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Stress supporting structures from interlocking in random packings of granular materials ERIC BROWN, SHOMEEK MUKHOPADHYAY, Yale University, ALICE NASTO, Massachusetts Institute of Technology, SULIMON SATTARI, DAVID BRANTLEY, KEVIN MITCHELL, University of California, Merced — We present experimental results and a model for strong strain-stiffening in random packings of interlocking granular materials such as chains and staples. Measurements of stress vs. strain are made on the materials under uniaxial compression, along with x-ray tomography to observe interlocking. These packings are found to exhibit strain-stiffening and sustain stresses several orders-of-magnitude beyond those of unconfined granular materials as long as there are system-filling clusters of interlocked particles. To model this behavior, we use a mean-field theory approach. First, the conditions for system-filling clusters can be predicted by by using the area available for interlocking for a given particle shape and a random network model. This model correctly predicts, for example, the minimum chain length required to have system-filling clusters. In this strong regime, the packing stiffness can be calculated using the link stiffness, mean strain on each link, and the probability of tight links, which agrees with experiments within a factor of 2. This model explains the strength of these packings as coming from stretching the links between interlocked particles, and strain-stiffening as a result of increasing number of tightly interlocked particles with increasing strain.

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