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EFFECT OF LAYER THICKNESS AND TYRE FOOTPRINT IN THE FLEXIBLE PAVEMENT DESIGN

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Abstract: The accuracy of any pavement deformation modelling depends greatly on the traffic characteristics, pavement structural properties and climate conditions. A clear understanding of structural changes of each layer with respect to the load, thickness of layers, speed and temperature are necessary to model the pavement deformation.

This paper discusses the essential understanding of the process of pavement deformation, including the effects of assuming constant modulus of the pavement layers, the stress dependent modulus of the pavement layers, and contact stress distribution between the tyre and the road.

Keywords: Finite element modelling; UMAT; Pavement response

1. Introduction

Road design plays an important role in the development of any nation. The standard Sri Lankan road consists of an asphalt surface layer and an unbound granular base course layer on subgrade. The granular base course layer distributes the wheel load and decreases shear stresses on subgrade layer. It is vital for a road design engineer to come up with an effective and optimised pavement design. Permanent deformation in roads can lead to decreased durability which can lead to serious safety and financial issues. The deformation can become more serious due to increased and repeated axle loading. Therefore, a careful study of the optimal cost, durability required and design parameter values for new road development is important. This can be done efficiently using numerical modelling, particularly through the use of finite element modelling.

In the recent past many roads are constructed in Sri Lanka with linking and widening existing roads, which cause uneven settlement and surface cracking along the joint between the old and new roads. The current mechanistic road pavement designs in Sri Lanka are based on empirical methods, according to Road Note 31, published by the Transport Research Laboratory about 30 years ago [Mampearachchi *et al.,* 2016]. This method puts a ceiling on limits of the material properties to input and as a result, most of the base course and subgrade materials available in the country cannot be used for the road construction in an optimal way. This condition has triggered shortage of pavement materials. This has also lead to an over-estimated or under-estimated pavement layer thickness.

This method described in the Road Note 31 calculates the elastic response of the road under static loading. It ignores the dynamic nature of the load and the nonlinearity of the material behaviour and these assumptions can lead to many errors [Bagshaw *et al.,* 2015; Kathirgamanathan *et al.,* 2014; Saleh *et al.,* 2007; Steven *et al.,* 2007; Tutumluer., 2008]. Further loads are defined as a constant pressure applied on a surface rather than a real tyre footprint. A review of literature [Gonzalez., 2009] for measuring contact stress distribution between the tyre and the pavement has shown that the traditional method used for the application of traffic loads does not conform to reality. Some reasons for this include: (a) Non-circular tyre imprints; (b) Non-uniform vertical pressure; (c) Mean vertical load pressure is not equal to the