HYDROFRACTURE PATTERN FORMATION DURING CENTRAL AIR INJECTION IN GRANULAR MATERIALS CONFINED IN THIN LAYERS

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Fluid injection in a granular material confined in thin layers leads to the formation of high permeability channels very localized, where fluids flow preferentially. This phenomenon is of primary importance for the understanding the role of fluids overpressures and leakage in saturated lowly consolidated gouges or sedimentary rock layers between cap-rocks in the presence of localized fluid sources. In an analogous model, we investigate the pattern formation during central air injection in a metric Hele-Shaw cell consisting of two metric glass plates with fixed 1mm separation filled with fine compacted granular material - glass beads from 70 to 150 microns diameter. In a loosely compacted material between horizontal plates, air is injected in the center at constant pressure of a few bar percents. This leads to the formation of wide fingers empty of grains analogous to viscous fingering in the central region, followed by thin branching fingers and eventually very localized displacement structures analogous to brittle cracks further away from the injection point. Fluid drag is balanced by the friction exerted by the confining cell, a compacted region being observed to grow indepth in front of the fingers as they propagate. The geometry and dynamics of these structures are characterized as function of the injection pressure. We also investigate this phenomenon using a coupled granular/fluid flow simulation model, where quasi two dimensional granular columns are submitted to fluid pressure gradients, central repulsive contact forces and Coulomb friction along the confining walls, while the fluid obeys a Darcy equation whose permeability is set by a coarse grained local solid
fraction. The main features of the experimental patterns are so recovered and studied.