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Off-road tyre modelling IV: extended treatment of tyre-terrain interaction for the multi-spoke model[☆]

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Abstract

Accurate prediction of the performance of an off-road vehicle depends largely on the model of the tyre–terrain interaction. One of the fundamental tasks in the characterisation of terrain behaviour is to establish functional relationships that can realistically describe the pressure–sinkage relationship and shear stress–shear displacement relationship. Because the structure, as well as the behaviour of natural terrain varies greatly, it seems unlikely that a unified theory or method can be developed in the foreseeable future to adequately describe the normal and shear stresses at the interface between an off-road tyre and the terrain. However, the forces generated at the interface between tyre and soil are affected by the stresses acting on the contact patch so a model which describes these stresses well leads to an accurate indication of off-road vehicle performance. In this paper, a novel model including an extended treatment of tyre-terrain interaction was developed. In this model, a new description of the pressure–sinkage relationship and shear stress–shear displacement relationship was derived. The multi-spoke tyre model was used to predict the off-road tyre forces with the application of a new description of the terrain behaviour. A computer program using MATLAB software was developed to complete the study. A comparison between the results of the multi-spoke tyre model in two different cases with the application of two different theories of terrain behaviour is presented. The results are shown as tyre forces and moments in the three directions along the contact tyre length. It is clear from the results of the multi-spoke tyre model that the extended treatment of the terrain behaviour is a useful tool to describe the tyre–terrain interaction stresses, and it is helpful in improving the understanding of the tyre–soil interaction.

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