SIMULATION AND APPLICATION OF NATURE FIBER / EPOXY ALUMINIUM HONEYCOMB FOR IMPACT PERFORMANCE

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (REFRIGERATION AND AIR CONDITIONING SYSTEM) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning) with Honours

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this thesis entitled “Simulation And Application of Nature Fiber / Epoxy Aluminium Honeycomb for Impact Performance” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Date : 17/01/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning System) with Honours.

Signature : .....

Supervisor Name : DR. MUHAMMAD ZULKARNAIN

Date : 17/01/2022

DEDICATION

I would like to dedicate the sucess of this research to my beloved parents, See Cheng Piau and Loh Pek Hoon. Thank you for your softness in taking care of me, supporting, advisory and loving that gives my life happiness all the times. Second, this dedication is made to all my friends, thanks for all the supports. Wish all the happiness and cheerfulness will always colouring our life. Last, I'd like to offer my heartfelt appreciation to my supervisor, Dr. Muhammad Zulkarnain for his assistance in finishing this Final Year Project.

ABSTRACT

In recent days, the aluminium honeycomb sandwich panels are commonly used in industry application due to its high energy absorption capability of honeycomb structures. This paper studied the simulation and application of nature fiber / epoxy aluminium honeycomb for impact performance analysis. Aluminium honeycomb widely used in automotive and aeroplane industry. Honeycomb cores are applied to resolve minimal deflections for the panels and maximal energy absorption for sandwich panel. Aluminium honeycomb sandwich panel formed by two aluminium plates and a honeycomb core structure. The 3D model of honeycomb sandwich panel is developed by the numerical model method by using MATLAB software. The dimensions of the thin panel plate are 76 mm × 221 mm × 1 mm. The number of fibers was observed in 50, 100, and 150 fibers number. Finite element model (FEM) for the aluminum honeycomb focus on the impact performance analysis. Software ANSYS Workbench Dynamic is used to perform impact testing. Hemisphere impactors with diameters of 30 mm and structural steel as material were chosen as hard mass hammer to simulate the impact test.

ABSTRAK

Hari kebelakangan ini, panel sandwich sarang lebah aluminium biasanya digunakan dalam aplikasi industri kerana kemampuan penyerapan tenaga yang tinggi dari struktur sarang lebah. Makalah ini mengkaji simulasi dan aplikasi sarang lebah serat semula jadi / epoksi aluminium untuk analisis prestasi impak. Sarang lebah aluminium banyak digunakan dalam industri automotif dan kapal terbang. Inti sarang lebah digunakan untuk menyelesaikan pesongan minimum untuk panel dan penyerapan tenaga maksimum untuk panel sandwic. Panel sandwic sarang lebah aluminium dibentuk oleh dua plat aluminium dan struktur inti sarang lebah. Model 3D panel sandwich sarang lebah dikembangkan dengan kaedah model berangka dengan menggunakan perisian MATLAB. Dimensi plat panel nipis ialah 76 mm × 221 mm × 1 mm. Jumlah gentian diperhatikan dalam bilangan serat 50, 100, dan 150. Model elemen finite (FEM) untuk sarang lebah aluminium fokus pada analisis prestasi impak. Perisian ANSYS Workbench Dynamic digunakan untuk melakukan ujian impak. Impact hemisfera dengan diameter 30 mm dan keluli struktur sebagai bahan telah dipilih sebagai tukul jisim keras untuk mensimulasikan ujian impak.

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LIST OF SYMBOLS AND ABBREVIATIONS

HVAC	-	Heating, ventilation and air-conditioning
FE	-	Finite element
ALE	-	Arbitrary Lagrange-Eulerian

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CHAPTER 1

INTRODUCTION

1.1 Background

Honeycomb structures are structures with a geometry of the honeycomb to allow for the reduction of the amount of material required to achieve reduced weight and expense. Honeycomb structures come in a variety of shapes and sizes, but it has an array of hollow cells built between the thin vertical walls. Because of honeycomb's excellent energy absorbing ability and high strength-to-mass ratio, the aluminium honeycomb structures are commonly used in engineering fields. Deformable barriers, which are used in some crash tests to determine the crashworthiness of cars needed by regulations, are an example of a typical application.

In the last few decades, the mechanical behaviour of honeycomb structures has been extensively studied, from quasi-static to dynamic loading conditions. Despite the fact that aluminium honeycombs have been extensively studied and implemented in a wide range of fields, there are still several problems have to be resolved.

Aluminium honeycomb is light weight material that offering very excellent strength and corrosion resistant. The aluminium honeycomb has provided a very stability and superior strength. Also, aluminium honeycomb's lightweight properties can help to minimise transportation costs and labour requirements. Because of its light weight and high strength, so architects and designers could use it in a variety of ways. Installation is simpler, safe and more stable. In addition, installation times are reduced.

The arrangement of aluminium honeycomb materials is similar to the beehives. This type of material is ideal for a variety of aerospace applications. The most advanced and reliable materials are needed to ensure the optimal safety, durability, and good strength in the aerospace industrial. As we know, aerospace materials must be very light in weight to allow for efficient aerodynamics. It is also having to be durable to ensure the protection of pilots with passengers to hold off the physical forces of flight. Also, the heat resistant to prevent structural transform during the rapid and high temperature variations that occur at high-speed and high-altitude flight. The aluminium honeycomb can completely meet all of the criteria mentioned above.

Aluminium honeycomb is used in a variety of aerospace applications and become one of the most suitable materials for critical substructures in planes, and engines, as well as the propellers and other non-aerospace structures such as wind turbine blades. Aluminium honeycomb is also used in aircraft, HVAC systems for less sensitive applications.

1.2 Problem Statement

The impact behaviors of fiber random distribution sandwich, including bending stiffness, strength and failure mechanism, are a challenge that needs to investigate, with providing the mechanical performance characteristics that need to study. The involving fibers distribution technique need to well introduce during construct 3D composite panel as coupling the honeycomb core. The stress and strain distributions have strong influences on the impact behaviors of the sandwich beams that need to explore. The energy absorber of the sandwich is required to present during impact process.

1.3 Research Objective

Final Year Project (FYP), also known as Projek Sarjana Muda (PSM), important for all of the students from Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan (FTKMP). It aims to provide opportunities for students to theory and have learned in the UTeM.

The objective is an important factor in the production process of a project. This is because without the objectives set, the project does not have direction and goals regularly. The objective should be to ensure the smooth and successful project. The main aim of this research is to test the impact on Nature Fiber Sandwich Aluminium honeycomb panels with aluminium. In particular, the objectives of this research are:

i) To develop 3D sandwich model of thin-walled honeycomb with nature fiber composite panel using fiber random distribution method.

ii) To analysis impact performance by varied fiber nature component content.

1.4 Scope of Research

The scope will conduct in the 3D simulation of Finite Element Analysis where the fibers distribute randomly in the longitudinal direction. Fiber distribution will develop by using MATLAB coding and the content is varied. All-composite sandwich thin-walled honeycomb with hexagon cores and coupled by nature fiber panel. The mechanical performance of the sandwich under impact test are studied by a three-dimensional (3D) failure mechanism.