ANALYSIS OF TIRES VERTICAL LOAD SENSITIVITY USING A SEMI-EMPIRICAL MODEL

Abstract. *The study of tire performance is essential in the development of suspensions for motorsport vehicles. Over time, numerous models have been developed to estimate tire behavior under various parameters, including vertical load. This research specifically explores the influence of vertical load on a racing tire used in Formula SAE prototypes, with a focus on its lateral performance and to estimate grip loss due to lateral load transfers. The investigation began with the collection of lateral force data for a tire used by Formula SAE teams, measured under five distinct vertical loads. These data were obtained through empirical testing, sourced from a company that provides a widely recognized database for tire analysis in Formula SAE competitions. With this information in hand, the tire was modeled using a semi-empirical curve-fitting method, which allowed for the calculation of at least eighteen coefficients derived from the real data obtained during the tire tests. This modeling process allowed for the identification of the tire's optimal operating conditions, where it achieves the highest lateral force output for any given vertical load. In addition, by considering the real-world parameters of the center of gravity position and the mass of a Formula SAE prototype, both the static and dynamic loads applied to each tire were estimated with a high degree of accuracy. This approach allowed for a more precise analysis of the lateral performance of each tire under the influence of lateral load transfers. The study further revealed a trend of decreasing vehicle lateral performance as lateral load transfers increase, a consequence of the non-linear nature of tire grip. This observation underscores the importance of addressing this phenomenon during the design phase of racing vehicles. Ultimately, this work seeks to present a methodology that contributes to automotive engineering by advancing the study of lateral vehicle dynamics, particularly within the context of student-level high performance vehicle design.*

Keywords: *Tire Analysis. Vertical Load. Lateral Load Transfer. Formula SAE. Semi-Empirical Model.*