Method for Prediction of Micropile Resistance for Slope Stabilization

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2007 International Workshop on Micropiles
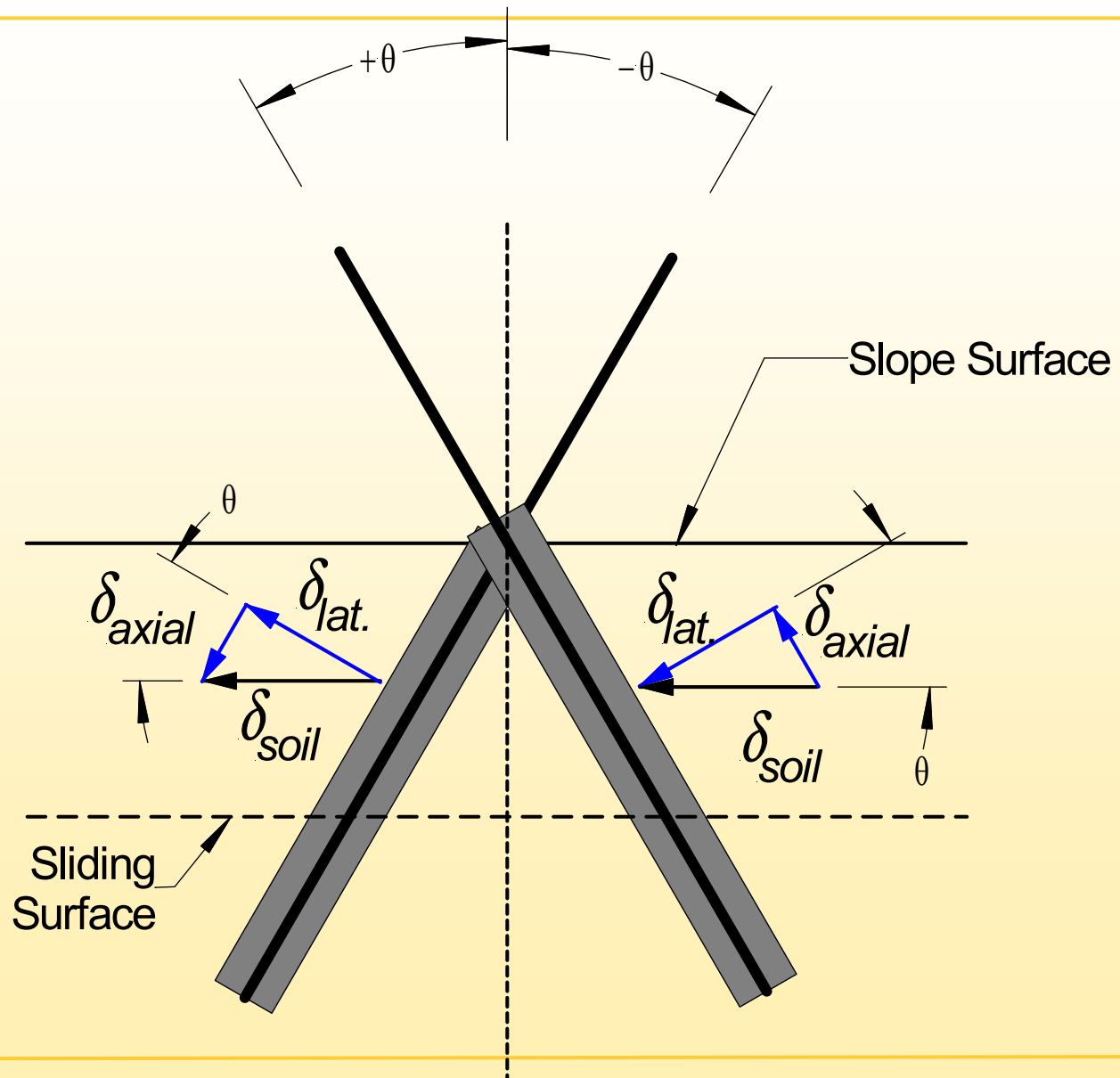Toronto, Ontario
September 27, 2007

Limit States for Soil Reinforcement

- Geotechnical failure
  - passive failure (lateral) above or below sliding surface
  - pullout failure (axial) above or below sliding surface
- Structural failure
  - flexural failure
  - shear failure
  - axial failure
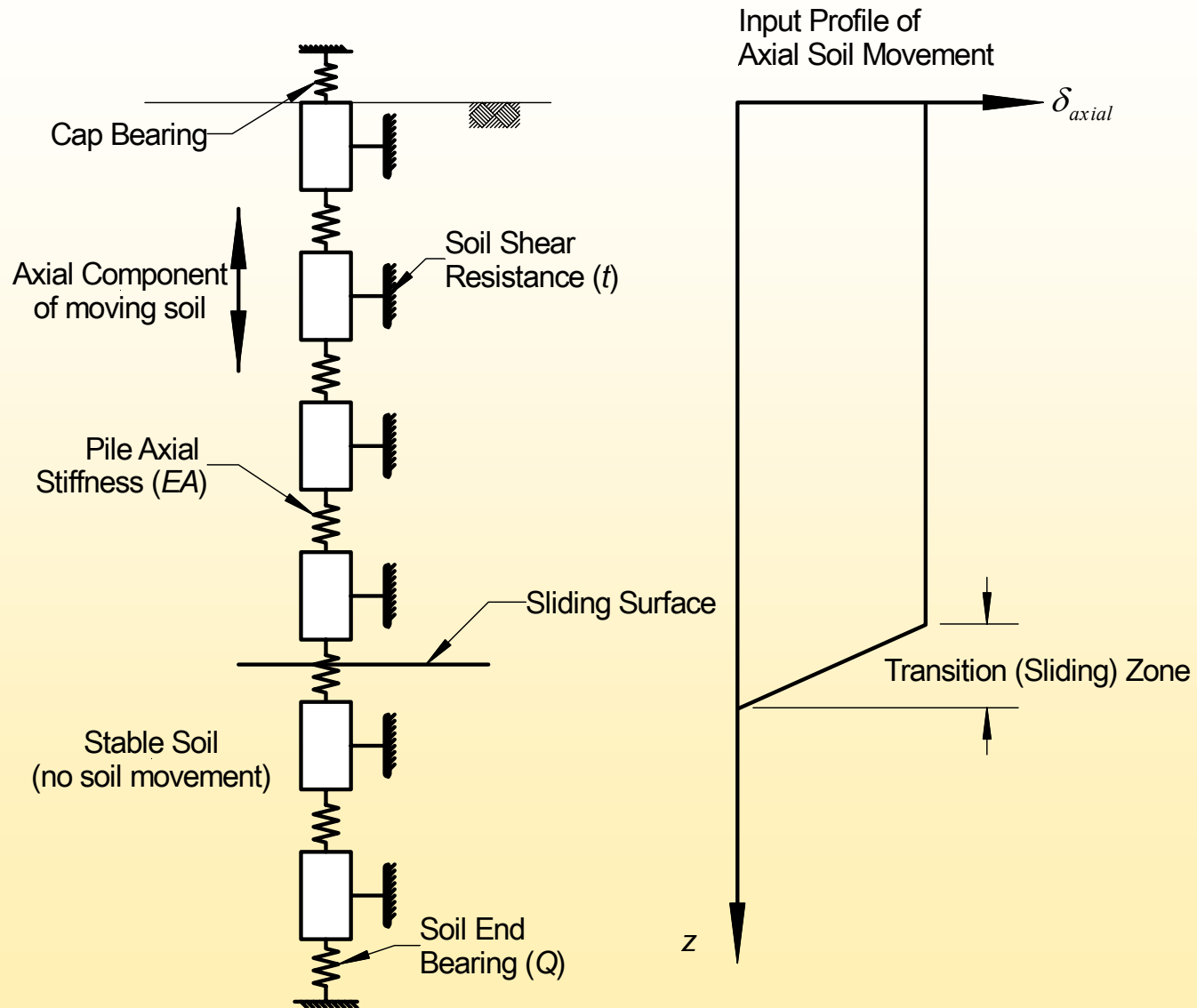   - compression
    - tension
- Serviceability limits

Proposed Approach

- Estimate/assume profile of soil movement

- Resolve soil movement into axial and lateral components

- Predict mobilization of axial and lateral resistance

  - Using "t-z" analyses for axial load transfer
  - Using "p-y" analyses for lateral load transfer

