Modeling of Granular Solids under Extreme Compaction

ABSTRACT
Consolidation of granular materials is a widely utilized manufacturing process in several industries ranging from ceramic processing, to energetic solids to pharmaceutical products. The response of solids produced via compaction exhibits a distinctive behavior resulting from the microstructure that develops during the formation process. In this presentation, we examine the evolution of the microstructure during consolidation and its impact on the resulting solid properties. In order to properly account for this microstructural evolution, predictive constitutive models of inter-particle interactions for high levels of confinement and a variety of physical mechanisms are needed. We have developed a new nonlocal contact formulation that overcomes the typical, but unrealistic, assumption that contacts are independent regardless the confinement of the granular system. This formulation has been incorporated into a fully discrete model that concurrently solves for contact forces at the granular scale, for nonlocal deformations at the mesoscale, and for static equilibrium at the macroscale. The numerical experimentation reveals a distinctive behavior between the initial stages of consolidation characterized by a well-know process of jamming, and the subsequent regime or post-jamming response where non-local particle interactions play a significant role. One of the key observations from the numerical studies is that the force network distribution evolves differently in the interior and the boundary of the granular solid as confinement is increased. The implications of these predictions are expected to play pivotal role in manufacturing by powder compaction as well as in the understanding of the physics of granular solids.

BIO
Dr. Alberto Cuitino, Professor and Chair of Mechanical and Aerospace Engineering at Rutgers, is currently the Site Director of the NSF Engineering Research Center for Structured Organic Particulate Systems, which brings together a cross-disciplinary team of engineers and scientists as well as industry leaders to improve the way pharmaceuticals, foods and agriculture products are manufactured. C-SOPS is advancing the scientific foundation for the optimal design pharmaceutical products with advanced functionality while developing the methodologies for their active control and manufacturing. Dr. Cuitiño received a Civil Engineering Diploma from the University of Buenos Aires, Argentina, in 1986, and a MS degree in Applied Mathematics and a Ph.D. degree in Solid Mechanics from Brown University in 1992 and 1994, respectively. His research interests include pharmaceutical manufacturing, material modeling and simulations, dislocation mechanics, fracture in metal single crystals, granular materials, mechanical behavior of solid foams and folding patterns in thin films. Dr. Cuitiño served as editor of Mechanics a publication of The American Academy of Mechanics and as subject editor for Applied Mechanics of Latin American Applied Research.

Refreshments will be served at 3:45 p.m.
Hosted by Amine Benzerga