Uniaxial compression of discrete S shape particles

Presented by: Katheryn Wang
José Andrade
Siavash Monfared
Introduction

● **Granular material**: any collection of discrete solid objects
● Spherical grains have been widely studied
● Use of granular material in architecture

https://www.amazon.com/FoxPlay-Basketball-Ball-Pit-Zippered/dp/B079Y9CQX8  
(Dierichs, Wood, Correa, & Menges, 2017)
Motivations

- Reusable construction materials
- Solution to high CO$_2$ emissions of concrete
- Less precise construction required

http://islandbreath.blogspot.com/2012/08/credibility-expectations.html

Objectives

- Design and perform uniaxial compression test to understand the mechanical behavior of the S shape
- Verify simulations from Level Set - Discrete Element Method by comparing them to experimental results
S Shape Particle

- Not studied before
- McMaster-Carr Open-End S-Hooks
  - Zinc-plated steel
  - Usable length ⅝ in

https://www.mcmaster.com/#Rope-Hooks/=a1a8bda8bb9c4487a89b402d36be3e2ejx0pobab
Methodology

- ADMET MTESTQuattro universal testing machine
- Random pouring of 775 particles into cylinder
- Pre-compress with 10 lb.
- Maximum displacement of 30 mm
- Constant strain rate
- Trials with maximum load of 15000 and 20000 N
Cylinders
Simulation
Experiment
Results

Load vs. Displacement

One piece cylinder

Load vs. Displacement

Two piece cylinder
Analysis

- Similar outliers in both methods
  - Reached 13,996 and 12,637 N
- On average, one piece cylinder creates columns that can bear greater loads
Conclusions

- Hollow cylinder lifted up creates columns that can bear more load
- Confinement and removal method affects maximum load
Ongoing and Future Work

- Test other methods of forming columns
- Test other aspect ratios
- Understand other mechanical properties through more experiments
  - Three point bending test
  - Vibration test
- Verify simulations with experimental results
- Simulate experiments that can’t be performed in the lab
Thank you

Professor José Andrade
Dr. Siavash Monfared
Computational Geomechanics group
Ms. Jenni Campbell
Questions?