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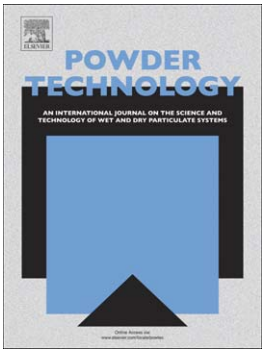

Qualitative and Quantitative Assessment of 3D-Scanned Bulk Solid Heap Data

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Qualitative and Quantitative Assessment of 3D-Scanned Bulk Solid Heap Data

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Abstract

According to angle of repose theory, non-cohesive bulk solid heaps will form a perfect conical heap if carefully poured. However, there are indications that global shape deviations from an ideal cone exist in experimentally generated heaps. For example, rounded heap tips and concave or convex heap shapes have been reported in the literature, but no studies exist concerning local shape deviations from spatial data. The main aim of this study was to compare the 3D-scanned spatial data from experimentally generated heaps of eight bulk materials with their respective counterparts according to angle of repose/continuum theory and to examine the differences both qualitatively and quantitatively. The results showed that mapping the differences between 3D scans and ideal cones onto a two-dimensional developed view of the ideal cone's lateral surface is a meaningful method for visualizing the heaps' real shapes and for illustrating global as well as local shape deviations. Furthermore, the averaged shapes and respective variances on the experimental heaps' circumferences were examined. Global shape deviations could be identified for lignite, milkpowder, limestone and coke. An important conclusion was that simple consideration of the averaged surface lines does not enable identification of rotationally asymmetric heaps; however, it can be useful for indicating global shape deviations. Large surface line variance implies considerable rotational asymmetry, however the converse conclusion is false.

Keywords: angle of repose, material characterization, experiment, 3D scanning, bulk solid, discrete element method calibration

1. Introduction

The angle of repose, Φ, is defined as the angle between a horizontal surface and the surface line of a conical heap of bulk material, as shown in Figure 1a. Its value has a practical use for silo dimensioning and chute design in bulk materials handling. The angle of repose is also used as a bulk property to calibrate discrete element material models against [1]. Although the angle of repose is not a pure bulk solid characteristic, it

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