# UNIAXIAL COMPRESSION OF SPHERICAL AND NON-SPHERICAL GRANULAR SOLID

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The behaviour of a granular solid subject to uniaxial compression is relevant to numerous scientific and industrial applications. This paper describes a closely matching set of experiment and discrete element computation of vertical compression of a granular solid in a cylinder. The primary objectives for the study were to investigate the accuracy of discrete element method (DEM) in predicting the response of such a system and to investigate the relative importance of DEM input parameters for producing satisfactory predictions. Since the majority of DEM computations in the literature were not validated or compared with experiments, it was deemed useful to conduct a careful DEM validation study where the input parameters were not assumed but measured directly in laboratory tests.

The uniaxial compression setup was designed to investigate the mechanical response of a granular material under vertical loading and the load transfer to the containing walls. The experiment consists of an instrumented Perspex cylinder which was filled with the test solid. A load was applied to the test solid contained in the cylinder through a top platen driven by an INSTRON machine at a constant displacement rate. The applied load and vertical displacement were measured using the INSTRON machine. The force transmitted to the walls was measured using four pairs of strain gauges equally spaced around the cylinder walls in both circumferential and axial directions. The vertical force transmitted to the bottom platen was measured by another load cell. Experiments were conducted on glass beads and corn grains so that a comparison can be made between spherical and non-spherical particles.

DEM computations of the experiments were performed and compared with the experimental observations. The corn particle was represented using overlapping spheres to match the measured average major, intermediate and minor dimensions. A 4-sphere representation was chosen to manage the computational effort required for the large number of simulations planned. Spherical particles have a tendency to rotate more than non-spherical particles and may exhibit quite different behaviour from non-spherical particles, so it is important to study both systems. The required mechanical and geometrical properties for the particles were measured carefully in laboratory tests for use in DEM computations. The sensitivity of DEM prediction to the key input parameters was also explored.

The paper presents a close comparison of the experimental and numerical results which reveals several interesting observations. The well known Janssen equation was used to represent the state of bulk stress in the granular solid: a comparison can thus be made between the measured and the DEM predicted values of the lateral pressure ratio K and the bulk wall friction $\mu$. It shows that DEM can produce many satisfactory predictions but for a number of reasons discussed in the paper, it may not always produce an accurate prediction. Thus it is important to have an understanding of the key parameters that must be accurately represented to give satisfactory predictions. It is also found that whilst it is important to use the correct particle stiffness parameter when attempting to predict the deformation response of a granular assembly, this may not be so important for predicting the force transmission in a dense quasi-static system.

**Keywords:** uniaxial compression, discrete element, compaction