- Select appropriate axial and lateral resistance with consideration given to movement required to mobilize resistance
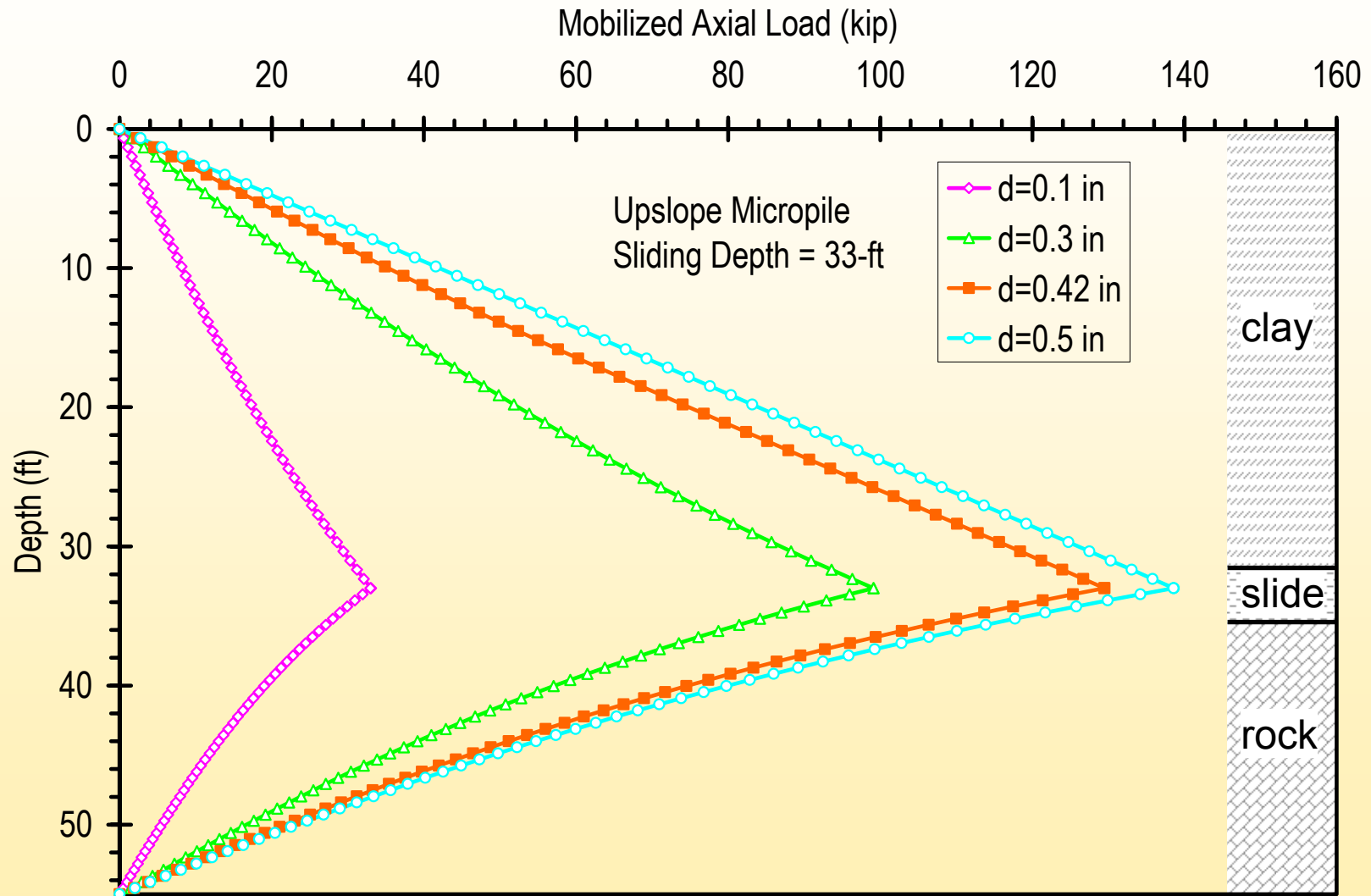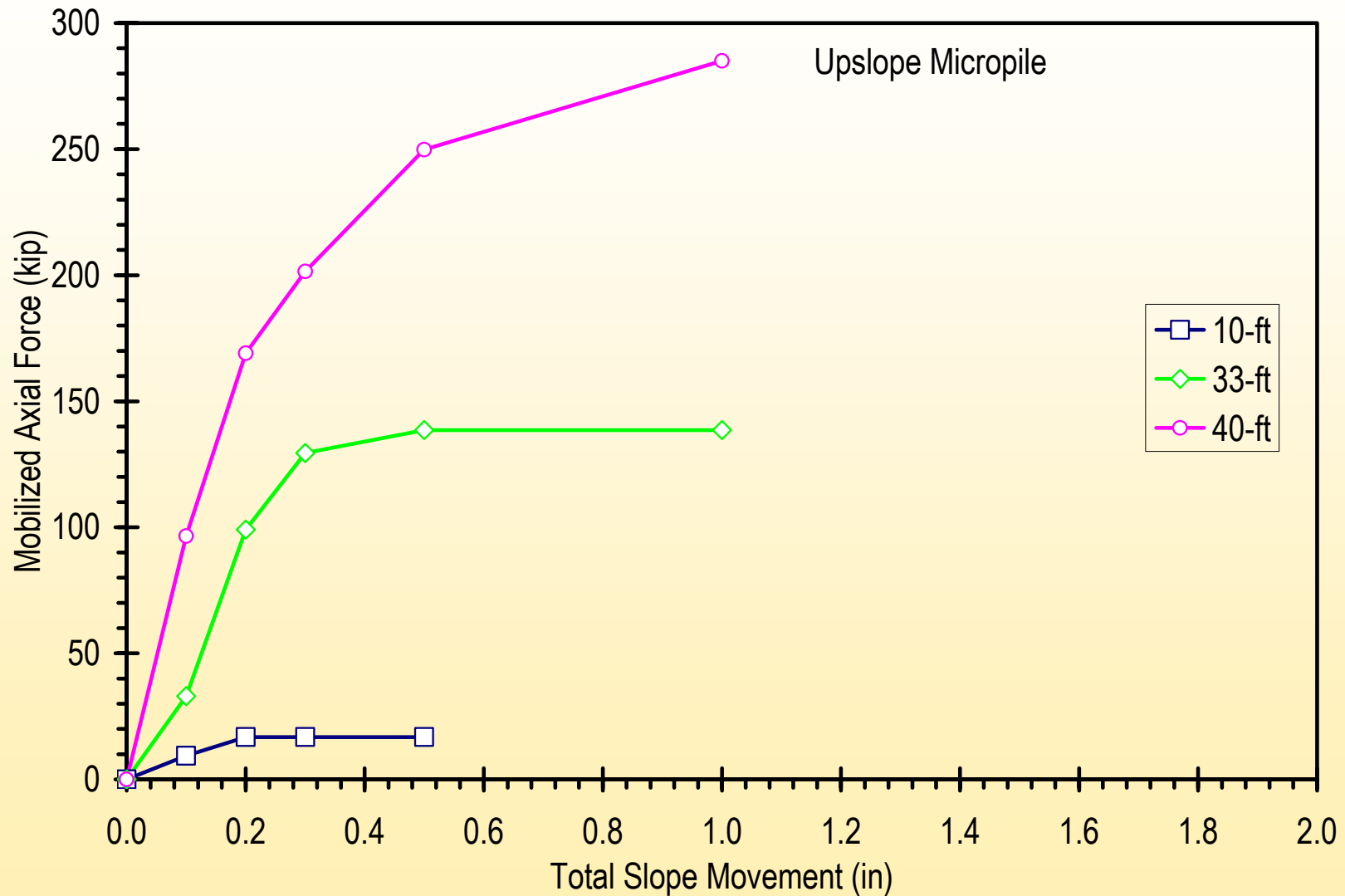
# Soil Movement Components

t-z analyses for axial resistance

Cap Bearing

Axial Component of moving soil

Soil Shear Resistance (t)

Pile Axial Stiffness (EA)

Sliding Surface

Stable Soil (no soil movement)

Soil End Bearing (Q)

