COMPUTATIONAL GEOMECHANICS

Caltech

Level Set - Discrete Element Method to Study the Behaviour of a Load-Bearing Column built from designed granular material

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Roadmap of the Talk

- **Motivation and Objective**

- Discrete Element Method and Level Set - Discrete Element Method

- Methodologies

- Results and Discussions

- Future work

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Introduction and Motivation

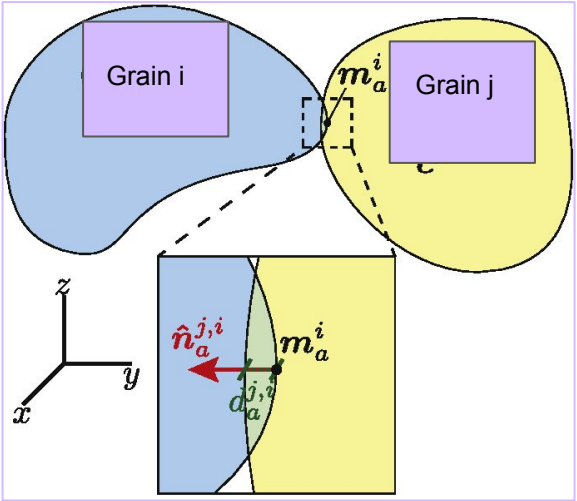
Dierichs, K. and Menges, A., 2016

Figure: Sand (Alamy.com)

Figure: Snow Pile (kicdam.com)

Objective

To study the behaviour of a column made up of S-shape particles using Level Set Discrete Element Method (LS-DEM)



Reid Kawamoto et al (2016)

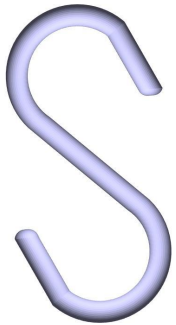
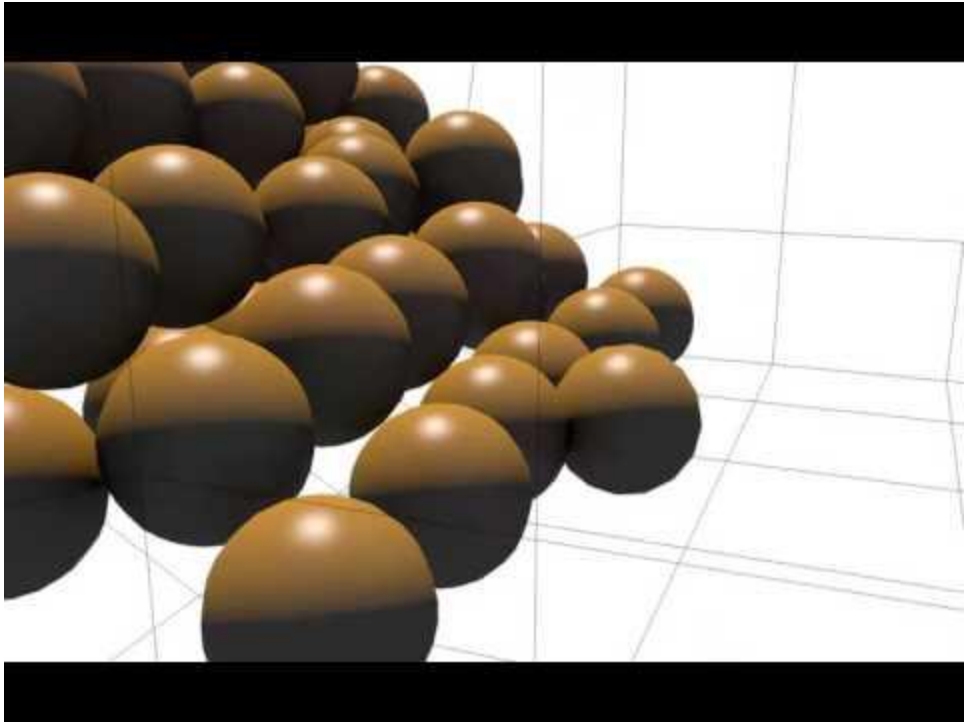


