Large-scale Physical Model Tests of Micropile Stabilized Slopes

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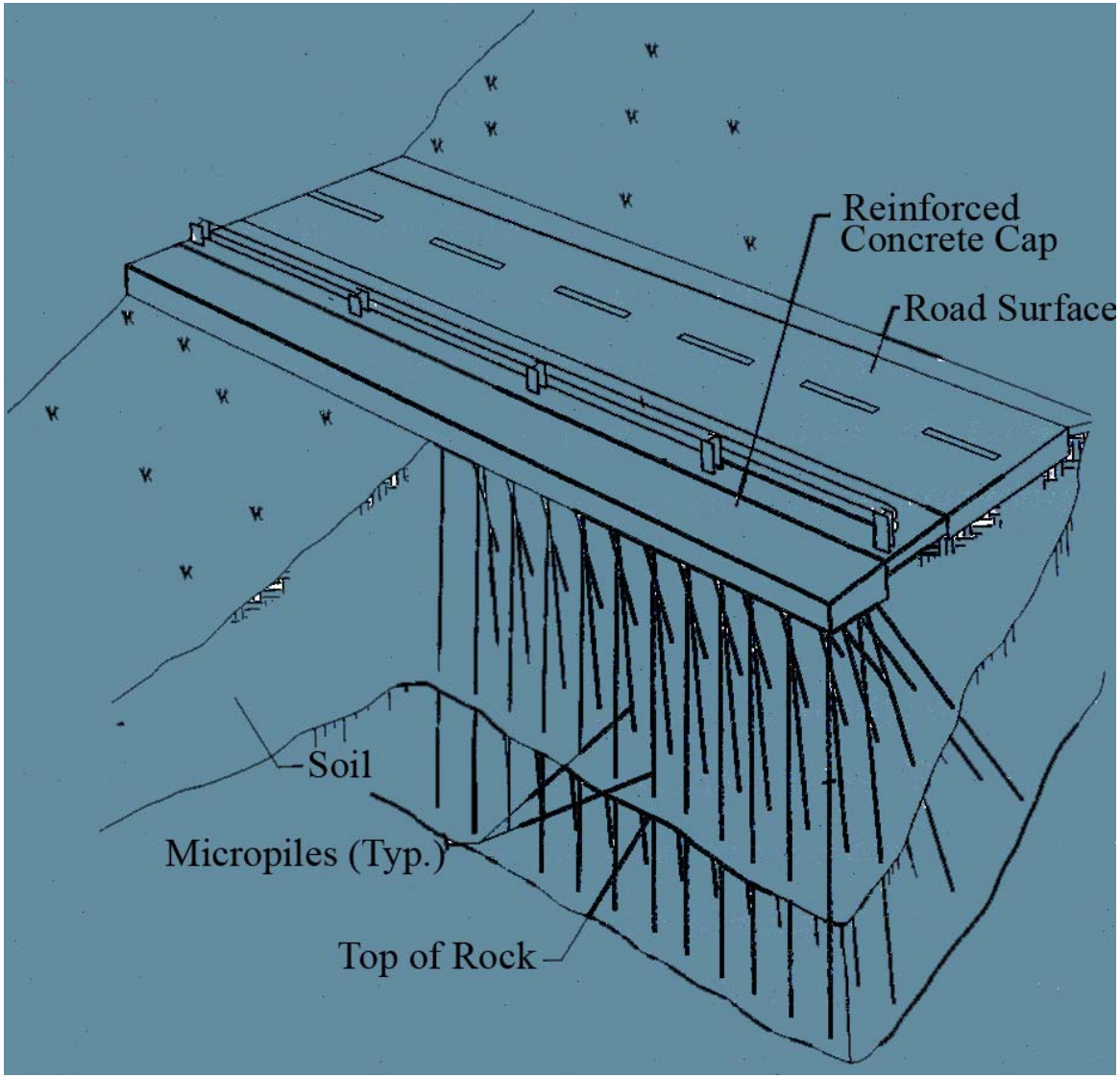
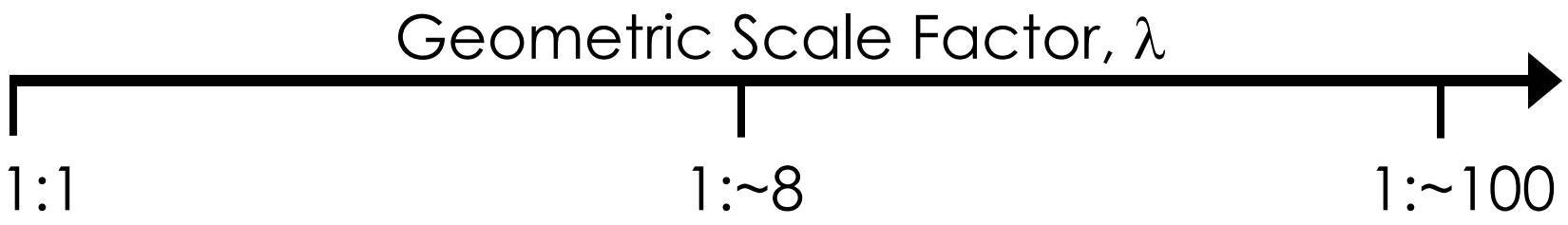
Stabilization Technique



Motivation

- How is force developed within reinforcing members?
- What is the interaction between the soil and the reinforcing members?
- How does geometric arrangement affect load transfer and limit loads?
- What group or network effects exist?