Input Profile of Axial Soil Movement

δ_{axial}

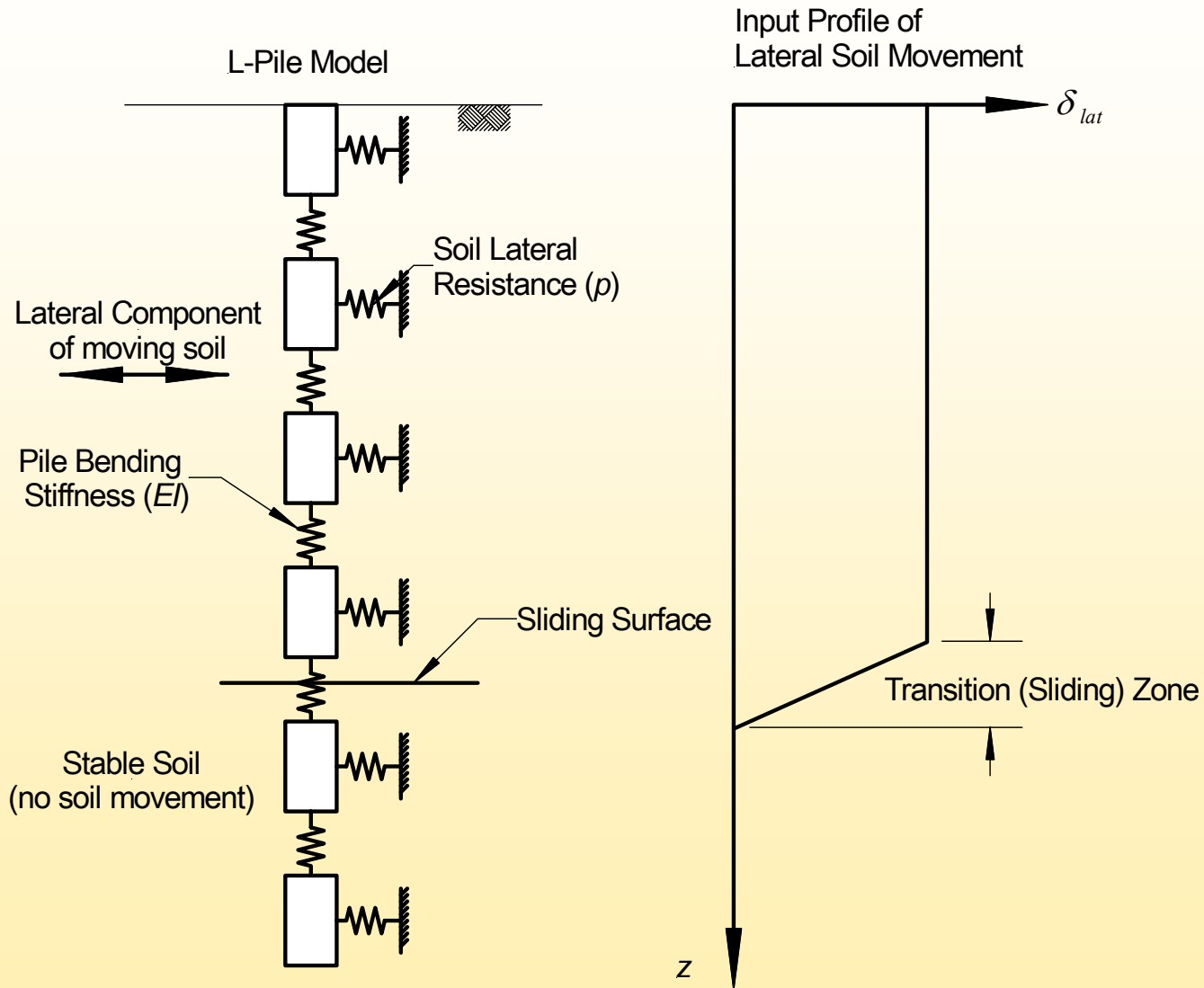Transition (Sliding) Zone

z

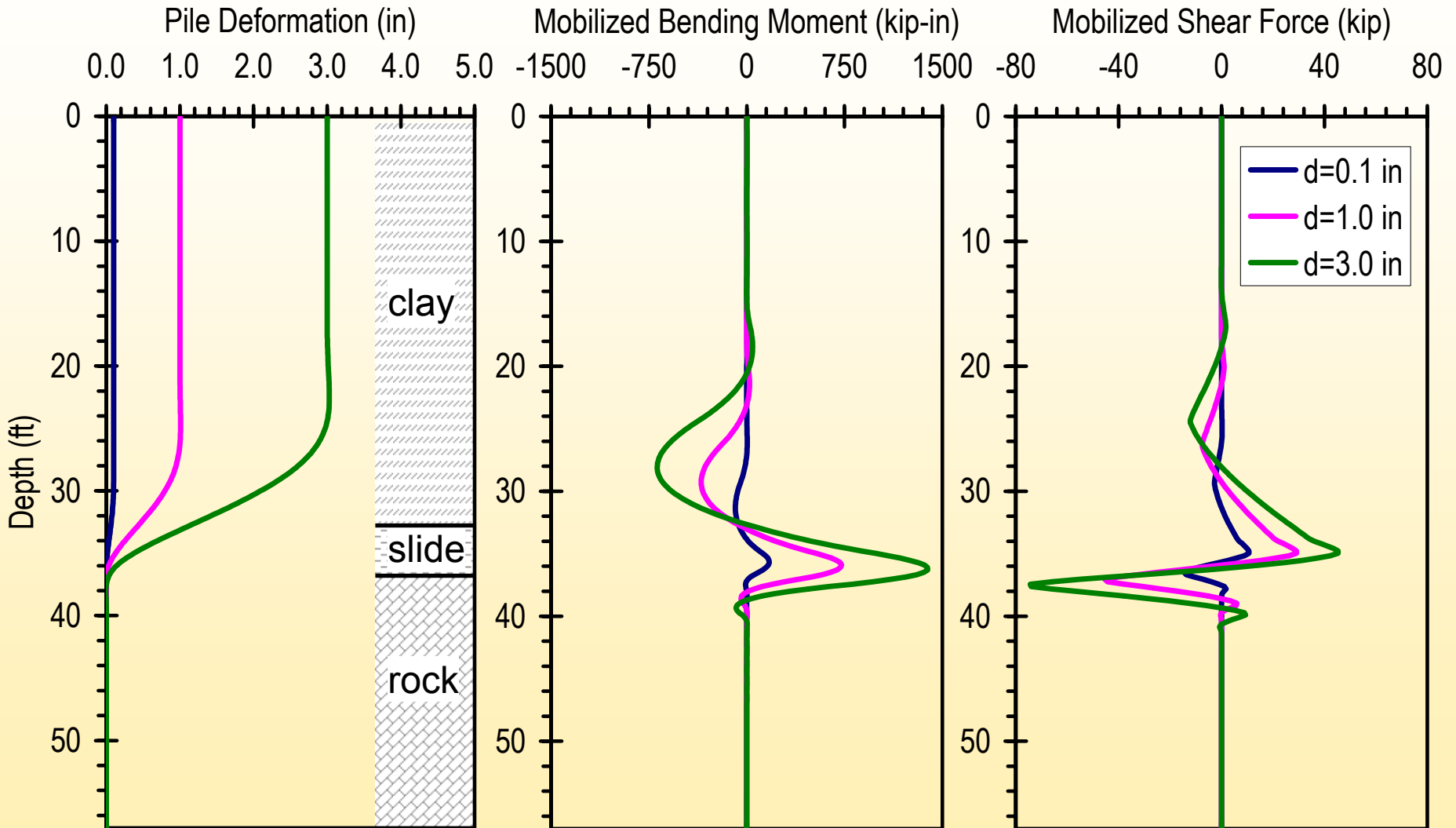# Mobilization of Axial Resistance

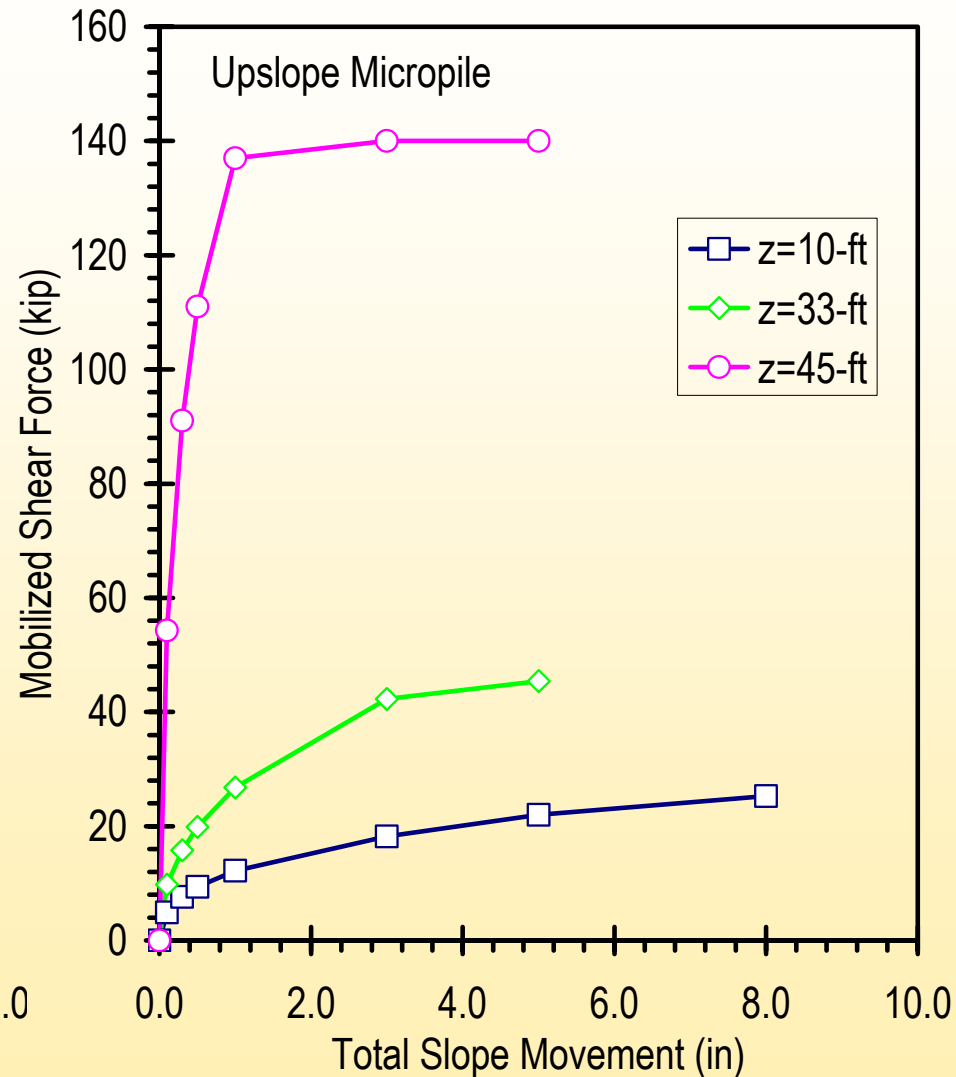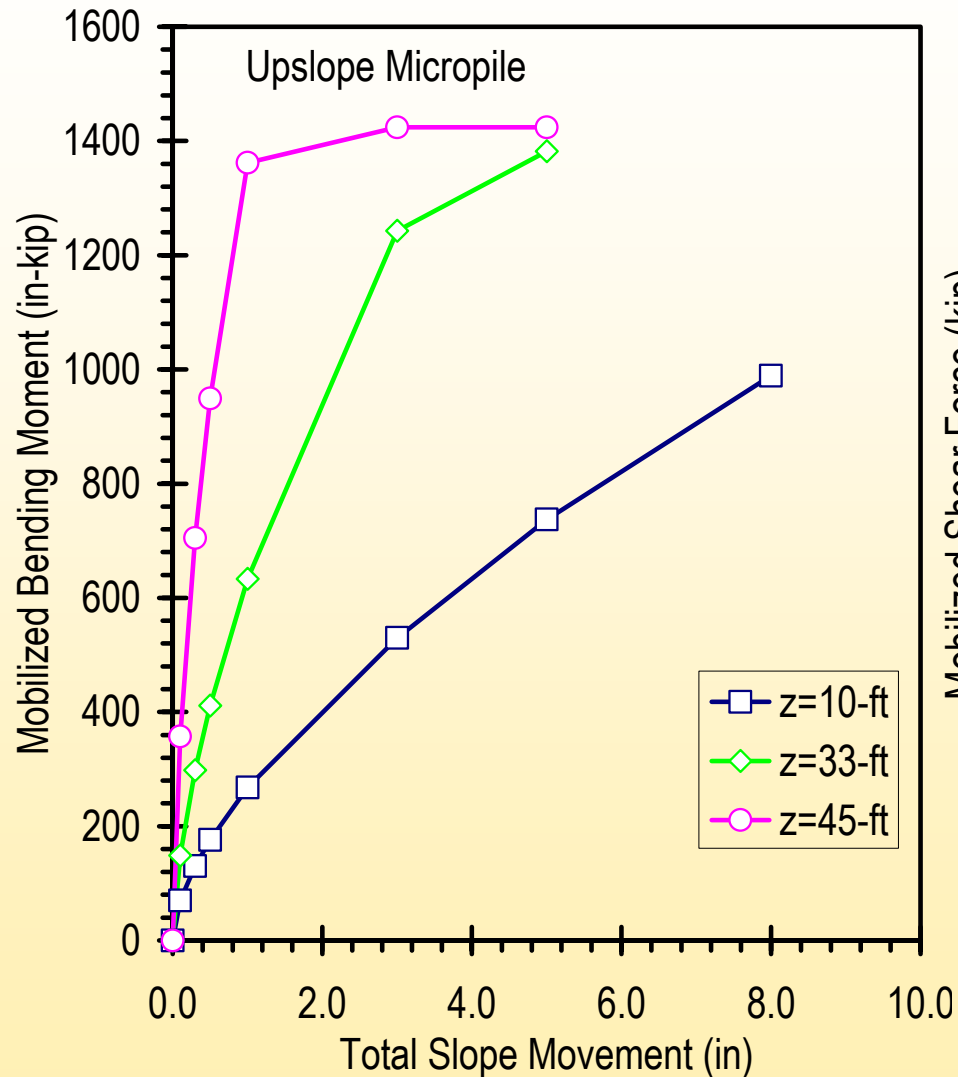# Mobilization of Axial Resistance

