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& JOHANSON
SCIENCE ENGINEERING DESIGN

DEM & BULK SOLIDS HANDLING

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OUTLINE

- Who is J&J?
- What is DEM (discrete element method)?
- Common flow problems
- When can we not use DEM to overcome flow issues or prevent them?
- When can we use DEM?
- DEM case study

WHO IS Jenike & Johanson?

Dr. Andrew Jenike (1914 – 2003) Developed the science behind bulk material handling

- Graduated from Warsaw University of Technology, B.S. Mechanical Eng.
- Served in the Second World War in the Polish Army
- Graduated from the University of London, Ph.D. Structural Eng.
- Associate Research Professor at the University of Utah
- Started Jenike & Johanson with Jerry Johanson from Jenike's home basement.

WHO IS J&J?

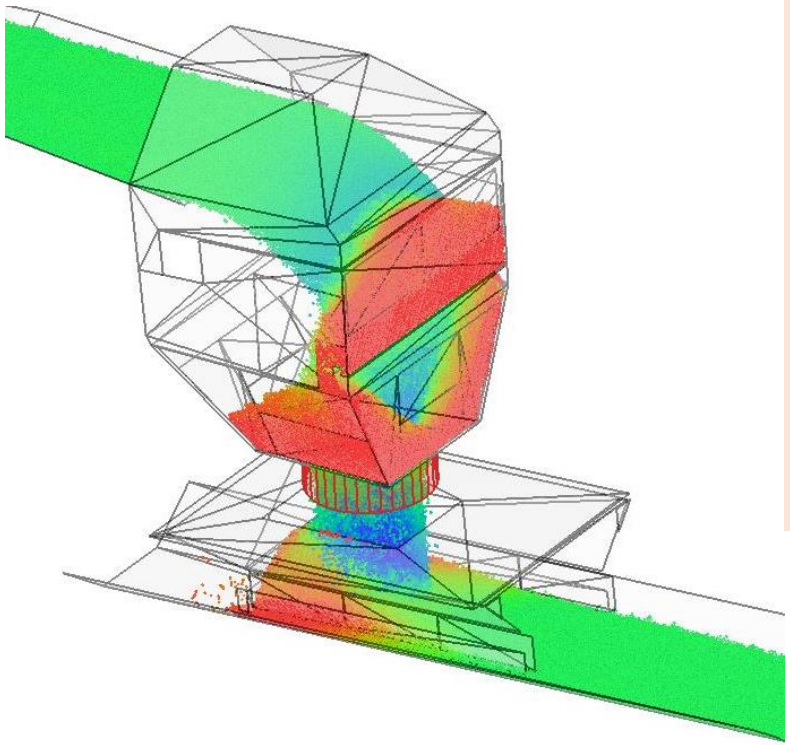
A specialized engineering firm focused on providing clients solutions to material handling applications

- 55+ years experience, all industries
- 13,000+ materials tested, 7,500+ projects
- 650+ accumulated years of solids experience
- Offices in Australia, Brazil, Canada, Chile, Boston, Houston, California

ALL INDUSTRIES WORLDWIDE

The science and engineering applies to all bulk material in all industries.

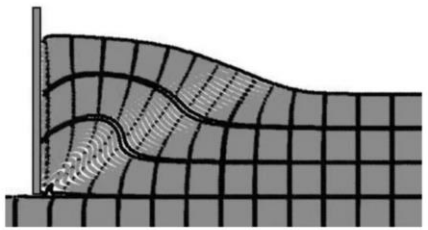
What is the Discrete Element Method (DEM)?



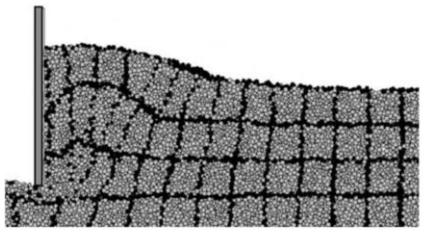
Distinct / Discrete Element Method (DEM)

- A way of simulating discrete matter
- A numerical model capable of describing the mechanical behavior of assemblies of spheres and non-spherical particles.
- Used for modeling the bulk behavior of granular materials and geomaterials like coal, rocks, ores, etc.

CONTINUUM



DISCRETE



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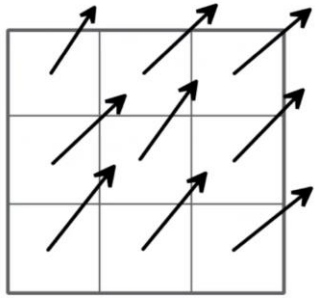
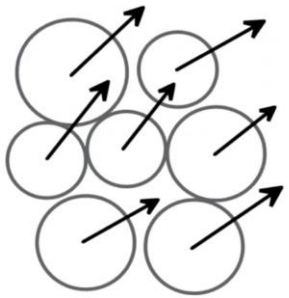
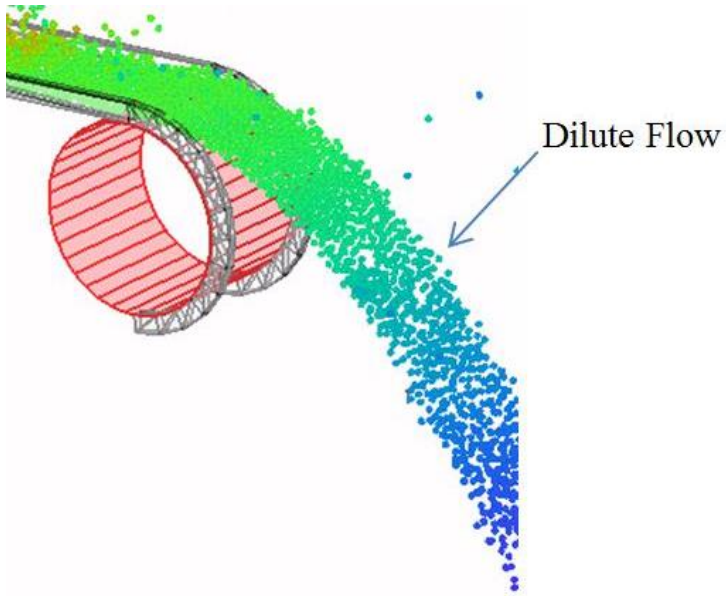


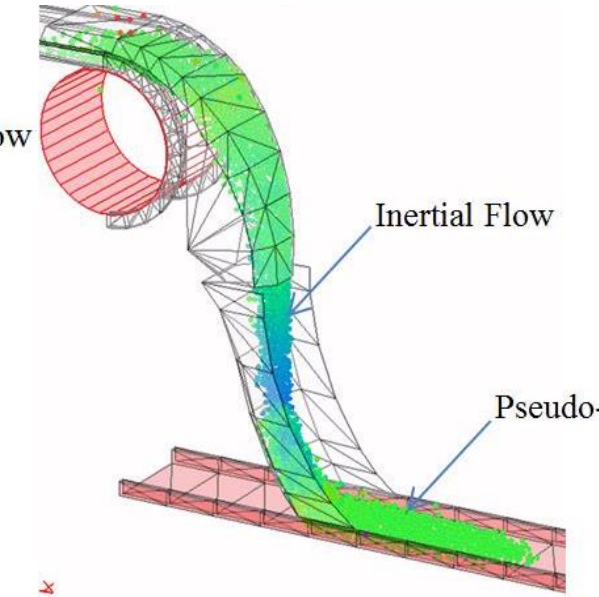
- Continuous matter
- Occupies entire space
- Continuum Mechanics
- FEM

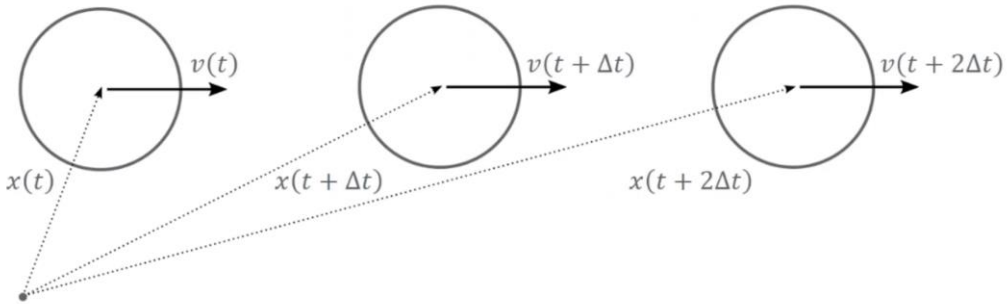
DISCRETE



- Dis-continuous matter
- Each particle is a unique quantity
- Material = assembly of particles
- DEM

