Effect of wall roughness on interface behavior of DEM-simulated granular material

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ABSTRACT

When fresh concrete is being placed in forms or during concrete pumping, a lubrication layer, called "boundary layer" is formed at the interface. The friction between the concrete and the wall (form or pipe) is closely linked to the formation and properties of this layer. To determine the tribological features of this layer, earlier experimental work has been conducted by using a plane/plane tribometer [1]. The results proved that the shear strength between a surface and the concrete is governed by the pressure and the surface properties (roughness).

Moreover, several studies in geotechnical engineering using different testing devices showed that the behavior of the granular materials such as soils near the interface is closely related to soil deformations experienced by structures. These examples show how important it is to understand and to characterize the shear strength and the behavior at the interface between granular material and rough surfaces. However, such studies are impossible by experiments due to difficulty in collecting microscopic information. The Discrete Element Method (DEM) is a useful tool to model at grain scale the interface granular material – rough wall. To simulate such an interface, the main challenge is to be able to simplify its complexity and to focus on determining the effect of roughness on the granular behavior.

This work aims to study the effect of surface roughness on the shear strength and the granular material behavior near the interface for various shearing conditions. An irregular roughness is modelled by monodispersed spherical particles glued on a horizontal plan. Regarding the granular medium, which is simplified by slightly polydispersed spheres, it is sheared between two rough walls. The walls are moving horizontally in opposite direction at a fixed velocity. In each simulation, the shear stress has been measured and the mean velocity profile has been plotted.

The results of the numerical simulations showed that the roughness is an essential parameter which affects the shear stress and the mean velocity profile. For a particles roughness diameter larger than the average particles diameter of the granular material, the medium is uniformly sheared and the shear strength reaches a constant value. For smaller diameter of the particles roughness, shear localization was observed. In this case, the shear stress increases with increasing roughness particles diameter.

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