The purpose of this project is to develop a method capable of simulating the damage process in a model of a mock explosive generated from microtomography data using MPM.

Presented is a technique which uses image processing on 3-D microtomography data to create input files for MPM simulations. Preliminary results are compared to experimental testing and Finite Element Analysis.

Robert Kaulbach
Abaqus Simulations

Performed simulations in Abaqus to find areas most likely to fail first

Particle: $E = 1000$ MPa

Binder: $E = 215$ MPa

$U_x = U_y = 0$

1 MPa
Abaqus Simulation – Strain Energy Density
Regions likely to fail first are consistently at the edge and in-between particles.
Placed samples under compressive load inside a micro-CT machine.

Took images at increasing strains to observe damage process.
Micro-CT Imaging
Micro-CT Imaging
Micro-CT Result

It is seen that damage initiates as debonding at the particle edge.

Cracks then grow in the binder between particles.
With image processing techniques provided by Dr. Zhenxing Hu, the greyscale micro-ct images were converted into binary color.

The binary color images were then turned into point data for MPM simulations.

A partial model was simulated with compressive loading to observe damage process.
Image Conversion to MPM Data
Image Conversion to MPM Data
MPM Results

Initial Stage
Damage first appears near edge of particles

Initiation of damage
Cracks then spread between particles

Damage Growth
Summary

All areas of testing show consistent results.

MPM results can be explained.

Next steps:
Simulate entire cylindrical model
Investigate behavior under confined compression