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Similarity theories and size effects in DEM modeling cohesive materials

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Abstract: The discrete element method (DEM) is a powerful numerical tool for modeling the mechanical behavior of cohesive materials. In recently years, DEM has been extensively applied to rocks, soils, concretes and ceramics. Since material properties concerned cannot be input into DEM simulation code, in contrast to FEM for instance, the model parameters of DEM must be calibrated with numerical experiments in the context of inverse analysis. Similarity theory will play a very important role in this procedure. Due to the limitation of computational resources at present, simplified mechanical models are needed to be employed in DEM, and inevitably, a much smaller number of particles (elements) are simulated in DEM by using (much) enlarged particle sizes compared to the original sizes. Even with GPU parallelized code, the number of particles used in a DEM simulation is normally less than 10 million. Thus, the size effects to discrete element models should be investigated to confirm their validness. In this paper, a research frame for modeling cohesive materials with DEM is proposed. Some numerical examples, mainly focusing on brittle materials and fresh concrete, are given. The results show some modeling issues to which we should pay more attention when we apply DEM to industrial applications.

Keywords: Similarity theory, Size effect, DEM, Cohesive materials