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A PARTICLE FINITE ELEMENT APPROACH FOR THE POWDER FILLING

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ABSTRACT

A new numerical approach to study the powder filling stage, in powder metallurgy manufacturing process, is explored. The novel aspect of the work is the complete model formulation in the frame of the particle finite element method to study the motion of a representative set of particles during the powder filling stage.

The main objective is to obtain relevant and representative information about density evolution and localization of empty cavities, which can reduce severely the final properties of the manufactured part.

The numerical model is formulated in the context of the large plastic deformation theory in which the most relevant aspects of the phenomena are captured by means of a plastic flow model, defined in terms of two yield surfaces: one elliptic cap and one Drucker-Prager line. Characterization of the material parameters follows the usual strategy outlined by the continuum approach. In this case, the Drucker-Prager angle represents the internal friction angle of the material and can be calibrated using some of the techniques provided by the soil mechanics theory.

Typical limitations of classical finite element methods, in terms of transferring information during remeshing, are automatically circumvented by the recently explored meshless methods. On the other hand, unlike other “particle-following” methods like the discrete element methods, the approach keeps the full physical significance of the problem and consistence with its mathematical approach.

The finite element technology developed in previous works can be applied directly to solve the incremental problem; it means that any existing code can be extended to include this new approach, easily.

The contact algorithm is based on the generation of a contact interface defined through a family of mixed elements composed by nodes of the powder and nodes of the rigid solid, and a constitutive model provided for them. This novel contact interface traces more carefully the changes in curvature around convex and concave zones of the rigid solid. These properties increase robustness of the contact problem especially in the region of sharp corners. The performance of the approach is assessed via numerical simulation of actual industrial problem.

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