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The crossover from random close to random loose packings of frictional disks[1]

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Mechanically stable packings of frictionless disks with contact interactions form through fast quenches at random close packing (RCP). However, for frictional particles with static friction coefficient μ greater than μ^*, the packing density slides toward random loose packing (RLP) at large friction. We elucidate the crossover from random close to random loose packing through simulations of bidisperse disks using the geometric asperity (GA)[1] and Cundall-Strack (CS) friction models. We demonstrate that a change takes place in the structure of allowed mechanically stable packings in configuration space: From uncorrelated points at zero friction to linear and other low-dimensional structures at small friction to higher dimensional structures at large friction. Further, we use the GA model to study dynamical mechanical properties without ad hoc assumptions for sliding contacts, and we find that low-frequency vibrational modes with significant rotational content display a strong peak below μ^*. Their rotational content drastically changes from co-rotating contacting particles for low friction to counter-rotating, gear-like, for μ greater than μ^* and the groups of particles with gear-like dynamical contributions percolate at μ^*. Finally, the very existence of the low-frequency vibrational peak gives rise to a change in the scaling of the static shear modulus with pressure compared to the frictionless behavior.

[1] S. Papanikolaou, C. S. O' Hern and M. D. Shattuck, arxiv:1207.6010 (2012)

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