduction, designs can be chosen to deal with a subset of those representations with the end goal of model form. By change parameter or part is importance in simulation, because in simulation result must be same with actual test.

1.2 Improvement

Improvement in concerned is an improvement to the FE model which has been modelled after actual composite. Various parameters can be changed to improve the quality of the composite in the FE model. By leveraging the simulation result, any weaknesses in the composite can be viewed through structural analysis. This structure will display all the places in which the composite of all the poor can be identified. Among the most important element to be taken into account to improve the FE model is geometry, finite element mesh generation, and material specification. Improvement in the FE model is very important in the study of present-day engineer, especially in aerospace, automotive industries, manufacturing industries and chemical industries. With improvement in the FE model, various studies can be done without wasting time to repeatedly execute the study.

1.3 Problem Statement

For composite tensile test, it should be done by carrying out some experiment to get the right result. But every experiment will take time and cost, this causes a waste of energy and time occur. By running tests for each composite produced it will be consume a lot of time, because to prepared a composite need some research also skills. Therefore, when there is a lot of composite needs to be tested it will be take a long time also take many cost.

The machine required to calibrate annually, biannually, quarterly or monthly depending upon requirements. If the machine is the main thing and always be used then the problem when due date for calibration achieved automatically the machine cannot be used then give effect for the next test. To calibrate the machine it should be carried out by the manufacturer of the machine or any individual who has gained recognition. The costs must be incurred to carry out the process of re-calibrate.

In this study will focus on the composite applied to make use of the actual test and simulation. This study will prove that the actual results of the study can be the same with the simulation. With the successful completion of this study it can safe time, energy, and material costs. No more wasteful and waste time by running real tests on composite, only create FE model in simulation result will approx.

1.4 Objective

From the foundation and the issue articulation that have been expressed, the goals of this anticipate are state as takes after:

1) To run actual tensile testing on composite materials.
2) To create/model the tensile testing using hyper work.
3) To validate and improve FE model.

1.5 Scope

The aim of this studies is to make result for tensile test between actual and simulation is same also make some improvement to the FE model. To make this research success there are shown as follow to support the objectives of this studies.

1) Fabricate specimen based on composite tensile test.
2) Tensile test should be done with FE model.
3) Simulate FE modelling in Altair Hyperwork.
4) Improvement will be done in FE model.

1.6 Result Expectation

1) Replace actual with simulation
2) Can predict tensile behaviour of composite with different design.
3) Methodology to simulate composite tensile.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction (Composite Material)

A composite material is made by merging at least two or more materials, frequently ones that have extremely distinctive properties. The two materials coordinate to give the composite amazing properties. Regardless, inside the composite it can without a doubt recognize the various materials one from alternate as they don't separate or blend into each other. Mostly composites created by only two materials which one is the matrix or binder. It is called the reinforcement because the material surrounded and binds together with fibre of fragment. By made a composite, weight, cost, and stiffness-critical components, such as aircraft body static structure, do not require the very high directional properties accessible with composites strengthened with adjusted ceaseless fibres.

2.1 Type of Composite

There are a few distinct sorts of composites been use today to develop new product. These sorts of composites cover a scope combination of various material. The most widely recognized sort is polymer matrix composites, be that as it may, framework composites and ceramics matrix composites are also common additionally basic as are normal composites, for example a wood. The common of types of composites most used is particle-reinforced, fibre-reinforced and structural.

2.1.1 Particle-reinforced composites

The reinforcing constituent is installed in a matrix to shape the composite. One type of composites is particulate reinforced composites with cement being a decent illustration. The total of coarse shack or rock is inserted in a matrix of bond. The total gives solidness and quality while the bond goes about as the binder to hold the structure together.

2.1.2 Fibre-reinforced composites

There are two type of fibre reinforced composite which is aligned fibres and random fibres. Aligned fibre also have continuous and discontinuous aligned. Where the continuous are longer than critical length is the minimum length necessary such that the entire load is transmitted from the matrix to the fibres. Furthermore, the discontinuous the fibre are shorter than the critical length. However, random fibres also called discrete or chopped fibres which is the strength will not be as high as with aligned fibres (Prasanna Kumar Ilankeeran, 2012).

2.1.3 Structural

A structural composite consists of both homogenous and composite material. There properties rely depend on, the characteristic properties of the constituent materials and additionally the geometric plan. There are two type of structural which is laminar compost and sandwich panel show in figure 2.1.

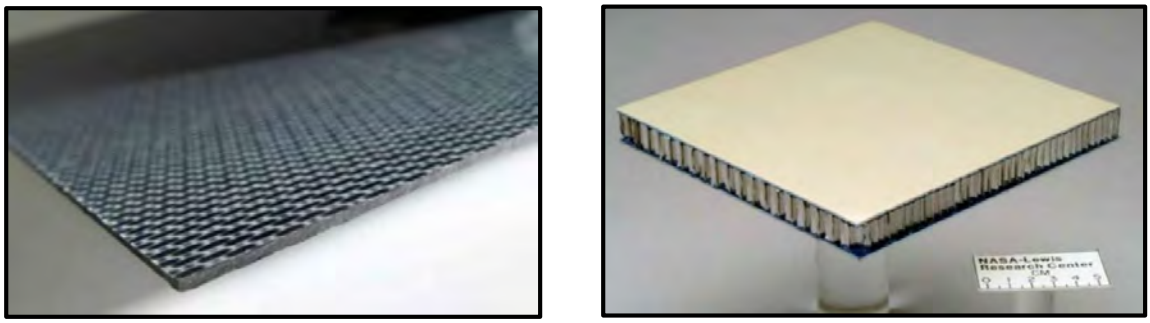

Figure 2.1: Laminar composite (left) and sandwich panel (right).

