Discrete Element Method Simulations in Industry

Where do we go from here?

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Vision

- Numerical laboratory - To boldly go where few experiments or theories have gone before …!!

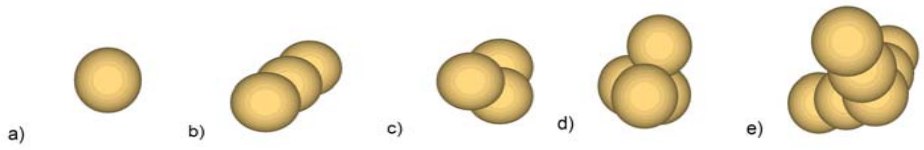
- Exploit fundamental understanding of particle-particle interactions and powder mechanics with new calculation tools to solve difficult problems in solids processing.

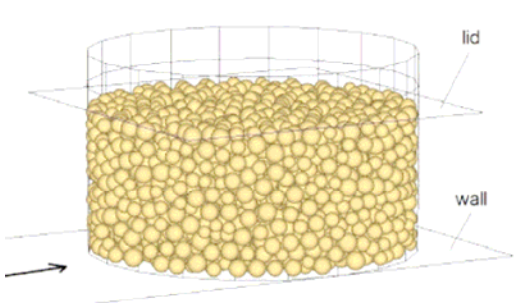
What was done so far?

- Selected examples of DEM applications
  - shear testers
  - storage in silos
  - screw conveyers
  - mixers
  - packing structure
  - material testing
  - pneumatic conveying/fluidized beds

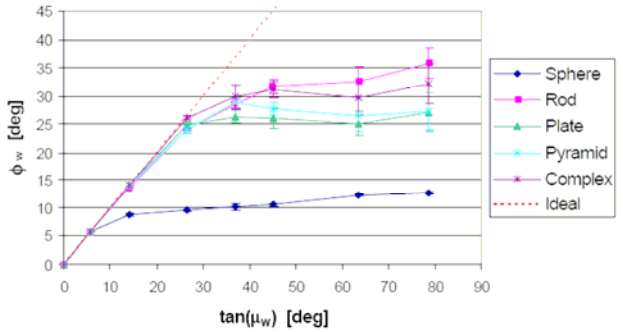
New insights and agreement with theories.
Models have been calibrated for the systems under investigation.

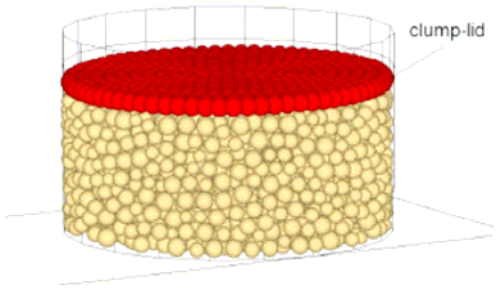
Wall friction calibration for storage problems



