Recreating the damage process in a Mock Explosive material from Microtomography Images

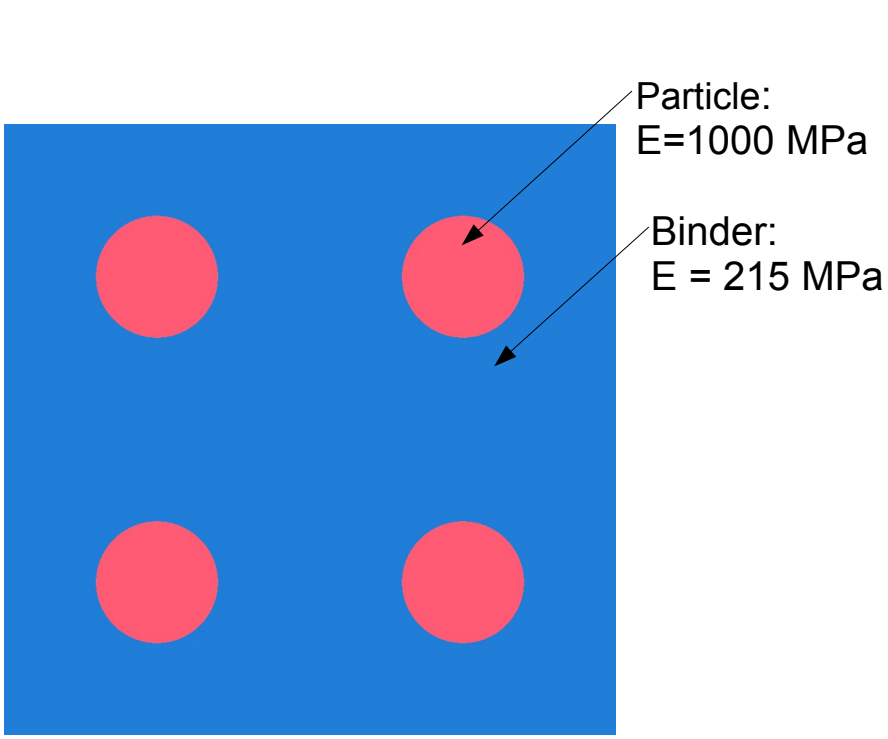
The purpose of this project is to develop a method capable of simulating the damage process in a model of a mock explosive generated from micro-tomography data using MPM.

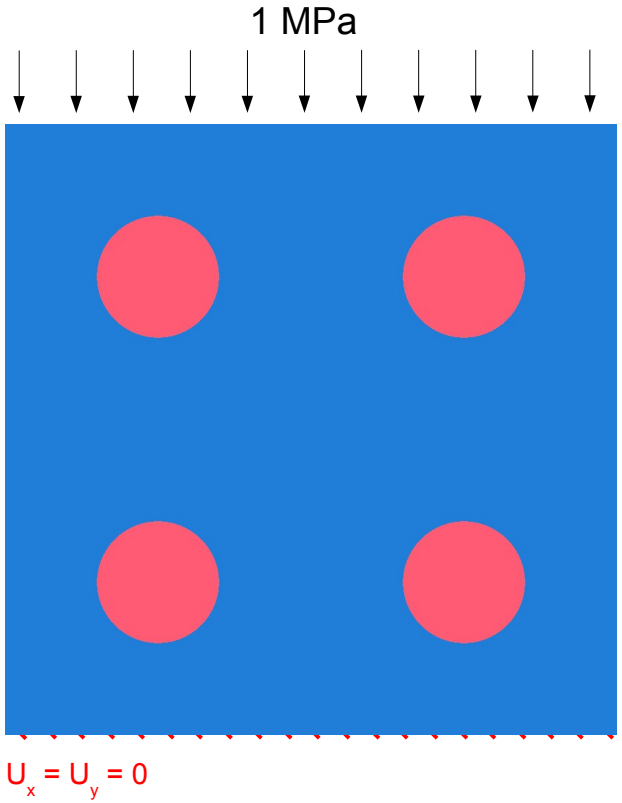
Presented is a technique which uses image processing on 3-D micro-tomography data to create input files for MPM simulations. Preliminary results are compared to experimental testing and Finite Element Analysis.

