A robust computational approach for dry powders under quasi-static and transient impact loadings

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Abstract:

Powders are challenging materials for many engineers and scientists, since they often show unexpected behavior which is quite different from the behavior of gases, liquids or solids. In addition, powder-like materials appear quite often in real applications. Our study is driven by the need to appropriately grasp the behavior of dry powder and our main focus is on the damping and energy absorbing behavior of dry powder under impact loading. The overall approach, including both the model and the algorithmic setup, that we developed for this purpose is presented in this paper. Applicability to quasi-static as well as highly transient real world problems and robustness are crucial constraints for the whole undertaking. These requirements are met through a model with relatively few and, more importantly, easy-to-obtain material parameters and through some special algorithmic developments. After a general introduction into powder, our continuum model based on finite strain elasto-plasticity for the simulation of quasi-static and transient dynamic processes is presented. Then the algorithmic setup, i.e. the required return mapping
algorithm formulated in principal stresses, is presented. Finally, the parameter determination from standard laboratory tests is described and appropriate numerical results are shown for both quasi-static and highly transient impact cases.

Stichworte:
Powder materials; Continuum model; Finite strain plasticity; Return mapping; Impact loading

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