

Uniaxial compression of discrete S shape particles

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Introduction

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

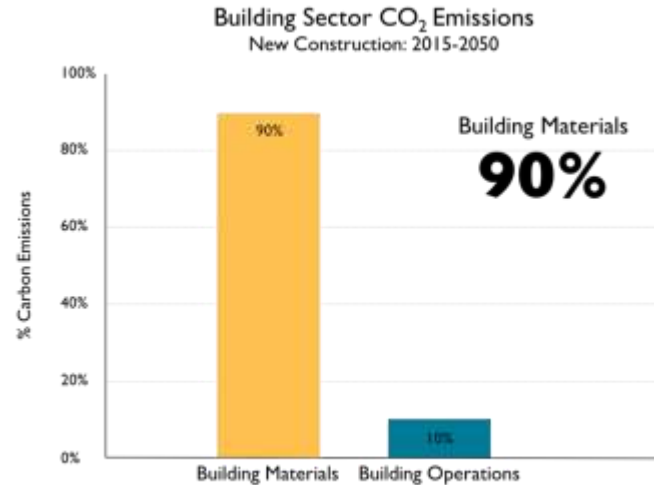


Motivations

- Reusable construction materials
- Solution to high CO₂ emissions of concrete
- Less precise construction required



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



Source: © 2018 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: IEA (2011), Richard Stone, CMCS (2011), McKinsey Global Institute



<https://www.buildinggreen.com/feature/urgency-embodied-carbon-and-what-you-can-do-about-it>

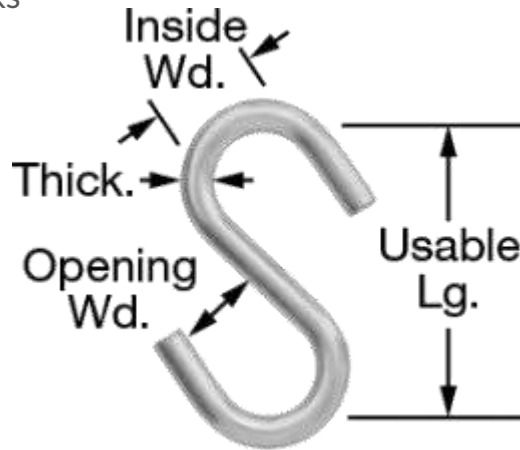


Objectives

- 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

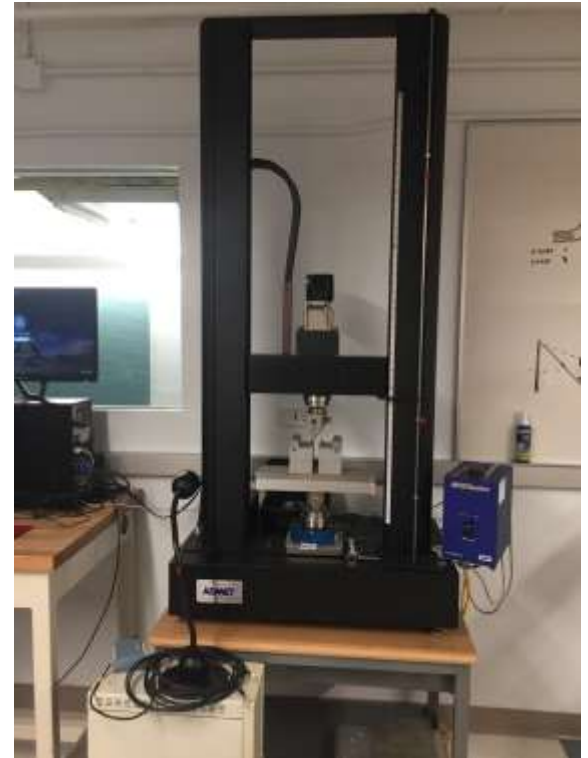
- Not studied before
- McMaster-Carr Open-End S-Hooks
 - Zinc-plated steel
 - Usable length $\frac{5}{8}$ in



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

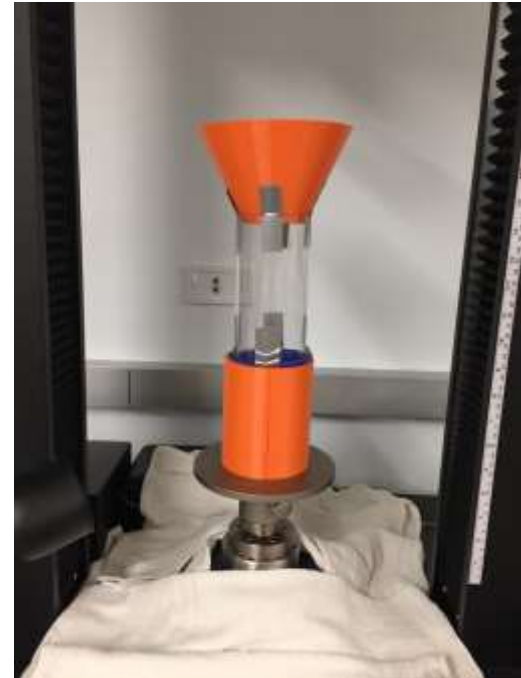
Methodology

- 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



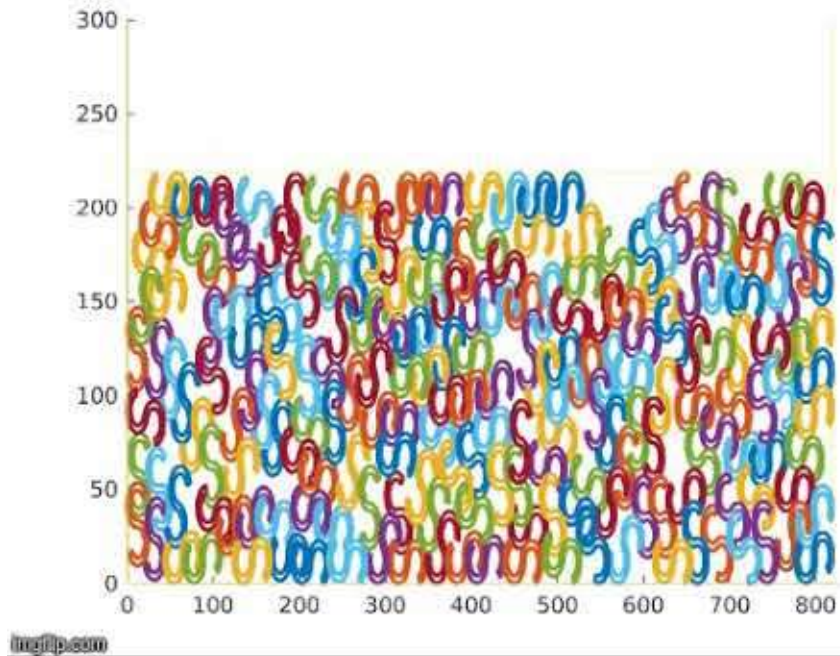


Cylinders





Simulation





Experiment





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

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Computational Geomechanics group

Ms. Jenni Campbell

Questions?