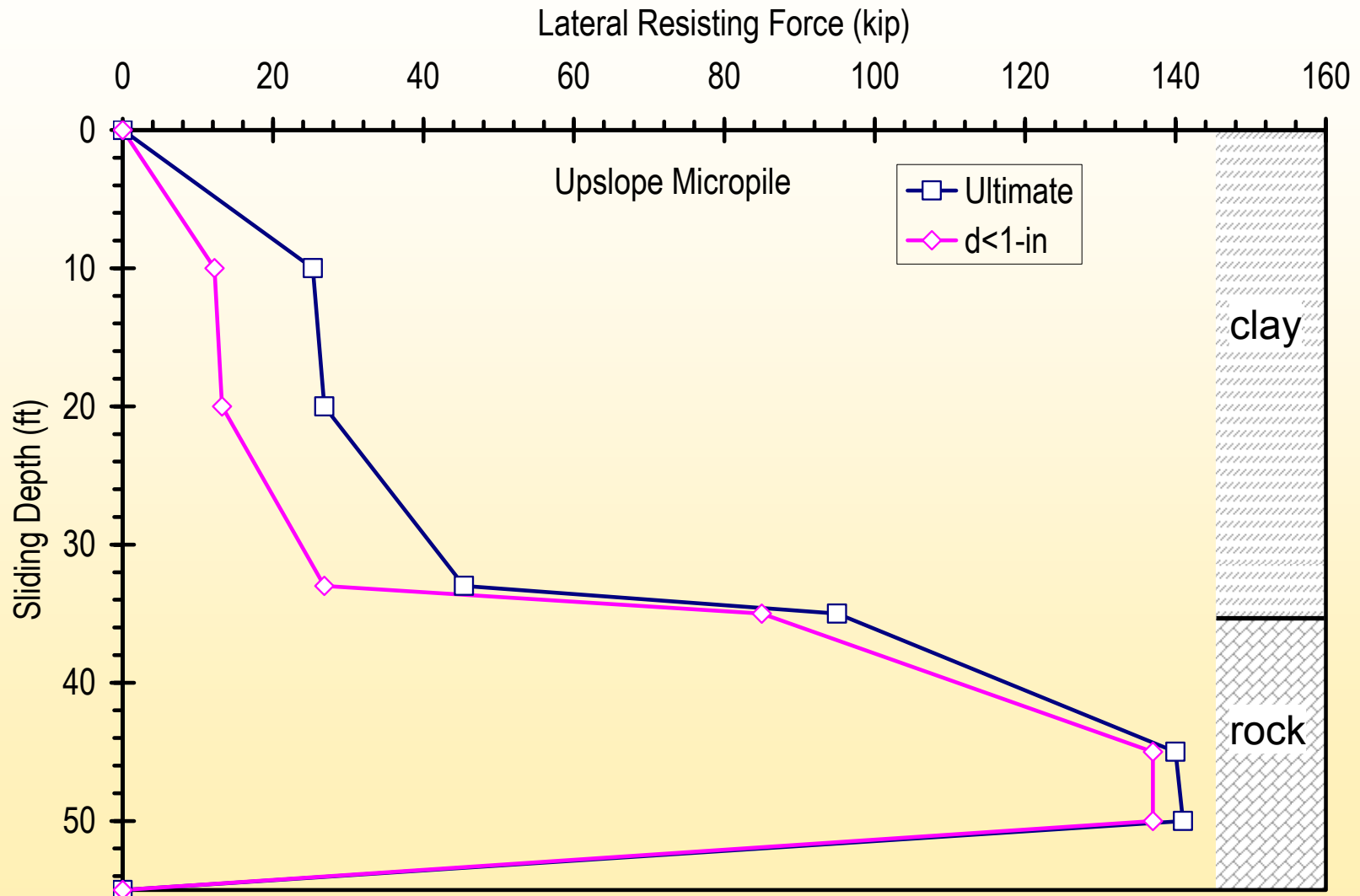# Axial Resistance Function
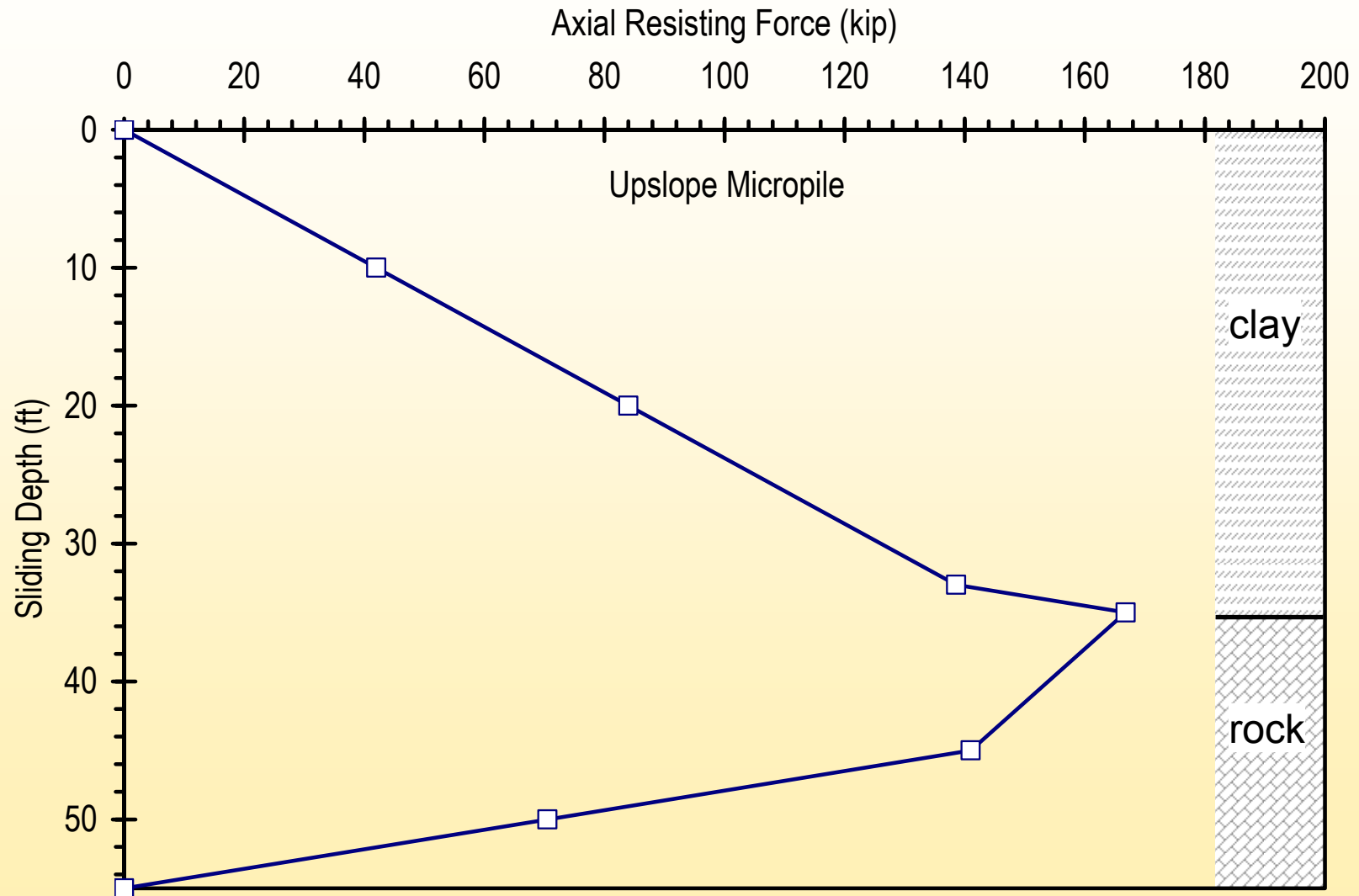
p-y analyses for lateral resistance

