Comparisons of shear strength of particulate materials determined by the direct shear test and DEM simulations

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ABSTRACT

The shear strength is a very important property of granular materials in geotechnical design and analysis. It can be measured by standardized laboratory tests such as the triaxial test and the direct shear test. Though using the triaxial test can get more reliable values of shear strength, the direct shear test is mostly performed to determine shear strength of granular materials, especially in the design of storage because of its simplicity and repeatability. In our study, the bulk material is an assembly of man-made ceramic balls with two diameters ranges, e.g. 14 – 17 mm and 29 - 35 mm. Such bulk material is typically used in design of thermal energy storage units. To measure the shear strength of such particulate materials with such large particles, the direct shear test is more suitable than the triaxial test.

This paper presents the two direct shear tests [1] used to measure shear strength of particulate materials with large particles. These tests have been numerically simulated using discrete element method [2]. Due to different packing methods in numerical modelling, three different simulations were performed which varying the material parameters of particles (i.e. friction and rolling friction of particles and between particles and walls) [3].

Numerical results are compared with laboratory tests results. Though initial agreement of the cohesion results between laboratory tests and numerical simulations was not completely satisfactory, the friction angle results obtained from numerical simulations matched closely with those observed in laboratory tests. The reasons for discrepancies of cohesion results between numerical and laboratory tests are analysed in this paper. Moreover a reasonable method to minimize the effects of these differences is presented.

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