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Experimental Study of Breakage of Particles under Compression

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ABSTRACT

Granular materials are used widely and can be seen in natural and industrial applications such as sand bags or pharmaceutical pills. During their manufacturing, processing, transport and use, granular materials are subjected to various kinds of loadings. If the amplitude of the loading is above the strength threshold, particles constituting granular materials may fracture. It is very important to understand the failure of particles under these loading conditions to prevent or control their failure during all stages of their manufacturing and use. Better characterization of the fracture behavior of particles composed of different materials and sizes will allow more precise application and better maintenance of granular materials in commercial usage.

The effects of size and material properties on the deformation and fracture behavior of granular particles are studied by investigating particles from three different size ranges for three different materials. The mechanical behavior is characterized by force-displacement and stress-strain plots under quasi-static compression (strain rate = $10^{-2}s^{-1}$). Along with the deformation behavior, the strengths of particles are also recorded and Weibull distribution is fitted to the fracture stresses.

It was observed that the smaller particles break at lower forces but actually withstand higher stress at fracture. The calculated Weibull moduli for different size range and materials show that the flaw population from the manufacturing process is different for different sizes and materials.

This study shows that size and material properties alter the fracture stresses. Future experiment can be performed for the same particles under dynamic compression to better understand effects of strain rate on the fracture of particles.

KEYWORDS

Granular material, Compression, Fracture