Robert Kaulbach

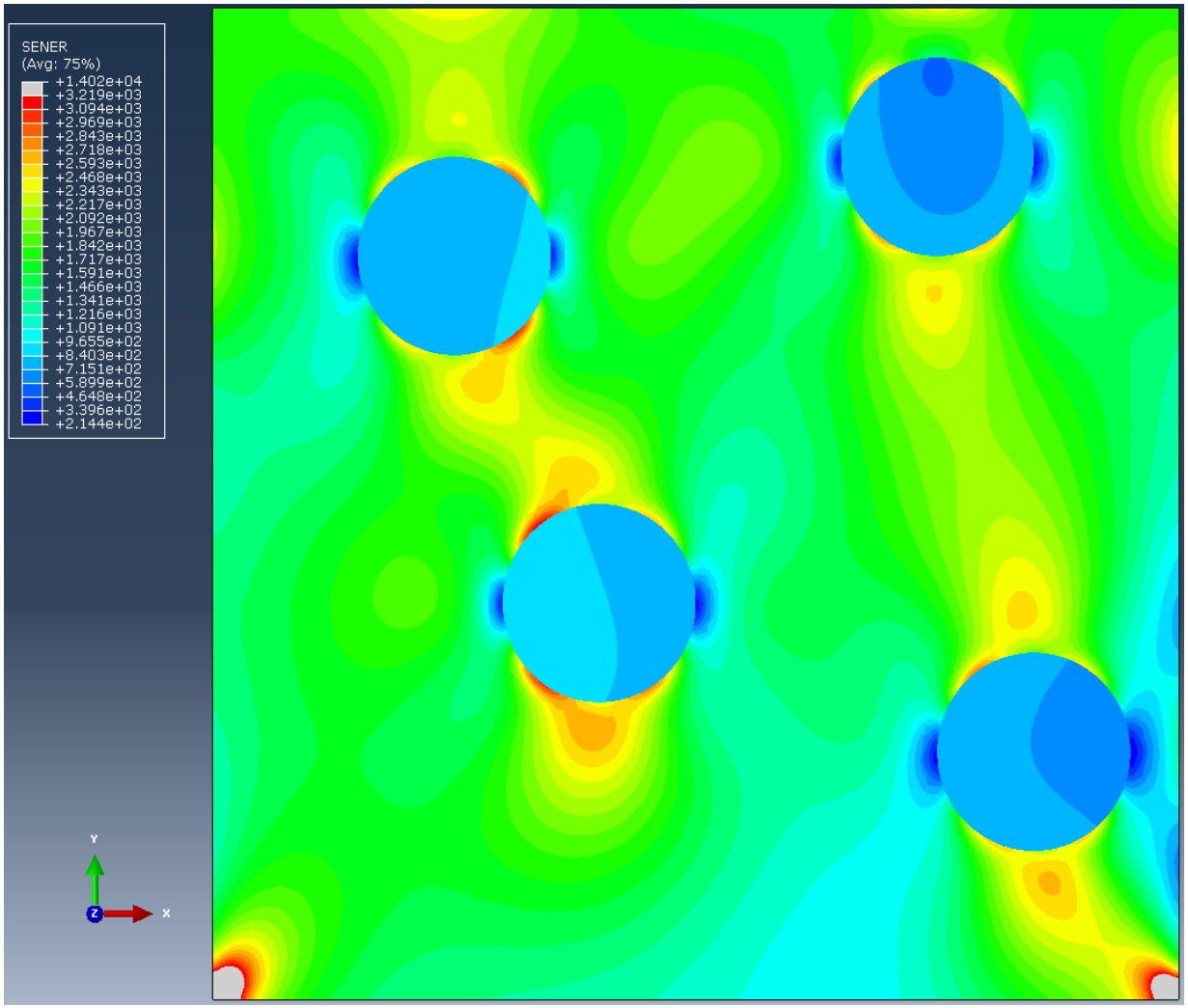
Abaqus Simulations

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

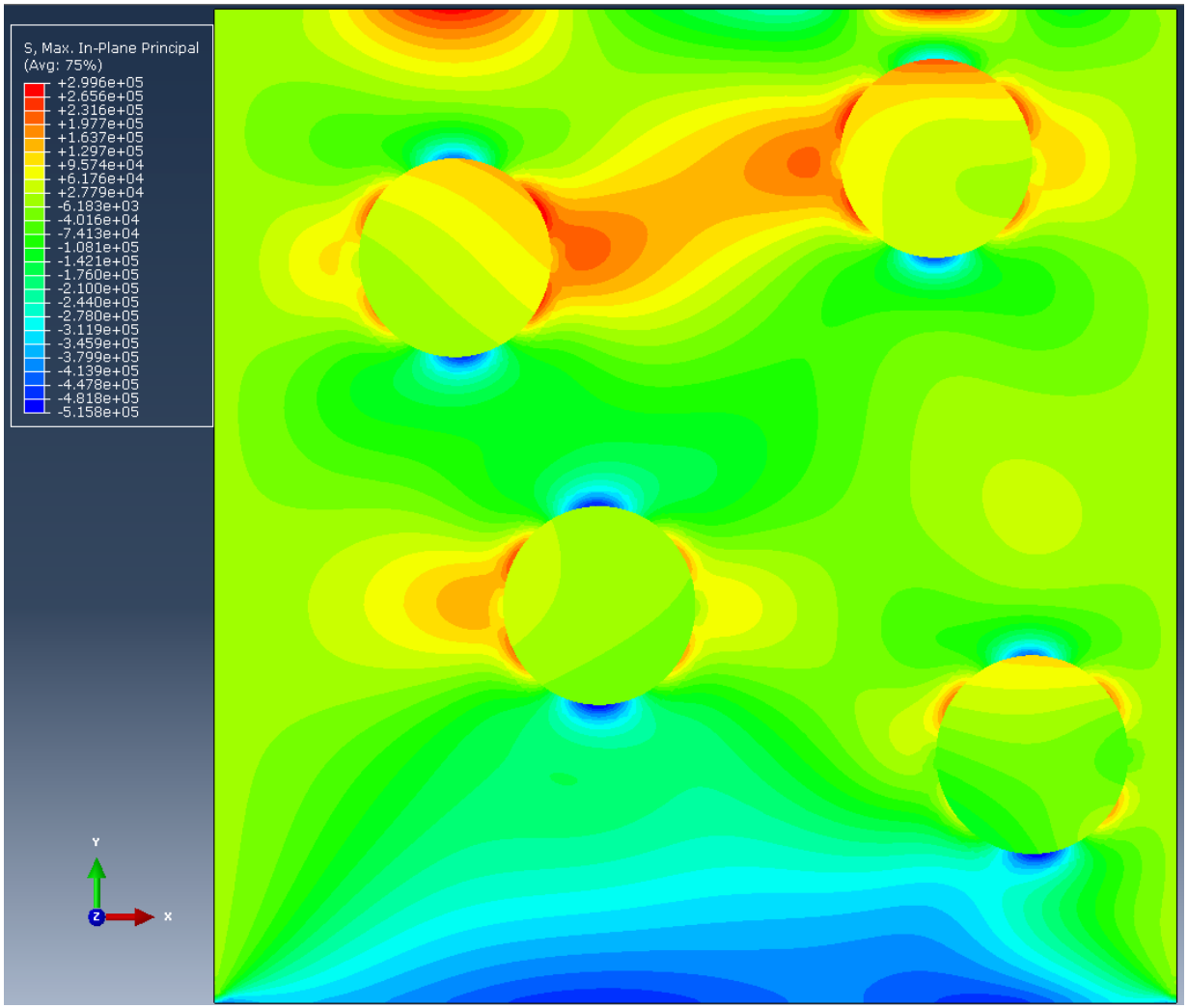




Abaqus Simulation – Strain Energy Density



