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MECHANICAL ENGINEERING COLLOQUIUM SERIES 2015-2016

Mechanical Engineering Lecture in Mechanics

The Curious Nature of Granular Flows: Continuum Modeling and Computation

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On Friday, October 23rd at 4:00pm in 3-370

Granular matter is very common – sands, soils, raw materials, food stuffs, pills, powders – but the challenge of predicting the motion of a collection of flowing grains has proven to be a difficult one, from both computational and theoretical perspectives. Grain-by-grain discrete element methods can be used, but these become computationally unrealistic for large systems and long times. A broadly accurate continuum model would be ideal as it could provide a much faster means of calculating flows and stresses in real-world problems, such as those encountered in industry and geotechnical applications.

Motivated by this challenge, in this talk we present a new constitutive relation for granular matter, which is shown to produce quantitatively accurate predictions. The model emphasizes the key importance of cooperativity in the granular flow process through the inclusion of a grain-size-dependent length-scale within the rheology. Upon calibration of the model's three material parameters, solutions of the model are shown to be in quantitative agreement with over 160 experiments in several different families of geometries, including the notorious split-bottom cell. The same model is then shown to reconcile a number of other unusual features of granular media, such as the motion-induced "quicksand" effect, wherein flow at one location effectively removes the yield stress everywhere, and the observation that thinner granular layers behave as if they are stronger.

The talk will close with several ongoing directions in our group including new applications in vehicular locomotion on loose terrain, and the expansion of our modeling approach to wet particulate media.

Refreshments will be served before the seminar.
Please contact Tony Pulsone at pulsone@mit.edu with any questions.

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