Research Methods



Field Testing

Actual performance, but

-no control of environmental conditions

-remote test sites

-failure data rare

Large-scale Physical Modeling

Centrifuge Testing

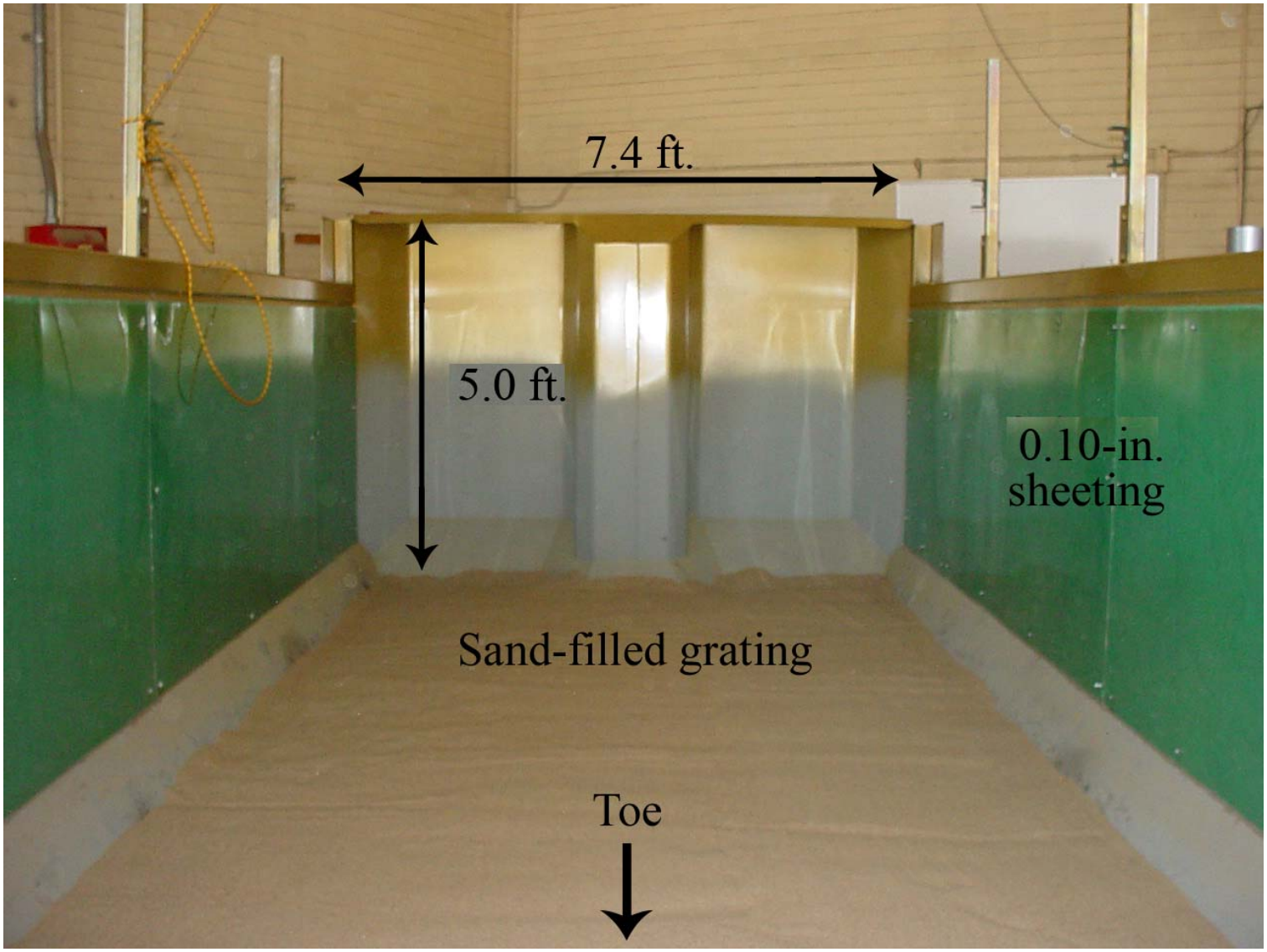
Reproduce stresses, but

-cannot model construction techniques

-member/soil interaction questionable

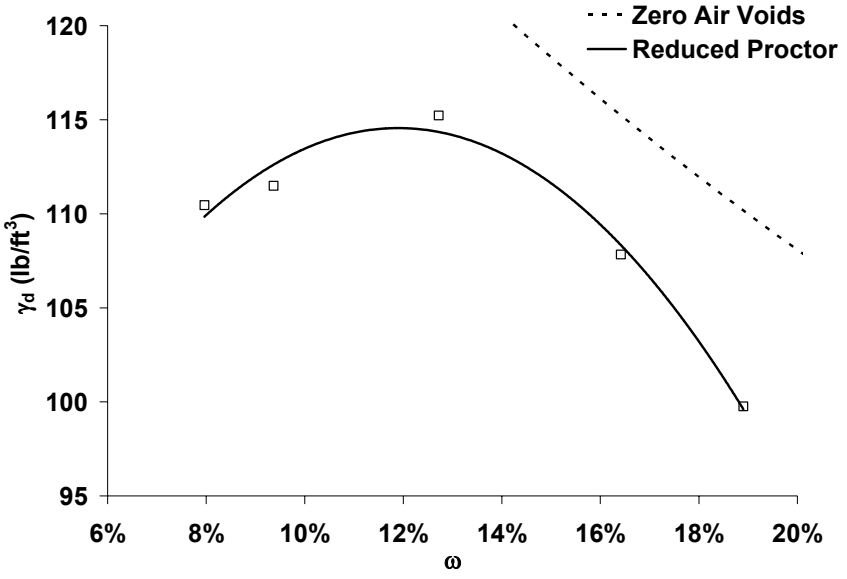
Modeling Device

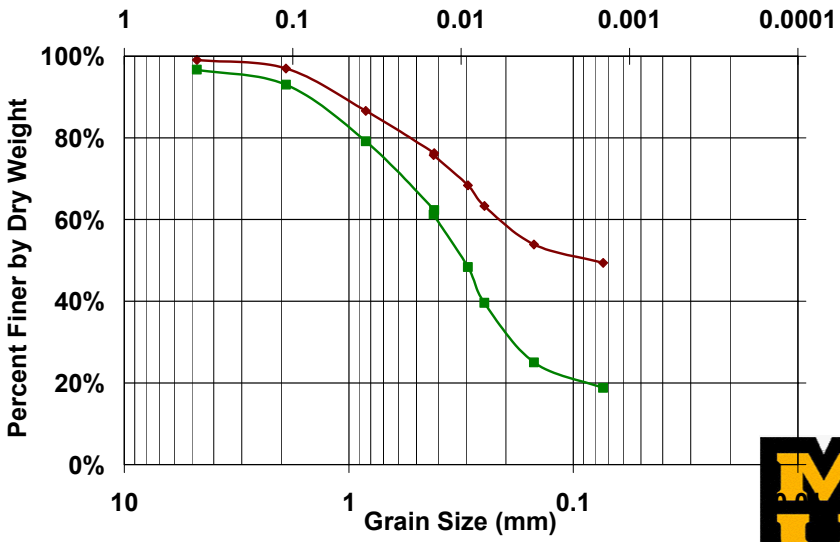
Model Container



Model Soil

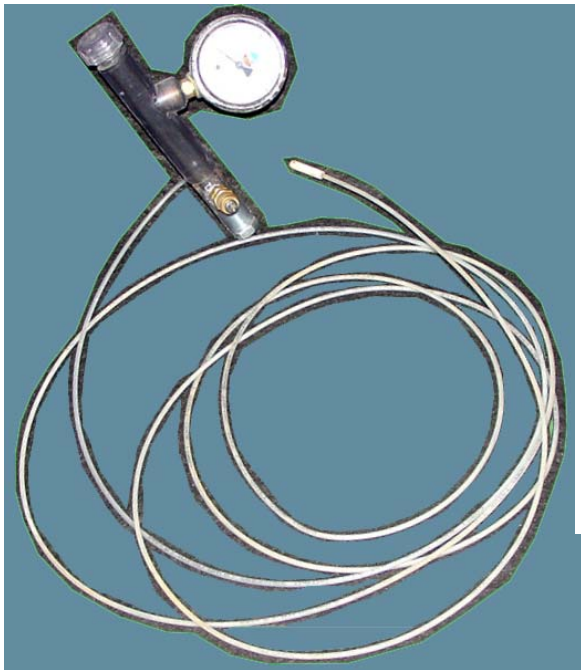
Liquid Limit	23
Plastic Limit	14
Plasticity Index	9
Organic Content	1%
Fines Content	19%
$\gamma_{d\text{-}max}$	115 pcf
w_{opt}	13%
ϕ'	33°