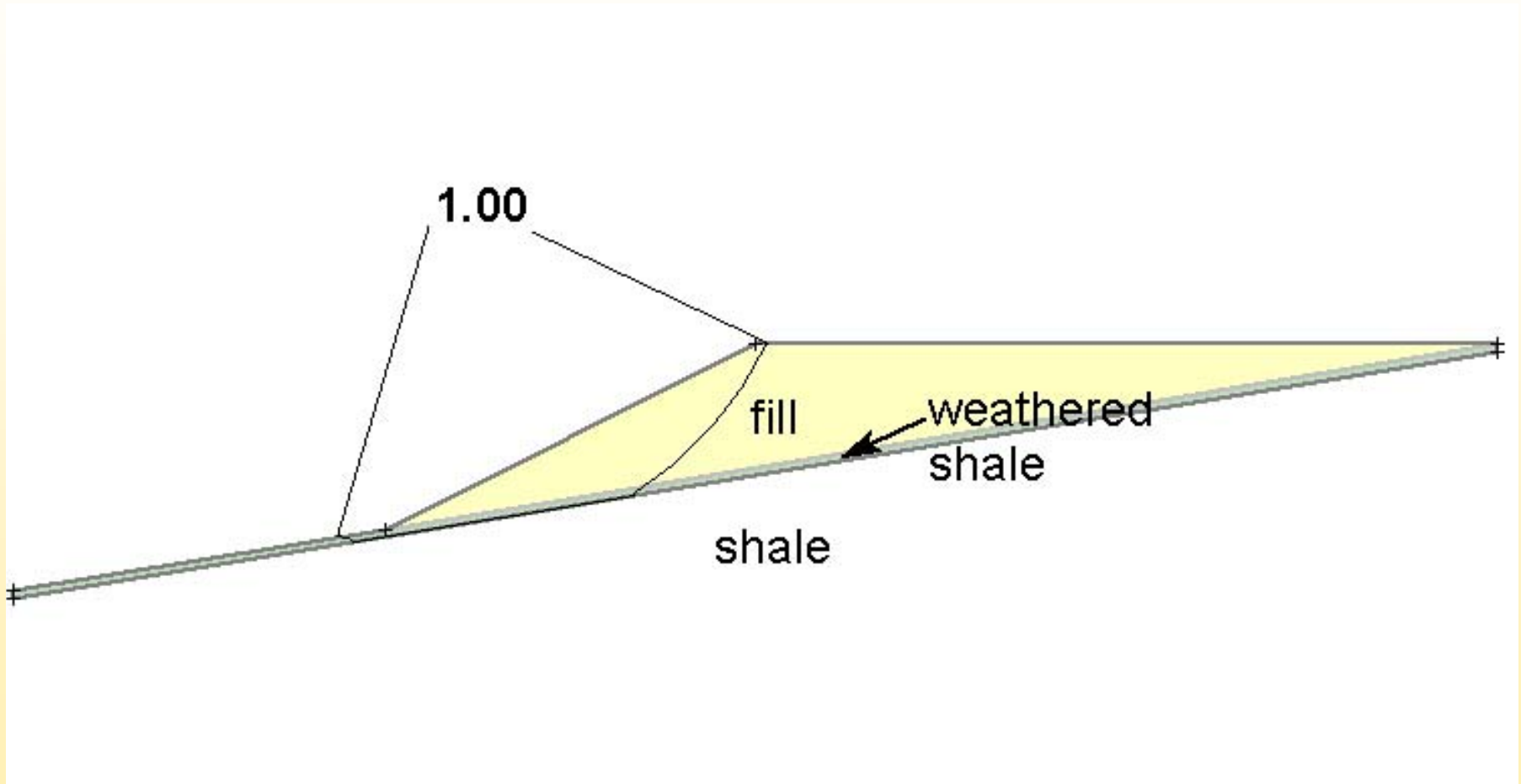# Mobilization of Lateral Resistance

Mobilization of Lateral Resistance

Lateral Resistance Function

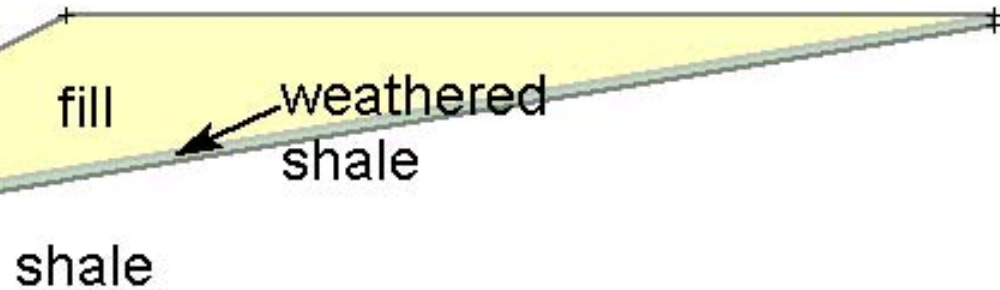# Example Problem

Example – with Micropiles

Micropiles battered at +/- 45º

fill

weathered shale
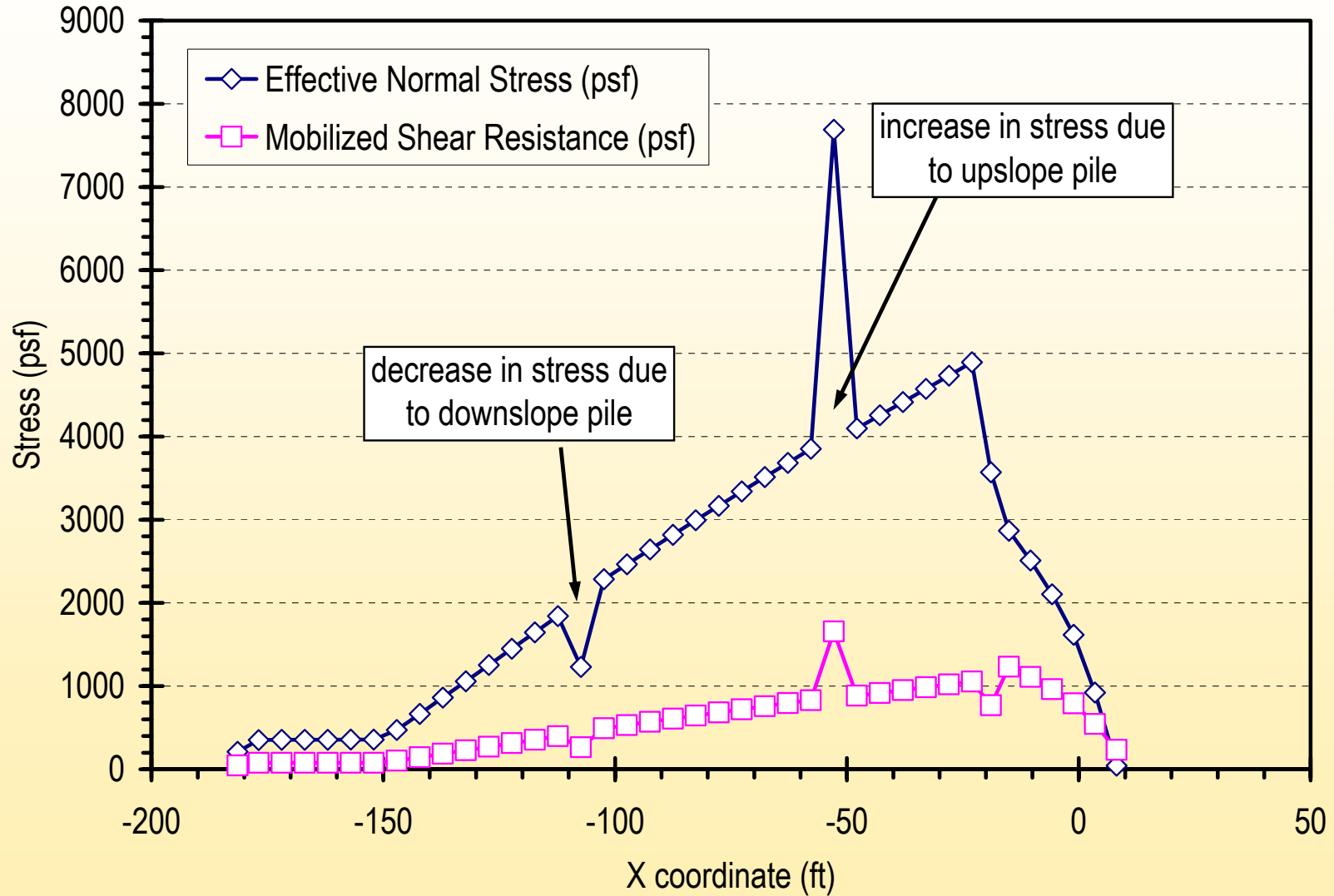
shale

Example Problem
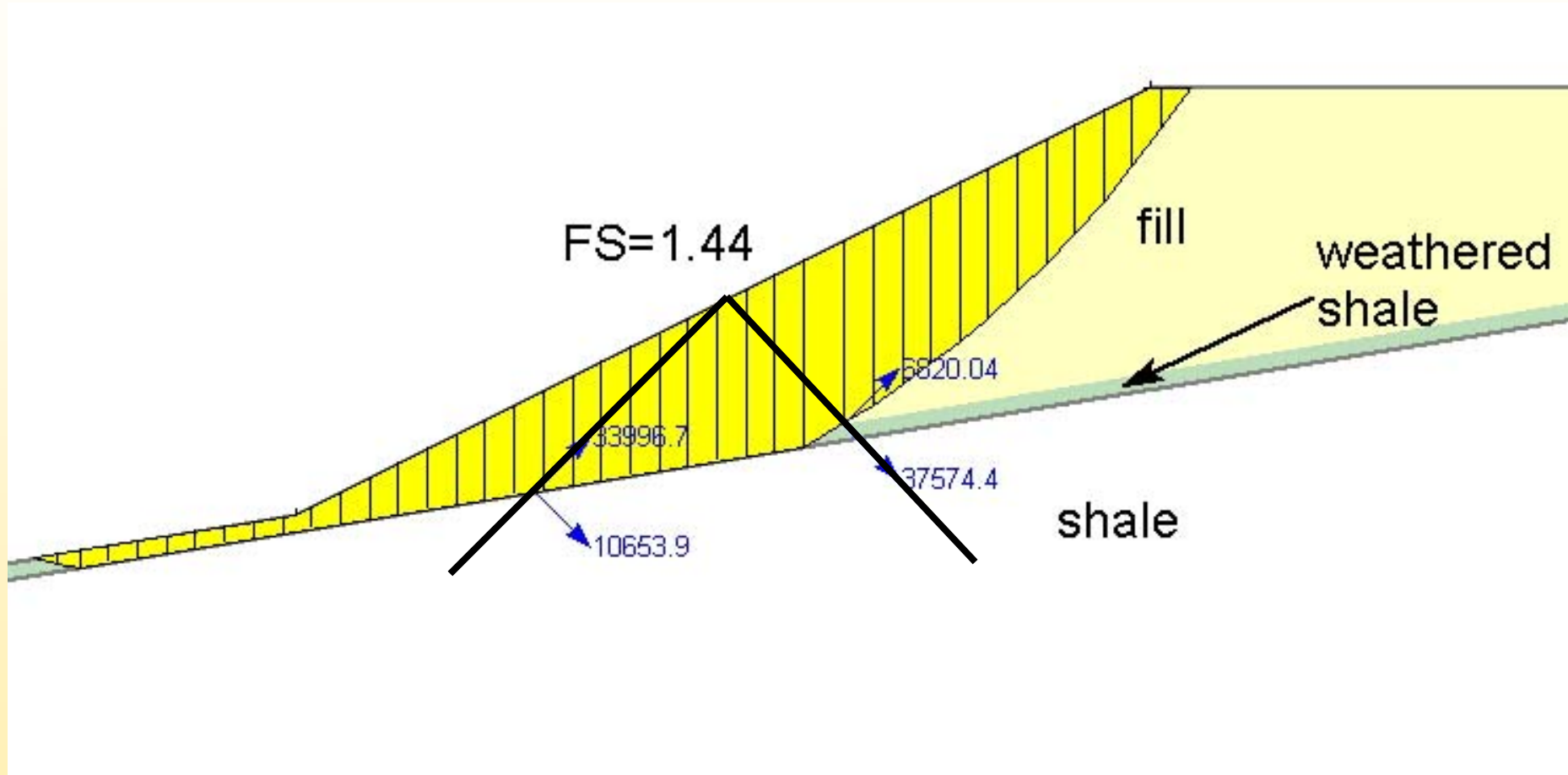
Stresses on sliding surface

