THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

0-6603-P1

TRAINING SESSION MATERIALS

Research Supervisor:
Robert Gilbert

TxDOT Project 0-6603: Long-Term Performance of Drilled Shaft Retaining Walls

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Performing Organization: Center for Transportation Research The University of Texas at Austin 1616 Guadalupe, Suite 4.202 Austin, Texas 78701	**Sponsoring Organization:** Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, Texas 78763-5080
Performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.	

Training Workshop
Proposed Design Approach

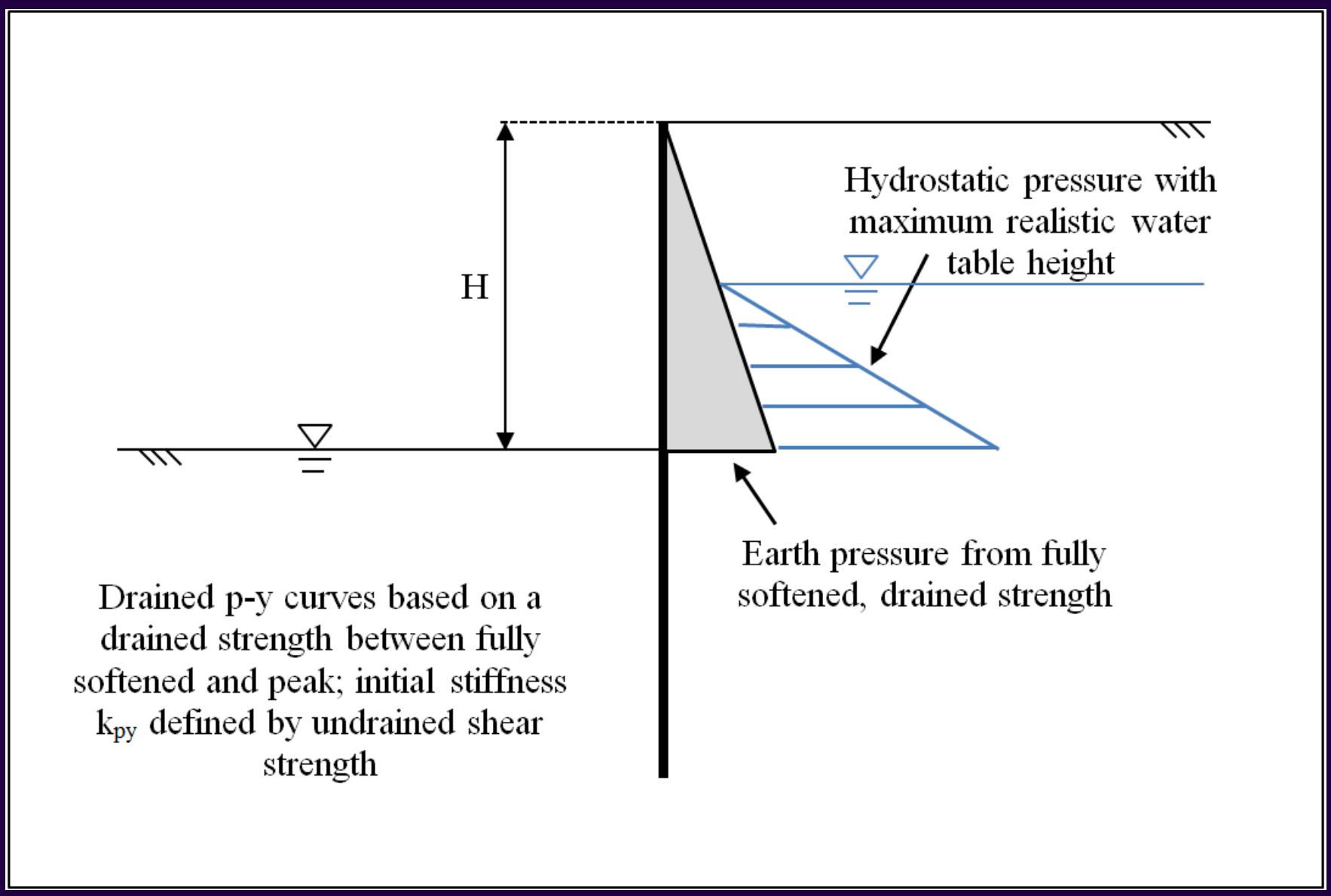
Long-Term Loading for Drilled Shaft Walls in Expansive Clays