Abaqus Simulation – Max. In-Plane Principal Stress

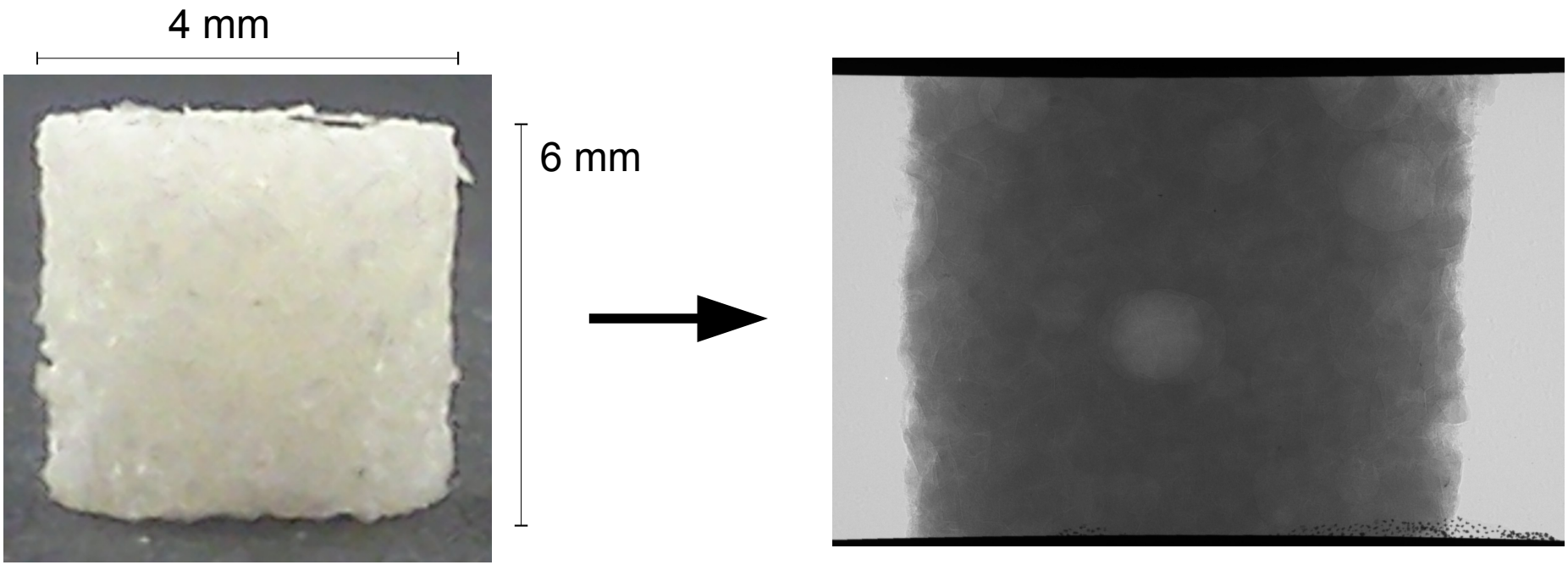


Regions likely to fail first are consistently at the edge and in-between particles

