# UNIVERSITI TEKNOLOGI MARA

# FINITE ELEMENT ANALYSIS OF GUIDED ULTRASONIC WAVES IN FIBERGLASS COMPOSITE LAMINATES

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Dissertation submitted in partial fulfillment
of the requirements for the degree of
**Master of Science**
**In Mechanical Engineering**

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# AUTHOR'S DECLARATION

I declare that the work in this dissertation 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

Composite laminates are widely used in engineering applications due to its high mechanical properties which is advantageous for critical engineering structures. Despite possessing major advantages, lack of test data to support the usage of the material promptly halt the advancement of composite laminates applications in industries. This research is carried out to analyse the geometrical effects on guided wave propagation in fiberglass composite laminate and scattering by delamination in fiberglass composite laminate. By utilizing Matlab and Abaqus/Explicit software, simulation of three-dimensional (3D) Finite Element (FE) fiberglass model is conducted and the signal obtained afterwards is processed and analysed. Four monitoring points strategy is implemented to assess guided wave signals. A few models are tested with different influencing factors which are thickness, excitation frequency, angle of monitoring points, and presence of delamination's. The results are then presented to properly differentiate the signal behaviour and wave field relative to parameter adjustments. Guided wave profile retains its shape at varying thickness, better defect detection in [0/90]° layup arrangement, ideal excitation frequency of 130 kHz and negligible factor of monitoring directions in fiberglass plate. Distinct scattering behaviour of guided wave is ascertained from the back scattering, forward scattering, and energy concentration within delamination, which contributed to proper and ease of delamination's identification in fiberglass composite laminates. These findings will contributed to overall integrity and reliability of non-destructive testing (NDT) inspection in composite structures.

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