FINAL SLIDES

The University of Texas at Austin

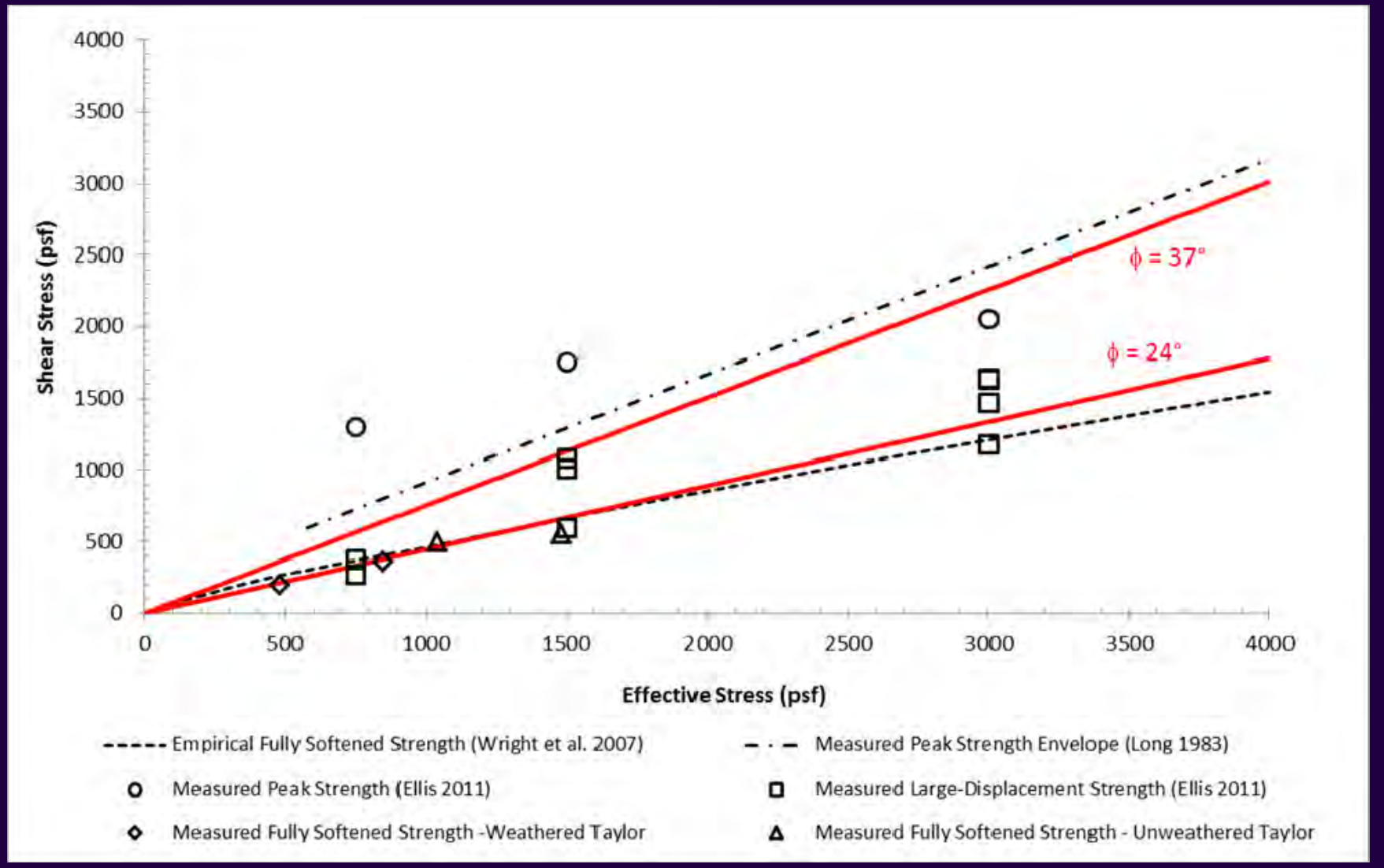
August 29, 2013

Proposed Design Approach

