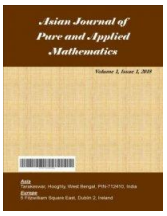

Asian Journal of Pure and Applied Mathematics

3(3): 9-28, 2021; Article no.AJPAM.606

Modeling of Tire-Road Surface Interaction under Wet Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Received: 30 August 2021
Accepted: 10 November 2021
Published: 12 November 2021

Original Research Article

Abstract

The occurrence of wet-weather accidents, from the perspective of the road surface characters caused by poor fluid friction obtained from the tire hydroplaning has for many years been a challenge for various road authorities. Any traction failure throughout high rushing causes fatal accidents and loss of most human lives. Many researchers, since the 1920s focused on aspects of measurement and prediction of fluid friction and the development of strategies to reduce wet-weather condition accidents. Despite the improvements in measurement techniques, the understanding of hydroplaning mechanisms has not improved much over the past decades due to a lack of development in the theoretical and numerical models that can explain and simulate the mechanisms. The study aims to model a tire-road interaction using finite element method to analyze fluid friction forces and hydroplaning effects during wet conditions. The findings show that the hydroplaning speed decreases with increasing water film thickness and tire inflation pressure i.e. a water thickness range of 1mm to 10mm generated a speed of 48.1m/s to 46.3m/s while as tire pressure range of 100kPa to 250kPa generated a speed of 42269.8m/s to 42261m/s. It was also observed that fluid friction force decreases with increasing tire sliding speed and water film thickness.

Keywords: CFD; ansys fluent; tire-road surface interaction; wet conditions.

1 Introduction

Tire slip on the road surface is a complex problem that involves the interaction of fluid dynamics with the contact mechanics of a load-carrying, pressured, complex pneumatic tire structure with a rough macro texture of the road surface. It can also be seen as a progressive violation of a water chunk into the tire-road contact area which results in the build-up of hydrodynamic forces on the tread portion of the tire which at

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3.4.3 Comparison with field experiments

In a study by [23], Locked wheel skid tests were performed at a selected site on a wet road surface with an average water film thickness of 6.5 mm at four different speeds (30mph, 40mph, 50mph, and 60mph). Field measurements were observed on the test wheel path using a CT meter and results were input into the MATLAB program that generated randomly the rough road surfaces. The model was assigned the same water film thickness values and the analysis was performed for different speeds while calculating fluid friction forces. It was observed that based on the experimental results and simulated numerical results, both results showed to closely related hence this shows that the proposed model is capable of simulating fluid friction between the tire, water film thickness, and the road surface.

4 Conclusions

The paper analyses the effect of water film thickness and tire inflation pressure on hydroplaning speed and fluid friction using a tire-water interaction model developed using Ansys fluent. The tire was tested at different water film thickness and tire inflation pressure. From the results obtained we conclude that that tire hydroplaning speed on a wet road surface is highly related to tire configurations and other operating conditions like water film thickness on the road surface that is more affected by road surface geometric factors. These factors should be considered together when developing safety improving countermeasures for driving safety.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Competing Interests

Authors have declared that no competing interests exist.

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