

IMAGING STRESSES IN SOIL

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Project Goal: Investigate soil-structure interaction through imaging interface stresses.

Concept Verification

Sensor Specifications



Tekscan, Inc.
Model: 5400NE
Evolution Sensor Handle

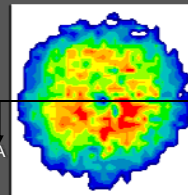
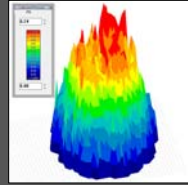


Dimensions

Length: 41.73"
Width: 25.20"
Matrix Width: 22.76"
Matrix Height: 34.80"

Sensels

32 columns, 52 rows
Total = 1,768 sensels
2.23 sensels per square inch

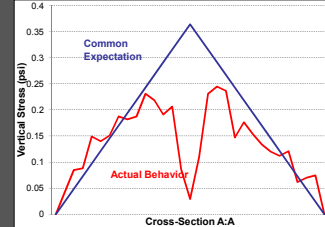


Contact Stresses Beneath Sand Pile

- Sample Preparation Method: sand raining
- Contact Stress Measurements: tactile sensors
- Anticipated Phenomena: stress depression under tip
- Reference: Wittmer, J.P., et. al (1996) "An Exploration for the Central Stress Minimum in Sand Piles," *Nature*, Volume N382, July 25, 1996, pages 336-338.

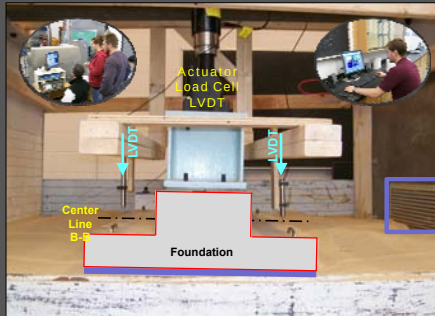
$$\sigma_{rr} = \sigma_{zz} - 2 \tan \phi |\sigma_{rz}|$$

Stress Distribution Under Conical Sand Pile



Vertical and Horizontal Stresses Due to Foundation Loading

Experimental Modeling



Dimensions

Volume: 78" x 78" x 66.5"
Soil mass: 10150lb

Sample Preparation Method

Sand raining
Elevation controlled frame
Constant pour height
Footings dimensions: 48" x 28"

Displacement Controlled Test

Programmed loading sequence
Servo-Hydraulic actuator
35 kips capacity
10 inch stroke

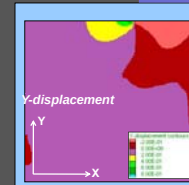
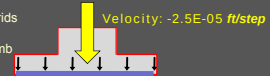
Instrumentation

Actuator load cell and LVDT
Additional (2) LVDTs
Horizontal (1) Tekscan Tactile Mat
Vertical (1) Tekscan Tactile Mat

Numerical Modeling

Model Parameters

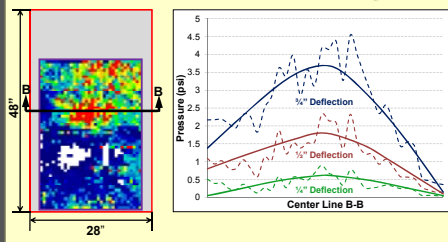
Height of soil: 37"
Width of soil: 78"
Grid Matrix: 38 x 79 (H x V)
Applied Constant Velocity: grids
1-15
Failure Criteria: Mohr Coulomb



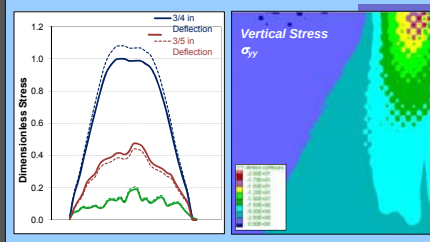
Soil Characteristics

Elastic Properties
 $G = 2.02 \times 10^5$ psf
 $K = 4.37 \times 10^5$ psf
Strength Properties
 $C = 2.86$ psi
 $\Phi = 27.15^\circ$
 $\gamma = 77.9$ pcf

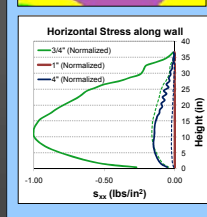
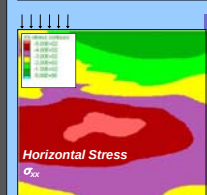
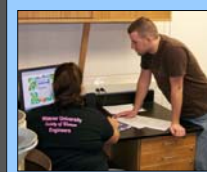
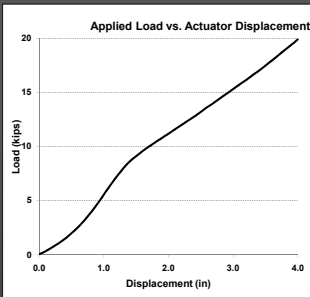
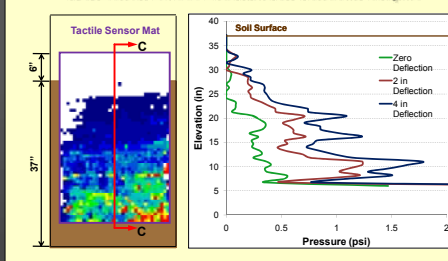
Vertical Stress Distribution Tekscan Output



Vertical Stress Distribution FLAC Model



Horizontal Stress Distribution Tekscan Output



Accomplishments

- Constructed foundation and instrumented for testing
- Applied vertical loading by hydraulic actuator system
- Obtained stress distributions at footing and wall interfaces
- FLAC simulations used to model vertical and horizontal stresses
- Parabolic vertical stress in sand verified through numerical simulations

Further Exploration

- Experimentally and numerically investigate dip in center of sand pile
- Obtain stress distributions within soil under applied footing loads
- Investigate stress distribution at interface of flexible structures (footings & retaining)