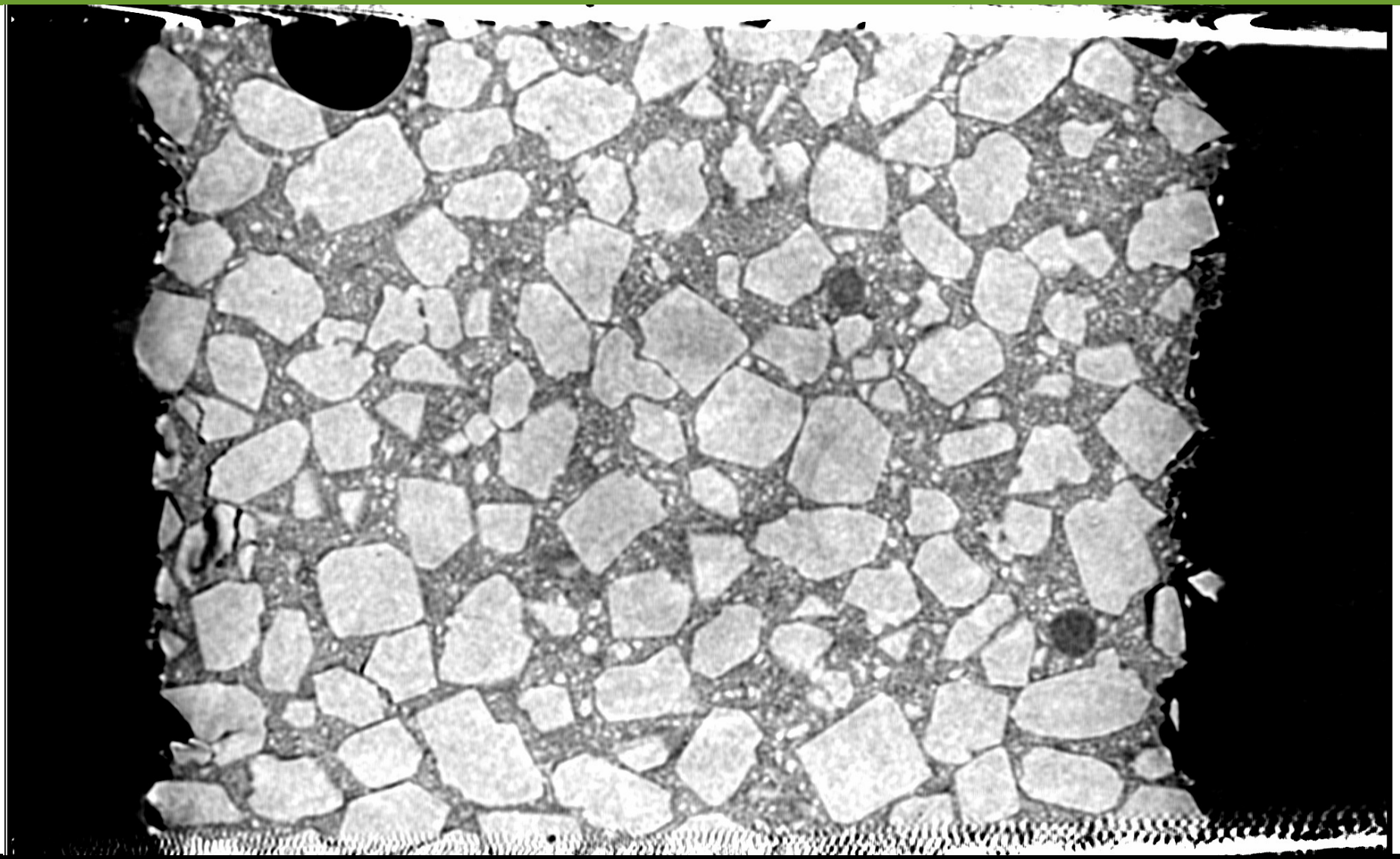
Micro-CT Imaging

Placed samples under compressive load inside a micro-CT machine.

