



# IFPRI Project Abstract

## ***Segregation of Cohesive Particles in Granular Flows***

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Project Start Date: 1 November, 2024

Abstract Date: 16 May, 2025

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### ***Project Objective:***

The goal of this research is to develop fundamental knowledge about cohesive particle segregation that will lead to an understanding of the key flow and particle parameters that influence segregation as well as insights into how to predict and control the segregation of cohesive particles.

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### ***Approach***

We are using computer simulations, validated with experiments, to develop a physical understanding of the flow and segregation of cohesive particles at the flow level. This IFPRI project leverages US National Science Foundation funds for a related project.

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### ***Recent Results:***

We consider cohesive particle segregation from three viewpoints:

- 1) Two-particle interactions: When a small cohesive particle collides with a large one, four scenarios can occur, depending on the combination of Bond number ( $Bo$ ), restitution ( $e$ ), sliding friction ( $\mu$ ), and rolling friction ( $\mu_r$ ): bouncing-detachment, sticking-attachment, sticking-rolling-attachment, and sticking-rolling-detachment.
  - 2) Percolation of fines: The percolation of fine particles through a static bed of large particles (no shear) demonstrates how different combinations of  $Bo$ ,  $e$ ,  $\mu$ , and  $\mu_r$  can result in similar levels of fine particle trapping, indicating an underlying simplicity of cohesive particle segregation.
  - 3) Bounded heap flow: The global effects of particle cohesion and shear on segregation are easily measured in terms of the segregation flux in one-sided bounded heap flow. Increasing  $Bo$  for all particles decreases segregation, as expected, although  $Bo \leq 5$  has little effect on segregation due to shear. Small particle cohesion reduces segregation due to small particle clumping decreasing the effective size ratio; large particle cohesion amplifies segregation due to clumps of large particles increasing the effective size ratio. The degree of segregation is insensitive to the details of the cohesion model, making computational studies generalizable.
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### ***Next Steps:***

Simulations will continue for the percolation of fines, to understand cohesion with no shear, and for bounded heap flow, to explore the impact of shear on cohesive particle segregation. In addition, we are exploring cohesive wax- and polyborosiloxane-coated glass particles in bounded heap flow experiments to validate simulation results.

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