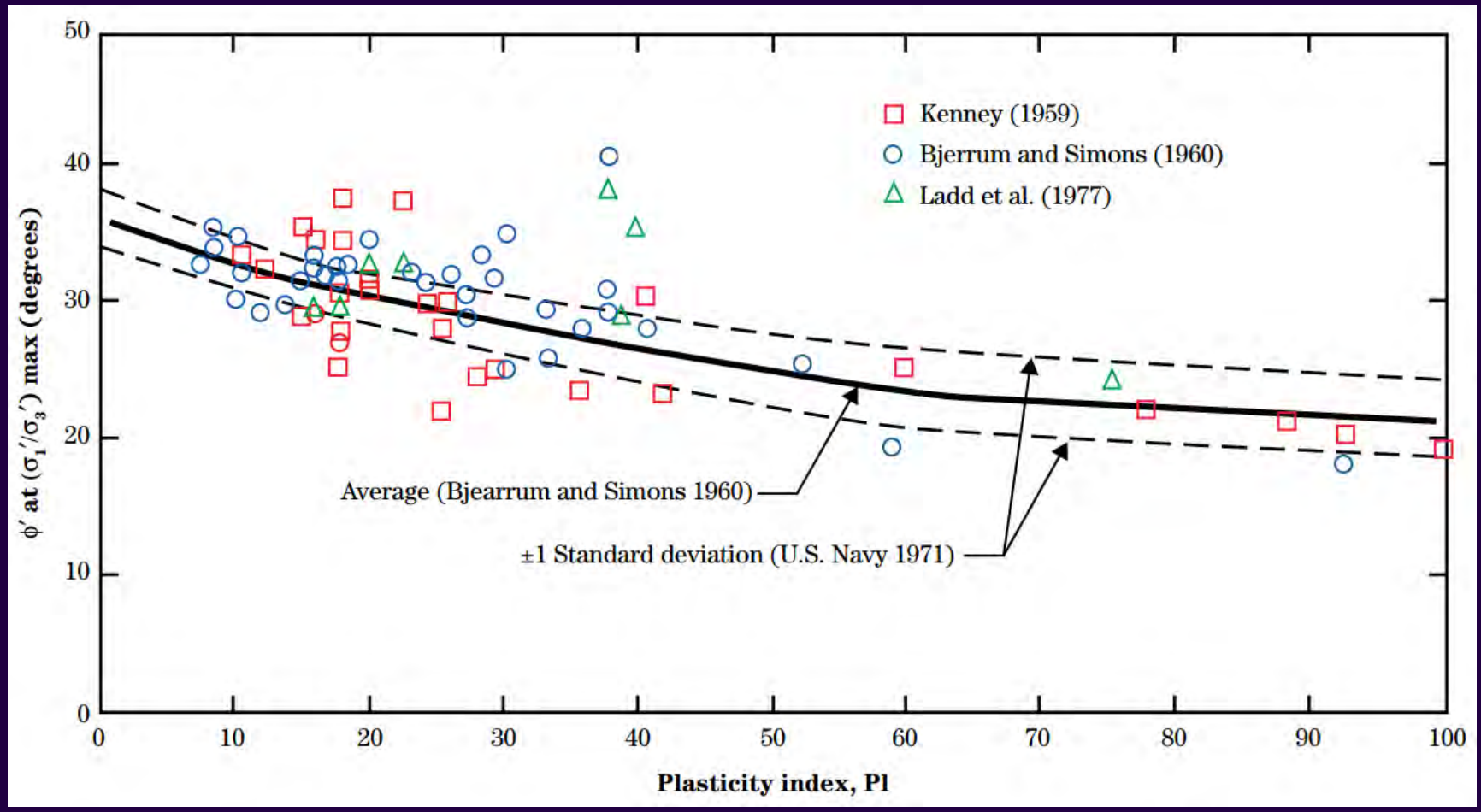


Drained Shear Strength

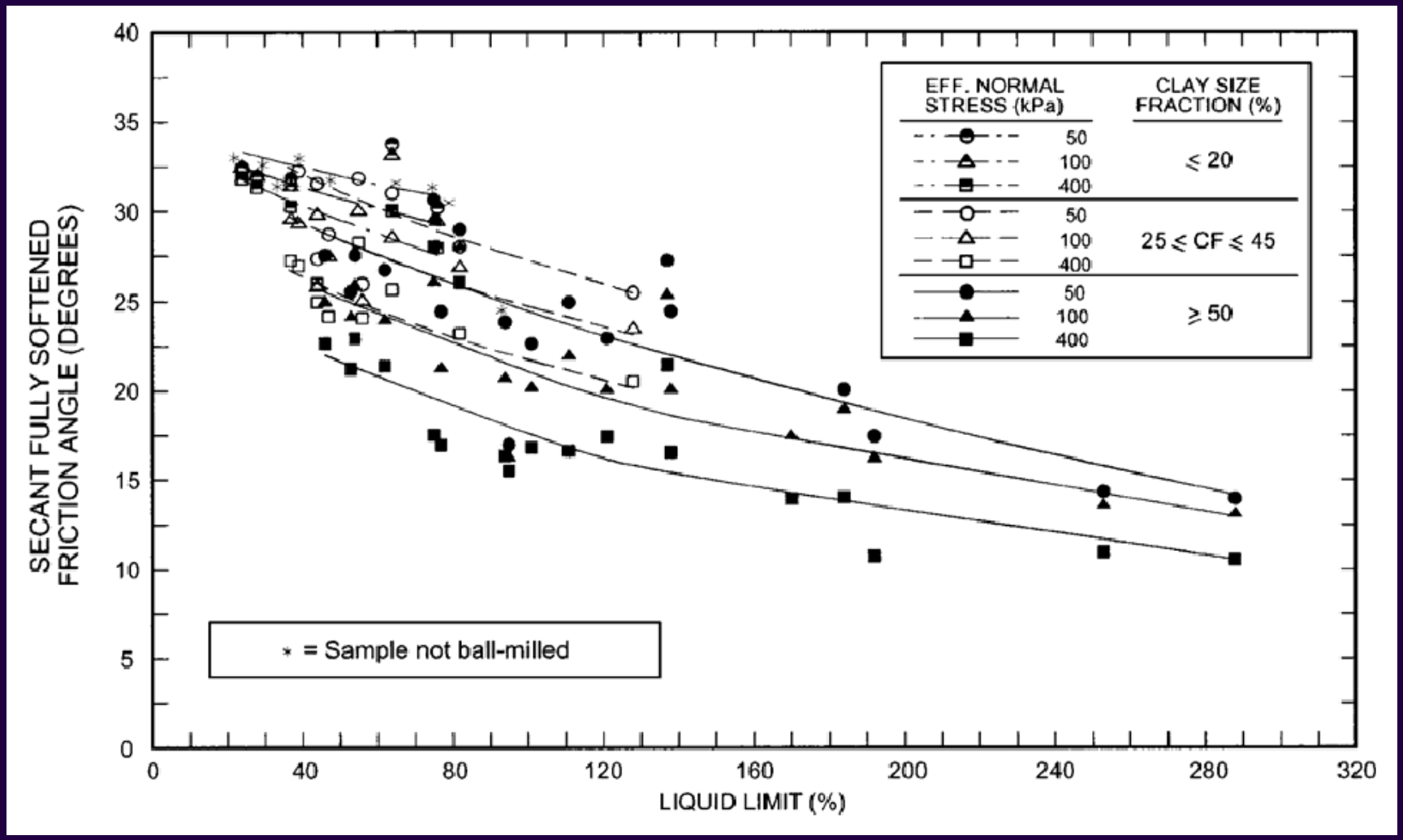
Drained Shear Strengths



