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Rigidity loss in disordered network materials WOUTER G. ELLENBROEK, Eindhoven University of Technology, VARDA F. HAGH, AVISHEK KUMAR, Arizona State University, M.F. THORPE, Arizona State University and University of Oxford, MARTIN VAN HECKE, Leiden University and AMOLF — Weakly jammed sphere packings show a very peculiar elasticity, with a ratio of compression modulus to shear modulus that diverges as the number of contacts approaches the minimum required for rigidity. Creating artificial isotropic network materials with this property is a challenge: so far, the least elaborate way to generate them is to actually simulate weakly compressed repulsive spheres. The next steps in designing such networks hinge upon a solid understanding of what properties of the sphere-packing derived network are essential for its elasticity. We elucidate the topological aspects of this question by comparing the rigidity transition in these networks to that in other random spring network models, including the common bond-diluted triangular net and a self-stress-free variant of that. We use the pebble game algorithm for identifying rigid clusters in mechanical networks to demonstrate that the marginally rigid state in sphere packings is perfectly isostatic everywhere, and the addition or removal of a single bond creates a globally stressed or globally floppy network, respectively. By contrast, the other classes of random network random networks show a more localized response to addition and removal of bonds, and, correspondingly, a more gradual rigidity transition.

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