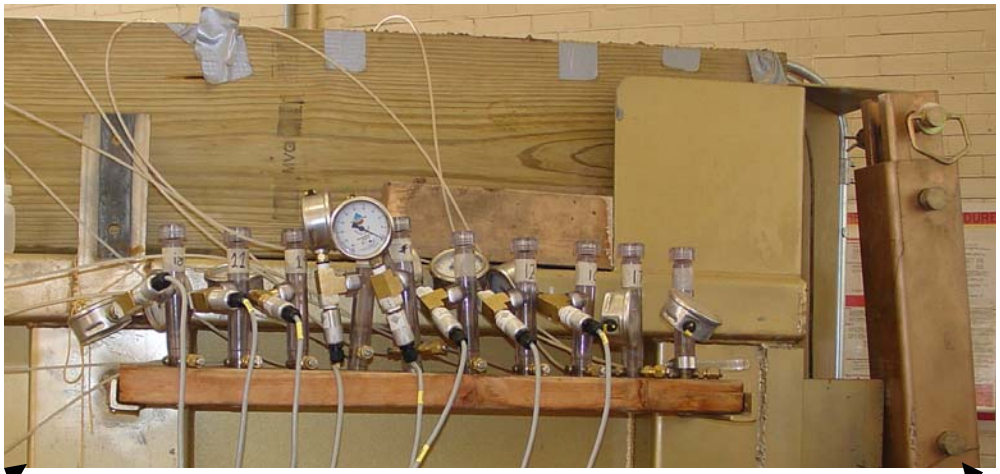


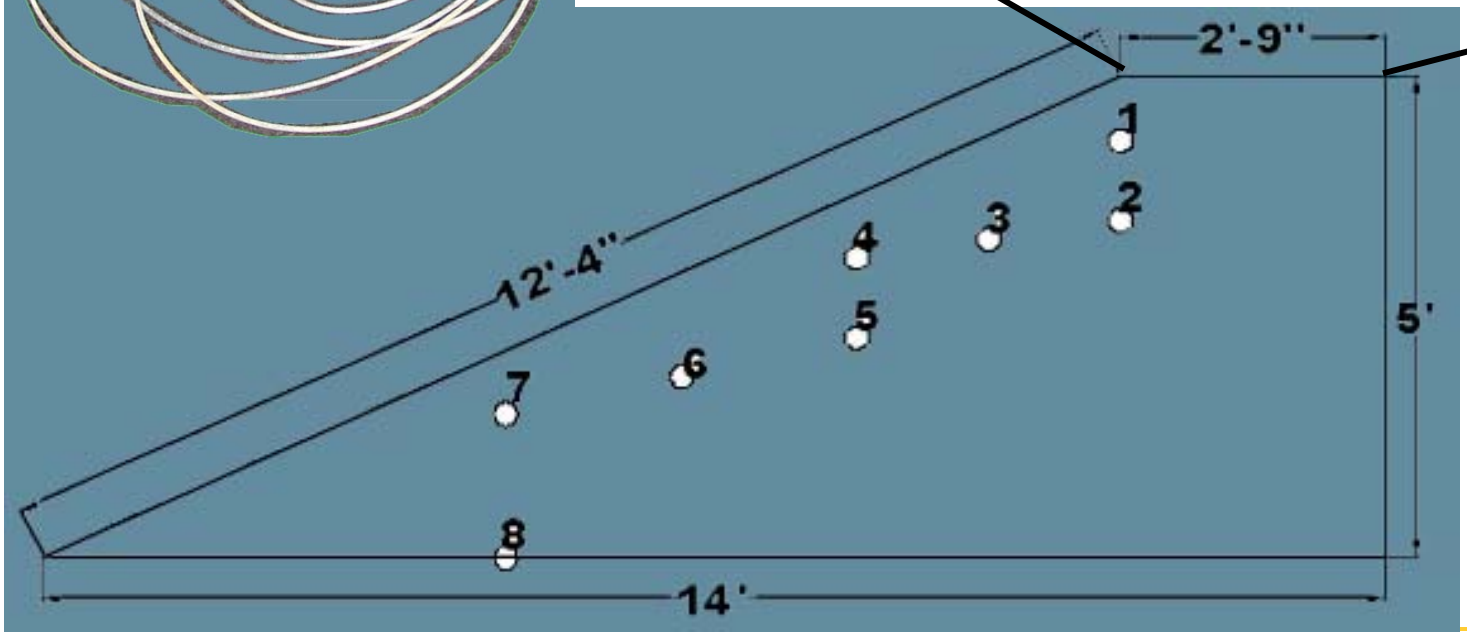


Pore Pressure Control System

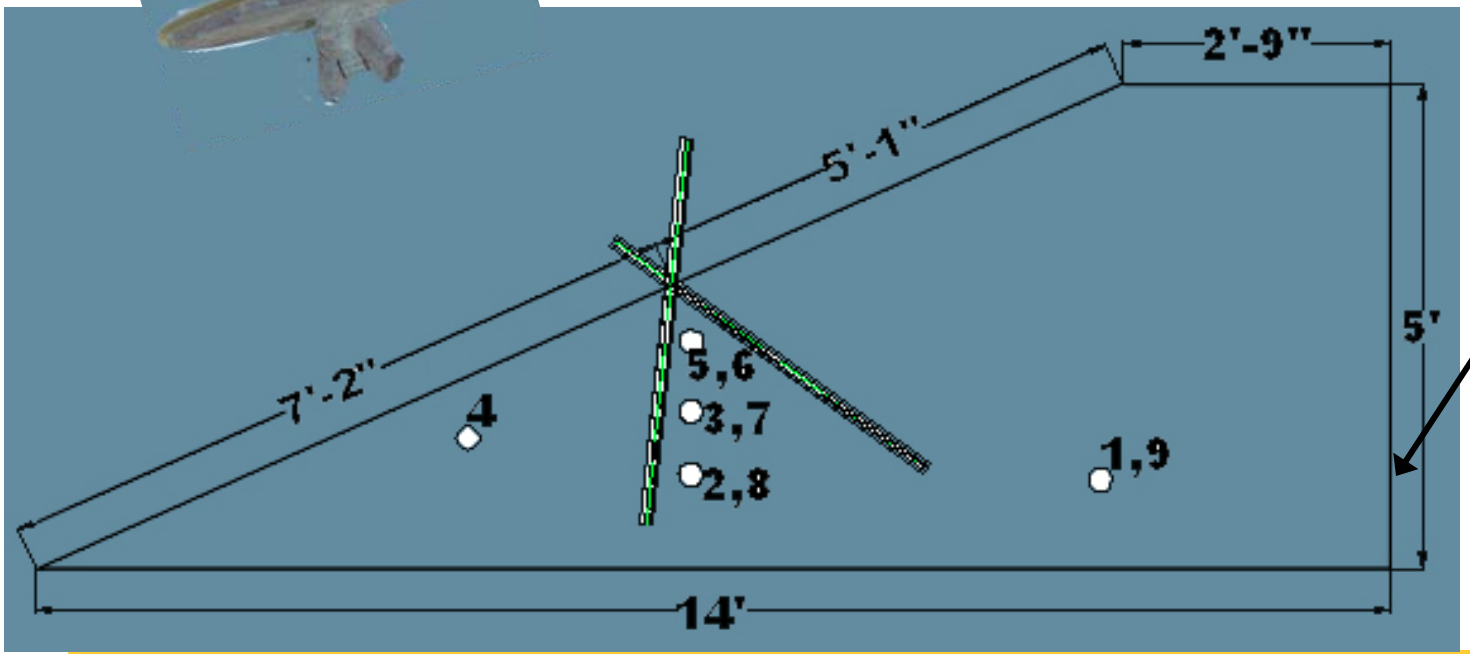
Instrumentation: Pore Pressure