Figure: S - shaped particle

Discrete Element Method



YouTube - DEM Research Group

Level Set - Discrete Element Method

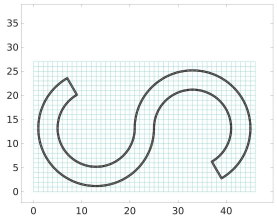
Wikipedia

www.itsnicethat.com

Level Set - Discrete Element Method

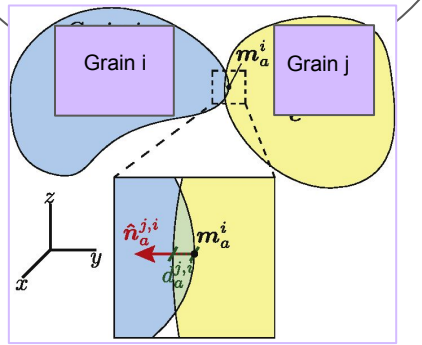
Input

- Surface points, mass, MOI
- Level Set values
- Properties of particle



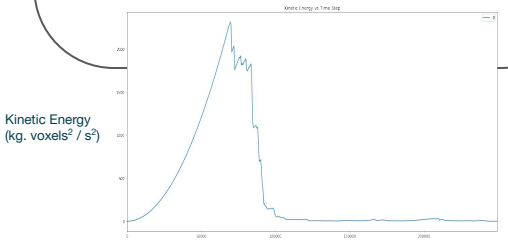
LS-DEM

- Contact check (using Level Sets)
- Interparticle force update
- Velocity/position update



Output

- Kinetic energy
- Positions and rotations



Simulations in 2 Dimensions

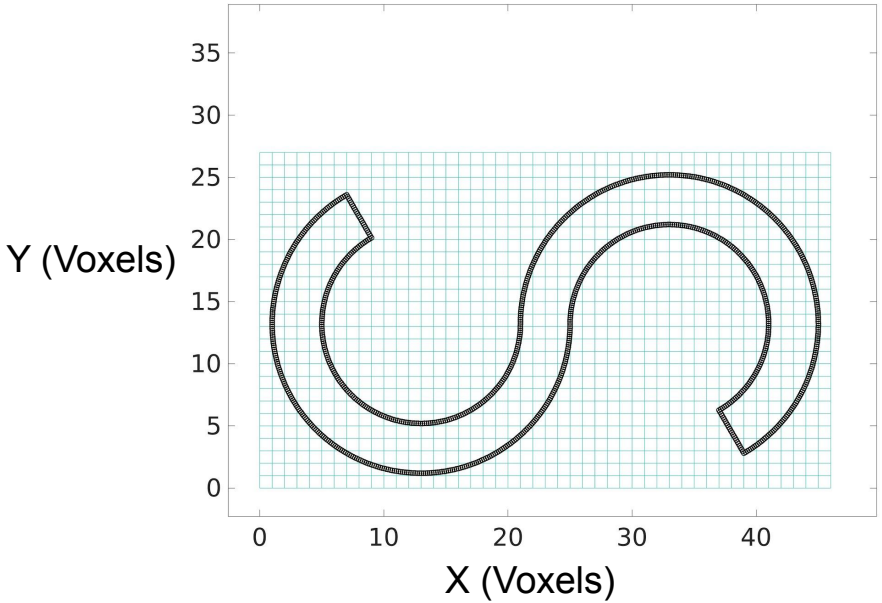
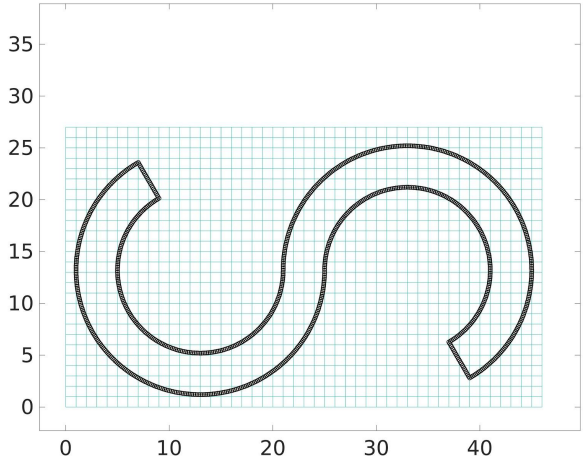


