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Revealing the strong backbone of natural granular flows using photoelastic methods

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Active geological faults, landslides, debris avalanches and volcaniclastic flows as well as many industrial processes all involve significant accumulations of granular material subjected to tectonic, mechanical or gravity driven loading. Their macroscopic motion (or rheology) is thus a direct consequence of the processes operating in this sheared granular material. However, the rheology is far from straightforward or predictable and commonly evolves as the granular flows themselves propagate. A key question in these environments is how the local behaviour at the individual granular contacts scale, actually scales up to influence macroscopic sliding.

Force chains (or grain bridges) are a ubiquitous phenomenon expressing how loads are transmitted across ideal granular materials under shear. They preferentially exploit a selective subset of frictional particle contacts leading to a highly heterogeneous distribution of load. Some grains ‘feel’ higher forces than average and therefore have significant fragmentation potential whilst other grain clusters experience very low relative loads resulting in enhanced mobility. Force chains play a crucial role in coupling grain scale processes with macroscopic flow regimes and when they form system spanning networks are likely to be of central importance in understanding the mobility of a range of geohazard relevant granular flows. A key challenge is that in nature and many rock deformation experiments we simply cannot directly see these intriguing but ephemeral features.

Here we explore the use of photoelastic techniques to visualise the force distributions appearing in 2D granular material under shear [1]. The approach exploits the optical property that certain materials rotate polarized light according to the amount of local stress they feel – thus allowing us to ‘see’ how force distributions develop under load. By tracking particle motions and mechanical resistance to applied shear, we can connect grain processes with emergent system spanning force networks and resulting macroscopic behaviour. Results are compared with those from computational work [2].

This approach has potential application to range of natural systems since these strong-yet-fragile load bearing skeletons are likely to control the strength, stability and dynamics of landslides, volcanic debris avalanches and earthquake faults.

[1] Daniels, K. and Hayman, N. (2008), JGR, 113, B11411, doi: 10.1029/2008JB005781
[2] Mair, K., and Hazzard, J.F., (2007) EPSL,10.1016/j.epsl.2007.05.006, 259 (6), p469-485