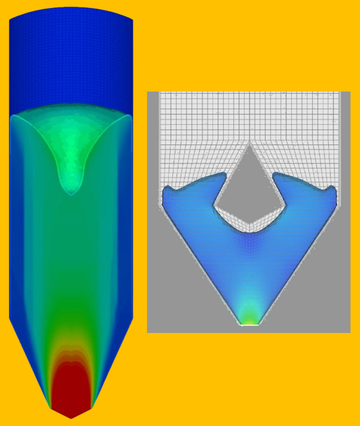
Current Research Activities in the Particulate Systems Laboratory (Mar 2026)

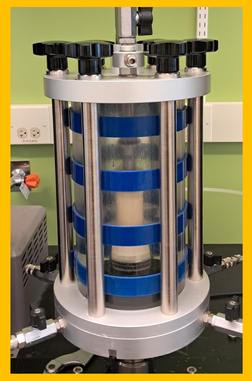
Prof. Carl Wassgren (wassgren@purdue.edu)
School of Mechanical Engineering, Purdue University

https://engineering.purdue.edu/~wassgren/research
Publication and Thesis Abstracts



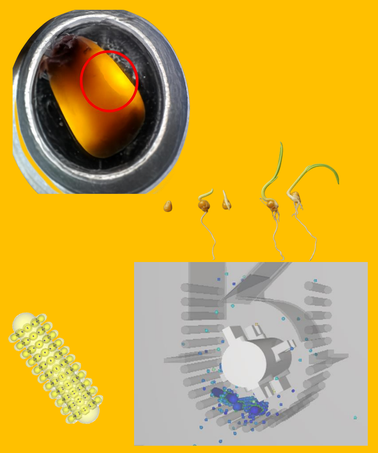
Continuum Modeling of Powder Flows. Models for predicting powder flow in industrial scale systems are lacking. Analytical and discrete element method models are limited by significant geometric and material assumptions. This work uses the Drucker-Prager Cap continuum model to predict powder flow in industrial systems. The model can include complex, dynamic geometries.

Timmy Ngo, Ph.D. student, co-advised with M. Gonzalez (ME)
Sponsor: Dow Chemical Company



Measurements of continuum model properties using a triaxial cell. The Drucker-Prager Cap model is an elasto-plastic model used in FEA simulations of powders. This research experimentally measures the model's parameters using a modified consolidated undrained triaxial test. By obtaining these parameters over a range of solid fractions, this work aims to improve the ability to accurately simulate powder behavior during powder processing.

Shayak Chatterjee, M.S.. student, co-advised with M. Gonzalez (ME)



Predicting maize germination fraction subject to grain damage. Mechanical damage during threshing creates internal and external cracks in maize kernels and reduces seed germination potential. This research experimentally investigates how compressive loading conditions and kernel moisture content influence crack initiation and how these, in turn, affect seed germination. Computational simulations are used to predict loading conditions during threshing.

Zebang Zhou, Ph.D. student, co-advised with K. Ambrose (ABE)
Sponsor: Bayer CropScience

Modeling maize grain damage in the presence of Material Other than Grain (MOG). Grain damage during harvest reduces effective yield, grain quality, and germination potential. This research investigates experimentally and computationally how MOG, which consists of cobs, stalks, leaves, and husks, affect the loads and damage on maize kernels during harvesting. Predictions of grain damage supports the development of efficient harvesting systems, reducing post-harvest losses and contributing to improved grain quality.

Johnson Adegboyega, Ph.D. student, co-advised with K. Ambrose (ABE)
Sponsor: CNH Industrial

Development and manufacture of controlled release agricultural fertilizers. A urea-gypsum cocrystal (URCASU) holds promise as a controlled release fertilizer; however, current synthesis pathways rely on batch processes lasting upwards of 24 hours. This research investigates twin-screw mixing as a continuous alternative, optimizing the yield by controlling material residence time and shear through screw speed, feed rate, and barrel temperature.

Ryan Chatterjee, MS student, co-advised with K. Ambrose (ABE)
Sponsor: USDA

Modeling powder consolidation state subject to an air burst. Humidity-sensitive powders often gain strength while stored in hoppers, causing flow stoppages that disrupt manufacturing operations. This research aims to quantify and model the effects of a localized air burst on a consolidated powder.

Sophia Knap, M.S. student co-advised with M. Gonzalez (ME)
Sponsor: P&G