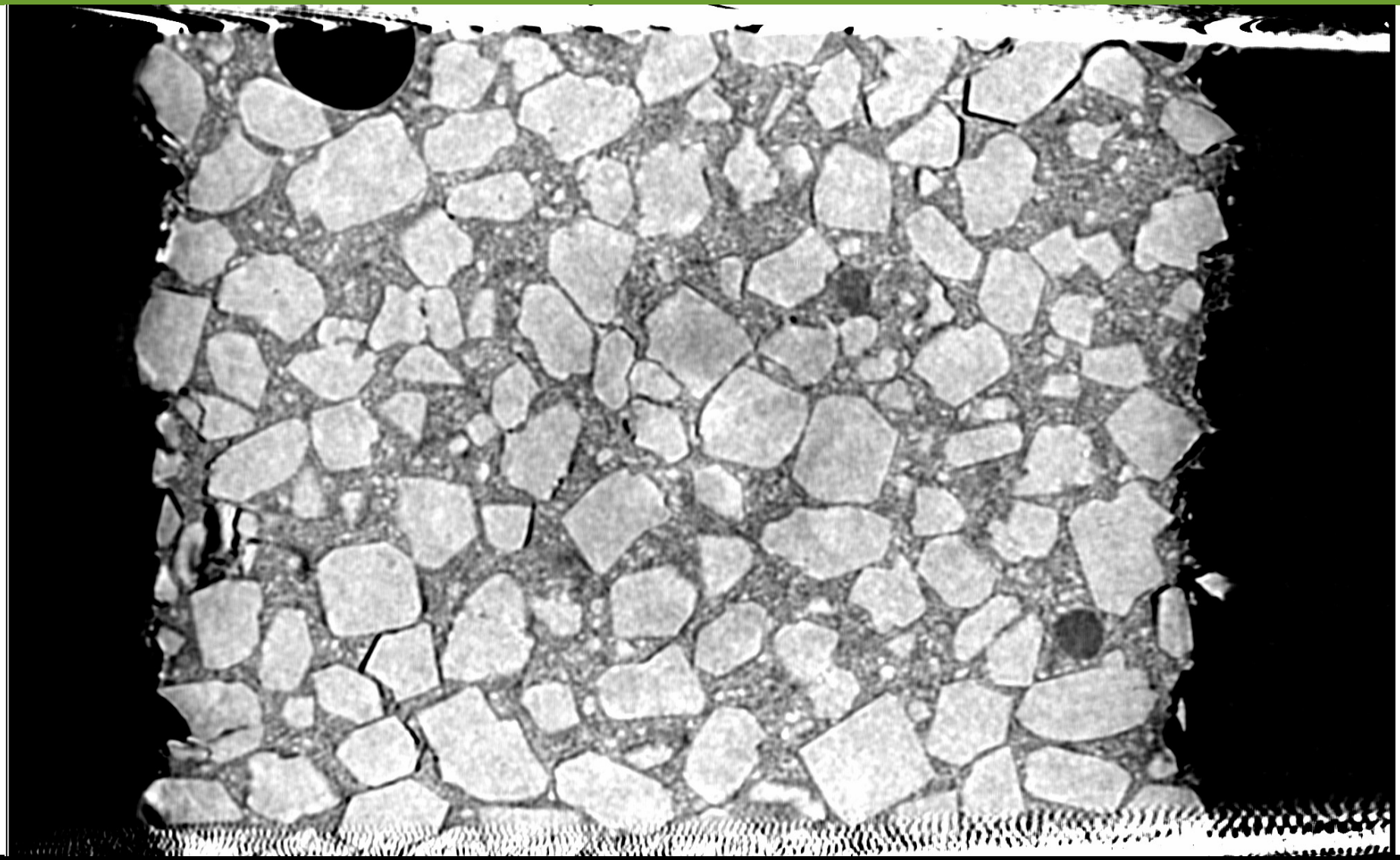
Took images at increasing strains to observe damage process.