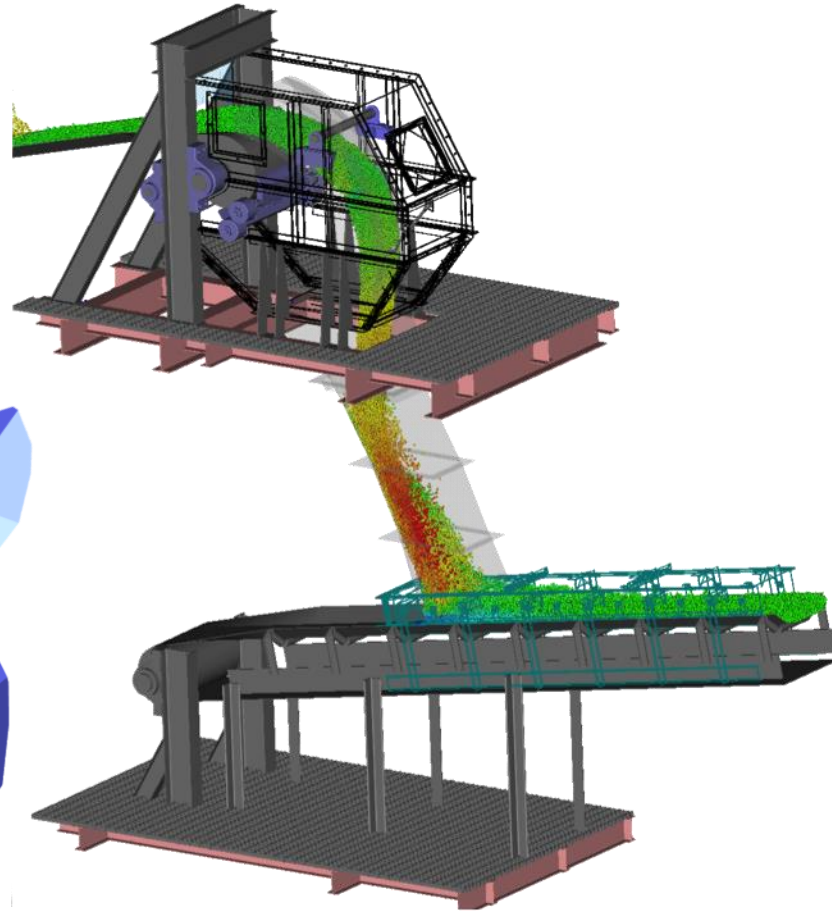






Discrete Element Modeling

- Body forces due to
  - Gravity
  - Magnetic fields
  - Fluid drag
  - Electrostatic fields
- Surface forces
  - Contact force
  - Cohesion force



Common Flow Problems

But what if your material doesn't FLOW through the process?

Materials

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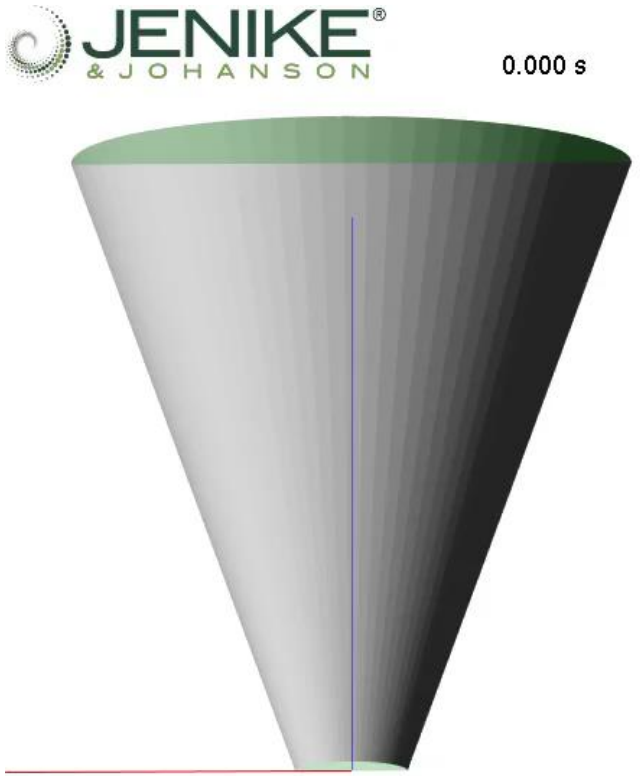
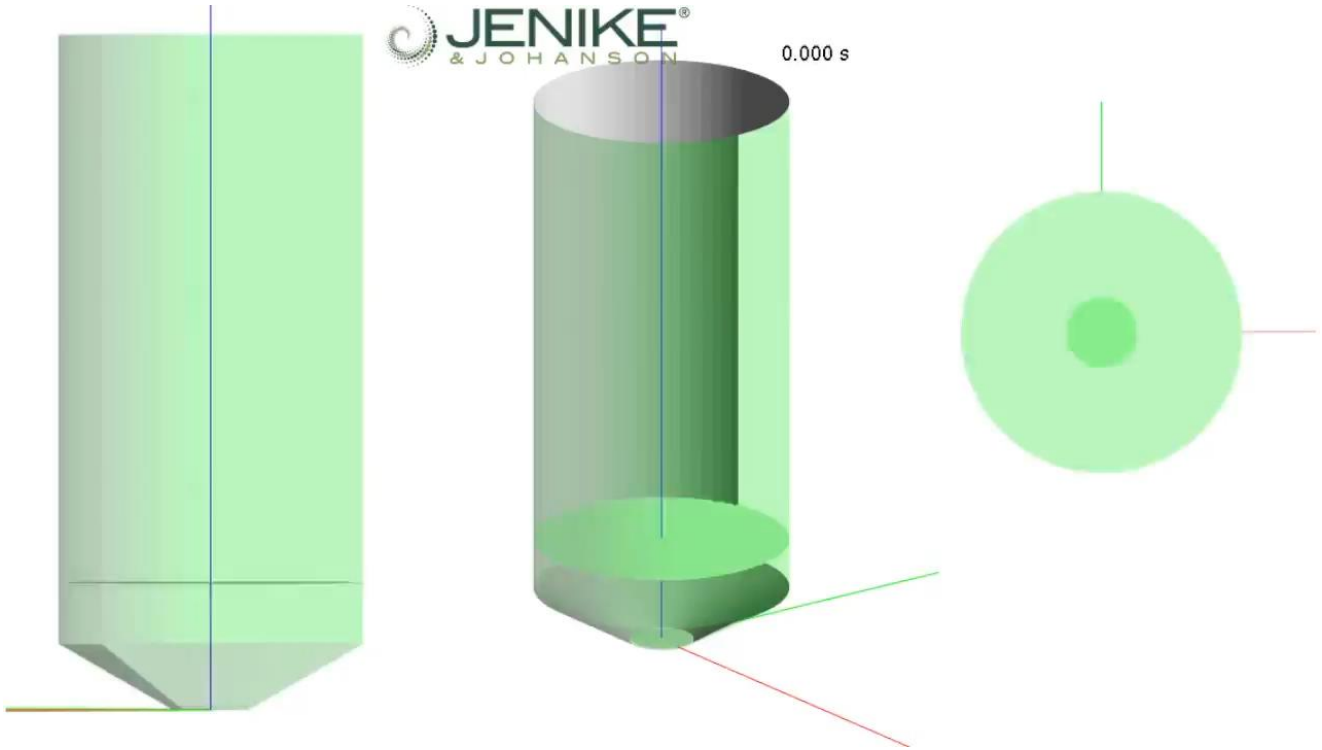
No Flow: Bridging and Arching

