Perspective
Volume 11:5, 2021

Metabolomics: Open Access

ISSN: 2153-0769 **Open Access**

An Evolution Law for Fabric Anisotropy and its Application

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Perspective

The importance of granular materials' microstructure to their behaviour has been proven through micromechanical research. Fabric tensors are a common feature of this microstructure. Fabric can alter dramatically during deformation, according to experimental and computer investigations. As a result, fabric evolution is crucial to constitutive modelling. Current fabric evolution rules for granular materials have been developed primarily for continuum-mechanical models, and they employ a multiple loading index multiplier coupled with a yield surface. Micromechanical models that do not include an explicit macro-scale yield surface cannot use such evolution laws. Based on findings from experiments and Discrete Element Method simulations from the literature, this paper offers an evolution law for fabric anisotropy. The impacts of intrinsic anisotropy, void ratio, stress ratio, loading direction, and intermediate principal stress ratio are all taken into account in the suggested evolution law. The value of the fabric anisotropy at the critical condition is solely determined by the Lode angle. The projected evolution of fabric anisotropy agrees well with the results of Discrete Element Method simulations, demonstrating both hardening and softening behaviour as well as defining the impact of the starting void ratio.

The mechanical behaviour of granular materials is crucial in a variety of engineering and science disciplines. This behaviour is represented by constitutive relations (that relate increments of stress and strain) that are generally formed in a heuristic manner within the framework of classical continuum mechanics for quasi-static deformation. Because granular materials contain a large number of particles and voids, an alternative (and complementary) micromechanical perspective has been developed, in which (constitutive) relationships between the behaviour of particles and contacts at the micro-scale and the continuum macro-scale are investigated. In shear, the material continues to deform at a constant volume and under continuous stress. Fabric anisotropy's uniqueness in the critical state has long been debated. Recent discoveries based on DEM simulation results have revealed that fabric anisotropy is approaching asymptotic values (Fu and Dafalias, 2011; Zhao and Guo, 2013; Kruyt and Rothenberg, 2014; 2016; Yang and Wu, 2016). The Anisotropic Crucial has explicitly considered these critical conditions. Current fabric evolution equations that have been devised for elasto-plastic continuum-mechanical models cannot be used in micromechanical models because micromechanical models lack explicit macro-scale yield surfaces. The goals of this research are to: analyse the parameters that influence the evolution of fabric anisotropy based on experimental and DEM simulation results from the literature; develop a novel evolution law that accounts for these parameters of influence and can be embedded in micromechanical and continuum-mechanical models; and predict the behaviour of granular materials. Illustrates some example results from Chantawarangul (1993), Yang and Wu (2016) three-dimensional DEM simulations in which the second-order fabric tensor is based on the contact normal vectors. Chantawarangul (1993) looked at fabric evolution in spherical particle samples under shear for various loading directions, i.e. for various intermediate primary stress ratios b. Yang and Wu (2016) studied the influence of void ratio, intrinsic fabric anisotropy, and loading direction on the evolution of fabric anisotropy using three-dimensional samples made up of so-called "clumped" particles The microstructure of granular materials, as quantified by fab- rick tensors, is important to their behaviour. Therefore, fabric is taken into consideration in some continuum-mechanical and micromechanical models. Results of experimental and DEM simulations show that fabric changes significantly during deformation. Hence, an evolution law for fabric anisotropy of granular materials has been proposed, that is based on observations from results of experiments and three-dimensional DEM simulations from literature. This fabric evolution law can be used in combination with both continuum-mechanical and micromechanical models.

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Received 21 September 2021; **Accepted** 05 October 2021; **Published** 12 October 2021

How to cite this article: Niels P Kruyt. "An Evolution Law for Fabric Anisotropy and its Application." *Metabolomics (Los Angel)* 11 (2021): 299.