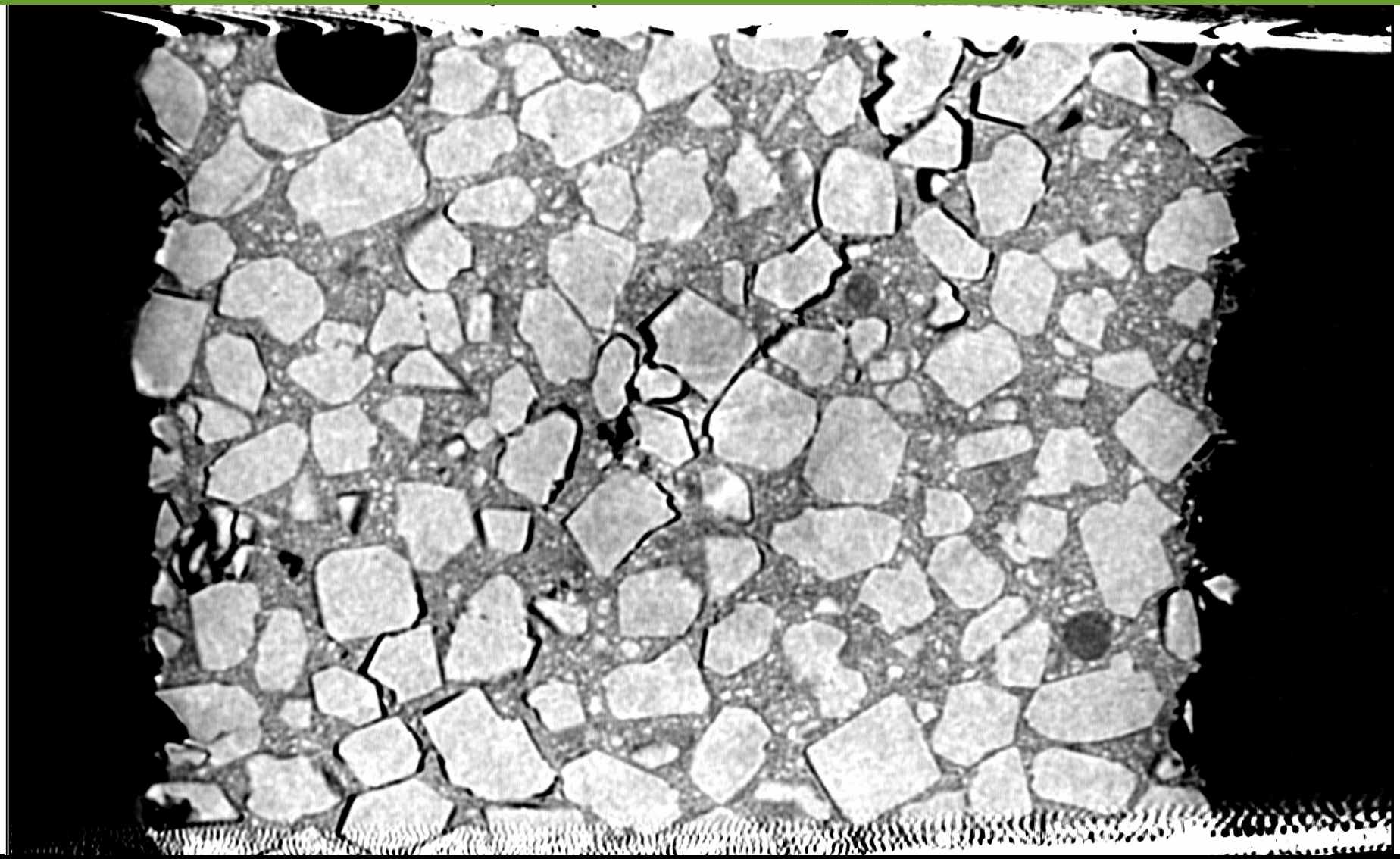
Micro-CT Imaging



Micro-CT Imaging



Micro-CT Imaging



Micro-CT Result

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

Cracks then grow in the binder between particles.