Figure: Level set grids and the particle

Calibration of the Input Parameters

- 1 mm = 2 voxels

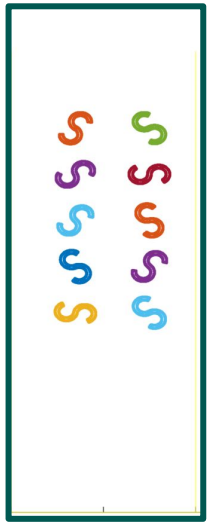


- Density of acrylic = 1.475e-7 kg/voxels^3

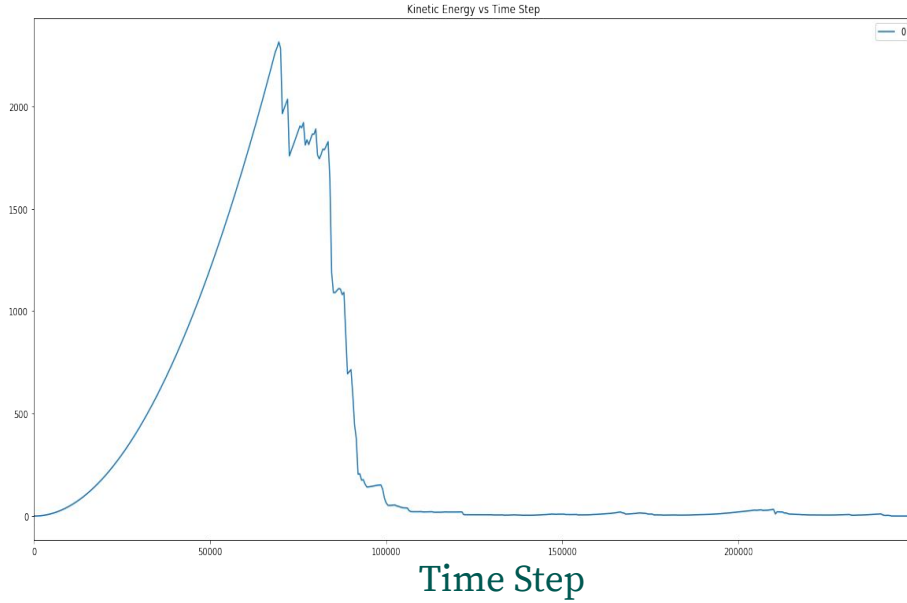
- Gravity (g) = 19600 voxels/sec^2

- Time step (dt) - Criteria for static equilibrium in DEM (Tu and Andrade)