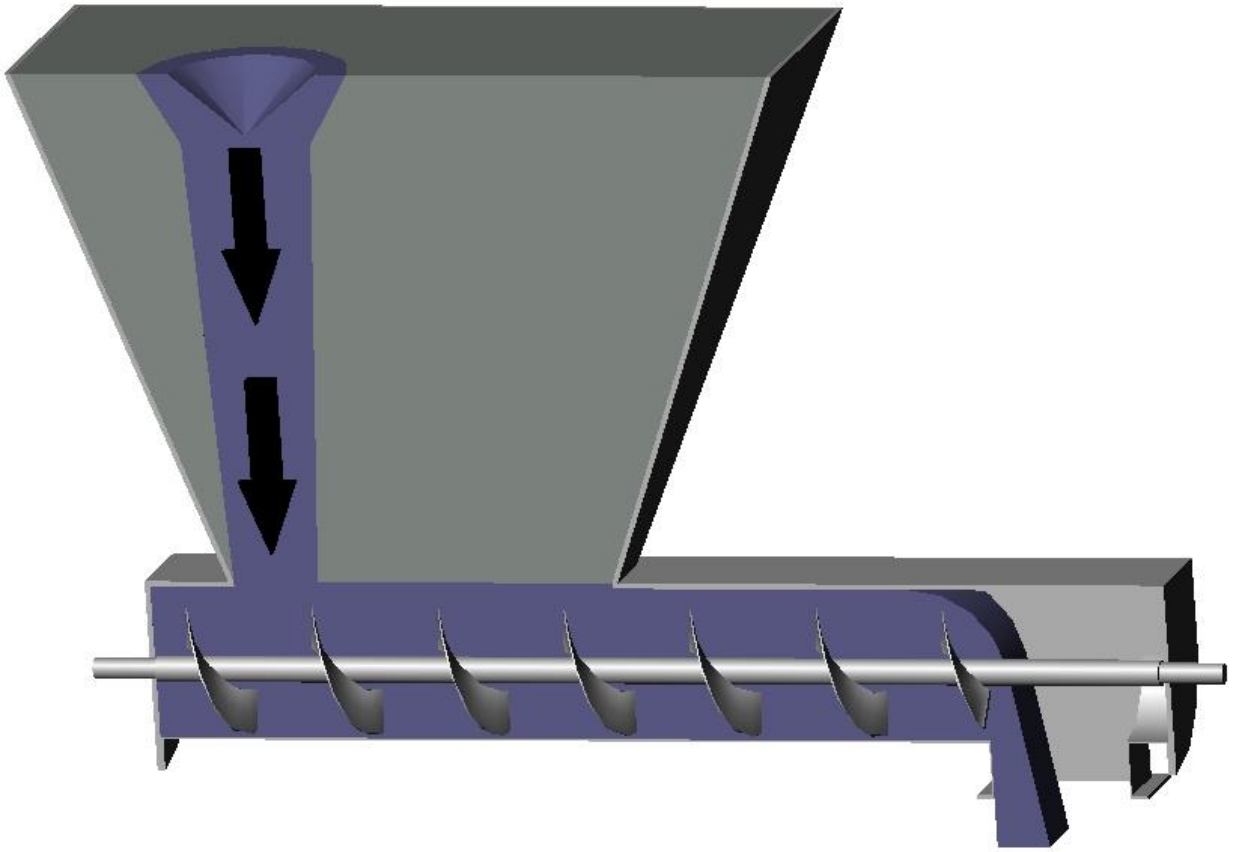


Some Flow to No Flow: Rathole

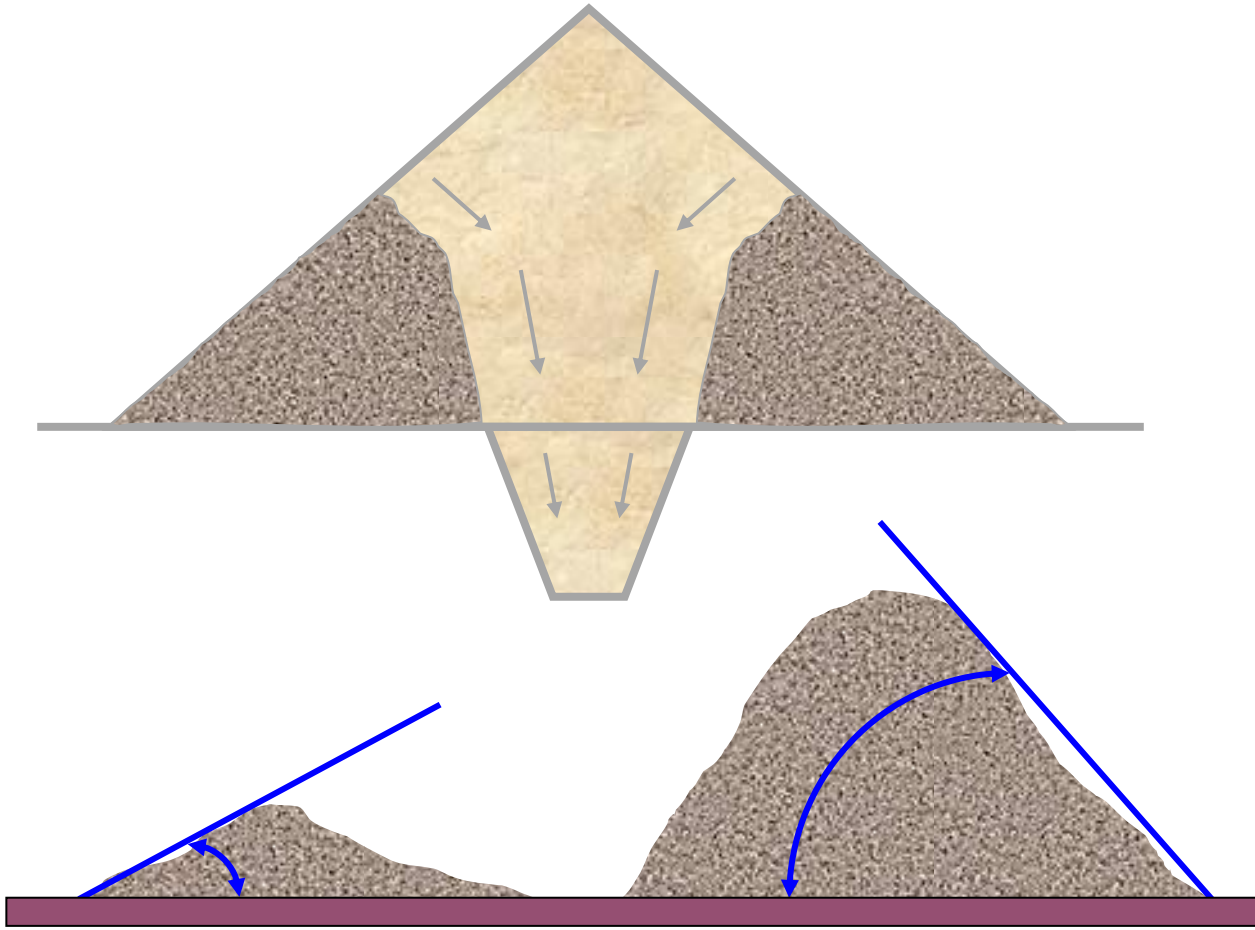


Some Flow to No Flow: Rathole

Fluidization



When is DEM not so useful?



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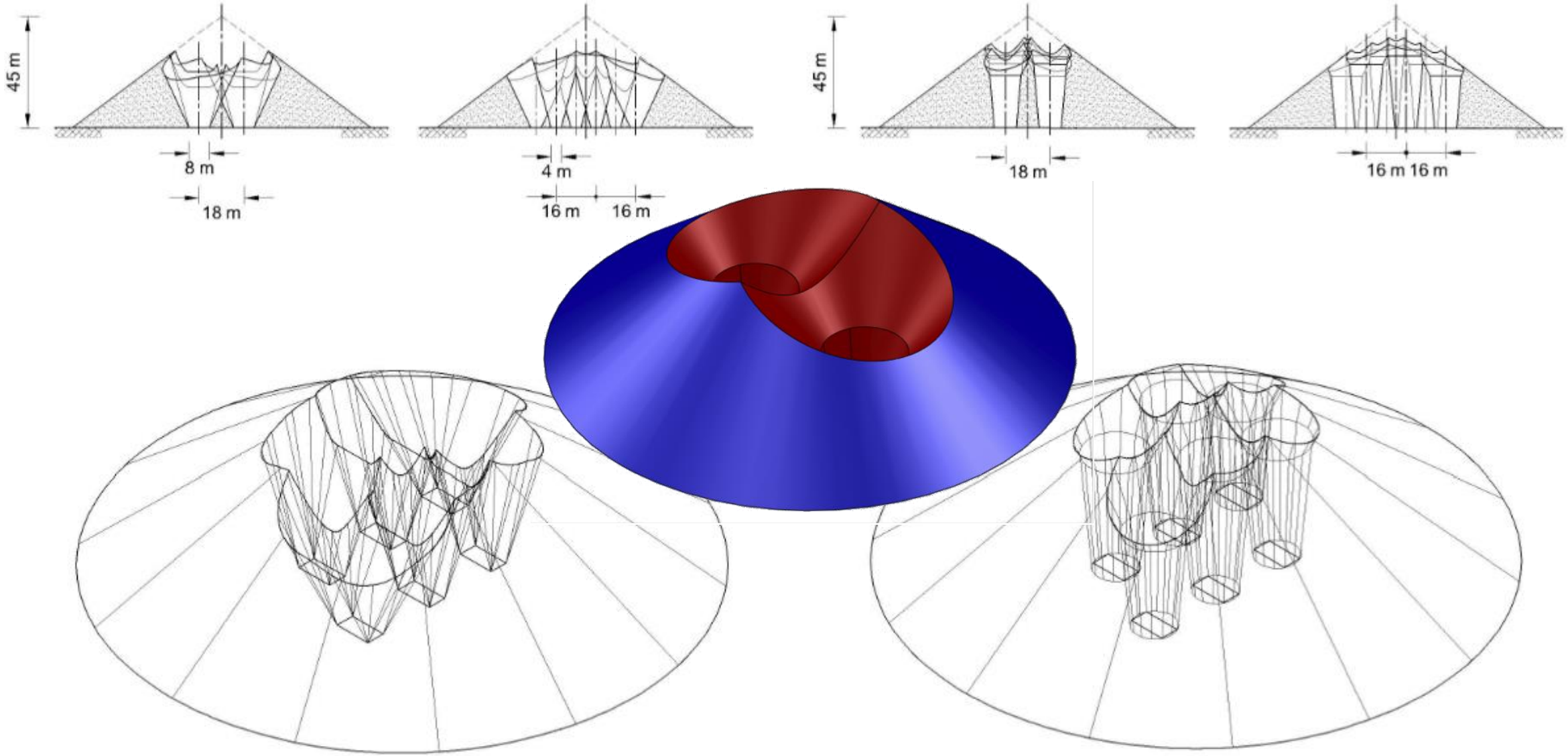