Fully Softened Strength, PI Relationship



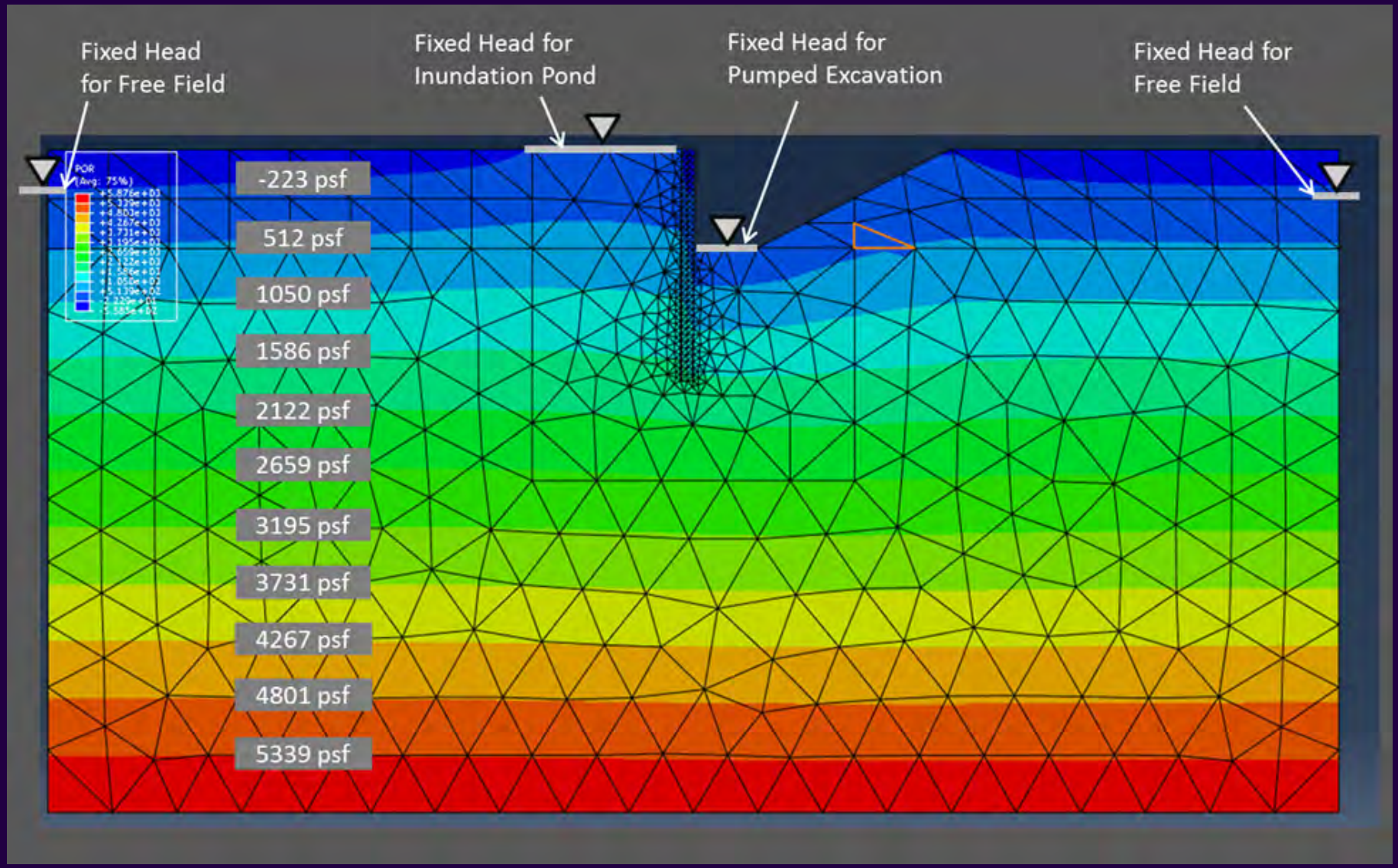
Fully Softened Strength, Wright et al. (2007)