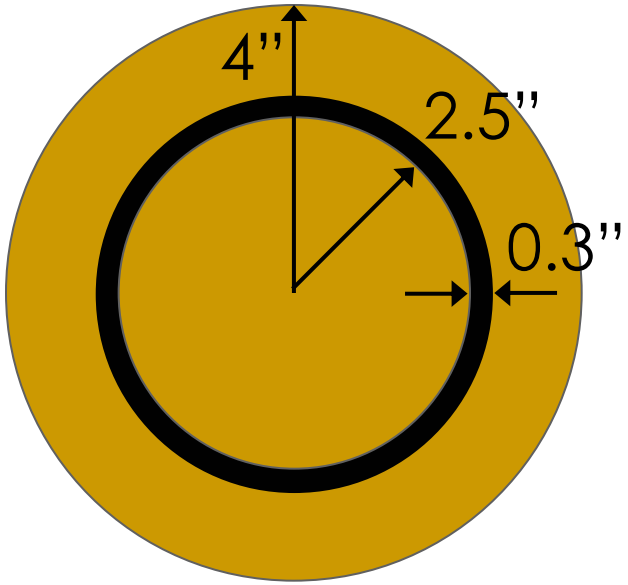


Instrumentation: Displacement



Reinforcement & Similitude

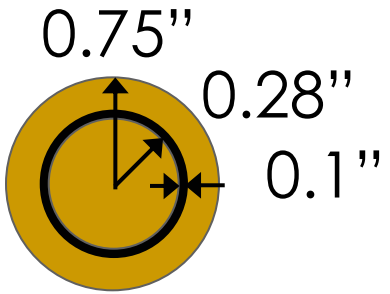
- Can't scale stresses, but can scale reinforcement stiffness appropriately:



EI = 3.65x10^6 lb-ft^2

$\lambda = 8$

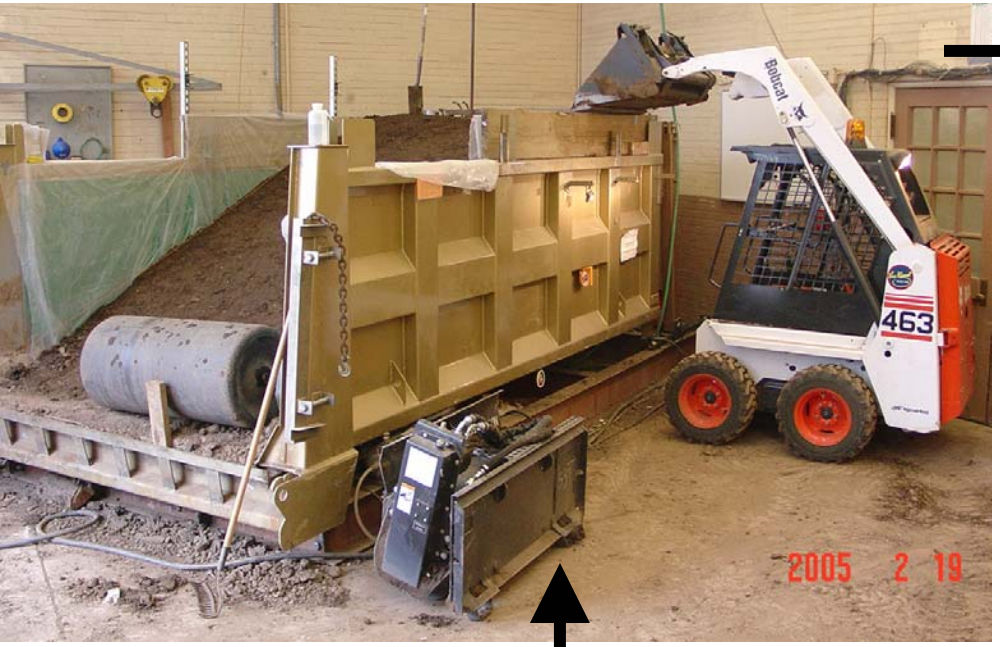
$\lambda_{EI} = 1{,}448$



EI = 2,200 lb-ft^2

Instrumentation: Strain Gages

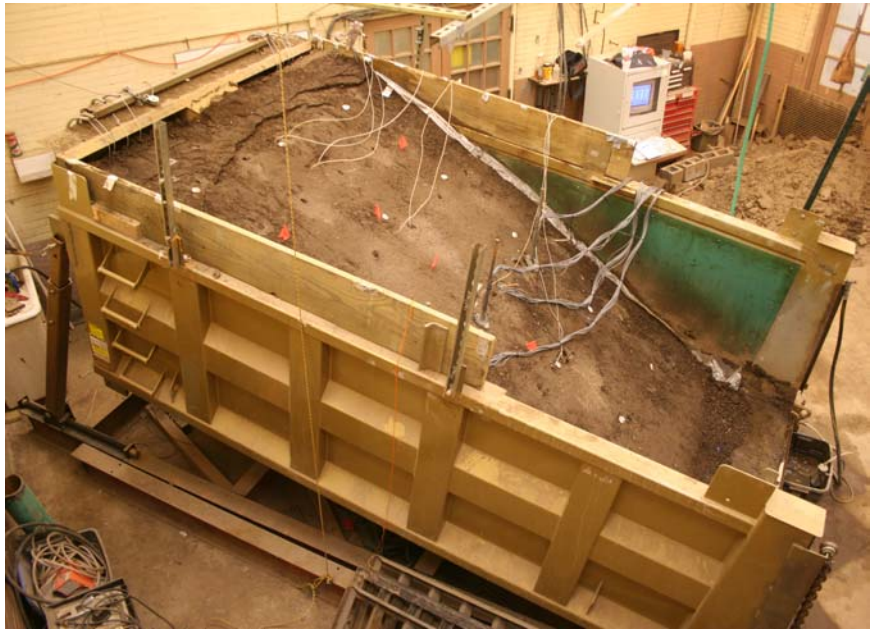
Construction



