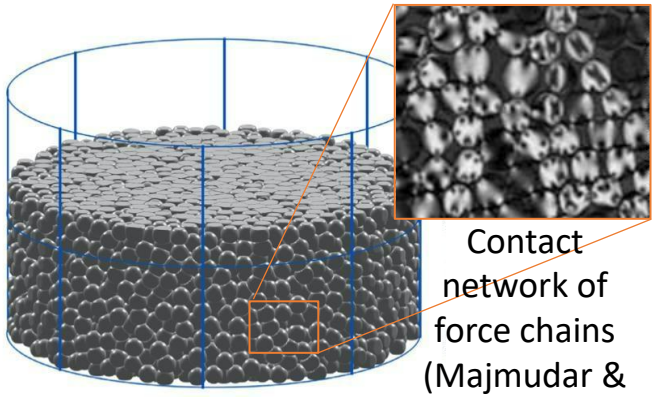
A Semi-Mechanistic Contact Law for Large Deformation Unconfined and Confined Compression of Plastic Spherical Particles with Power-law Hardening

Objective

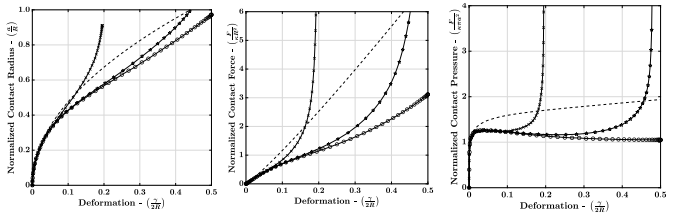
Prediction of microstructure evolution during compaction capturing heterogeneous behavior.



Compacted Granular Bed (Gonzalez, 2019)

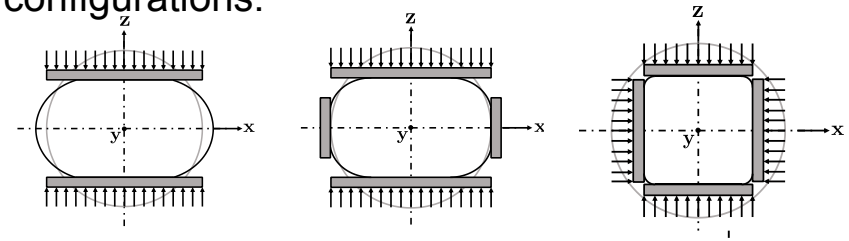
Contact network of force chains (Majmudar & Behringer, 2005)

Developing force-area-deformation relationships during compaction capturing loading configuration and material dependency.

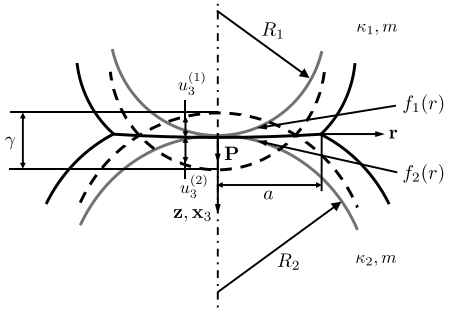


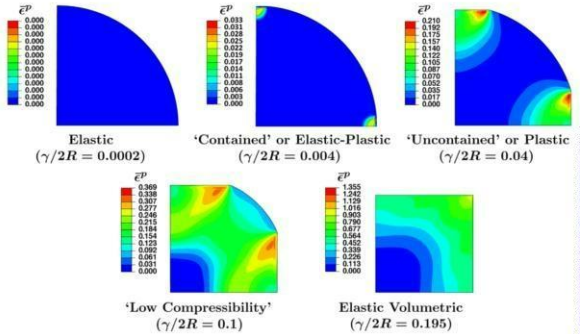
Approach and Methodology

Utilize FE simulations for different material properties and loading configurations.



Contact radius through the curvature-corrected (Agarwal and Gonzalez, 2018) radius-displacement relationship of the similarity contact law





Normalized hardness through analysis of elastic behavior during different deformation regimes

$$P(\gamma; R, 1/m, \mathrm{LC}) := \bar{H}(\gamma/2R; 1/m, \mathrm{LC})\kappa\pi\{a(\gamma; R, 1/m, \mathrm{LC})\}^2$$

$$\underbrace{P(\gamma, \mathbb{A}, \mathbb{B}; \lambda, \zeta, \mathrm{LC})}_{\text{Contact Force}} := \underbrace{\bar{H}(\gamma\mathbb{A}/4; \lambda, \zeta, \mathrm{LC})}_{\text{Normalized Hardness}}\ \sigma_y\ \pi\ \underbrace{a(\gamma, \mathbb{A}, \mathbb{B}; \lambda, \mathrm{LC})^2}_{\text{Contact Radius}}$$

Results

Verification by showing good agreement between contact law results and FE simulations for force-radius-deformation