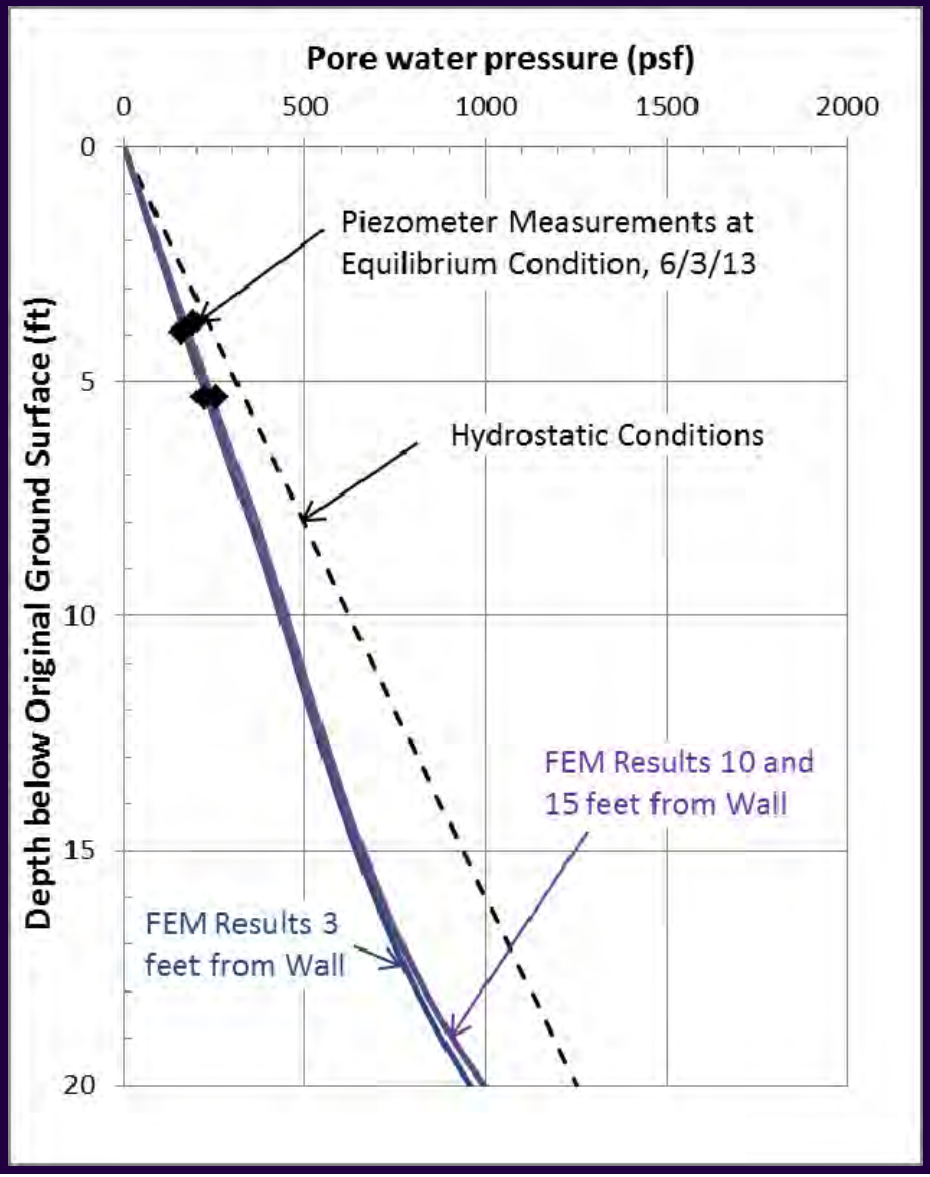
$$\phi_{secant} = 55.3^\circ - 16.7^\circ \log_{10}(w_{LL}) - 6^\circ \log_{10}\left(\frac{\sigma'_f}{p_a}\right)$$