Comparison with measured resistance

- Compared resistance predicted using proposed method with measured values
  - Mobilized axial resistance
  - Mobilized bending moments
- Used measured values for:
  - Soil strength
  - Pore water pressures
  - Soil deformations
- Developed "best match" using "p-modifiers" and "t-modifiers"
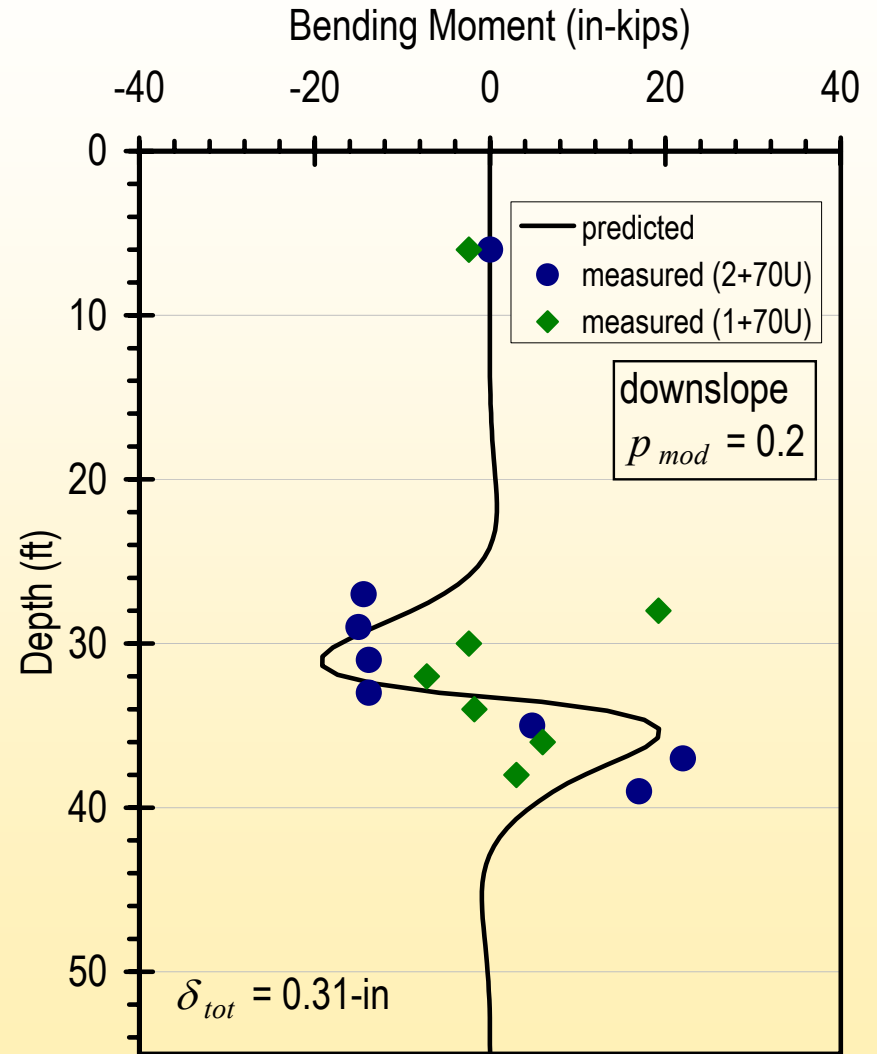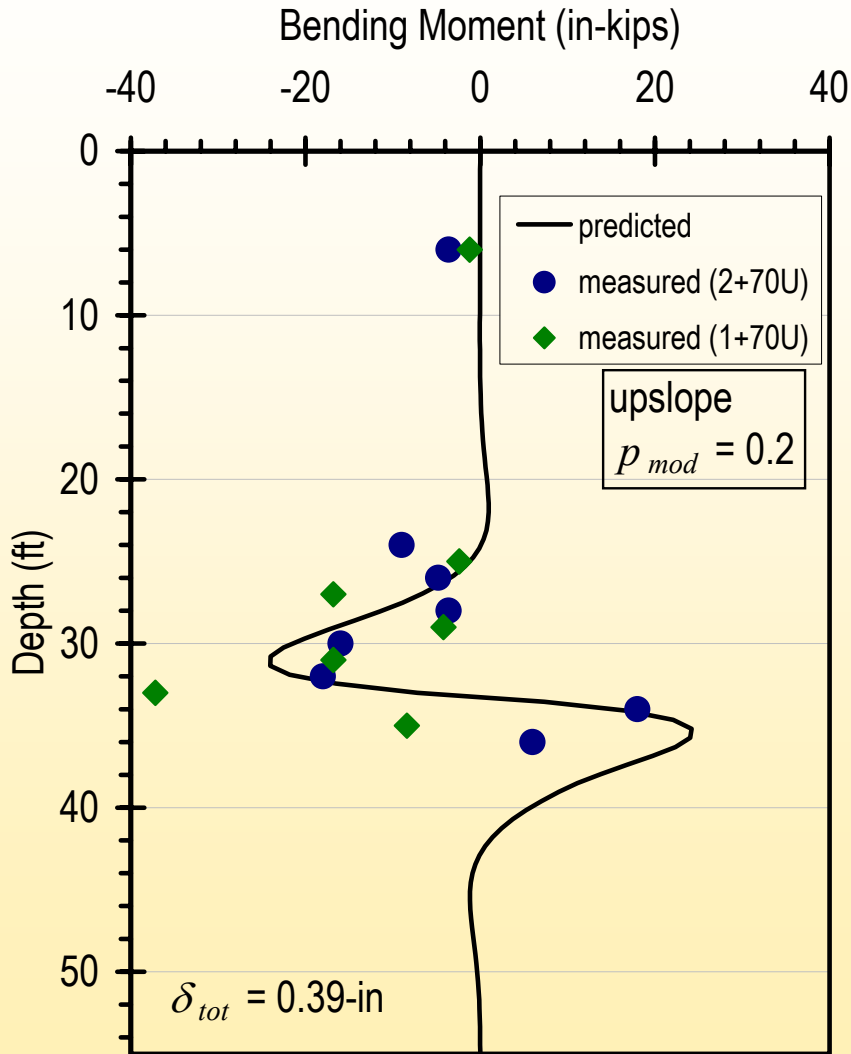
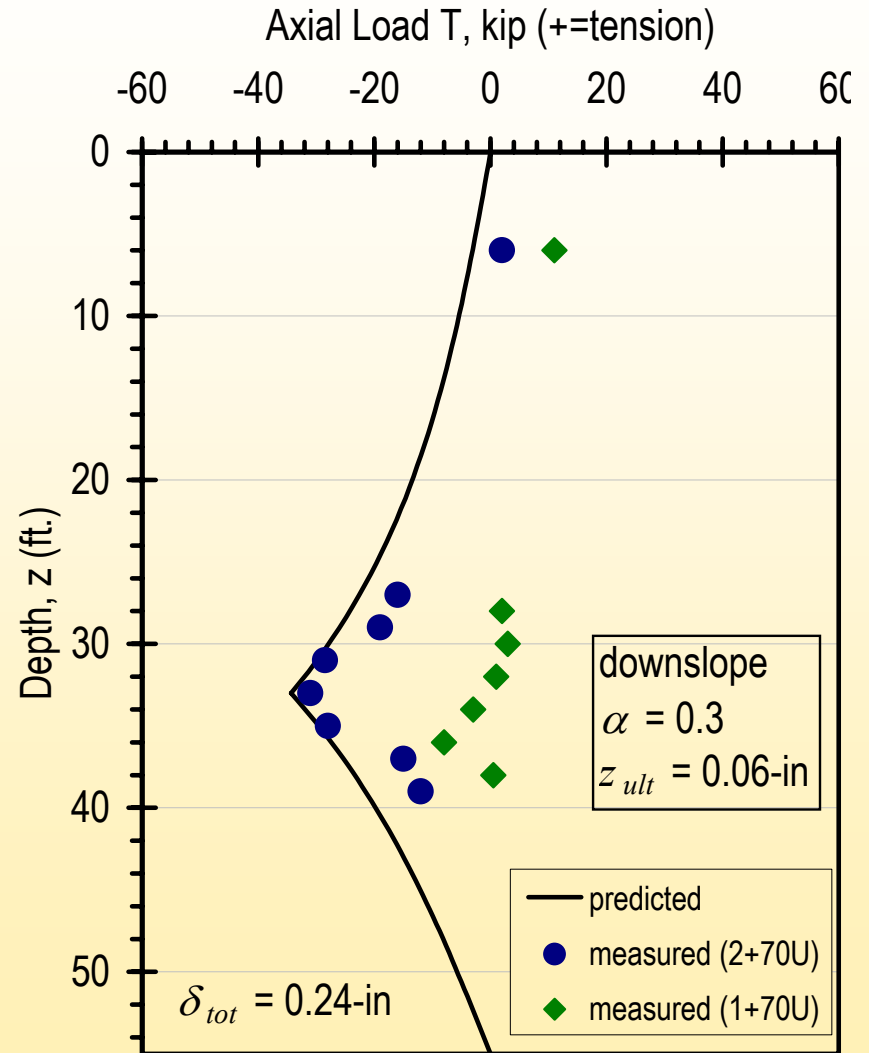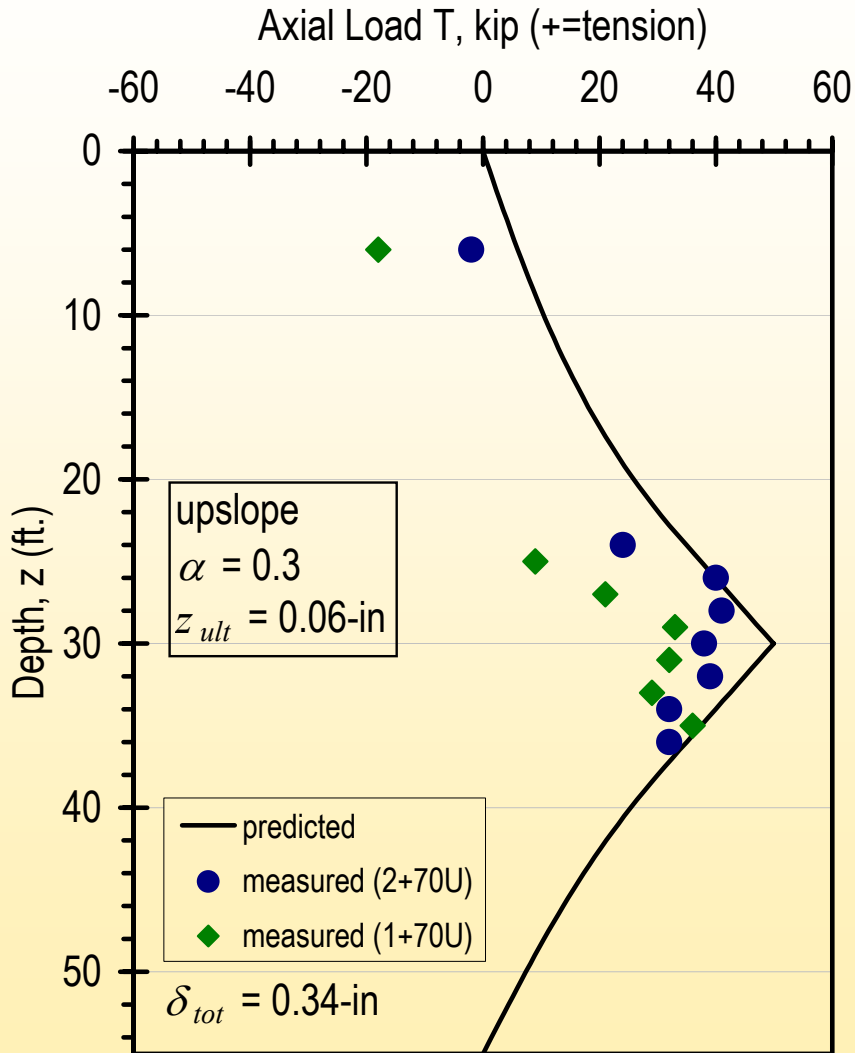# Modified p-y curves
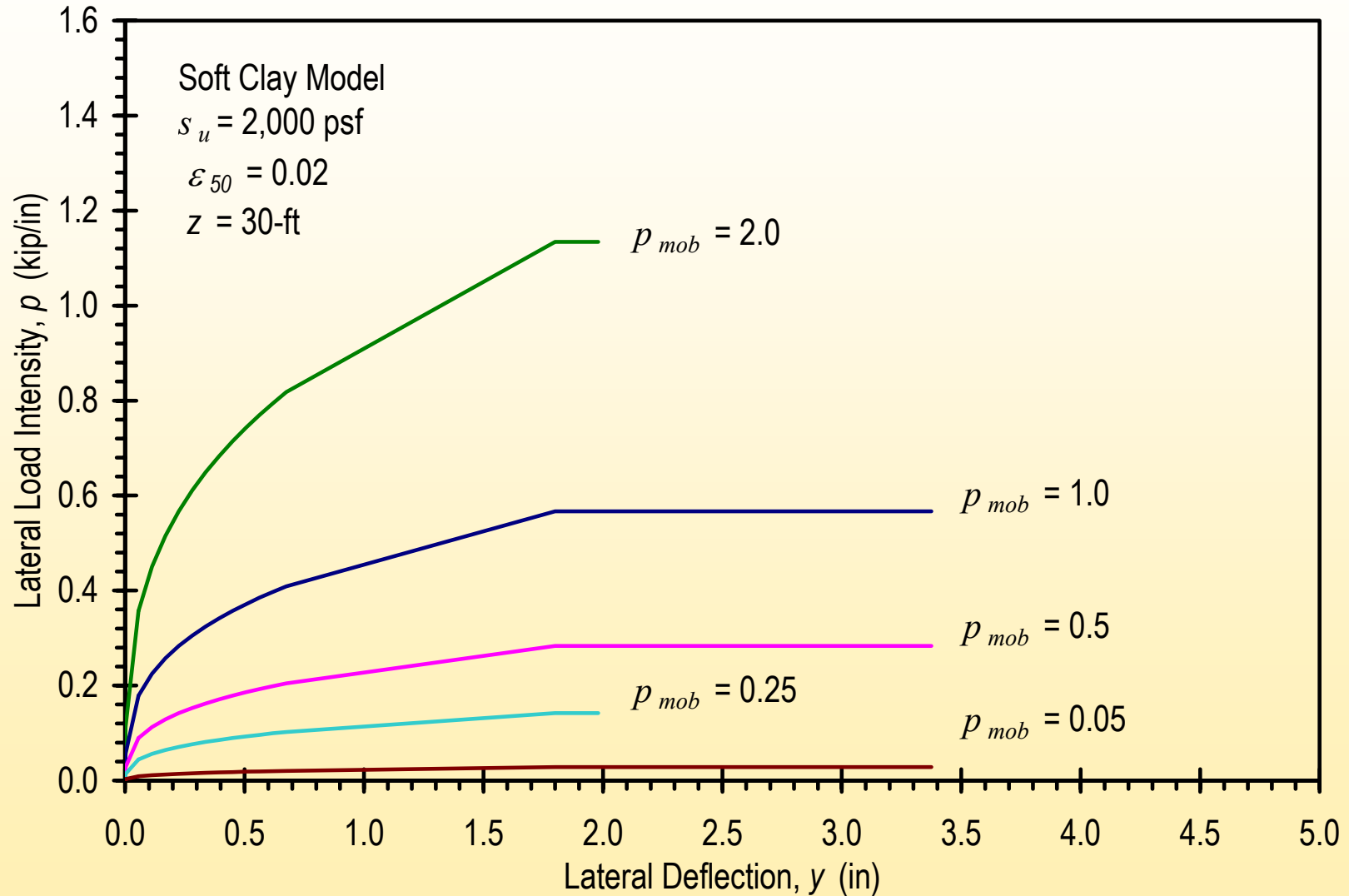
Modified t-z curves
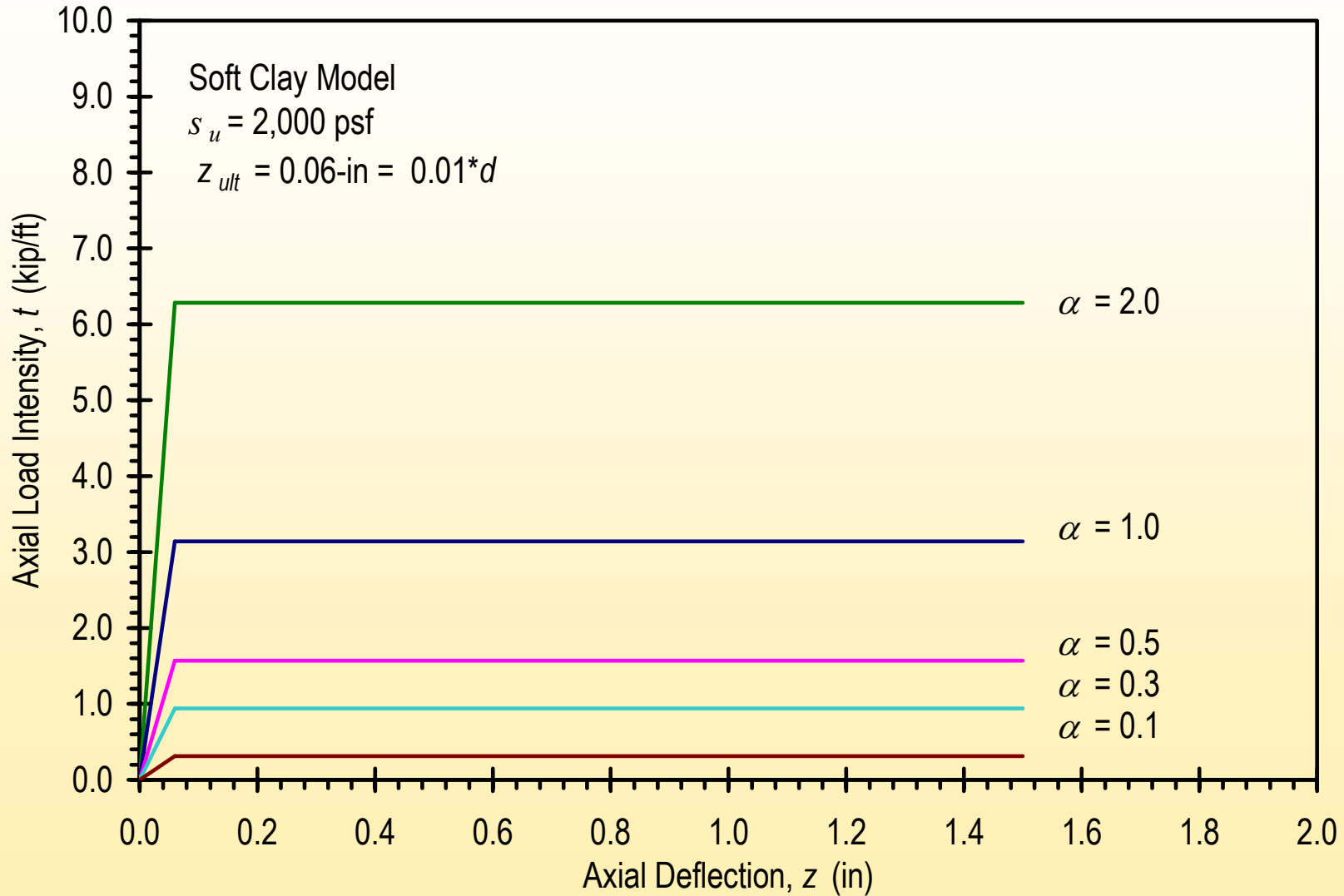
Littleville Alabama Case