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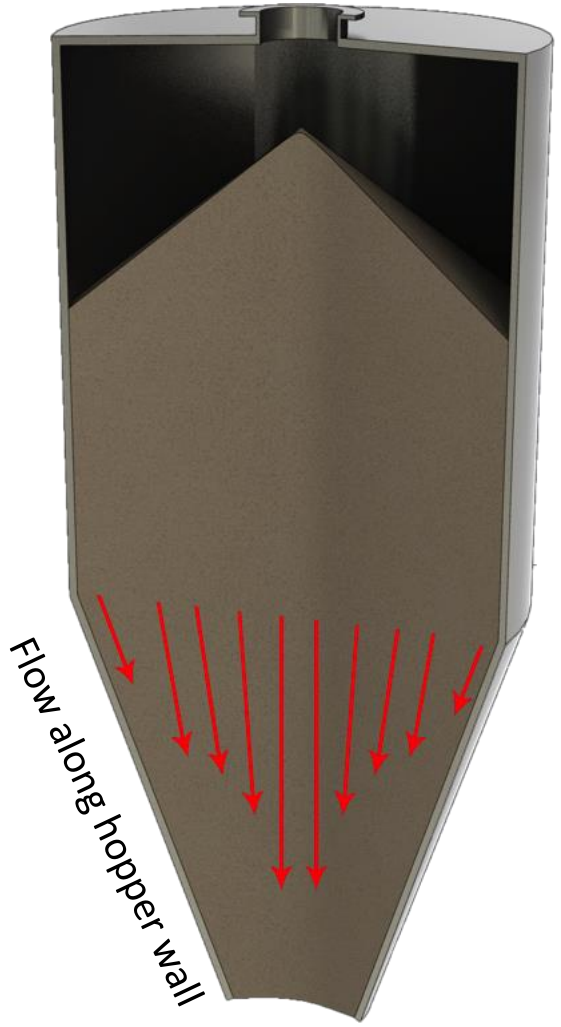
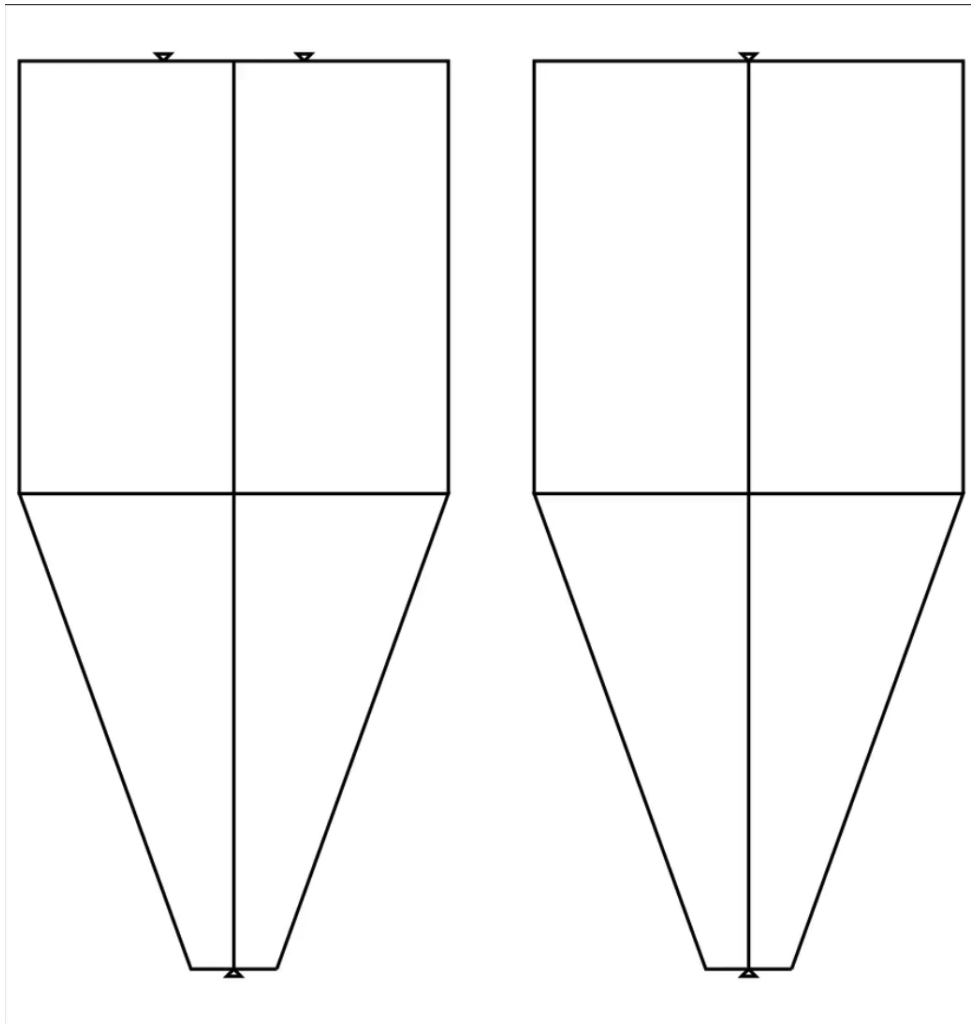
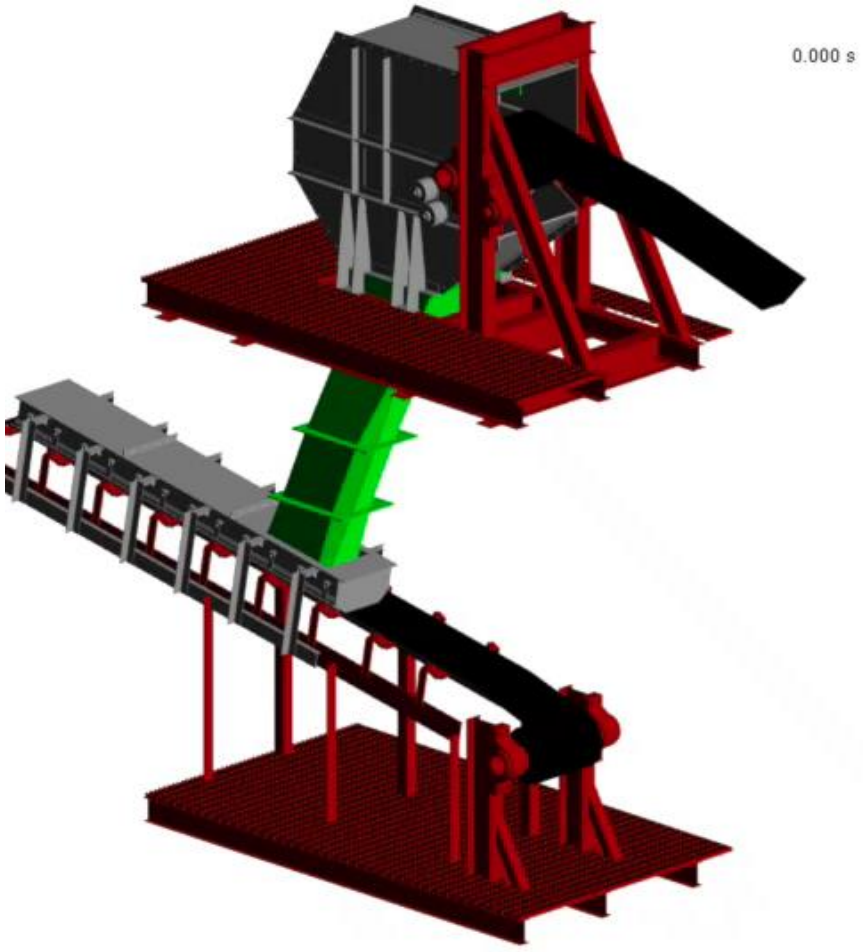
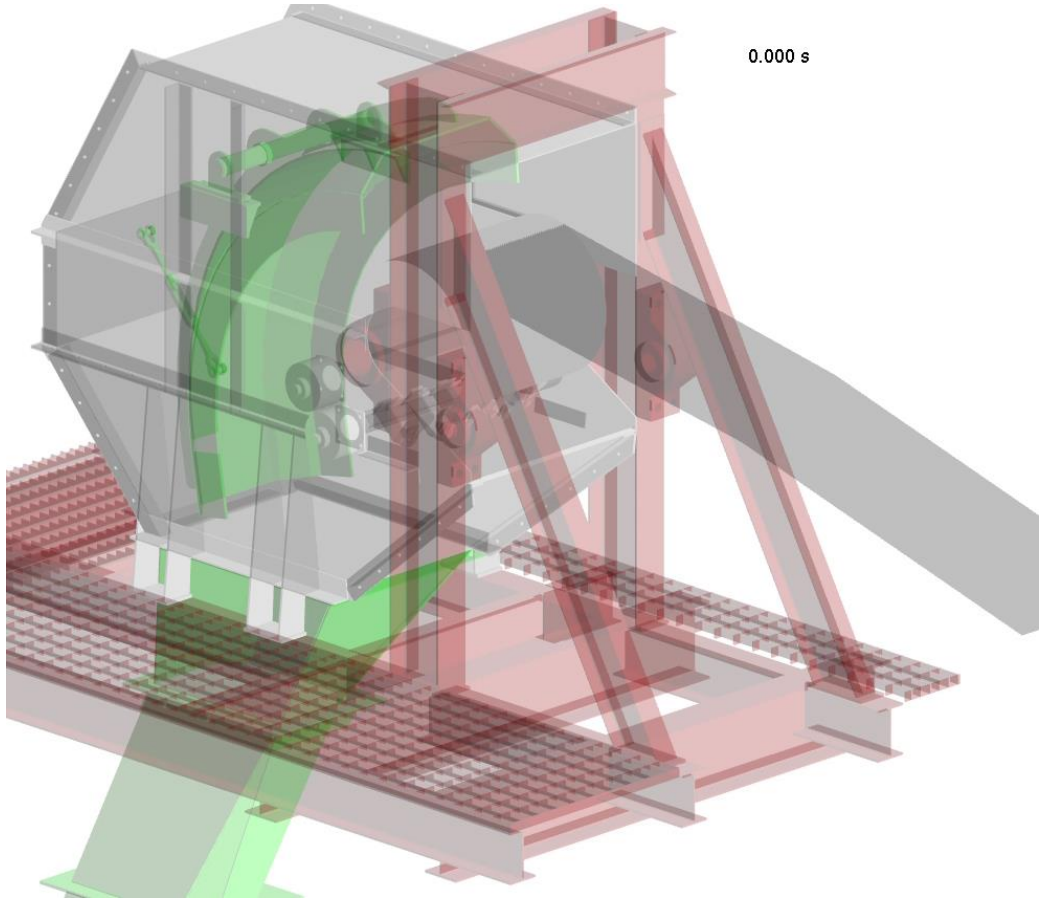