Pore Water Pressures

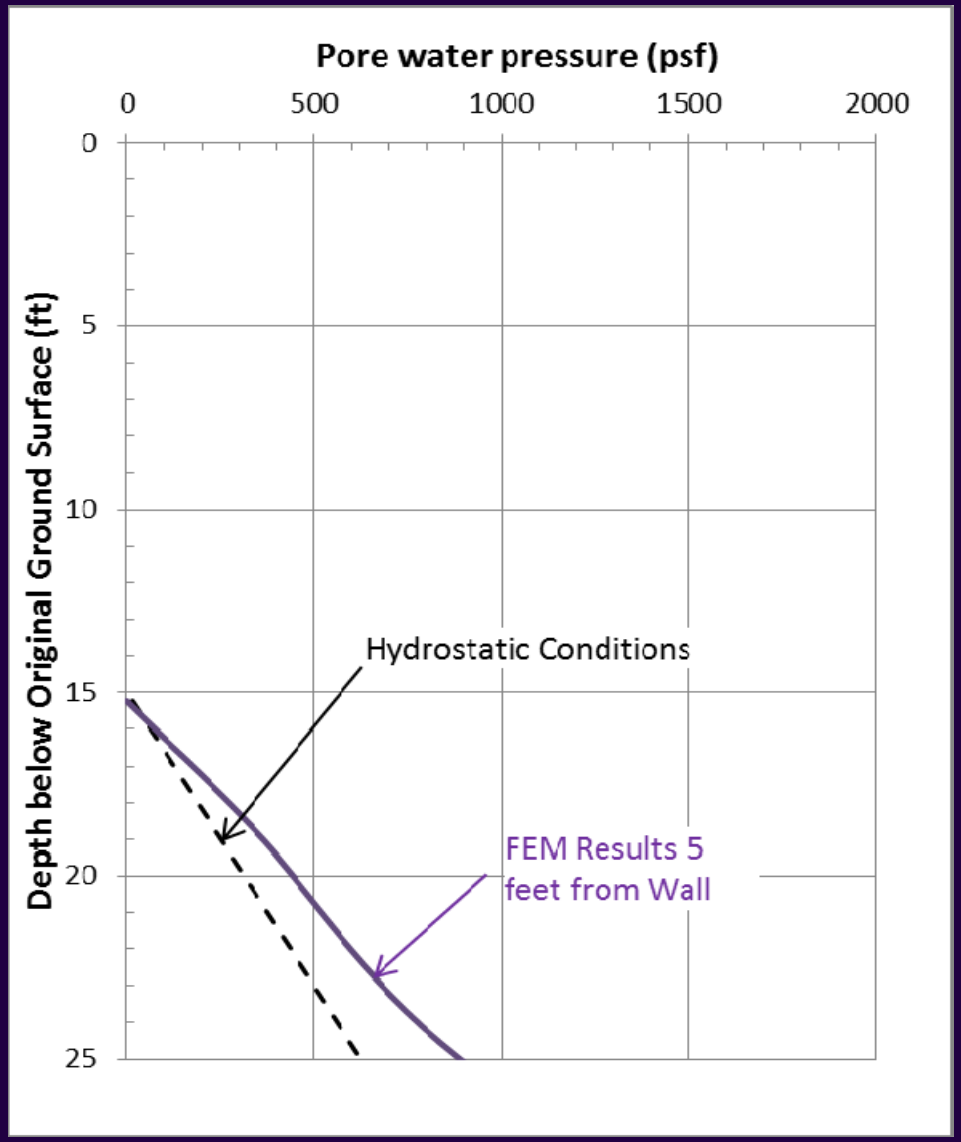
FEM Analysis for Inundation Flow



