Bachelor Thesis

The effect of material properties (sand vs. glass beads) on the structural development of analogue Coulomb wedges

Bachelorarbeit zur Erlangung des Grades Bachelor of Science (BSc.)
am Department für Geo- und Umweltwissenschaften
der Ludwig-Maximilians-Universität München
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Abgabetermin: 24.08.2010

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München, den 17.08.2010

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1 Abstract

This study aims at investigating the effect of material properties of granular materials on the structural development of convergent Coulomb wedges in analogue experiments. Analogue materials used in this study include natural quartz sand, glass beads of different grain size (40-800 μm) and corundum sand. Internal friction and cohesion of analogue materials, as well as basal friction and cohesion of material on Alkor foil are both measured with the Schulze Ring-Shear-Tester. The influence of sieving style on material properties and experiment outcome is investigated by performing experiments in which material is sieved from heights of 10 cm to 90 cm by different people and the resulting bulk density of the granular material is measured. A series of systematic analogue experiments in both the push and pull setup are performed for different analogue materials. The experiments are documented with digital sidewall pictures and 3D laserscanning. The digital images are evaluated with Particle Image Velocimetry (PIV) to visualize the strain evolution over time. Thrust spacing, activation time and reactivation of in-sequence thrusts are measured for each experiment. A new spatially and temporally high-resolution approach to measuring surface slope is introduced and applied to image analysis and to the evaluation of profiles obtained with laserscanning. This allows the visualization of the temporal development of surface slope, wedge width and wedge height. This procedure is compared to other methods of determining surface slope. The effect of sidewall friction on experiments is quantified by measuring lateral changes in surface slope. This dataset is also used to identify the main differences between pushed and pulled wedge experiments. Surface slope was found to be highly transient for pushed wedge experiments, whereas it reached and attained a stable value in pulled experiments. Pushed wedges are supercritical and they typically exceed the critical surface slope by 5-15°. Wedge width and wedge height grow as square root functions of convergence. The density of granular material is highly dependent on sieve height. Sieving from a height of less than 50 cm produced a bulk density that was up to 10% less than the maximum bulk density. Glass beads were found to produce a more regular structure of in-sequence-thrusts in both, space and time, than sands, while displaying less variability. Pushed wedges are not described by Critical Taper Wedge Theory, because they exceed predicted surface slope by more than 5-15°.