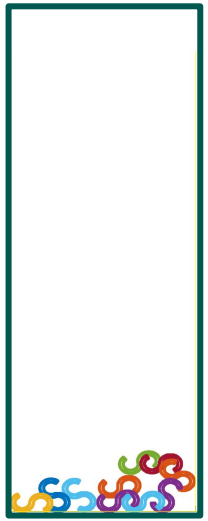
Pluviation with 10 S-Shaped Particles



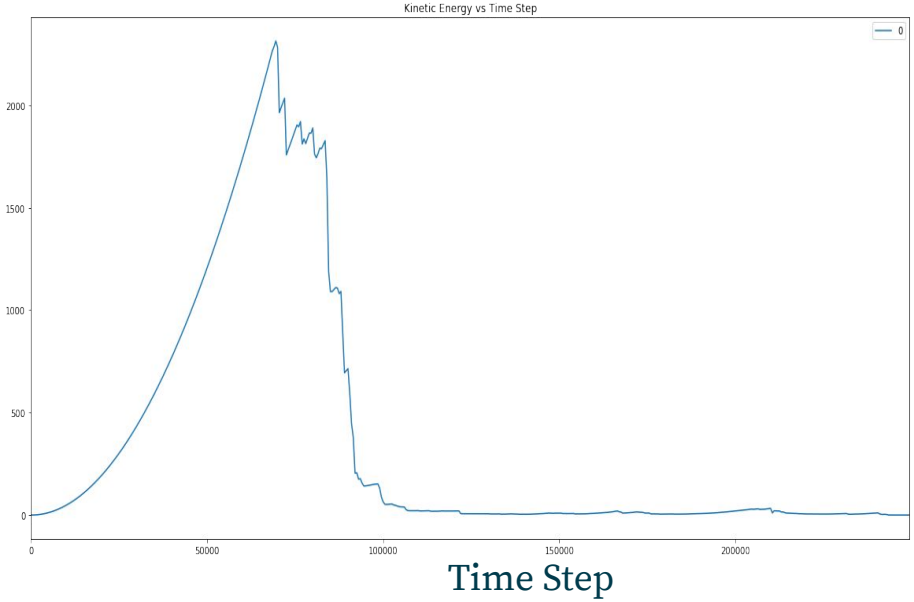
Kinetic Energy
(kg. voxels^2 / s^2)



Pluviation with 10 S-Shaped Particles

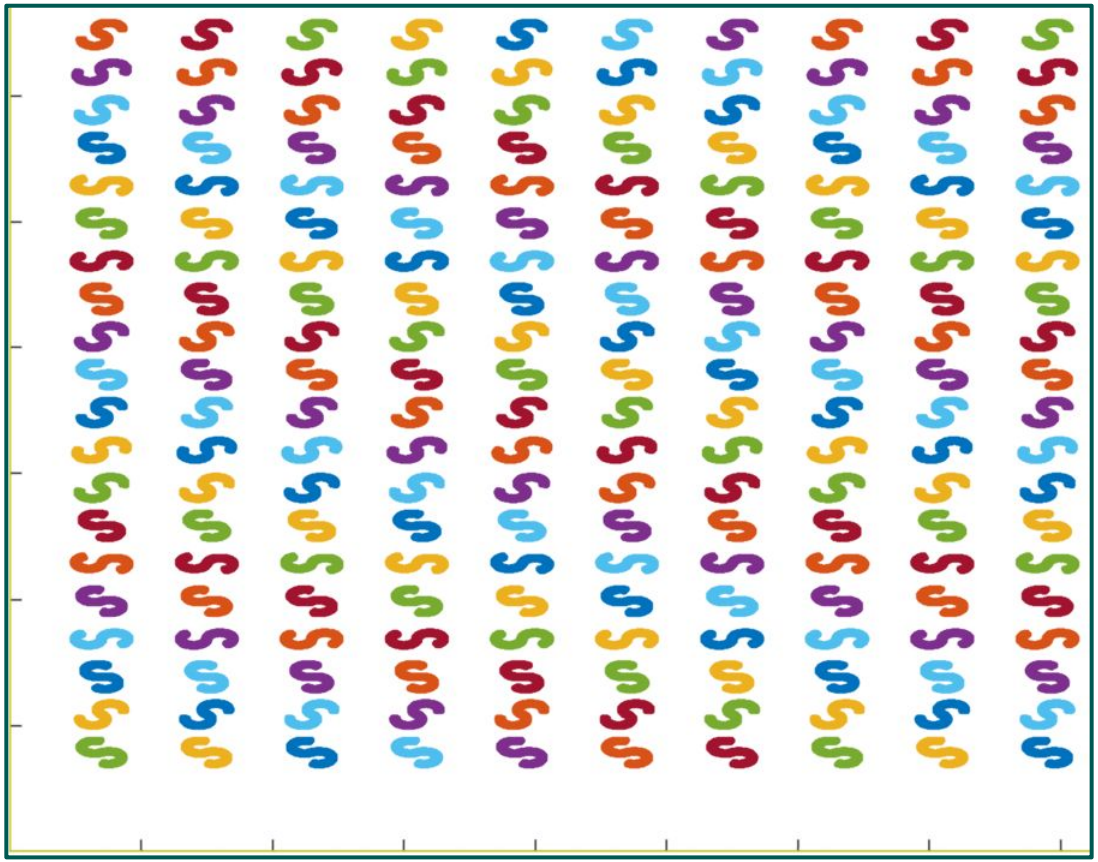


Kinetic Energy
(kg. voxels^2 / s^2)