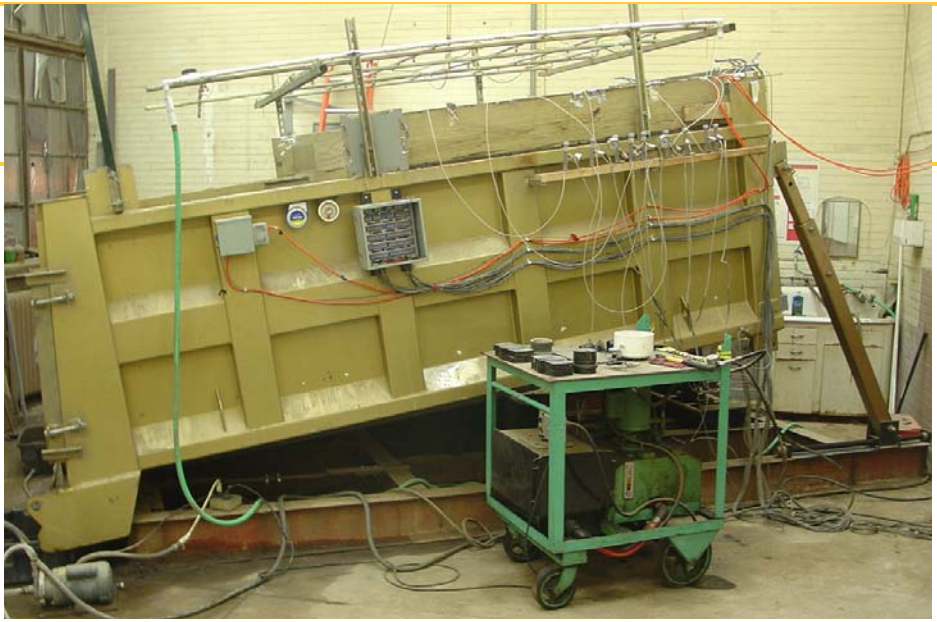
Construction: Model Micropiles

Construction: Model Micropiles

As-constructed



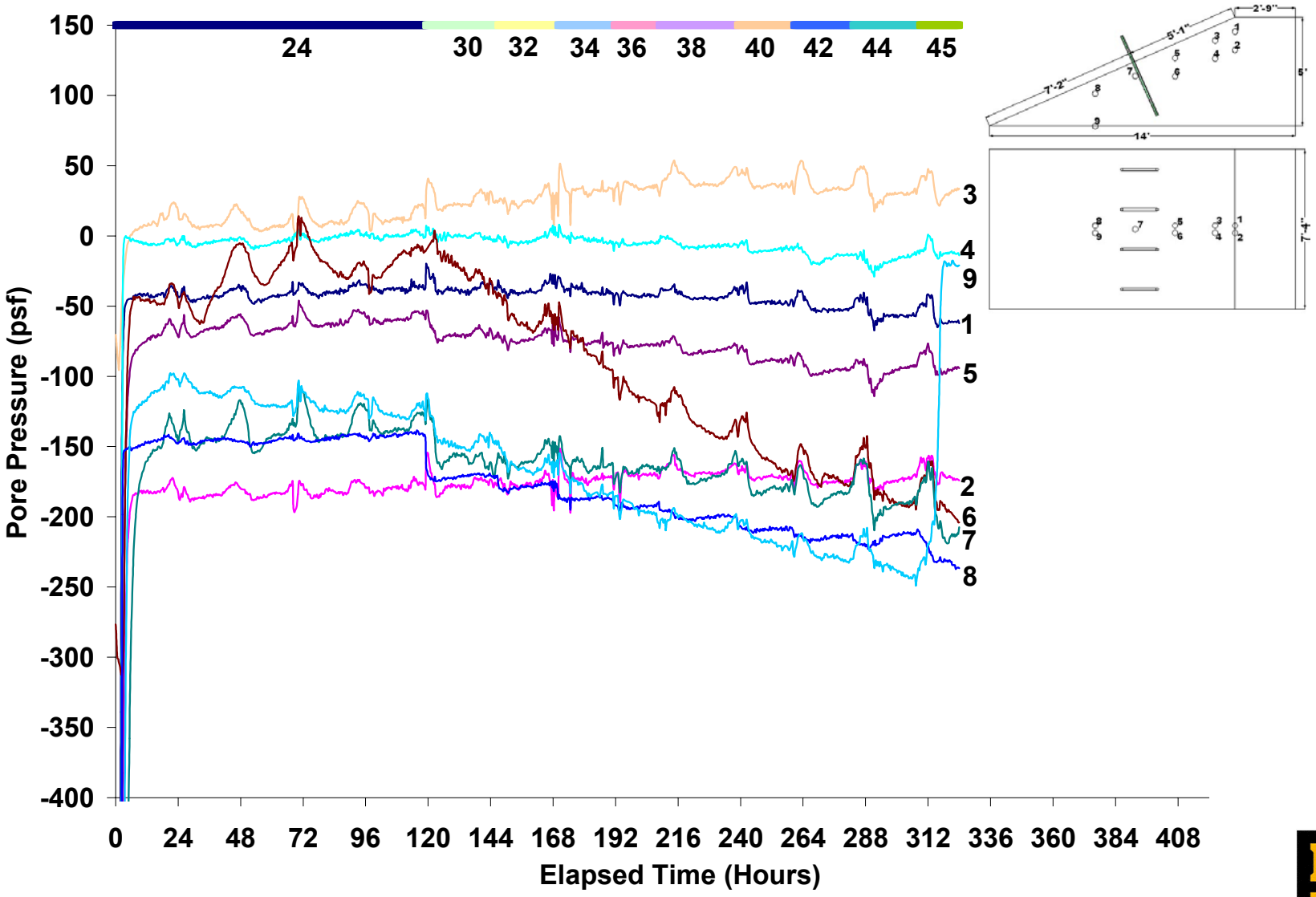
Testing



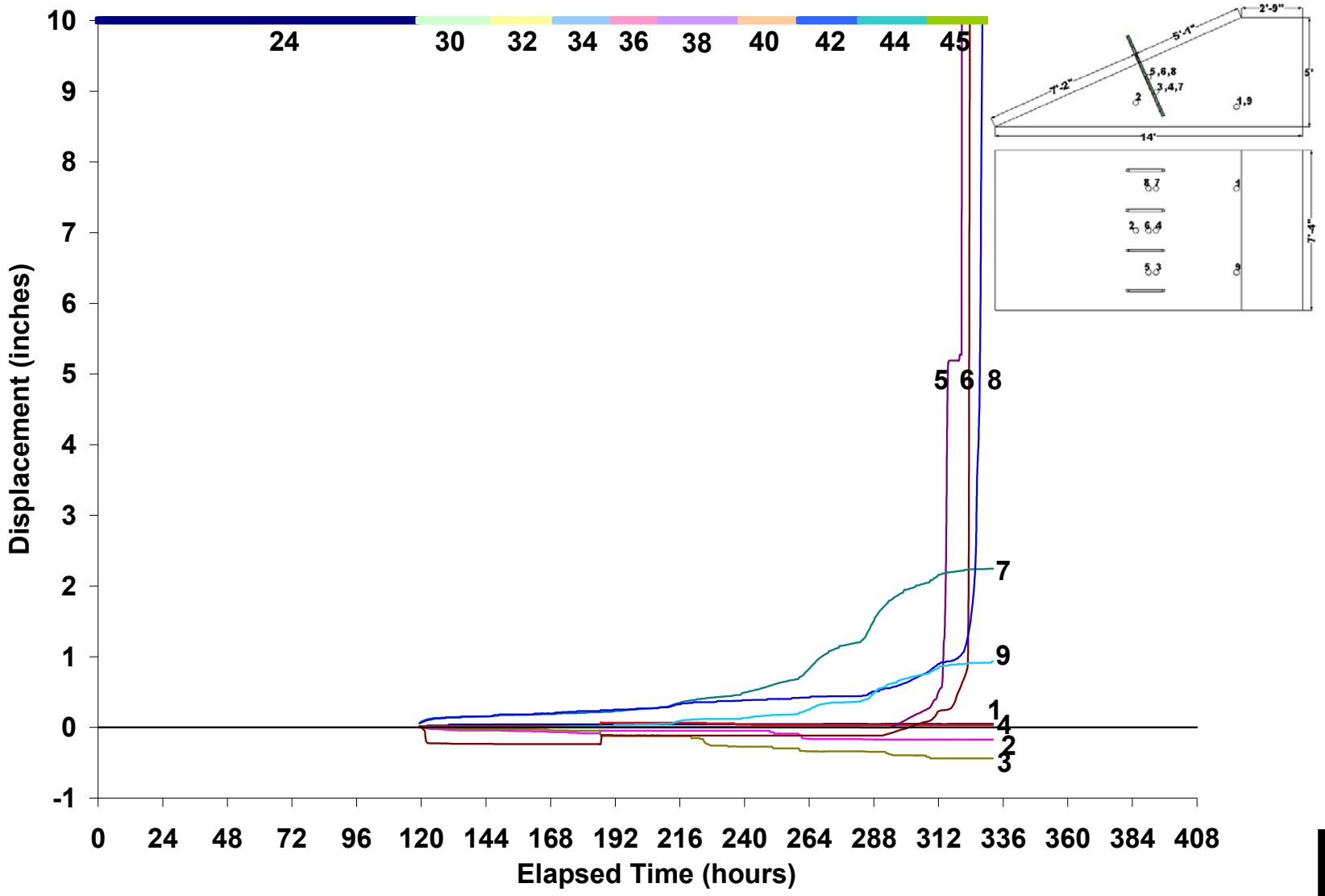
Failure!

