DEVELOPMENT OF A FRAMEWORK TO SELECT OPTIMAL CROSS-SECTION DESIGN FOR IMPROVED SOLID TIRE PERFORMANCE

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Master of Engineering in Manufacturing Systems Engineering

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the Master of Engineering in Manufacturing Systems Engineering

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Declaration

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The supervisor/s should certify the thesis/dissertation with the following declaration.
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Name of the supervisor: Dr. R.K.P.S. Ranaweera
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Signature of the supervisor: Date: 2025-06-18

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Abstract

Solid/resilient tires are used in material handling equipment such as forklifts, trailer trucks, etc. Long-lasting life, less rolling resistance, and zero defects are the main demanding requirements to reduce downtime and save energy in the solid tire market. The geometrical design of a solid tire is one of the main factors that decides the performance. Cross-section design is a key design aspect that is rarely discussed in published literature separately. Therefore, this research is constructed towards a systematic study to develop an optimized cross-section design for solid tires based on the desired requirements. Commonly available cross-section designs of solid tires were selected to develop virtual simulation models. Static elastic nonlinear finite element simulation models for each design were developed in Abaqus CAE software. The same material layer construction and load constraints were maintained in developing all simulation models. Relevant simulation results were obtained by referring to the previous studies. Three physical tires were manufactured with the same material construction for physical testing. The deflection and dynamometer testing machines were used to obtain results of different solid tire designs. Simulation results and physical testing results were analyzed, and it was implied that the simulation results were validated by physical testing. Further, the relationships between these results and solid tire performance parameters were evaluated. Considering the outcome of the analysis, a framework was developed to predict the performance of the solid tire based on the desired requirement, and it also facilitates the selection of the optimal cross-section design. A case study was carried out to predict the performance of the two designs, which were not physically tested but analyzed in simulation. This study could be further expanded with other design aspects and the material construction to predict solid tire performance.

Key Words: cross-section, performance, simulation, solid tires

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