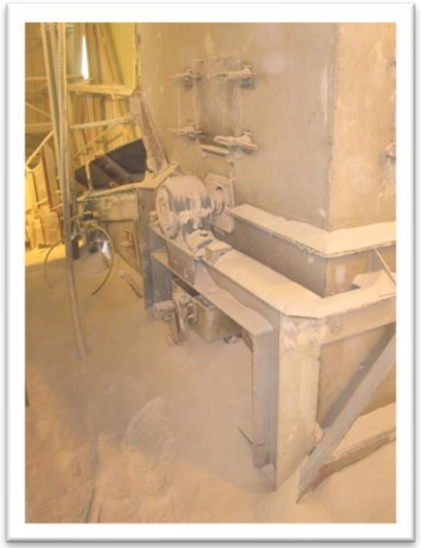
When can we use DEM?





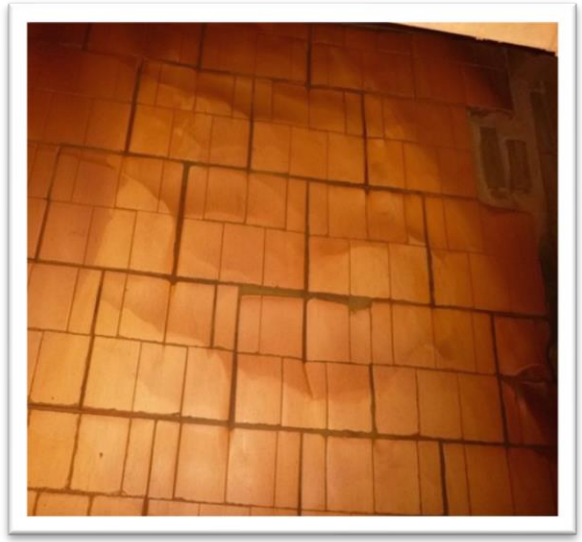
Common DEM Problems-Transfer Chutes

Buildup and Plugging



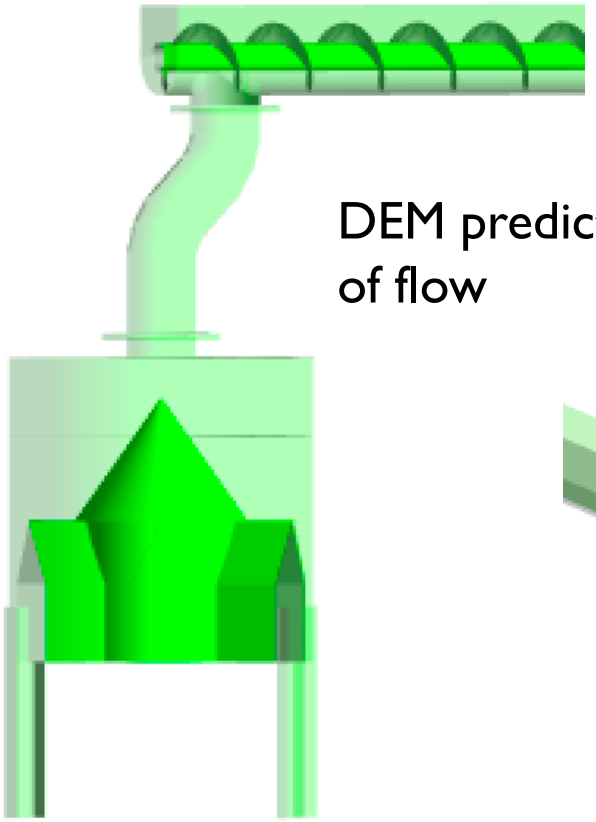
Spillage

Conveyor Rates

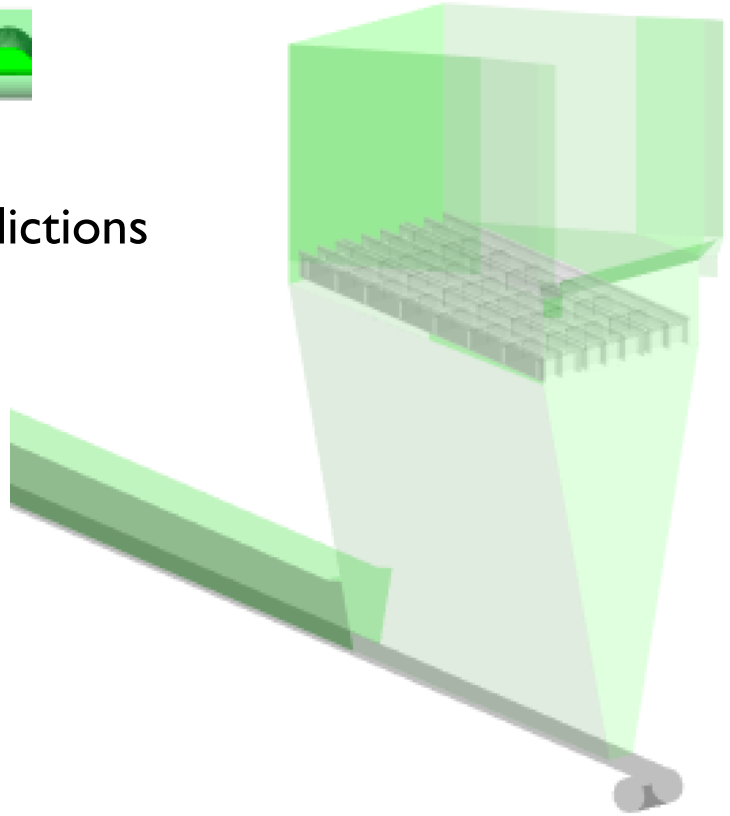


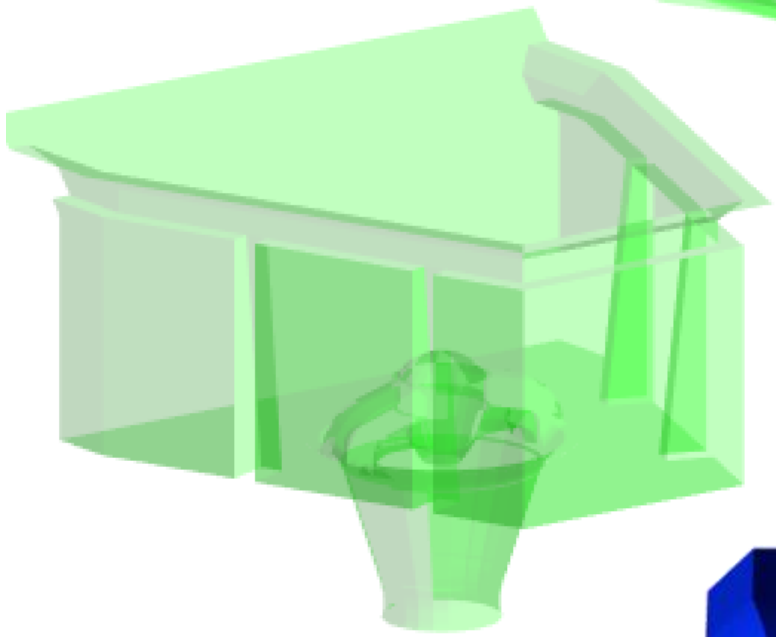