Time Lapse Movie Clip

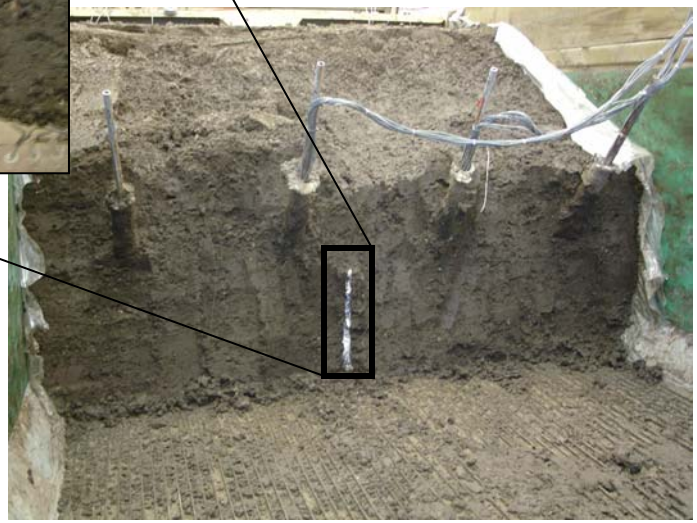
Model Performance – pore pressures

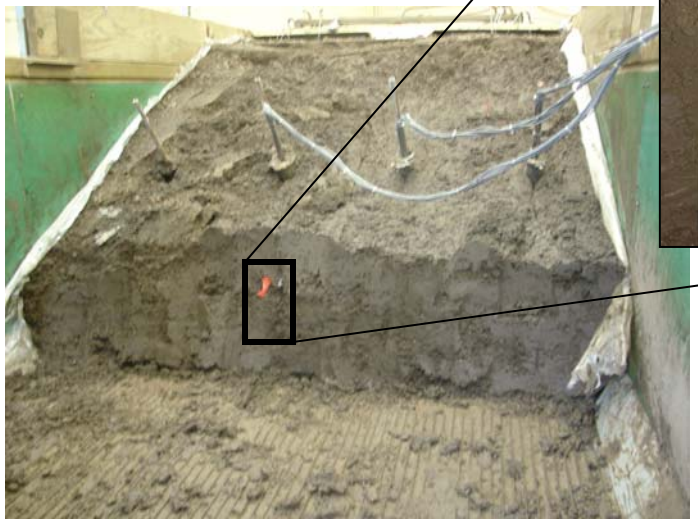


Model Behavior - deformations



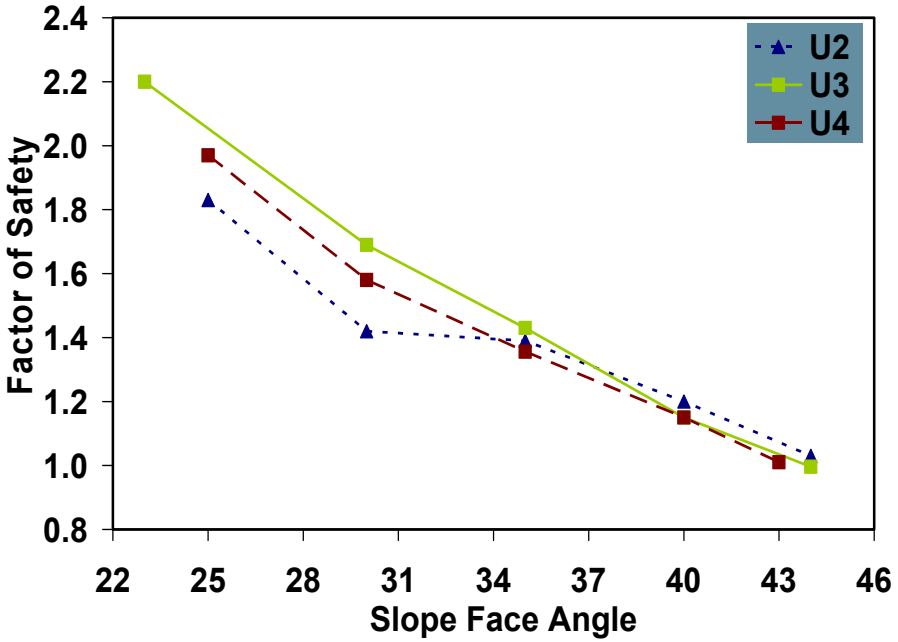
Forensics

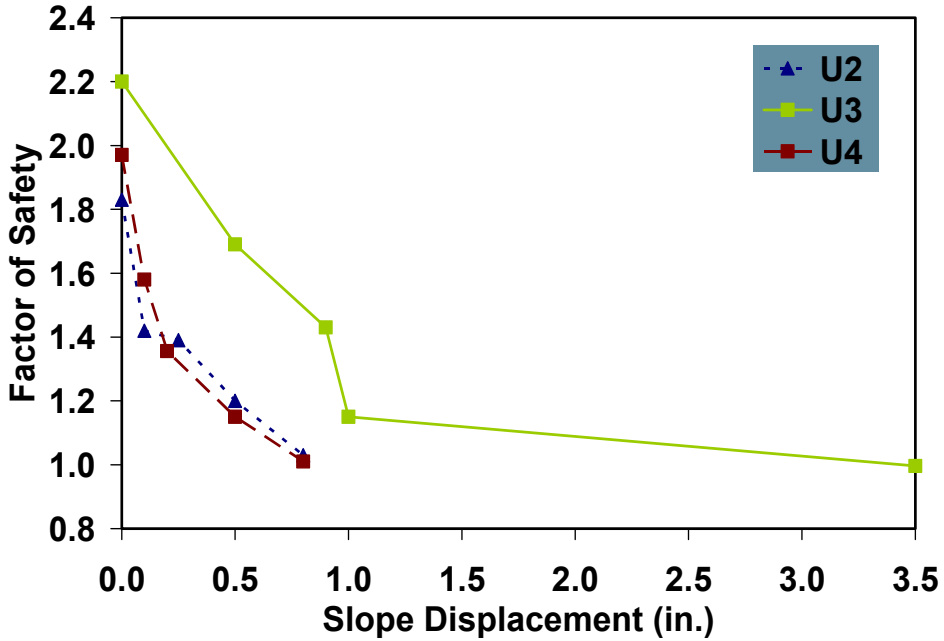




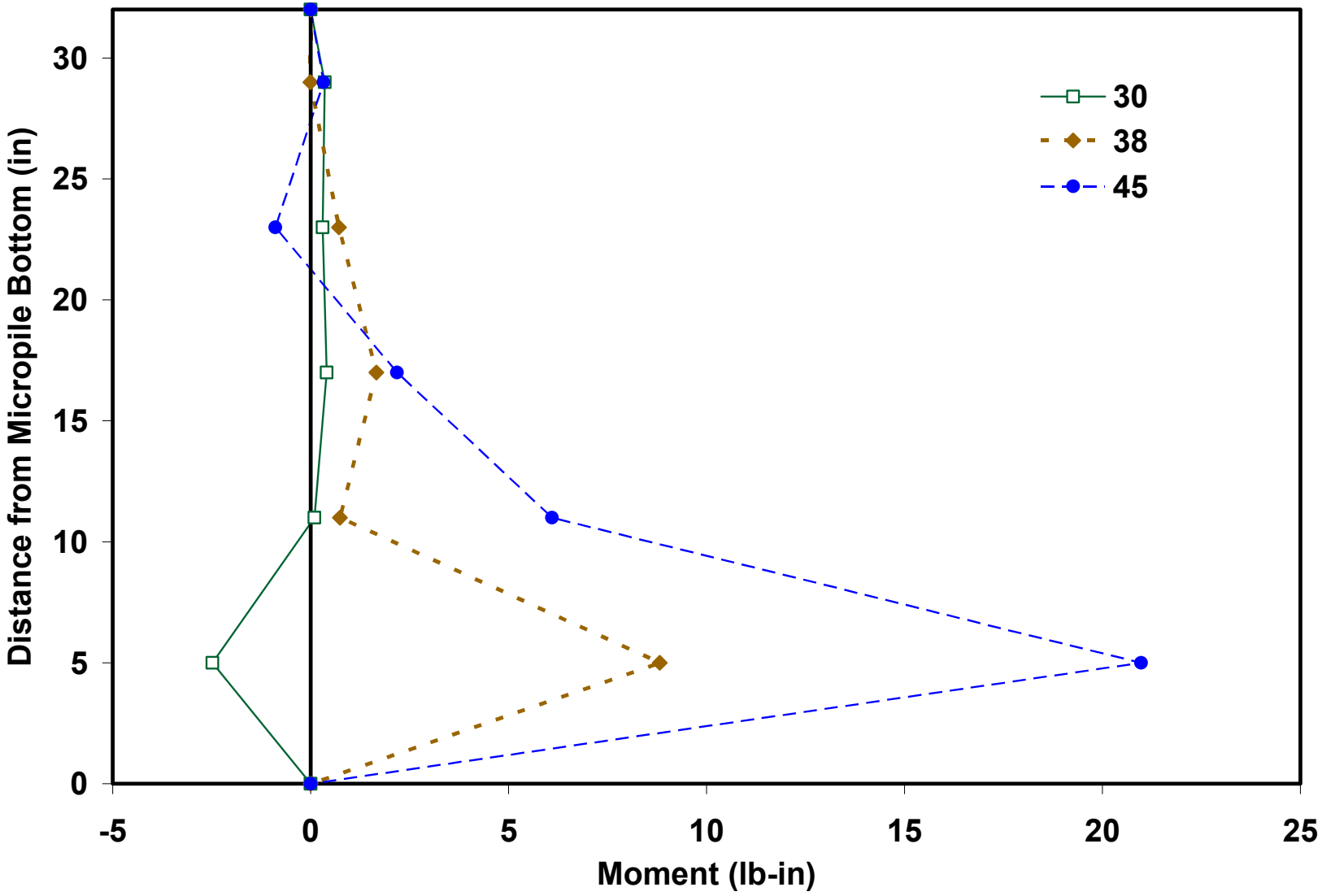
Forensics

Interpretation of Results

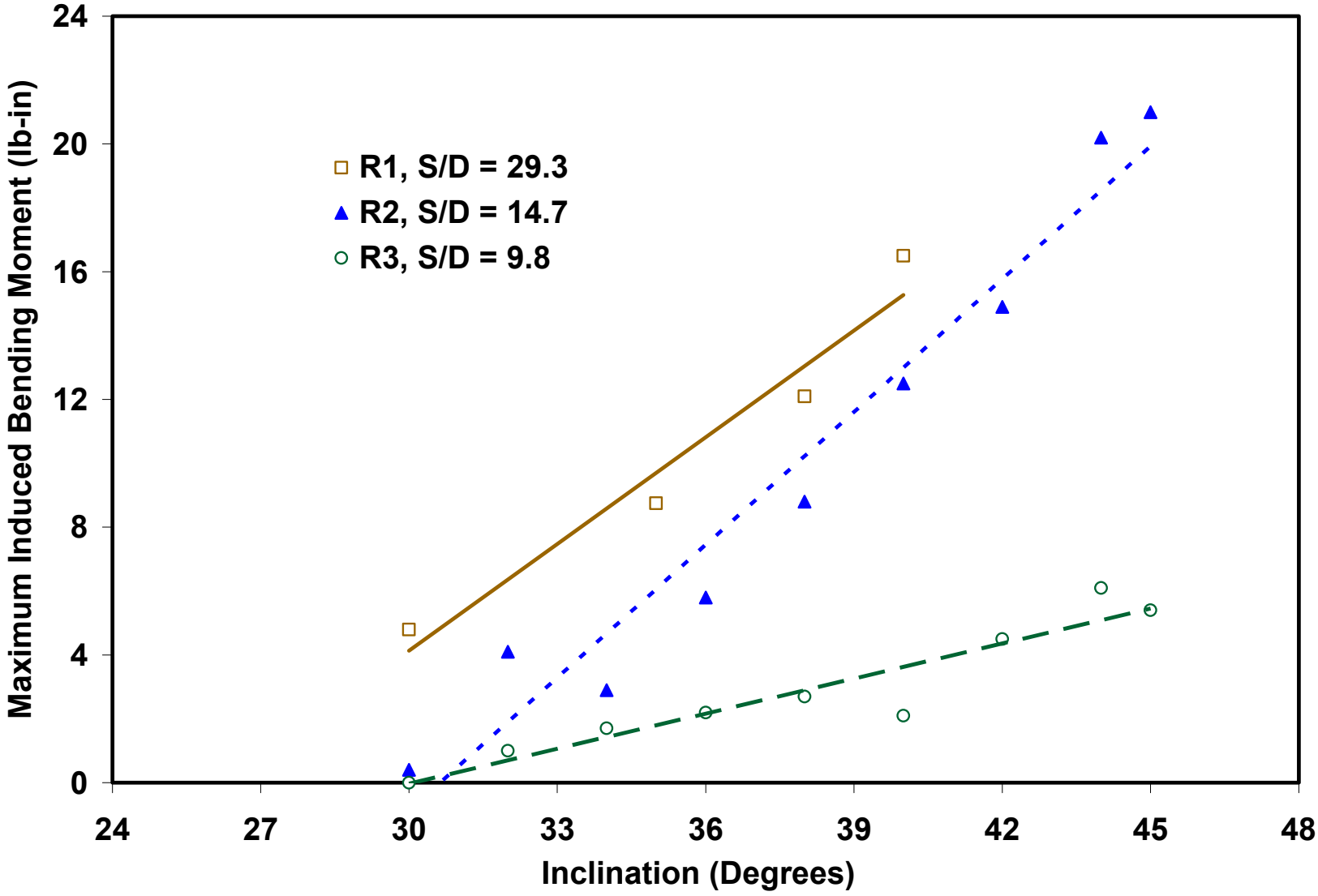




Moment Distribution

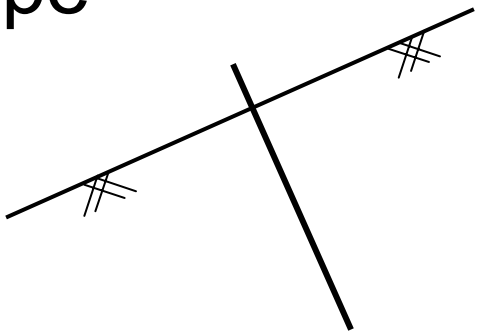


Load Transfer

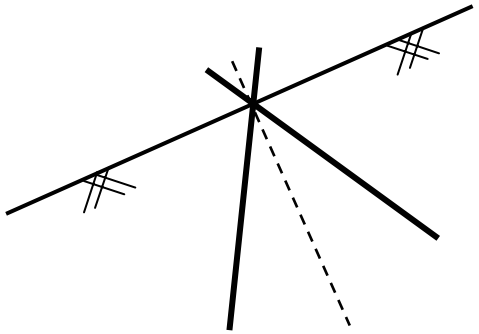


Completed Testing

- Unreinforced models
- Single Line, Perpendicular to Slope
  - s/d from 8 to 30
  - “rigid” and scaled members



- Single Line, A-Frame
  - s/d from 4 to 8
  - No cap beam



Future Testing

- A-frame arrangement with capping beam
- Reticulated micropile
- Larger scale device

Observations

- Tests performed for unreinforced slopes indicate modeling errors are small
- Model micropiles reasonably representative of field scale micropiles
- Mobilization of resistance is roughly linear
- Capping beam necessary for conditions tested to date

Acknowledgements

- Funding provided by U.S. National Science Foundation, Grant CMS0093164