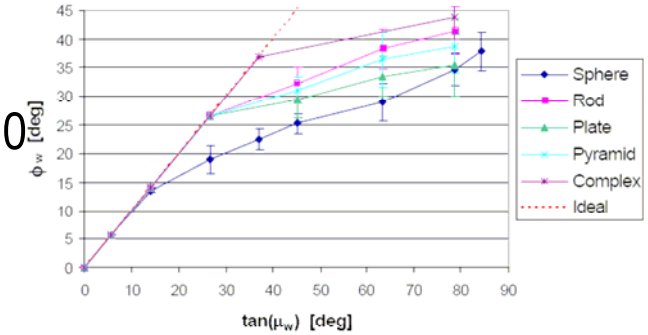


particle friction 0.1



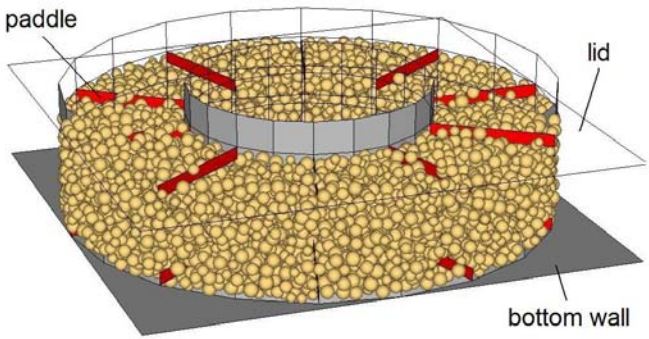


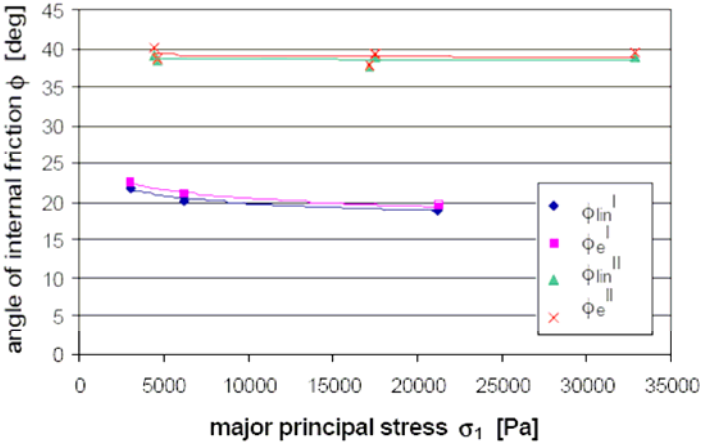
particle friction 1.0

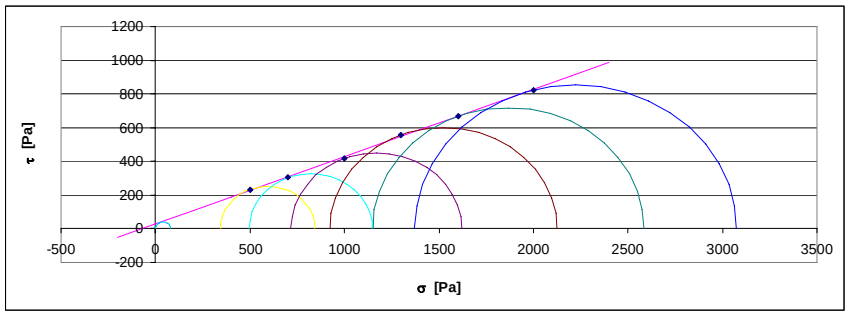


Is the numerical tester reflecting the physics of the real tester?

Determining particle-particle friction -rotational ring shear tester-







Flow properties:

ϕ_{lin} = 21.8 deg

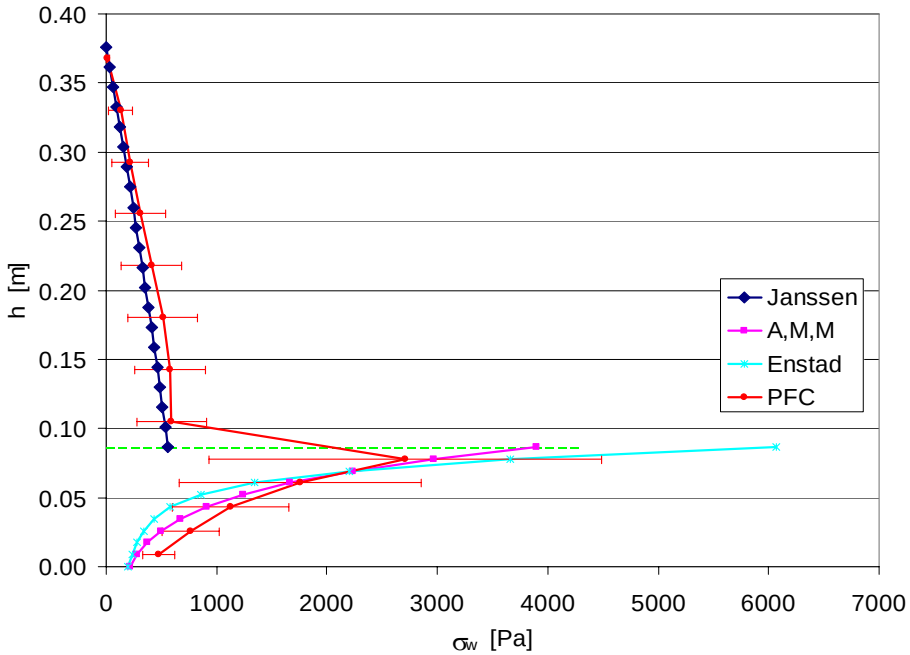
ϕ_e = 22.5 deg

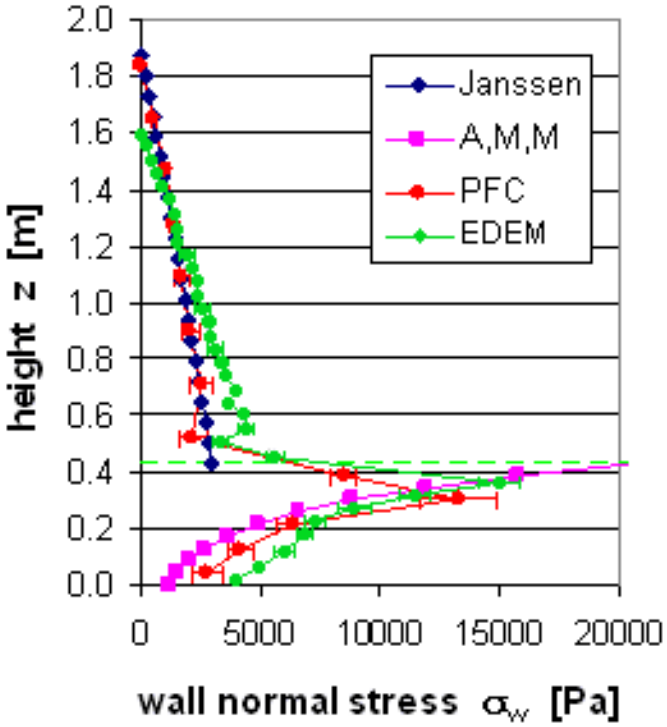
c = 27 Pa

f_c = 80 Pa

ρ_b = 589.5 kg/m^3

Time averaged wall normal stresses during discharge





What is needed?

- good understanding of the right contact models and their calibration for the specific materials
  - LSD, Hertz, Burgers, liquid bridges, Ludings, etc How complicated do we have to get?
  - contact bonds, parallel bonds
    - » Do we need to study the particle-particle contact or is a system response good enough?
    - » Experimental validation on a particle-particle level or for the assembley? –It depends.

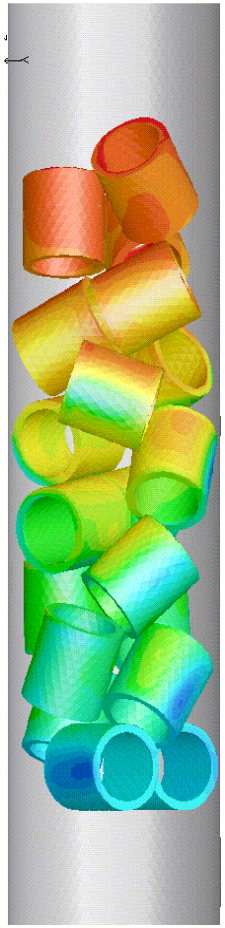
- Calibration techniques for micro parameters
  - choose the right one - depending on granular flow situation
    - » particle-particle contacts dominate (shear)
    - » particles bouncing around (dilute flow)

- Multi phase flow
  - coarse grid for fluid
  - Dem particles the fluid phase
  - coupling with flow simulation software
    - » particle induced or dampened turbulence
    - » shape and drag coefficent

- How many particles do we need for a realistic system response? scale up of particle size
- Coupling of continuum approach and DEM

User norm/guide “DEM101” the unique calibration parameters and procedure

Process optimization: DEM-Fluent/CFX- reaction



Pressure Field
(Axial Plane)

Velocity contours
(Axial Plane)

Velocity vectors
(Axial Plane)