Wear

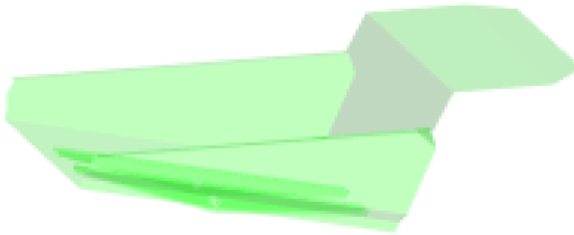
Common DEM Problems

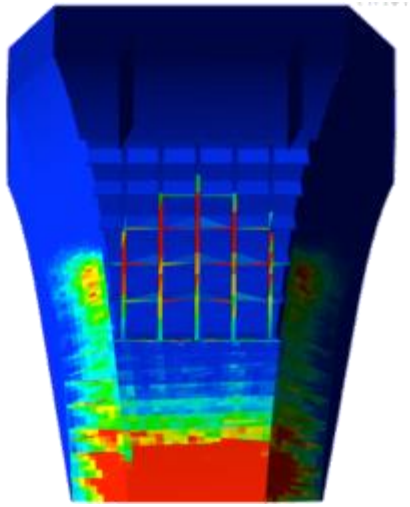


DEM predictions of flow



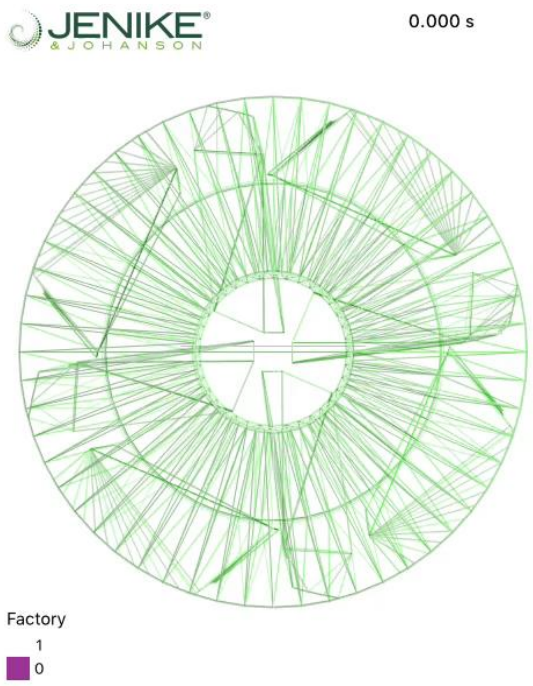


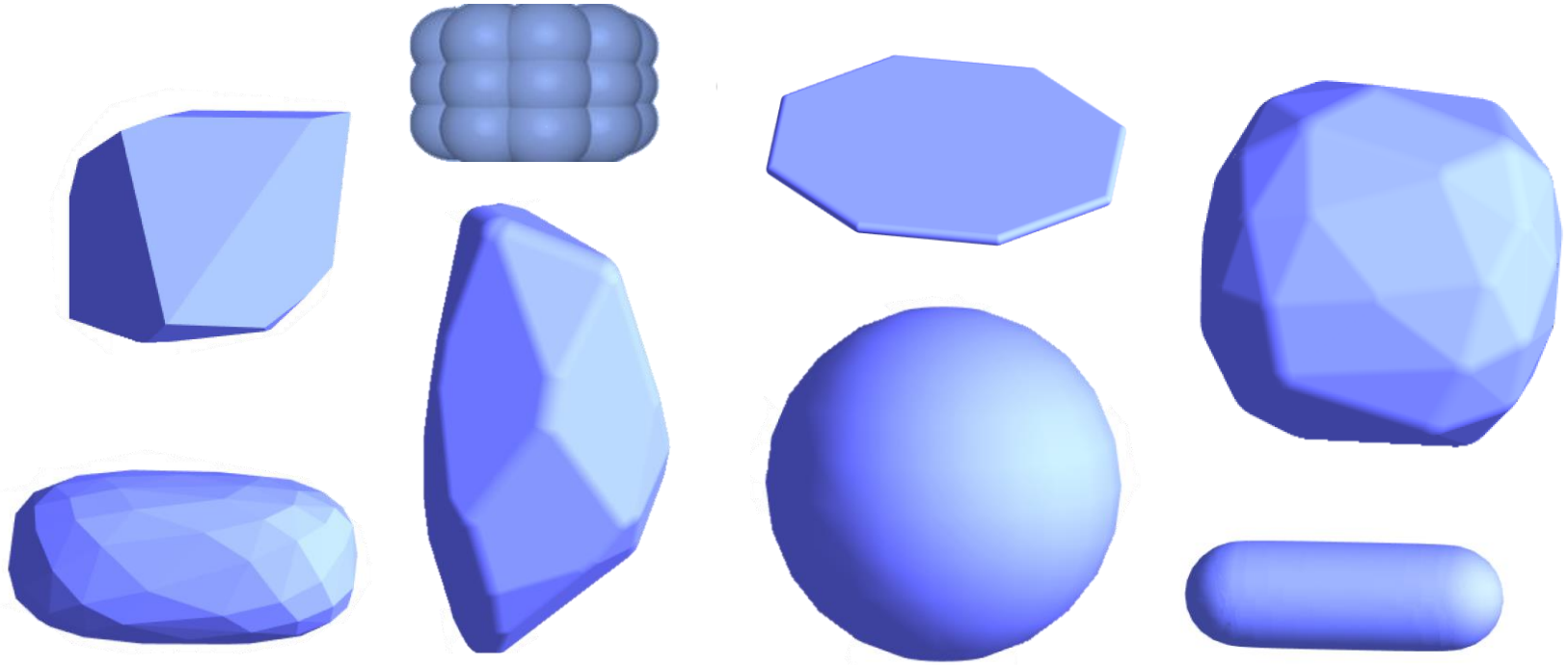




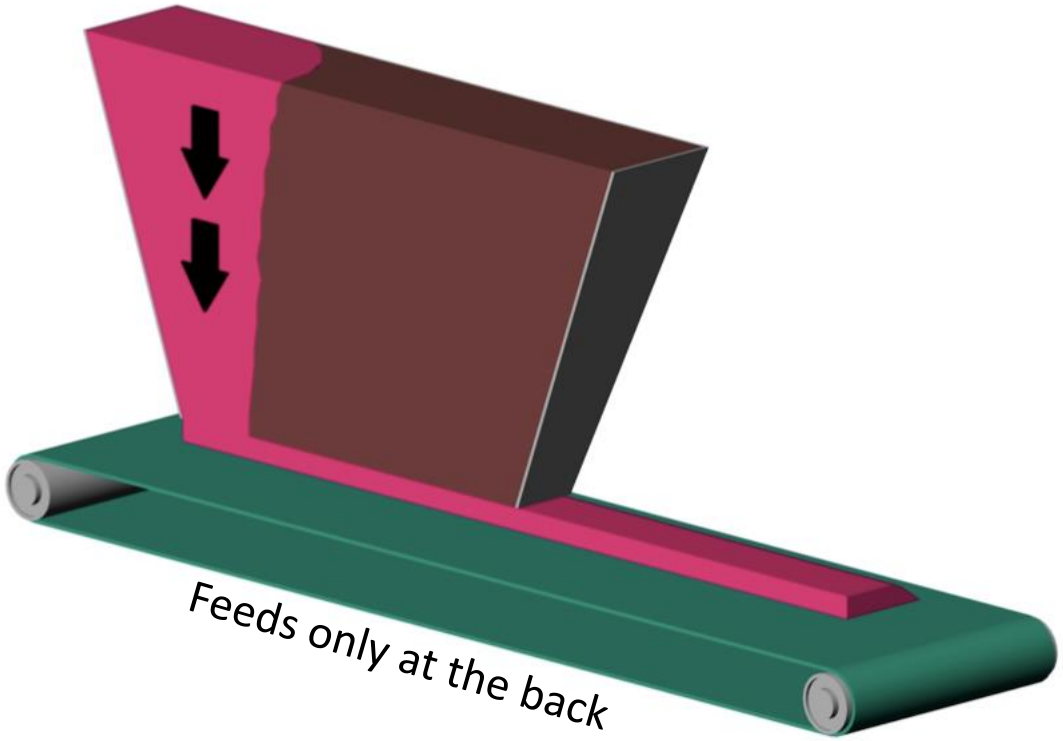
DEM predictions of wear patterns

