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Transitions from jammed to flowing granular matter[1]

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In static and slowly flowing granular materials forces are transmitted through a network of direct particle contacts. We experimentally examine how the contact networks fails and rearranges as granular matter starts to flow. Through surface measurements and 3D imaging of particle motion and forces we deduce how a granular contact network breaks and re-forms under shear forcing and point forcing. At small forcing, in the jammed state, we observe that low probability "jumps," in which a grain moves significantly more relative to the others, play a significant role in the relaxation of the jammed state[1]. Under larger local forcing, the jammed state fails and grains rearrange locally. The characteristics of this rearrangement sensitively depend on the number density of particles and direction of forces that had been applied to jam the material (history dependence). If the direction of principal stress is changed (e.g. by changing the shear stress direction), the contact network breaks everywhere. The material is transiently weaker, more compact, and exhibits linear strain until a new contact network forms cooperatively[2]. [1] WL and M. Toiya with P. Ribiere, P. Richard, R. Delannay and D. Bideau to appear in Phys Rev. Lett. (2005). [2] M. Toiya, J. Stambaugh, and WL, Phys Rev Lett. 83, 088001-1 (2004).

[1]with M. Toiya. Supported by NASA Grant NAG-32736 and NSF Grant CTS0457431