Pore Water Pressure Profile in Retained Soil

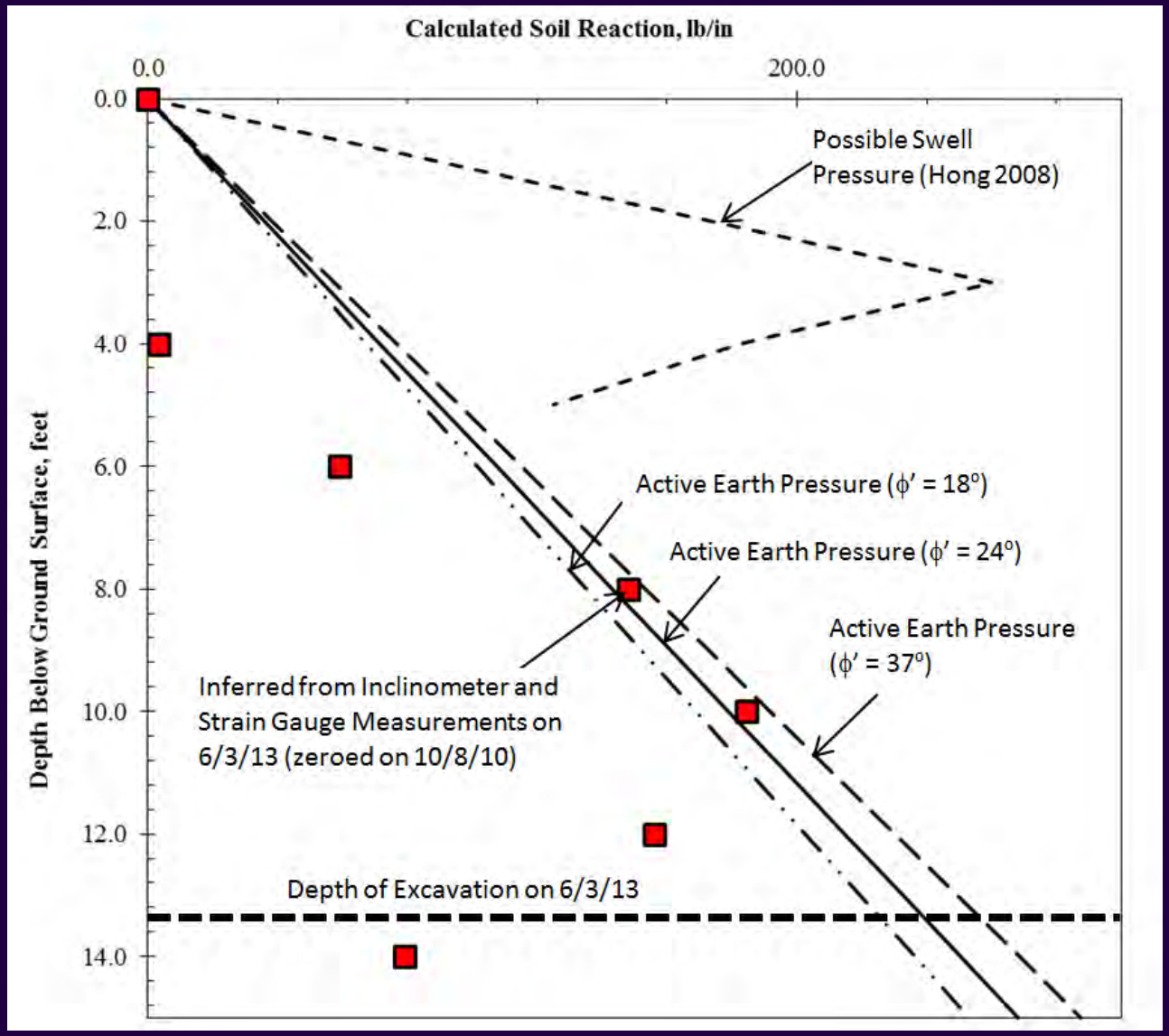


Pore Water Pressure Profile in Retained Soil