2.2 Tensile Test

A tensile test, otherwise called strain test, is likely the most crucial kind of mechanical test that perform on material. Tensile tests are simple, relatively inexpensive, and fully standardized. By pulling on something, it can be decide how the material will respond to powers being connected in strain. As the material is being pulled, it will discovered its quality alongside the amount it will stretch.

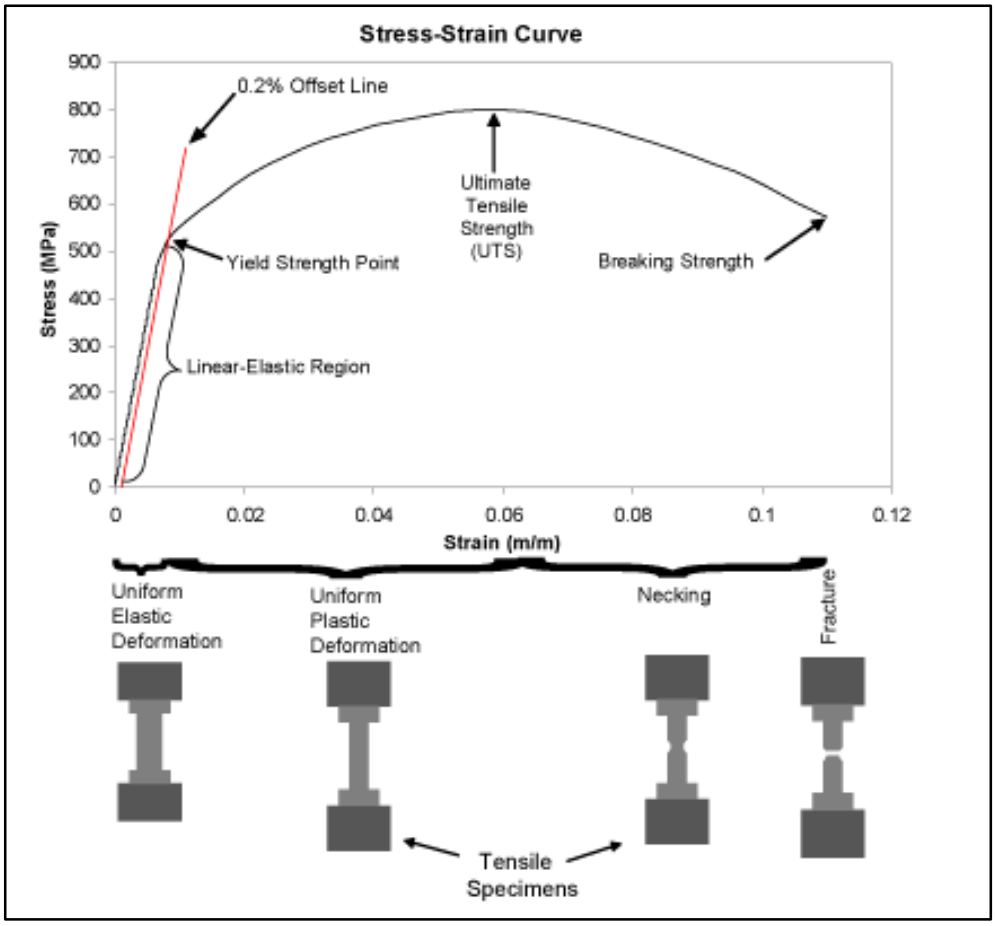

Figure 2.2: Changes plastic deformation of specimen.

Based on figure 2.2, the stress and strain initially increase with a direct relationship. This is the linear-elastic part of the bend and it demonstrates that no plastic twisting has happened. In this area of the bend, when the stress is decreased, the material will come back to its unique shape. In this direct district, the line complies with the relationship characterized as Hooke's Law where the proportion of stress to strain is a constant.

The slant of the line in this area where stress is in respect to strain and is known as the modulus of elasticity or Young's modulus. The modulus of versatility (E) defines the properties of a material as it experiences stress, deform, and after that came back to its unique shape after the stress is removed. It is a measure of the stiffness of a given material. To process the modulus of elasticity, just divide the stress by the strain in the material. Since strain is nothing unit, the modulus able have an indistinguishable units from the stress, for instance, kpi or MPa. The modulus of elasticity applies particularly

to the circumstance of a segment being extended with a tensile force. This modulus is of interest when it is important to register how much a pole or wire extends under a tensile load.

Yield quality is an extremely significance value for use in building basic outline subsequent to is the quality at which a metal or combination demonstrates huge plastic deformation. Since there is no clear point on the stress strain curve where elastic strain finishes and plastic strain starts, the yield quality is been that quality when a positive measure of plastic strain has happened. American engineering structural design, the yield quality is picked when 0.2 percent plastic strain has occurred, as showed on the designing stress strain chart of figure 2.2.

A definitive rigidity (UTS) is the maximum strength reached to in the engineering stress strain-curve. In the event that the example builds up a restricted abatement in cross-sectional area (normally called necking) appeared at figure 2.3.1. The engineering stress will diminish with further strain until fracture happens subsequent to the engineering stress is dictated by utilizing the first cross-sectional territory of the example. The more pliable a metal is, the more the example will neck before break and henceforth the more the lessening in the weight on the stress strain bend past the most maximum stress.

2.3 Modelling and Simulation

Modelling and simulation is an order for developing up a level of understanding of the interaction of the parts of a framework, and of the framework in general. A model is an improved representation of the real framework proposed to advance understanding. Whether a model is a decent model or not relies on upon the degree to which it advances understanding. A simulation for the most part alludes to a mechanized of the model which is keep running after some time to concentrate on the ramifications of the characterized cooperation.