# Mobilized Bending Moments – Littleville

Mobilized Axial Resistance – Littleville

Summary of evaluations

- Comparison of measured and predicted forces reasonable

- BUT…must use modified p-y and t-z models

- Possible reasons:
  - Drained vs. undrained loading
  - Group and/or scale effects
  - Softening of pile-soil interface
  - Pile inclination
  - Error/bias in measurements:
    - Shear strength parameters
    - Soil movement
  - Others???

Predicted Mobilization – Littleville
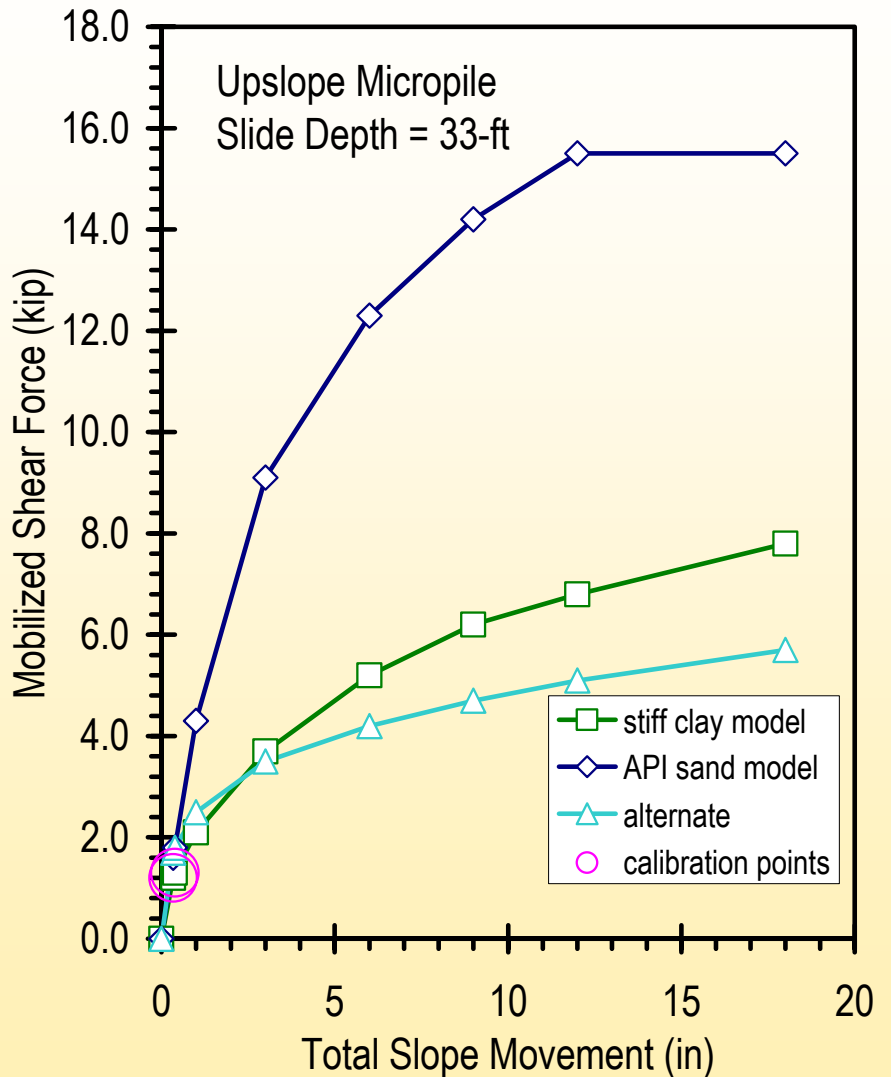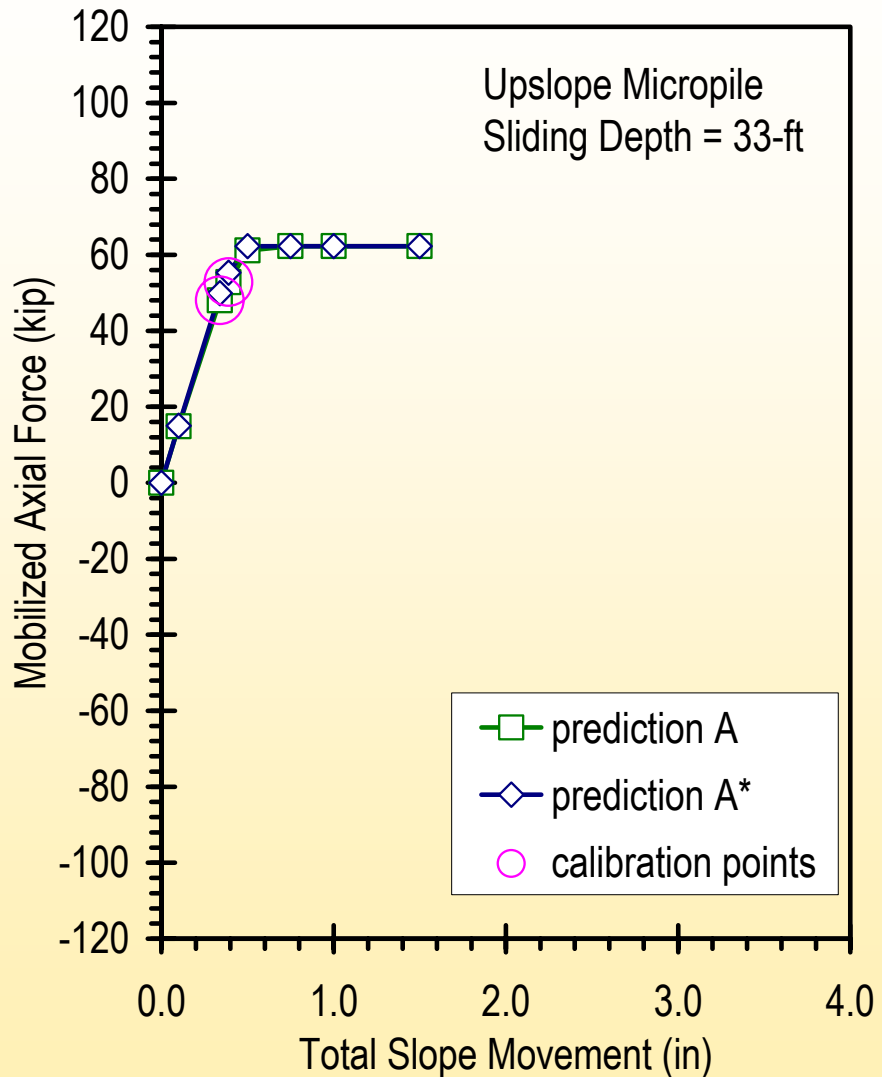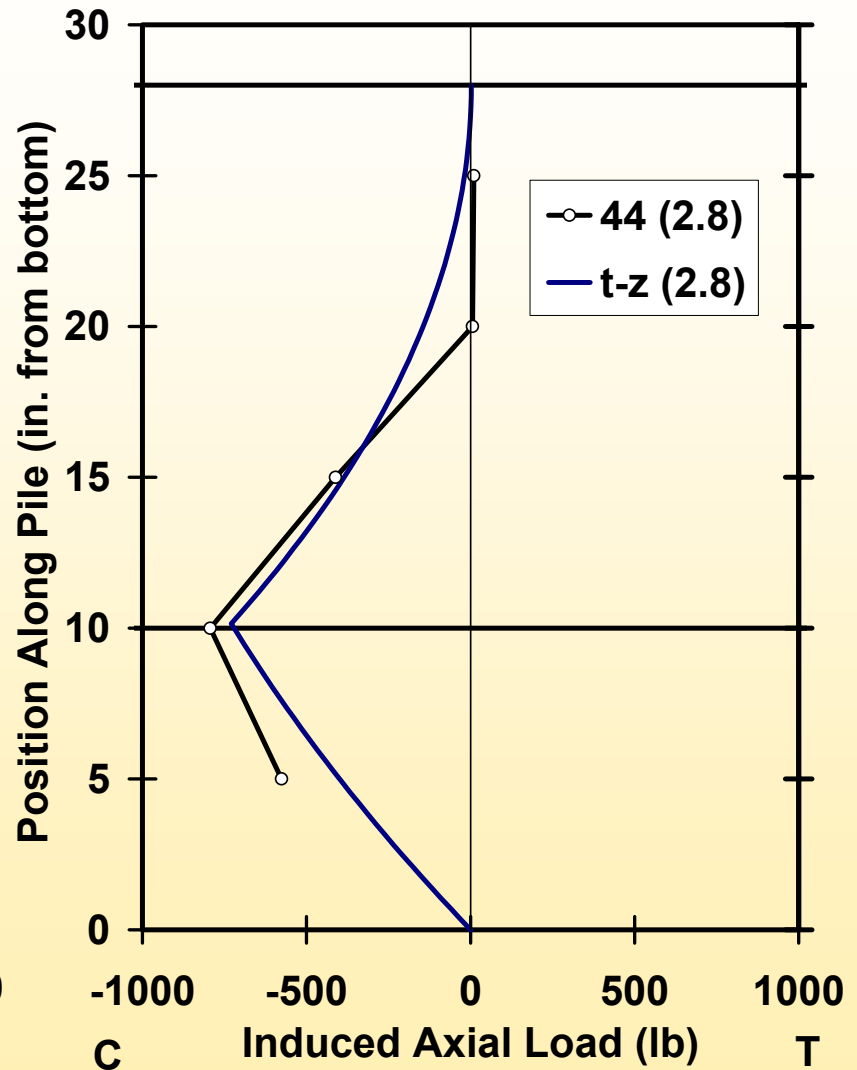
Large-scale Model Tests

