IFPRI Project Abstract

3D Printed "Perfect Particles"

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Project Objective:

Demonstrate multiple new ways 3D printing can be used to create controlled particles or agglomerate structures to advance our understanding of (a) Agglomerate breakage, (b) Agglomerate wetting, (c) Powder flow.

Approach:

A range of particles/granular matters with different material properties were 3D printed using different techniques and materials. Particle shape, size, structure, colour and infill/density were varied and controlled with accuracy, with experimental and simulation studies conducted in agglomerate breakage, stress visualization, liquid imbibition and powder flow etc.

Recent Results:

Agglomerate breakage: The strength distribution of a random sphere agglomerate as a function of orientation and compression rate has been plotted for the first time, demonstrating the unique fingerprint of the agglomerate structure. Real powder agglomerates with well-controlled strength and geometry from binder jetting have also been used in agglomerate breakage study. Two papers were generated with one published and one under review with APT.

Stress visualization: Stress visualization of 3D printed discs and 3D coffee bean model with orthotropic orientation was explored. The intensity field of the stress fringes were validated using FEA. Stress quantification of 2D and 3D particles were carried out using the gradient-squared method. We found that the method is more suited for 2D shapes and not complex 3D shapes.

Liquid imbibition: 3D printed lattice, voronoi and cement structure were used as powder bed analogues for liquid imbibition study. Effective surface coating was achieved to make the material surface hydrophilic/hydrophobic. Systematic analysis was carried out by comparing experimental results with theories and CFD simulations.

Particle flow and segregation: This study consists of multiple projects including 1. Coefficient of restitution of coffee bean geometry using EDEM. 2. Flow of irregular shaped particles/ particles with varying density using ROCKY. 3. Modify the surface roughness of the drum inner boundary. All DEM results will be validated against the comparative 3D printed experimental setup. These experiments in particular have been disrupted by lab closures since March at Deakin University due to Covid19. We hope to complete the experiments when the lab reopens, in time for the November final report.