FOOTPRINT SHAPE AND COMPONENT STIFFNESS ON ROLLING RESISTANCE OF TYRE

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A combined analysis of the two equations for rolling resistance R, one based on the whole tyre hysteresis ratio and a second one based on the tyre spring rate, indicated that the tyre parameters namely, the hysteresis ratio (h), the footprint dimensions width (w) and area (A) and the radial stiffness (K) were the first order effects that affect the rolling resistance. The rolling loss reduction with reduced tread width was explained by the footprint shape term (w/A) rather than by the tyre weight loss values. The K was partitioned into component stiffness values. The K value was approximately equal to 8 per cent of tread stiffness K(t), 15 per cent of carcass stiffness K(c) and 75 per cent of inflation pressure stiffness K(a) for a P195/75R14 size tyre for its working pressure range (207 -262 kPa). The K(a) term was evaluated for the first time for this tyre.

Key words: Component stiffness, Footprint shape, Rectangularity, Rolling resistance, Tyre.

INTRODUCTION

Rolling resistance of tyre is a physical property of interest to both the tyre and the automobile industries because of its direct effect on gasoline (petrol) consumption. Extensive research has been focused on how changes in tyre compound properties and tyre design parameters can help in reducing tyre rolling loss. The effects of compound properties have been published by Collins *et al.* (1965) and Willett (1973). Clark and Schuring (1988) applied thermal modeling approach to estimate the rolling resistance value. Schuring (1980) has published an extensive review on tyre rolling loss. Balbis (1983), Pillai and Fielding-Russel (1991) and Pillai (1993) studied the relation between tyre design parameters and the rolling loss. The present study is a further extension of the tyre design parameter approach. Pillai and Fielding-Russel (1992) developed a model equation for rolling resistance (R) in terms of the whole tyre hysteresis ratio (h) and the footprint dimensions, width (w) and area (A). Considering the tyre as a loaded spring and L as the tyre load, a second equation was obtained in terms of the potential energy stored in a loaded deflected tyre using its tyre spring rate or radial stiffness (K). The two model equations were combined and a resultant equation for R was obtained as

R(coefficient) = L.(w/A) x (h/K) ....(1)

A preliminary abridged version of these results was presented earlier (Pillai, 2000a). A more detailed experimental procedure and an extensive discussion and analysis of additional results are attempted here.

Equation (1) above suggested two simple methods to reduce tyre rolling loss: one by manipulating the footprint dimensions to reduce (w/A) value and the other by

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