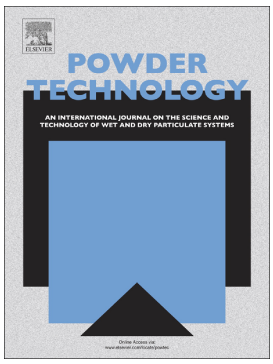

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Dynamic breakage of glass sphere subjected to impact loading

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Abstract:

The dynamic compression responses of four glass spheres with diameters 7.71mm, 11.90mm, 17.88mm, and 24.87mm are investigated by the modified split Hopkinson pressure bar device (SHPB). Based on the high speed images, the dynamic compression of the spheres can be divided into three stages, e.g. the quasi-elastic deformation stage, the non-linear deformation stage, and the brittle failure stage. The formation and growth of the shadow areas observed at the impact end and the support end in the spheres are the main causes of the catastrophic failure. The movement of the plane-like fronts of the shadow areas is activated and driven by local velocity gradients. Dynamic breakage of the spheres is then analyzed by the particle size distribution, the fractal properties, etc. The results show that there are two main failure mechanisms in the process of sphere breakage, e.g. the tensile failure mechanism and the shear failure mechanism. In order to investigate the transition of these two failure modes, a bimodal Weibull distribution model is preliminarily established on the Weibull statistical strength. The model shows both good simulations to the experimental data and obvious the transition process of two failure mechanisms. The scaling laws and the strain rate effects of breakage strength are then discussed. The results are helpful for the controlling of pulverization for brittle particles.

Keywords: Dynamic compression; Glass sphere; Brittle failure; Breakage strength; Tensile failure; Shear failure.

1. Introduction

Single particle breakage is one of the fundamental issues in theoretical description of physical and mechanical behaviors of granular material, and plays an important role in many domains, i.e. shear band and compaction band in geophysical processes and geotechnical engineering [1, 2], leakage in reservoir and petroleum engineering [3-5], grinding and droplet breakup in pharmaceutical and

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