slope failure v4.avi
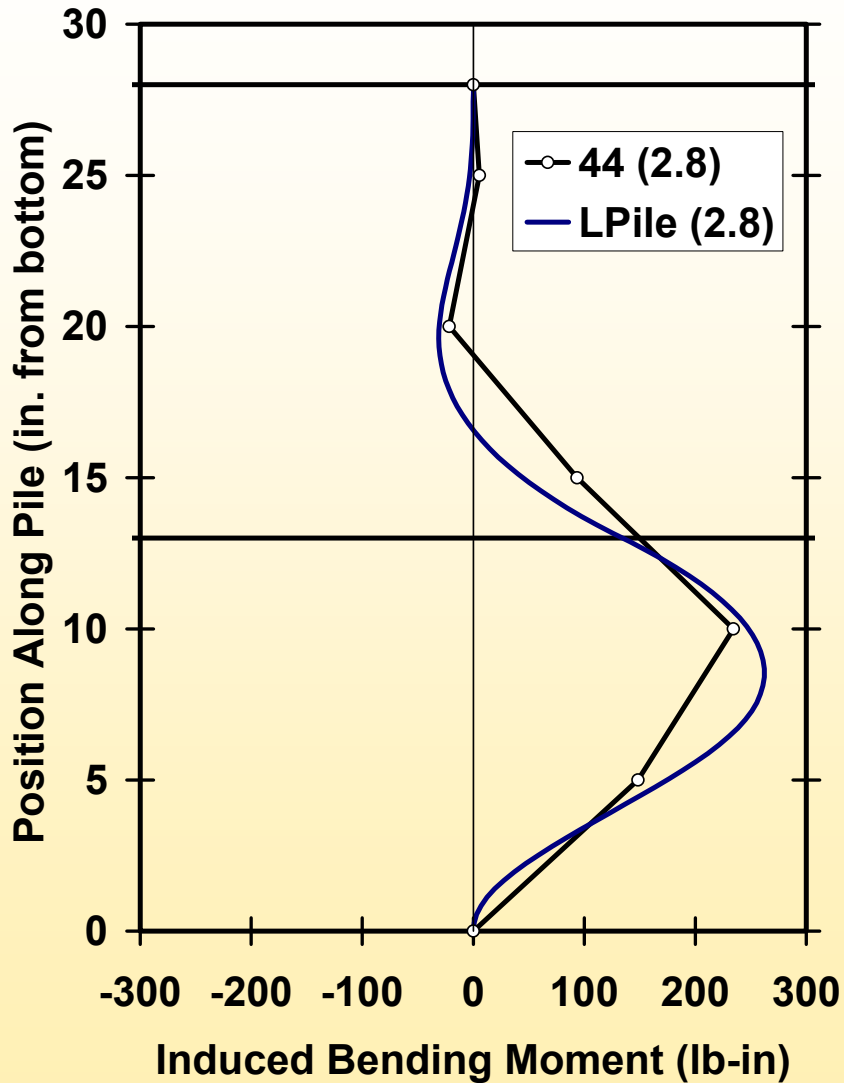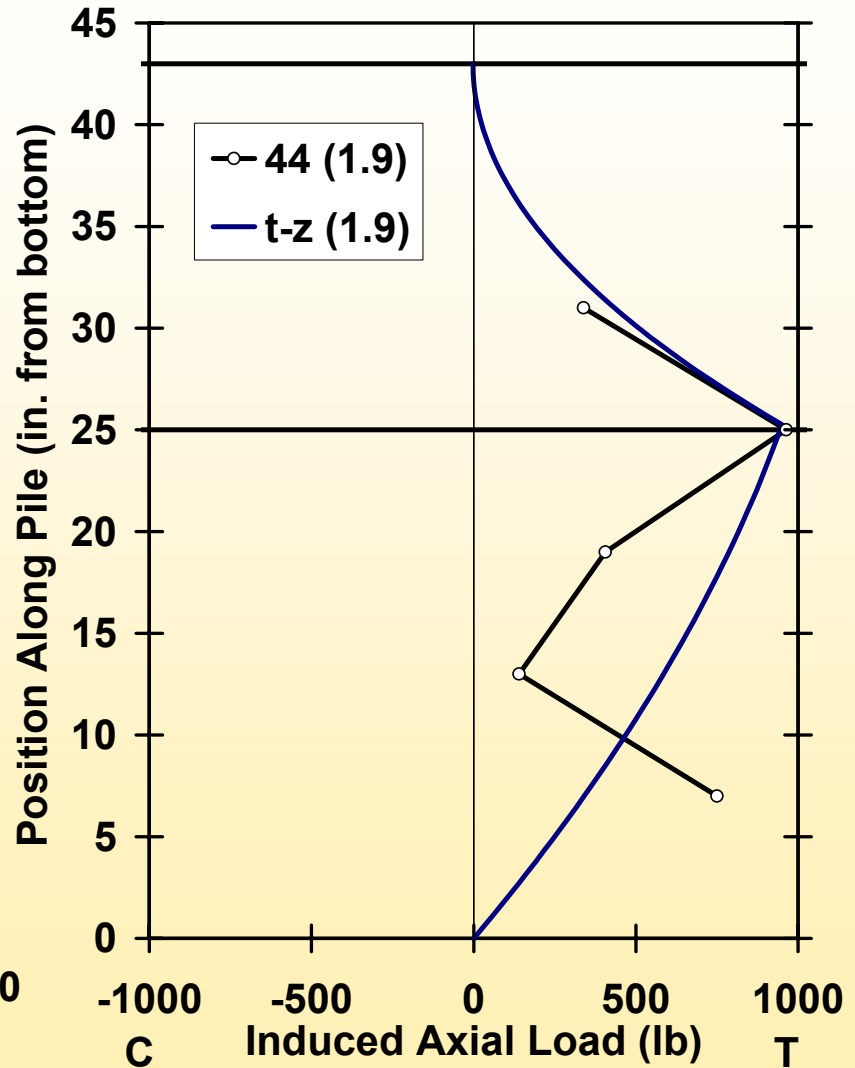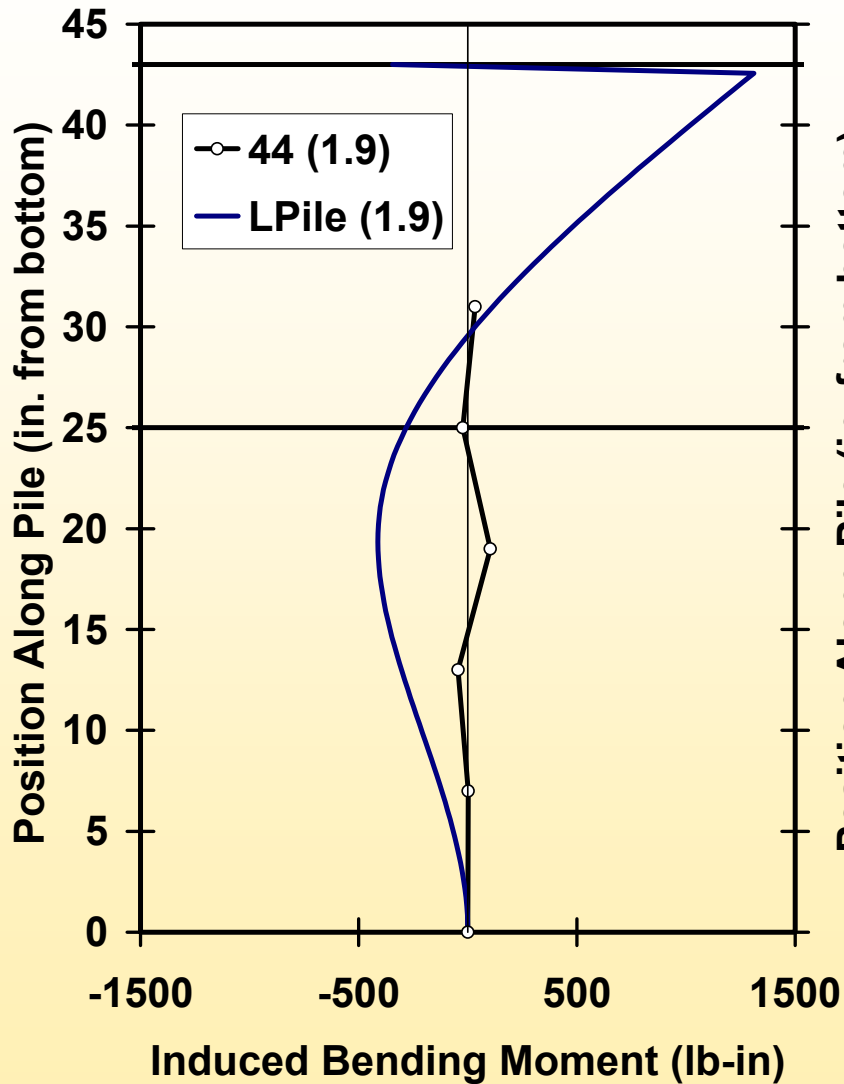

handpickedb.avi

Large-scale Model Tests

slope failure v4.avi

handpickedb.avi

Model vs. measurement – no cap

Test 2-A, Member 3 (downslope), *S/D*=10

Model vs. measurement – with cap

Test 3-A, Member 2 (upslope), *S/D*=10

Conclusions

- Proposed *uncoupled* method suitable for predicting micropile resistance when cap influence is limited

- Use of modified p-y and t-z models required

- When cap interaction is significant, uncoupled method does not accurately predict response

- Full axial resistance frequently mobilized at relatively small soil movements

- Full lateral resistance frequently not mobilized without substantially greater soil movements

- Additional data needed!!!

Acknowledgements

- ADSC/DFI Micropile Committee
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- Many students…