MPM Simulation

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

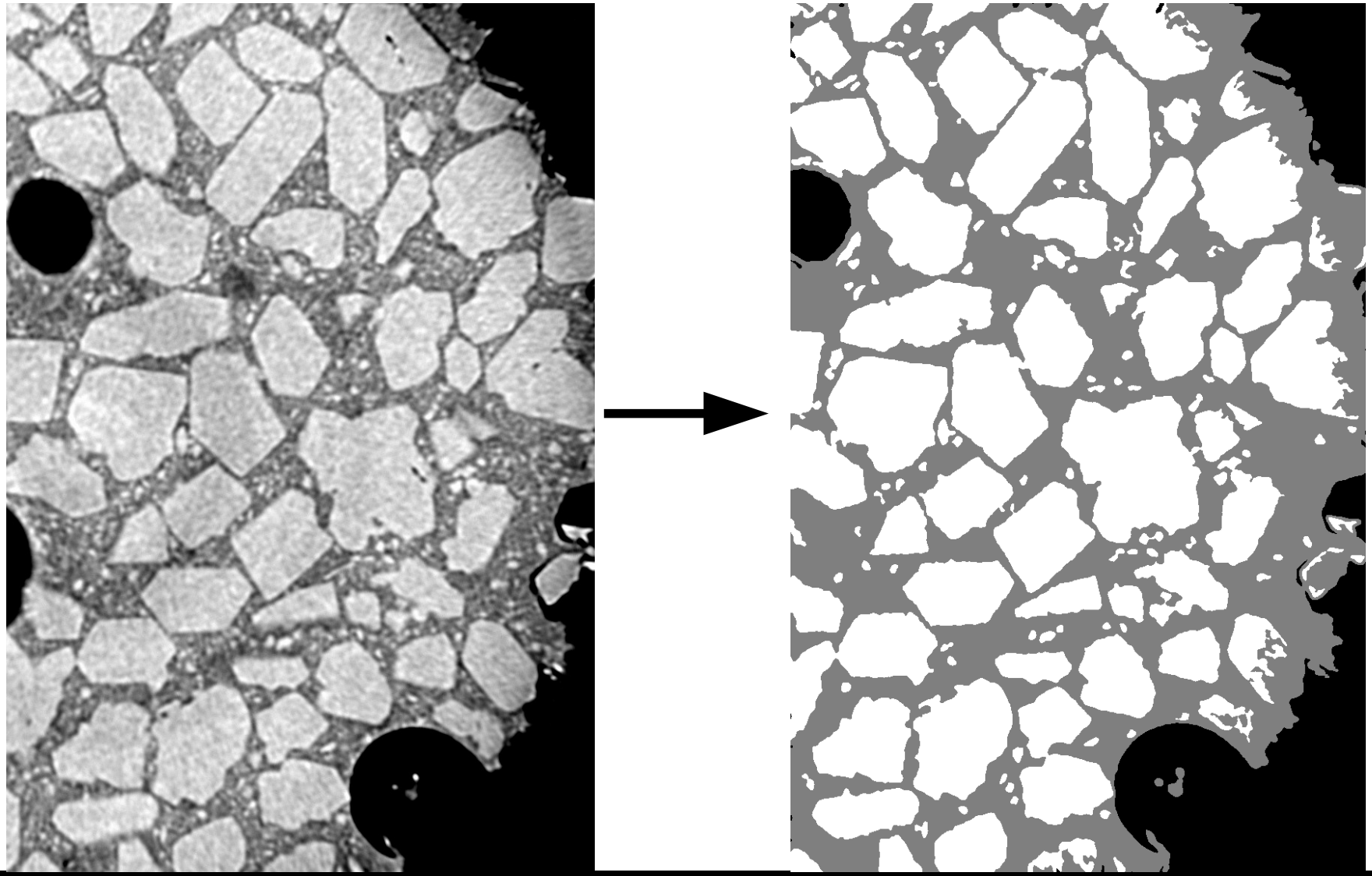
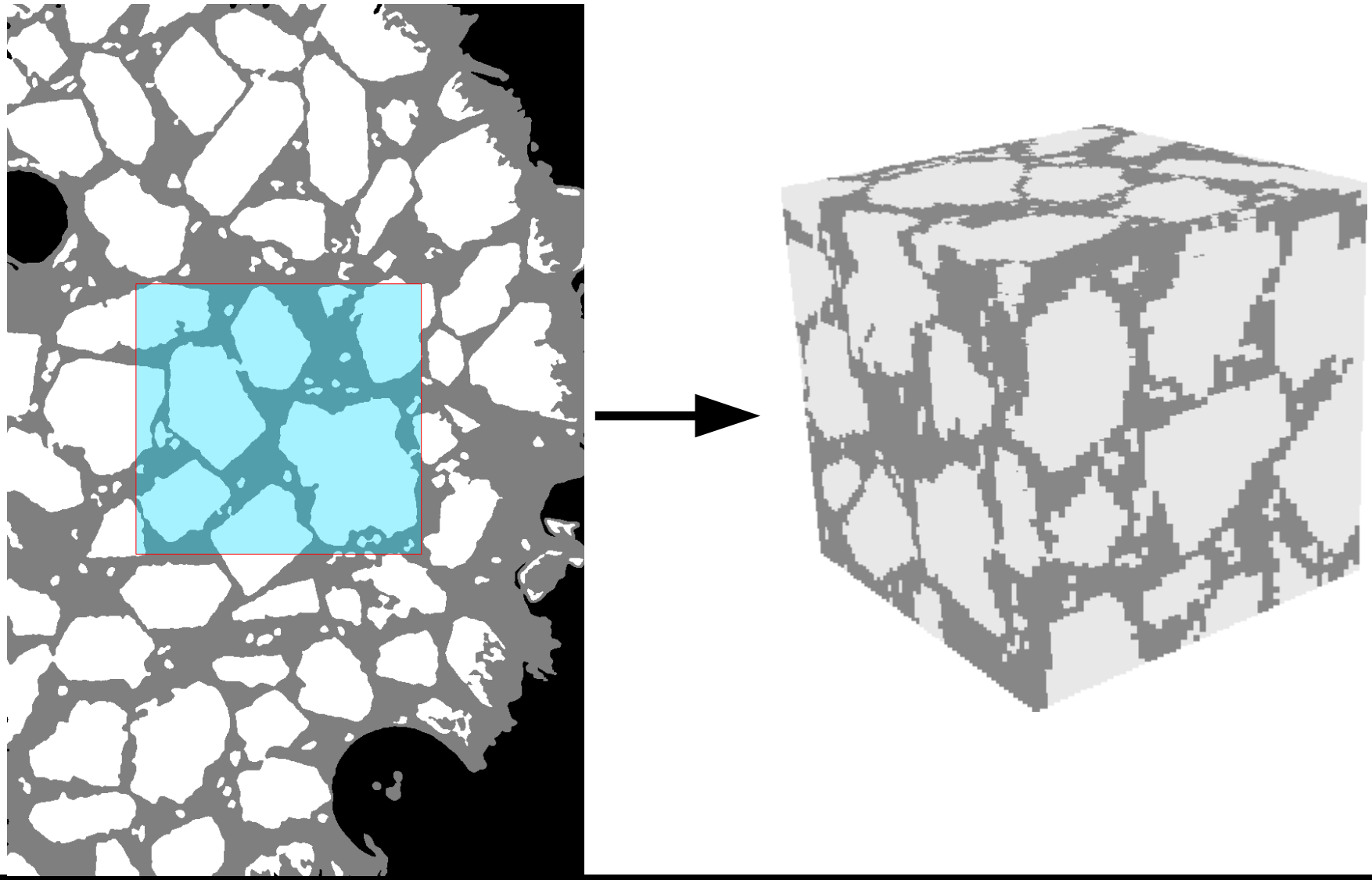
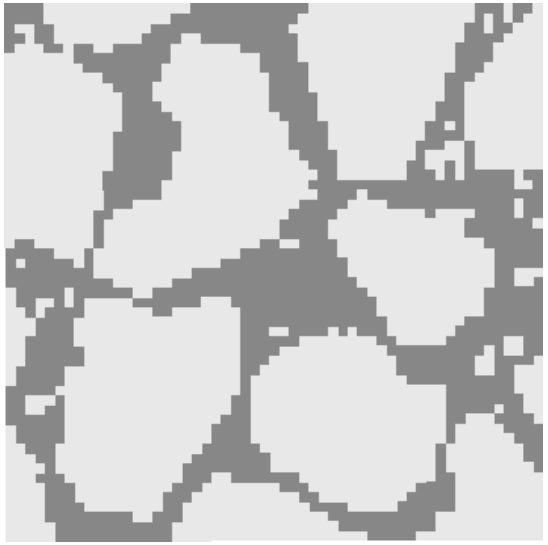