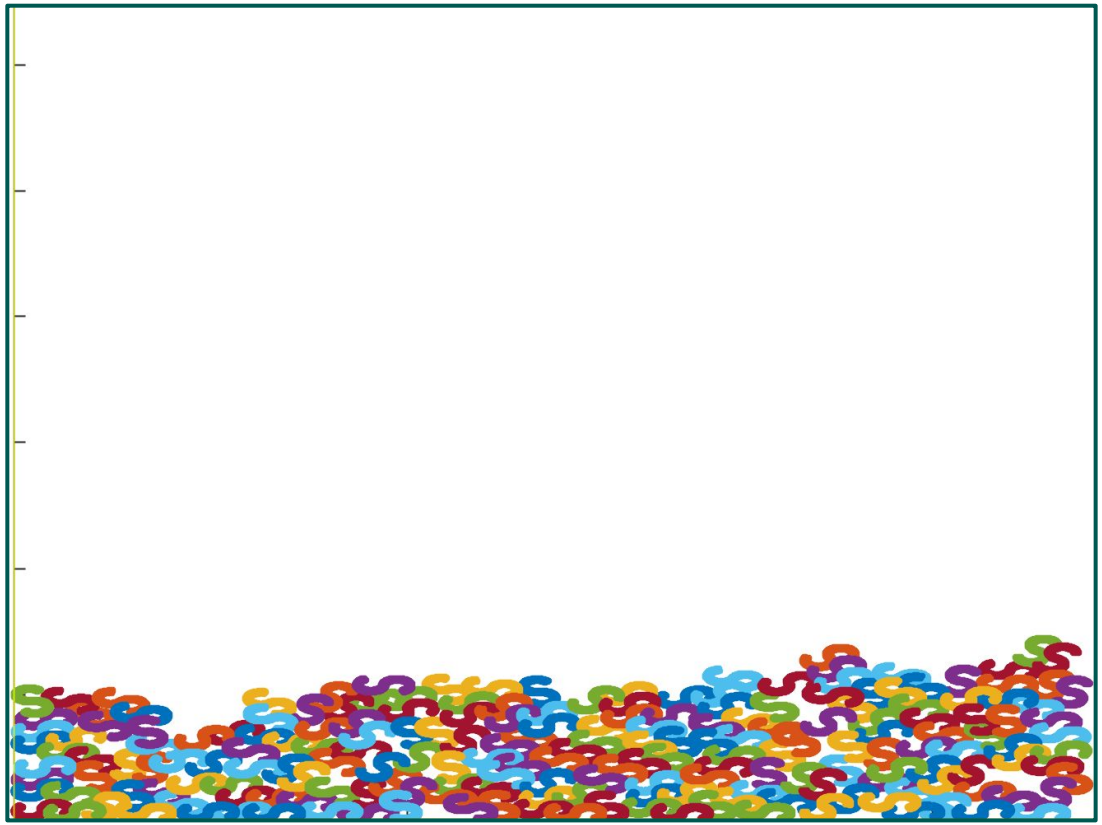


Time Step

Pluviation with 200 S-Shape Particles



Pluviation with 200 S-shape particles



Simulations in 3 Dimensions

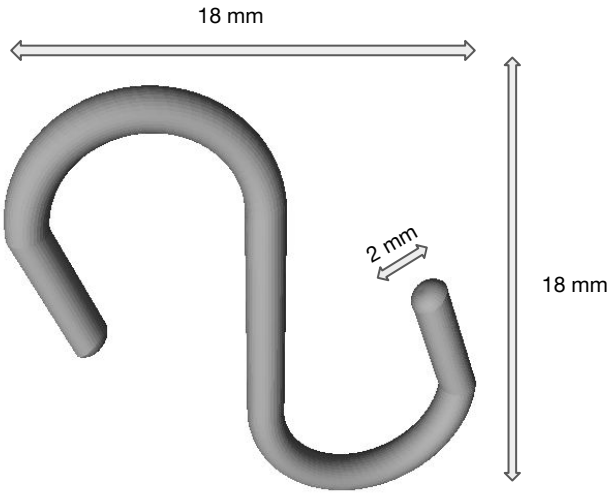


Figure: Original dimensions

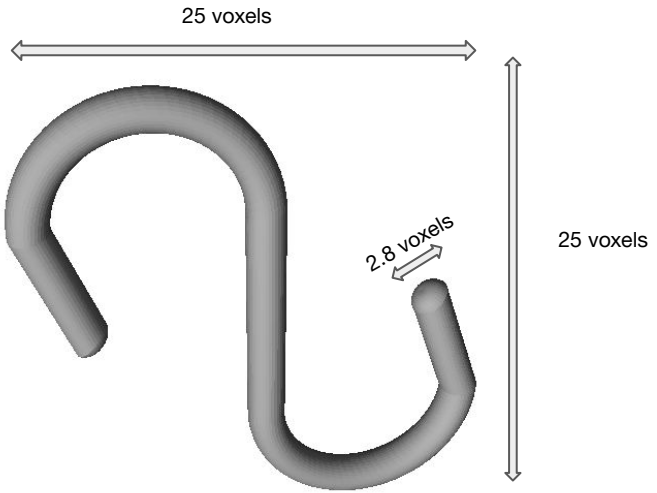


Figure: Dimensions in simulation

Calibration of the Input Parameters

- 1 mm = 1.4 voxels
- Density of galvanised zinc = 3e-6 kg/voxels^3
- Gravity (g) =14000 voxels/sec^2
- Time step (dt) - Criteria for static equilibrium in DEM (Tu and Andrade)

