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Effect of fines and grain size distribution on pore fluid pressure and velocity profiles in large scale experimental debris flow

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Shear rate and pore fluid pressure are important parameters for understanding the flow mechanics of geophysical flows, like debris flows. To assess the importance of fines content and grain size distribution on the generation and dissipation of pore fluid pressure and on the of shear rate in the vertical direction within the flow, we conducted experiments in a 4-m diameter rotating drum at the University of California at Berkeley. A probe to determine the mean particle velocity at different depths within the flow has been developed. The probe is based on measuring small variations in conductivity of the passing material and calculating the time lag between signals from two independent measurements at a small, known distance apart. Additionally, flow depth as well as pore fluid pressure and normal stress at the base of the flow were measured. We carried out a series of experiments with uniform gravel-water mixtures and mixtures with a wide grain size distribution, both with varying fine sediment concentrations. Averaged results of pore fluid pressure measurements range from hydrostatic conditions for gravel-water flows to nearly complete liquefaction for muddy mixtures having a wide grain size distribution. Velocity profiles mostly show the highest shear rates in lower region of the flow and the presence of fines tends to reduce the velocity in the upper layers. These measurements, as well as complementary discrete element modeling, seem promising to enhance the understanding of the flow mechanics of our laboratory debris flows and may help to improve constitutive models that describe natural events.