Image Conversion to MPM Data

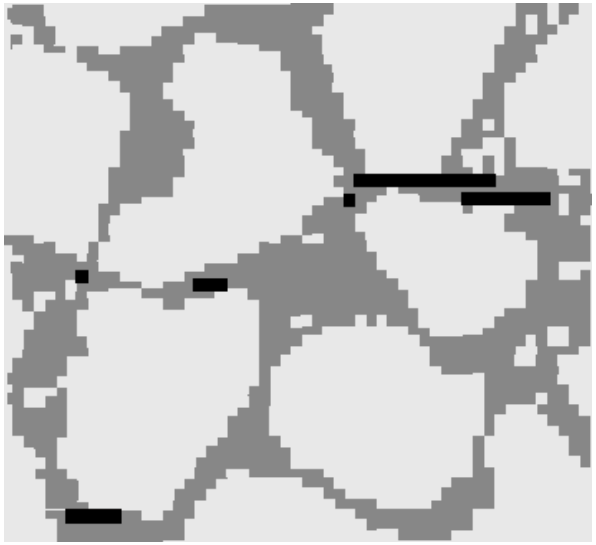


MPM Results

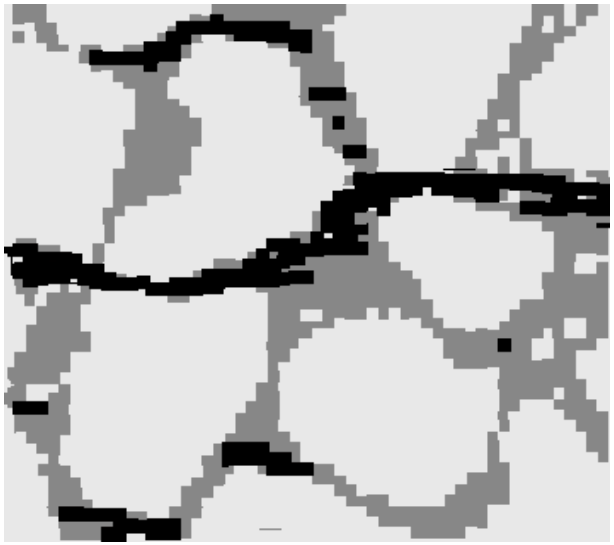
Initial Stage



Initiation of damage



Damage Growth



Damage first appears near edge of particles

Cracks then spread between particles

Summary

All areas of testing show consistent results.

MPM results can be explained.

Next steps:

Simulate entire cylindrical model

Investigate behavior under confined compression