Common DEM Problems

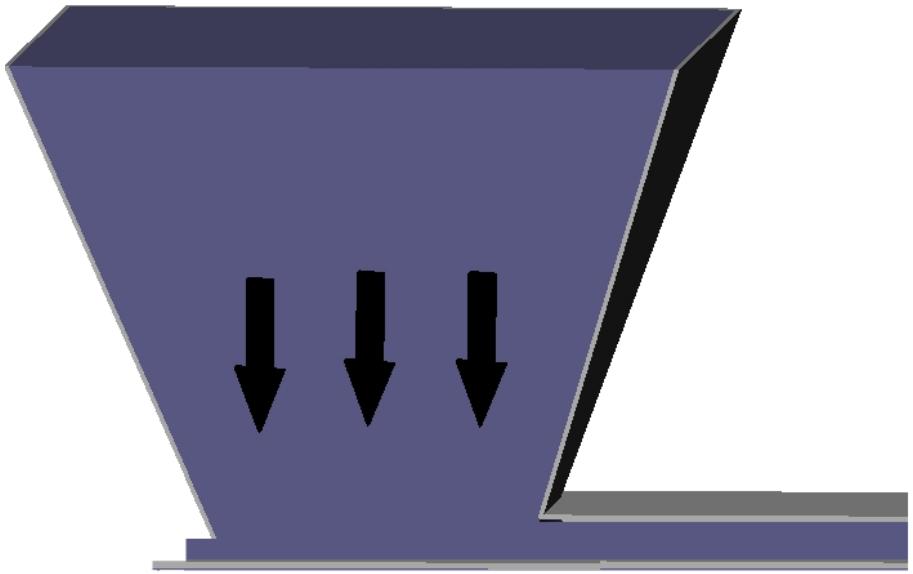




A DEM Case Study: Feeder Design

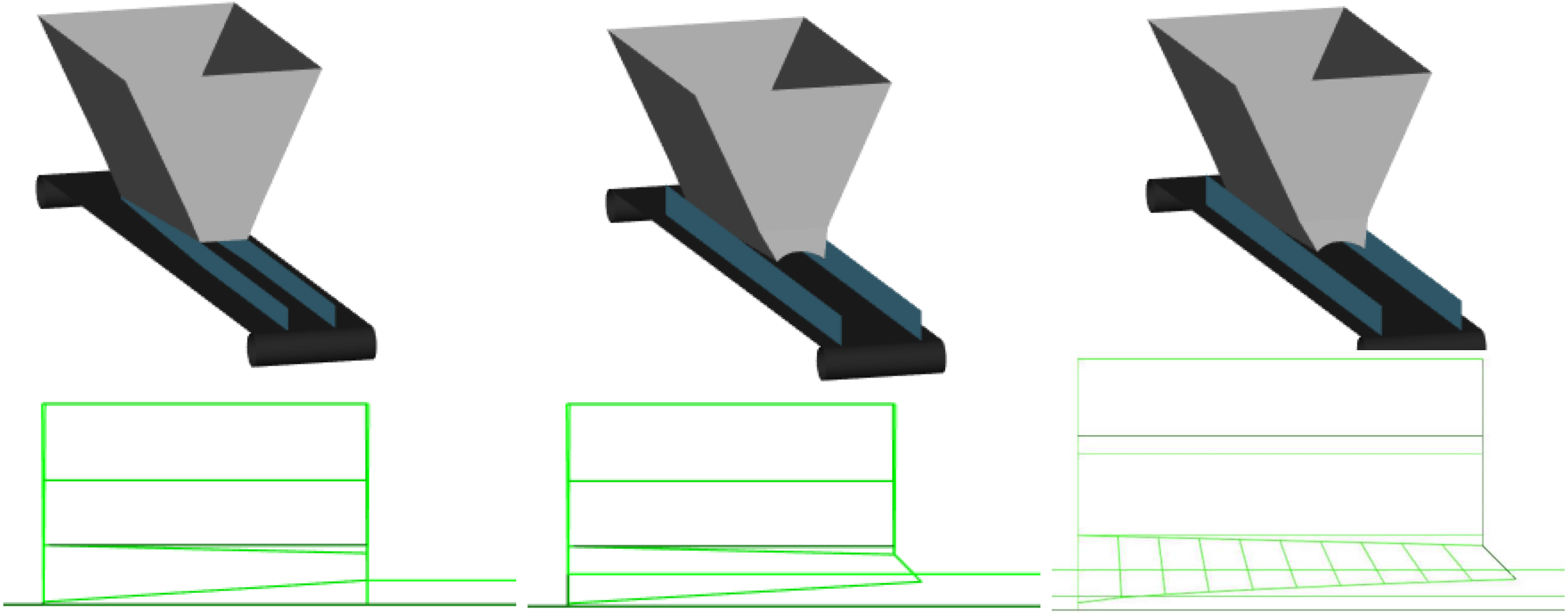


Feeds only at the back



Ideal behavior: mass flow

A DEM Case Study: Feeder Design



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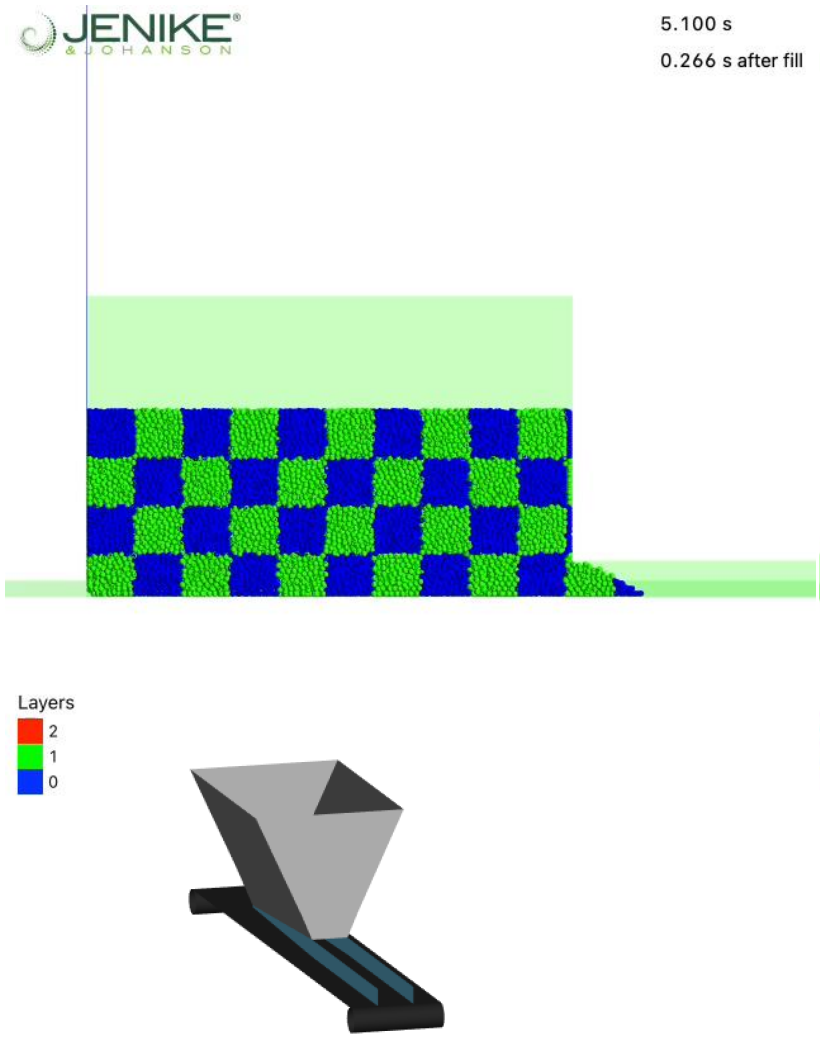

