

The Structure of Constitutive Laws for Powder Metallurgical Components

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In this paper we examine the structure of constitutive laws for the compaction response of particulate materials, where deformation results from the plastic deformation of the individual particles. Micromechanical modelling suggests a number of different structures for the constitutive laws. A deformation theory model is described which is based on the construction of surfaces of constant complementary work density in Kirchhoff stress space determined by following extremal work paths to the current state. Alternatively, an incremental anisotropic constitutive law can be constructed based on the existence of a yield surface, whose size and shape evolves as the powder compact is deformed plastically. It is demonstrated that the yield surfaces nest inside surfaces of constant complementary work density. The models are calibrated using data for a commercial steel powder generated in a triaxial cell. The nesting character of the different types of surface is demonstrated and the relative merits of the different types of model is discussed.

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