Calculation of Angle of Repose

Figure: Experimental setup

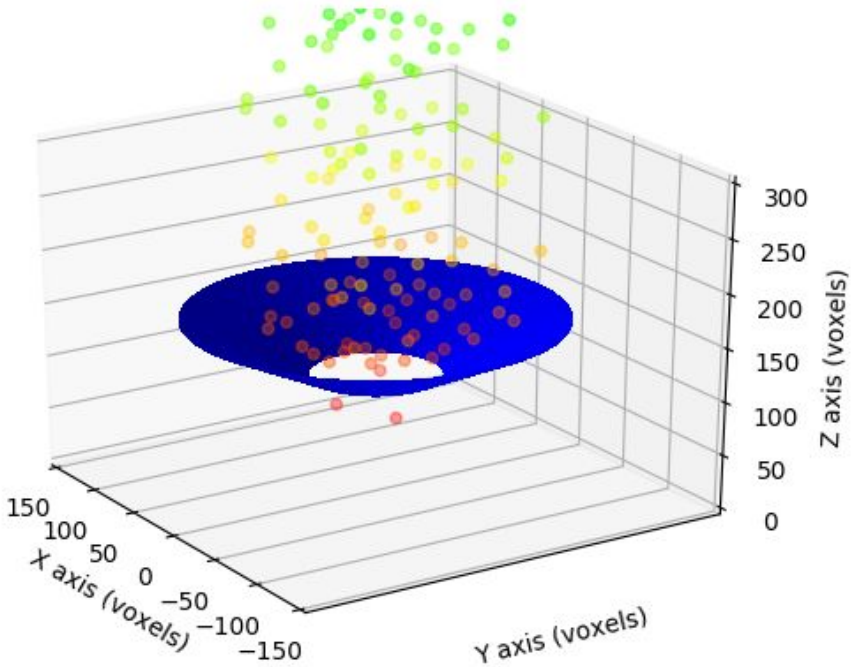
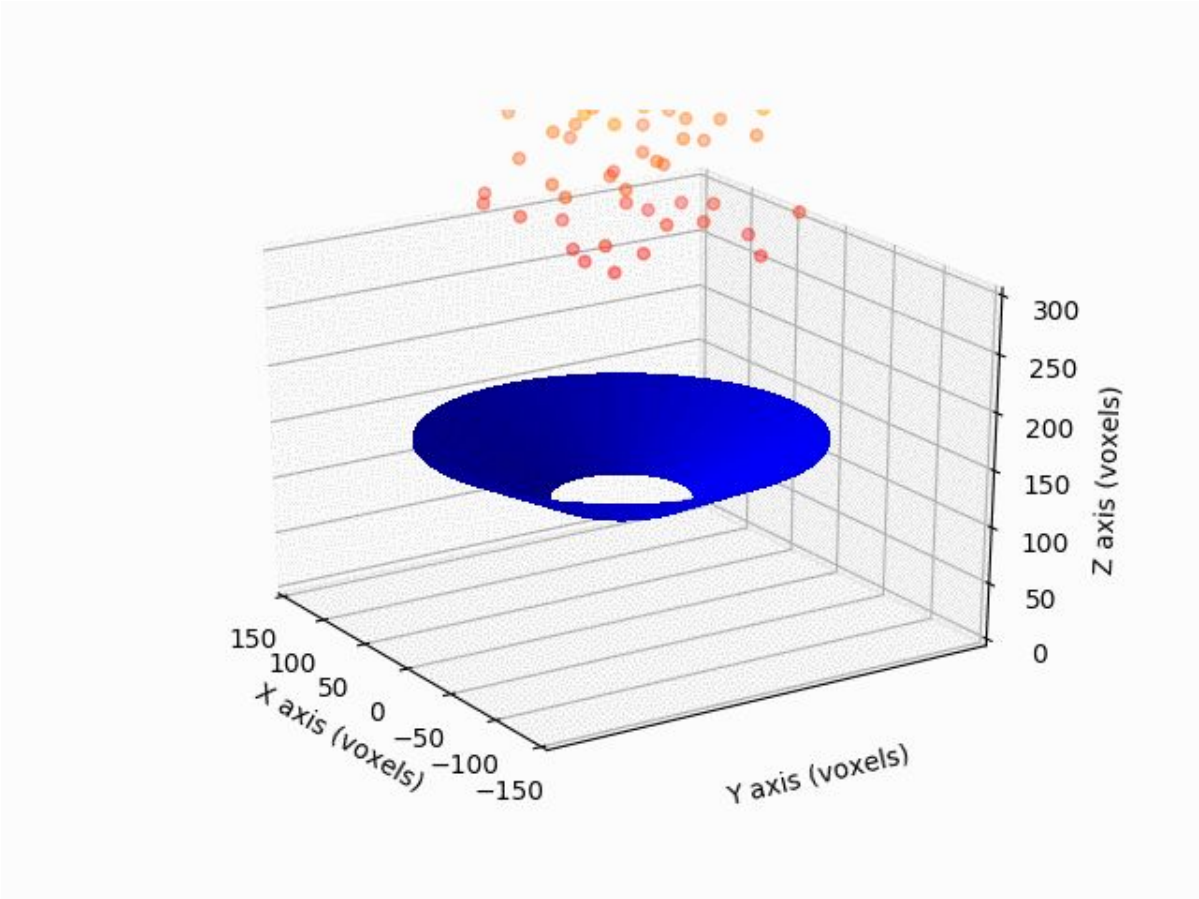
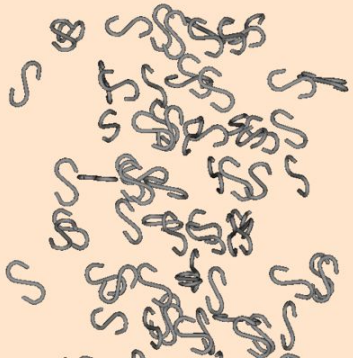


Figure: Simulation setup

Pluviation of S-Shaped Particles Through a Funnel





Future Work

- Calculation of angle of repose using LS-DEM (Image processing tools)

- Applying compression on the column made by S-shape particles and study its behaviour

- Validating the results obtained with simulations

Thank you!