

Forces on obstacles in flowing granulate

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In ordinary fluids, Stokes or Newton friction describe forces acting on obstacles very well. Granular material can flow in many situations as well, but the interactions with embedded objects are much more complex and only little understood. We performed experiments and numerical simulations with spheres that were suspended in flowing granulate. A vertical tube with an outlet of variable size is filled with grains. When the outlet is opened, the material flows downward with a velocity that can be controlled by the outlet size. The forces on a spherical obstacle are measured and compared to DEM simulation results. For rigid frictional grains and soft, low-frictional grains, very different force characteristics are found. A model is presented that explains the observations qualitatively and quantitatively.