UNIVERSITI TEKNOLOGI MARA

IMPACT, COMPRESSION AFTER IMPACT AND BENDING PROPERTIES OF HYBRID FRP-ALUMINIUM FOAM SANDWICH PANEL

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Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science

Faculty of Mechanical Engineering

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 18th December 2015 to conduct the final examination of Mohd Fadzli Bin Ismail on his Master of Science thesis entitled "Impact, Compression After Impact and Bending Properties of Hybrid FRP-Aluminium Foam Sandwich Panel" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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.

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ABSTRACT

Sandwich structures, which are made of metal face sheet and foam core, are widely been used in various industries due to their excellent energy absorption and impact resistance properties. Recently, fibre reinforced polymer (FRP) composites have been used in the fabrication of face sheets of sandwich panel due to their high specific strength and stiffness properties. The usage of hybrid FRP composite laminate is still new and few researches were found in this area. On top of that, the research data on aluminium foam as a core material in sandwich panel is also limited and need to be further studied. This research is aimed to determine the damage resistance and damage tolerance of hybrid FRP-aluminium foam sandwich panel. Damage resistance refers to the resistance of a material to damage when it is subjected to impact loading and damage tolerance is the ability of a material or structure to perform safely after damage. In this study, damage resistance is measured using impact test and damage tolerance is determined using compression after impact (CAI) test. In addition the bending test was also conducted in order to determine mechanical properties of the material, such as Young's modulus and strength. The sandwich panels were prepared using FRP composites face sheets, which consist of carbon and glass fibres reinforcements and epoxy matrix, and closed-cell aluminium foam core material. Drop weight impact, CAI and three-point bending tests were conducted in order to evaluate the properties of hybrid FRP-aluminium foam sandwich panel when compared to those of the pristine materials and aluminium honeycomb sandwich panel. The results showed that the hybrid FRP-aluminium foam sandwich panel has higher damage resistance or impact properties which were represented by higher peak force, energy absorption and specific energy absorption of 42%, 42%, and 20%, respectively, when compared to the neat CFRP-aluminium foam sandwich panel. In addition, it also has higher peak force, energy absorption and specific energy absorption of 135%, 1503% and 560%, respectively, when compared to the hybrid FRP-aluminium honeycomb sandwich panel. The damage tolerance or CAI properties of the hybrid FRP-aluminium foam sandwich panel were higher than those of the neat CFRP-aluminium foam and aluminium honeycomb core sandwich panels. Hybrid FRP-aluminium foam sandwich panel exhibited lower strength reduction of 54%, while the other sandwich panel systems recorded more than 70% strength reduction. Furthermore, the hybrid FRP-aluminium foam sandwich panel showed higher flexural strength and modulus by 309% and 333%, respectively, compared to the neat aluminium foam panel. It is also exhibited higher flexural strength and flexural modulus, by 338% and 136% respectively, when compared to the hybrid FRP-aluminium honeycomb sandwich panel. As a conclusion hybrid FRP-aluminium foam sandwich panel has better impact resistance and CAI properties when compared to conventional honeycomb sandwich panel. Therefore, this material is a promising advanced material that can be used to improve damage resistance and damage tolerance properties of modern structures.

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