3D DEM – FEM Coupling to Analyse the Tractive Performance of Different Tire Treads in Soil

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ABSTRACT

This contribution investigates the tractive performance of different tire treads on granular terrain by an efficient combination of the Discrete Element Method (DEM) and the Finite Element Method (FEM). The proposed coupling method has been shown to be a sufficient technique when resolving the different length scales involved in engineering problems dealing with granular assemblies in contact with deformable bodies [1][2].
Herein, the extended discrete element method (XDEM) is used to describe the dynamics of the granular assembly. Thereby the discrete approach accounts for the motion and forces of each grain individually. On the other hand, the finite element method accurately predicts the deformations and stresses acting within the tire tread. Hence, the simulation domain occupied by the tire is efficiently described as a continuous entity.
The coupling of both method is based on the interface shared by the two spatially separated domains. The interface coupling enables to apply a contact model fitting the particular contact behaviour between the grains and the tread surface. Thus, contact forces develop at the interface and propagate into each domain. The coupling method enables to capture both responses simultaneously. Each grain in contact with the tread surface generates a contact force which it reacts on repulsively. The contact forces sum up over the surface and cause the tire tread to deform. The resultant stresses are then again recognised by the granular assembly.
The coupling method compensates quite naturally the shortages of both numerical methods. It further employs a fast contact detection algorithm to spare valuable computation time [1].
The proposed DEM-FEM Coupling technique was employed to study the tractive performance of four different tire treads on a soil layer of the material sand. The simulations were conducted in accordance to the experimental measurements undertaken by Shinone et al. [3]. The contact forces at the surface of smooth, lug, rib and block tread patterns are captured by 3D simulations of different slip values of each tire 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

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