

**AN INVESTIGATION OF MOULD PARTS
DEFORMATION AND FAILURE ANALYSIS DURING
THE SOLID TYRE MANUFACTURING PROCESS**

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Thesis submitted in partial fulfilment of the requirement for the degree
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Declaration

Declaration of the candidate

I declare that this is my own work, and this dissertation does not incorporate without acknowledgment any material previously submitted for a degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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Declaration of the supervisor

The above candidate has carried out research for the Masters dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of the supervisor: Prof. Nirosh Jayaweera

Signature:

Date: 27/10/2023

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Abstract

Solid tyres are widely used in industrial and commercial sectors for their high durability and puncture resistance. Sri Lanka is a significant manufacturer of industrial solid tyres, with a market share of 20-25% and solid tyres accounting for 61% of the export value of rubber products [1, 2]. Solid tyre manufacturing involves the use of solid tyre moulds and compression moulding techniques, which require precise temperature and pressure control to ensure consistent quality and performance.

One of the critical issues in solid tyre moulding is the deformation and formation of cracks in mould parts, which can significantly impact the quality and performance of the resulting tyres. Despite extensive research in the field of tyre manufacturing, there is a significant gap in the investigation of solid tyre mould deformation and its impact on fatigue failure. Furthermore, there is a lack of studies that address preventative measures or maintenance strategies for mould deformation.

The primary focus of this research is to identify the root causes of clamping-type solid tyre mould deformations and part failure. In this study, a theoretical equation for rubber pressure was developed based on rubber compressive stress-strain testing data, and an experimental setup was constructed to measure pressure values in various sizes of tyre mould cavities during the tyre curing process. The accuracy of experimental pressure values was verified by comparing them with the values calculated from the developed equation. The strength of mould components were assessed by examining their stress and deformation using both practical data and finite element analysis. Further simulations were carried out to predict the fatigue life of mould parts under the cyclic loads applied by the tyre curing presses. The main outcomes of this research involve deriving a calculation equation for solid tyre mould pressure and developing a method to evaluate the fatigue life of solid tyre moulds. The research outcomes hold significant value for tyre manufacturers as they enable the prediction of maximum pressure and calculation of fatigue life cycles, allowing for the enhancement of tyre mould assemblies and clamping mechanisms to minimize deformation and improve durability. Furthermore, The solid tyre mould pressure calculation equation and the fatigue life evaluation method developed in this study can be further applied to other types of rubber product moulds and pressure vessel design applications.

Keywords: Fracture Propagation, Finite Element Analysis, Tyre Mould, Deformation.

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