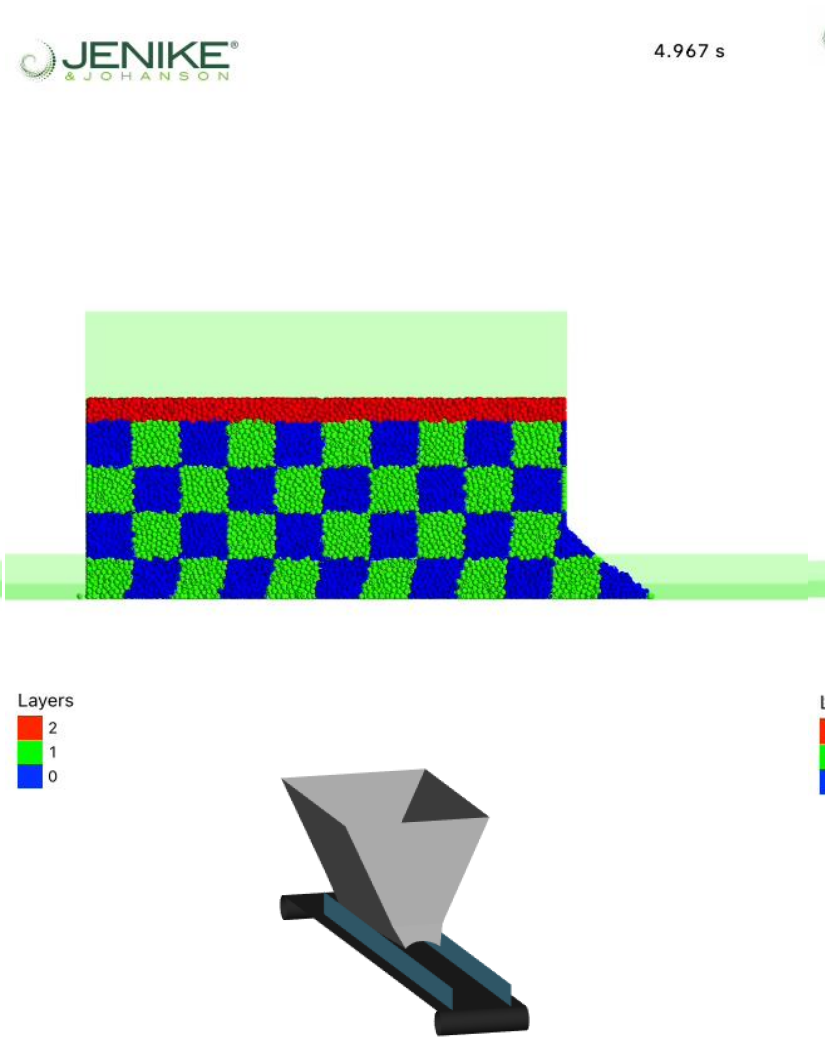

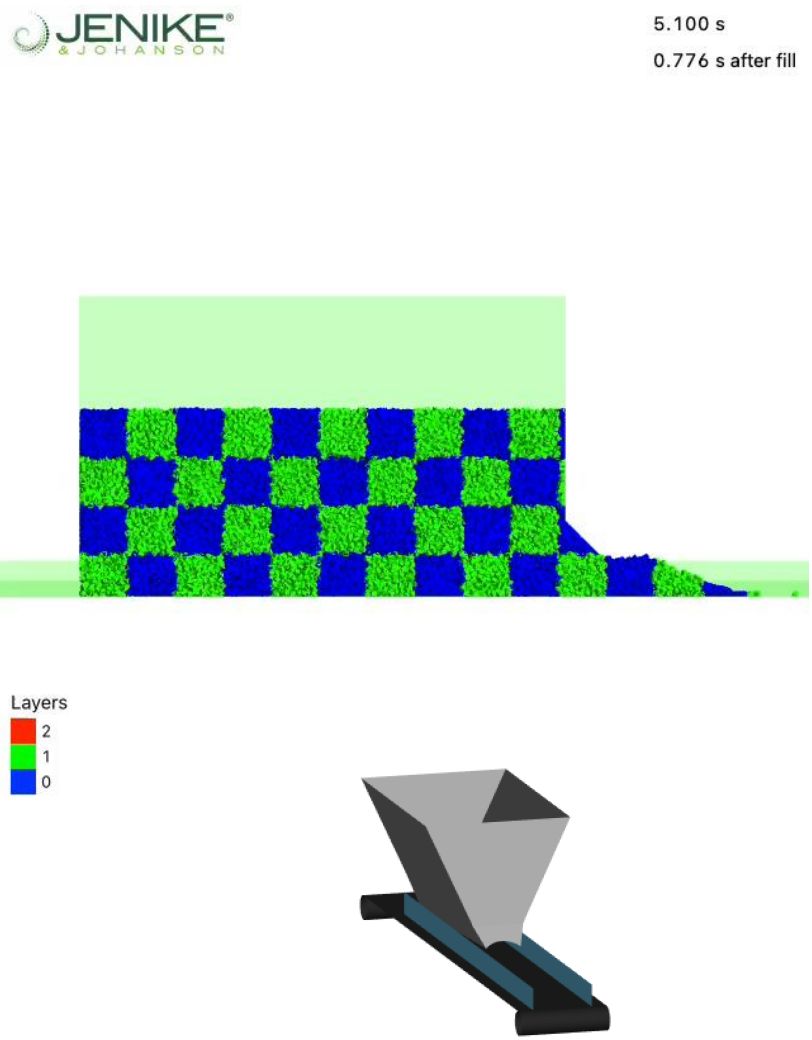

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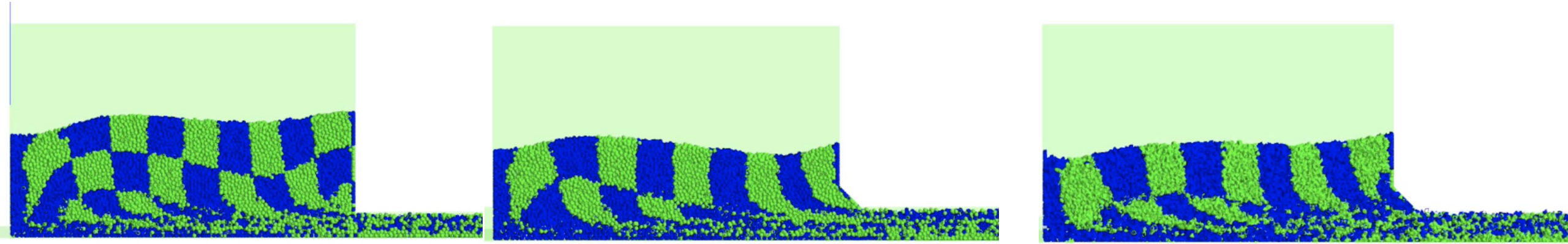
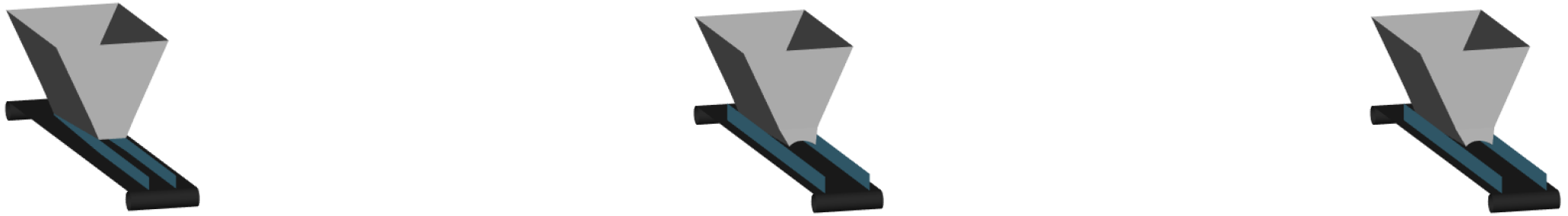
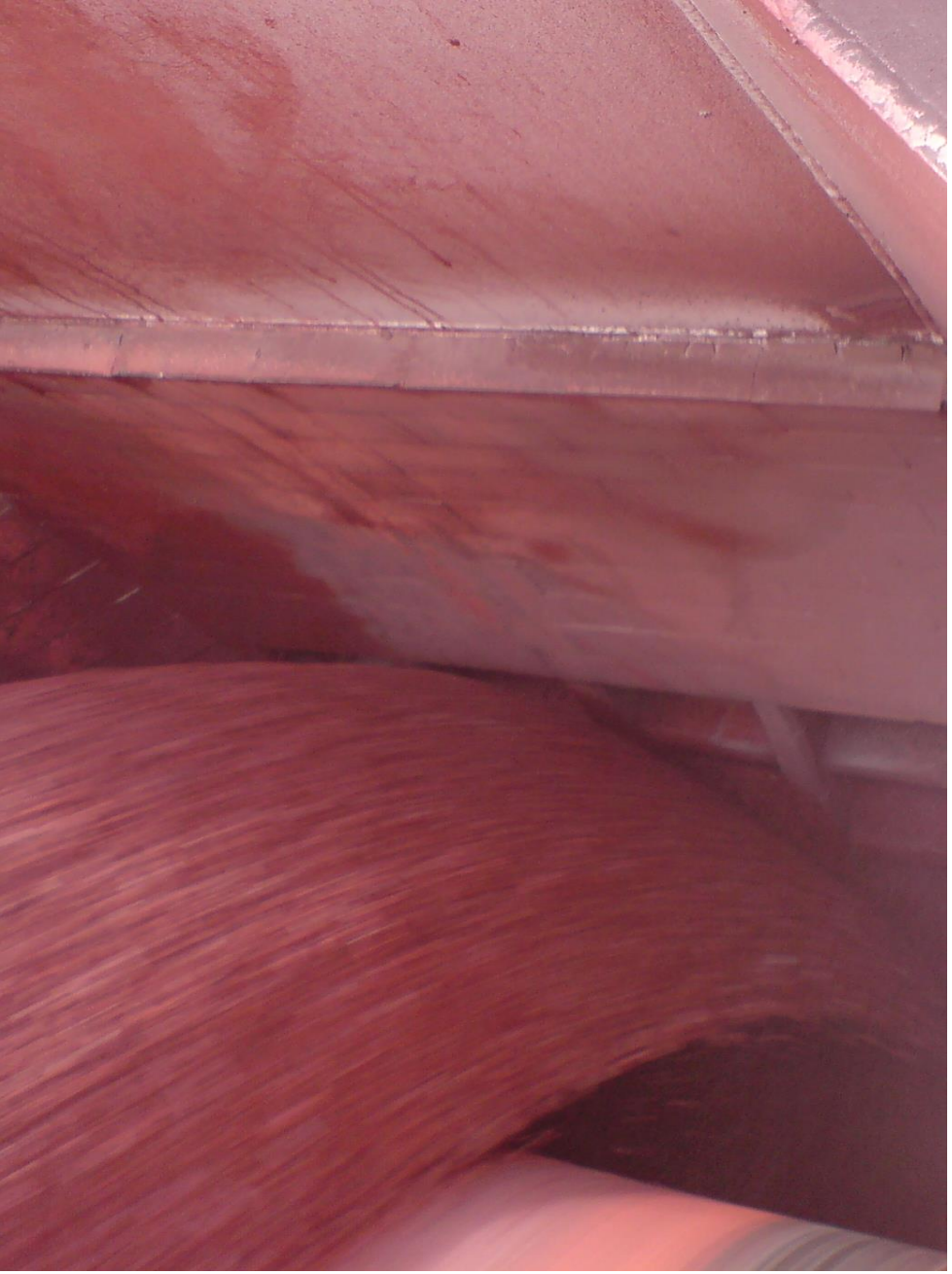
A DEM Case Study: Feeder Design







CONCLUSION

DEM A numerical model capable of describing the mechanical behavior of assemblies of spheres and non-spherical particles.

DEM is not ideal for large body problems like Stockpiles, fines powders in large quantities, and silo fills.

We can observe a number of material flow phenomena: mass flow, arching, ratholing, spillage, etc.

DEM excels in moving boundary problems, chute transfer design, blending, segregation with discrete and multi-shaped geomaterials.

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