Simulation of the Tractive Performance of Tire Treads on Granular Terrain by Means of FEM - DEM Coupling

Mark Michael*, Bernhard Peters* and Frank Vogel†

* Faculty of Science, Technology and Communication (FSTC)
University of Luxembourg
6, rue Coudenhove-Kalergi, L-1359 Luxembourg, Luxembourg
e-mail: mark.michael@uni.lu, web page: http://www.xdem.de

† inuTech GmbH
Fürther Strasse 212, 90429 Nürnberg, Germany
email: frank.vogel@inutech.de - Web page: http://www.inutech.de

ABSTRACT

The numerical simulations presented in this study investigate into the tractive performance of different tire treads on granular terrain. The proposed Extended Discrete Element Method (XDEM) as a combination of the Discrete Element Method (DEM) and the Finite Element Method (FEM) allows to sufficiently resolve the different domains involved in this engineering application [1]. Herein the motion of each grain is accounted for individually. Simultaneously, the finite element method accurately predicts the deformations experienced by the tire tread. Thus, the simulation domain occupied by the tire is efficiently described as a continuous entity. The coupling of both methods is based on the interface shared by the two spatially separated domains. The interface coupling enables to apply a contact model suited to the particular contact behaviour between the grains and the tread surface. In contact, forces develop at the interface and generate an impact in each domain. The coupling method enables to capture both responses simultaneously. Each grain in contact with the tread surface generates a contact force to which it reacts repulsively. The contact forces sum up over the surface and cause the tire tread to deform. It further employs a fast contact detection algorithm to save valuable computation time [1]. This concept is supported by the software tools of the Discrete Particle Method (DPM) and Diffpack. The tractive performance of four different tire treads has been studied on a soil layer of the material sand. The simulations were conducted in accordance to measurements of forced slip behaviour of the different tread patterns. The contact forces at the surface of smooth, lug, rib and block tread patterns are captured at different slip values for each tread. The simulation results are used to analyse the gross tractive effort, running resistance and drawbar pull of the different tread patterns in sand.

REFERENCES

[1] M. Michael, B. Peters and F. Vogel, “Resolution of Different Length Scales by an Efficient Combination of the Finite Element Method and the Discrete Element Method”, in Proceedings of the Eleventh International Conference on Computational Structures Technology, B.H.V. Topping, (Editor), Civil-Comp Press, Stirlingshire, United Kingdom, paper 249, (2012).

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Keywords: Finite Element Methode (FEM), Discrete Element Methode (DEM), DEM – FEM Coupling Simulations

Simulation des Traktionsverhaltens von Reifen auf granularem Untergrund durch Kopplung zwischen FEM und DEM

Stichpunkte: Finite Element Methode (FEM), Discrete Element Methode (DEM), Gekoppelt DEM – FEM Simulationen