Stochastic solution of geotechnical problems with truly discrete media

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ABSTRACT

This research deals with the solution of geotechnical problems on intermediate length scales, i.e. when the spatial scale of interest is larger than the size of the grains of the soil (or rockfill) but the medium cannot be considered as a continuous body. This is because on such scales, despite the large number of involved grains, the volumetric average stress fluctuates around the mean value and the fluctuation is due to the truly discrete nature of the soil. Then, the smooth stress field that would be predicted by continuum mechanics approaches should be replaced by a stochastic system of interparticle forces which form force chains. The forces can be transformed into equivalent stresses by means of homogenization techniques, but the obtained field is again non-smooth and stochastic.

A classical statistical mechanics framework is followed to anticipate the statistical distributions of equivalent (extensive) stresses according to the macroscopic constraints of the problem. In particular, we get stochastic models for two seminal problems in geotechnics: the at rest lateral earth pressure acting on a retaining wall and the vertical stress at a given point in the soil that is caused by a vertical surface load. The theory is validated through massive numerical simulation with the Discrete Element Method.

Mesoscale geotechnical analysis can find its main applications in the case of rockfill or other very coarse granular materials. However, it could be useful as well for laboratory, numerical and theoretical researches that are approached on intermediate length scales. This theoretical framework contributes to fill the gap between micro and macro geotechnics and the resulting stochastic models may be useful for reliability analyses.

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