Performance Simulation of Bio-Reinforced Composite Car Door Panel using Finite Element Analysis

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***Abstract*— Interior car door panel serves as an interface between the interior of the car and the inner workings of the door, and between vehicle occupants and the door. They are expected to meet a variety of design specifications regarding safety, aesthetics, and functionality. The objective of this study is to compare the current acrylonitrile butadiene styrene (ABS) car door panel material with polylactic acid (PLA) reinforced kenaf fiber bio-reinforced composite material. The objective is to suggest a recommendation to car manufacturers on the performance of bio-reinforced composites as a new material for the car door panel. Finite Element Analysis (FEA) was conducted to simulate the performance and the results were obtained by determining stress and deformation. The results show that PL It shows that PLA-kenaf composite can absorb higher maximum von-Mises stress (214.13 MPa) if compared to ABS (211.26 MPa). The PLA-kenaf composites also show lower maximum total deformation (12.012 mm) if compared to ABS (42.501 mm). From the analysis, it can be concluded that PLA-kenaf composite has better performance than ABS, therefore has the potential to replace the current material used for car door panels.**

Keywords—product development, automotive component, car door panel, ABS, bio-reinforced composite, FEA

I. BACKGROUND OF STUDY

The door panel serves as an interface between the interior of the car and the inner workings of the door, and between vehicle occupants and the door. They are expected to meet a variety of design specifications regarding safety, aesthetics, and functionality. In general, a car door can be opened and closed to provide access to the opening or closing to secure [1]. They are typically hinged partitions or sometimes attached by other mechanisms like tracks as sliding doors. These doors can be either opened manually or powered electronically. The powered car doors can be usually found on minivans and luxury cars.

An earlier study [2] details out there are two sides of a car door namely the interior side and exterior side of the door. The exterior side of the car door is typically exposed to the vehicle's exterior and colored with a decorative design appearance, while the interior side of the car door contributes to the overall functionality and ergonomics of the car ride. The interior side of the car door is also known as the car door panel. The interior car door panel is normally made up of a variety of materials. Those materials can be produced by vinyl and leather or sometimes can be made by cloth and fabric. The choice of the material for the car door panel is always intended to match the styles and materials used in the car's inner body equipment such as dashboard, seats, carpet, and others.

Dissimilar to the materials used for the exterior side of the car door, the interior car door panel needs to consider both aesthetic appeal and coziness [3]. Their overall function is associated with the ergonomics of the ride, such as armrests, door lock system, window control system, various switches, and compartments for small items and bottles [1,3].

A comprehensive review from previous research [4] reported that the safety of the car passengers can be enhanced by optimizing the interior car door panel's properties and design parameters. These design parameters include the elastic modulus and thickness of the interior car door panels. Moreover, the selection of appropriate material and thickness of car door panels can improve the car safety performance in a side collision [5].

Previous work [6] suggested that the selection of materials is significant because the materials used in vehicles serve as a structural reinforcement to absorb impact energy from transferring to the passengers. The effect of different properties of various materials will directly influence the vehicle crashworthiness. Hence, it can be concluded that the vehicle crashworthiness would be advantageous from materials with high energy absorption [7].

According to the previous study [8], natural fiber composites have arisen to become a choice of materials for automotive interior components, such as door panels, dashboards, seatbacks, and others. Automotive manufacturer, Toyota has used kenaf fiber for their five interior components in 27 car models. These kenaf fiber composites are typically made from kenaf reinforced polypropylene (PP) or kenaf reinforced polylactic acid (PLA). PLA and kenaf fiber are