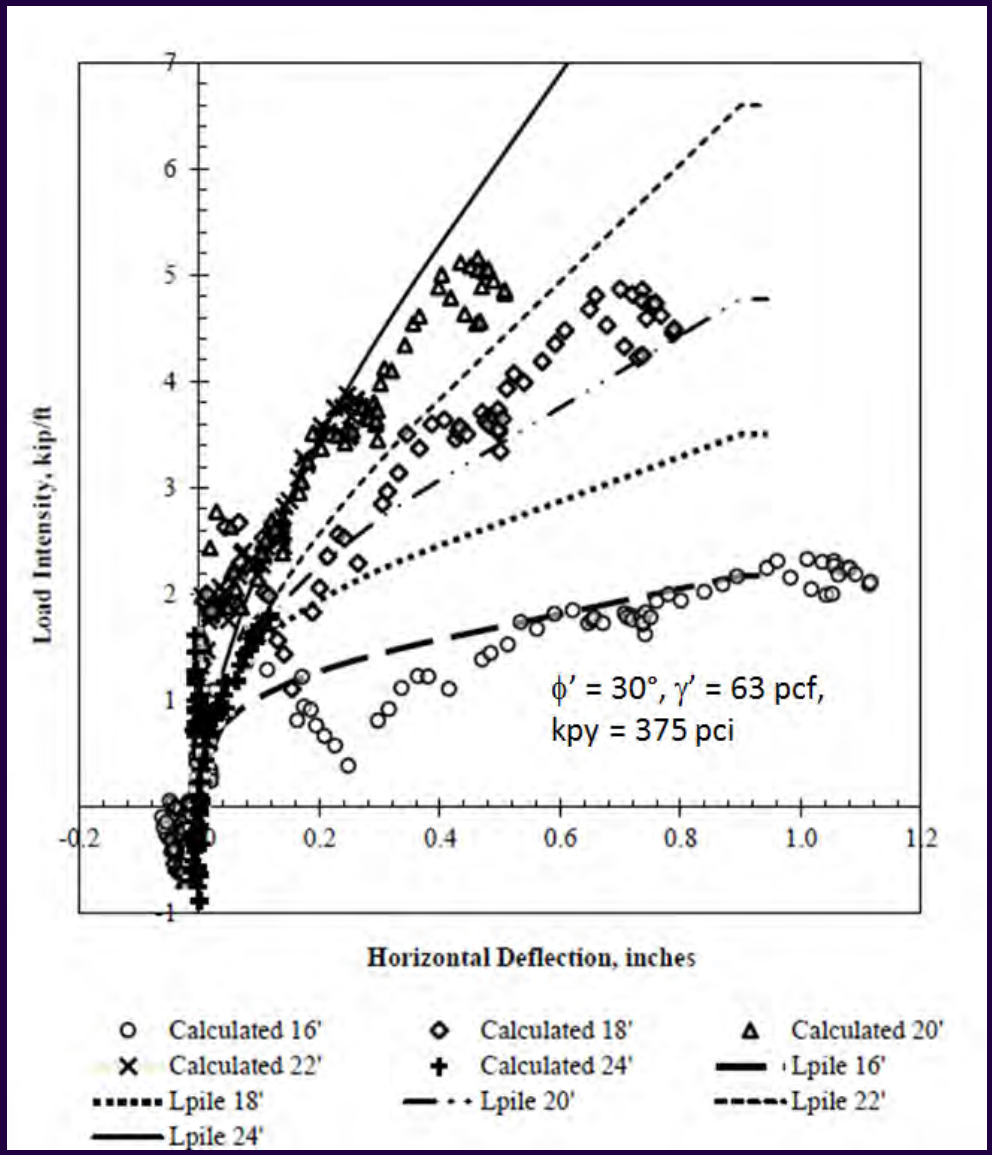
Active Earth Pressures

Calculated vs. Measured Active Earth Pressures

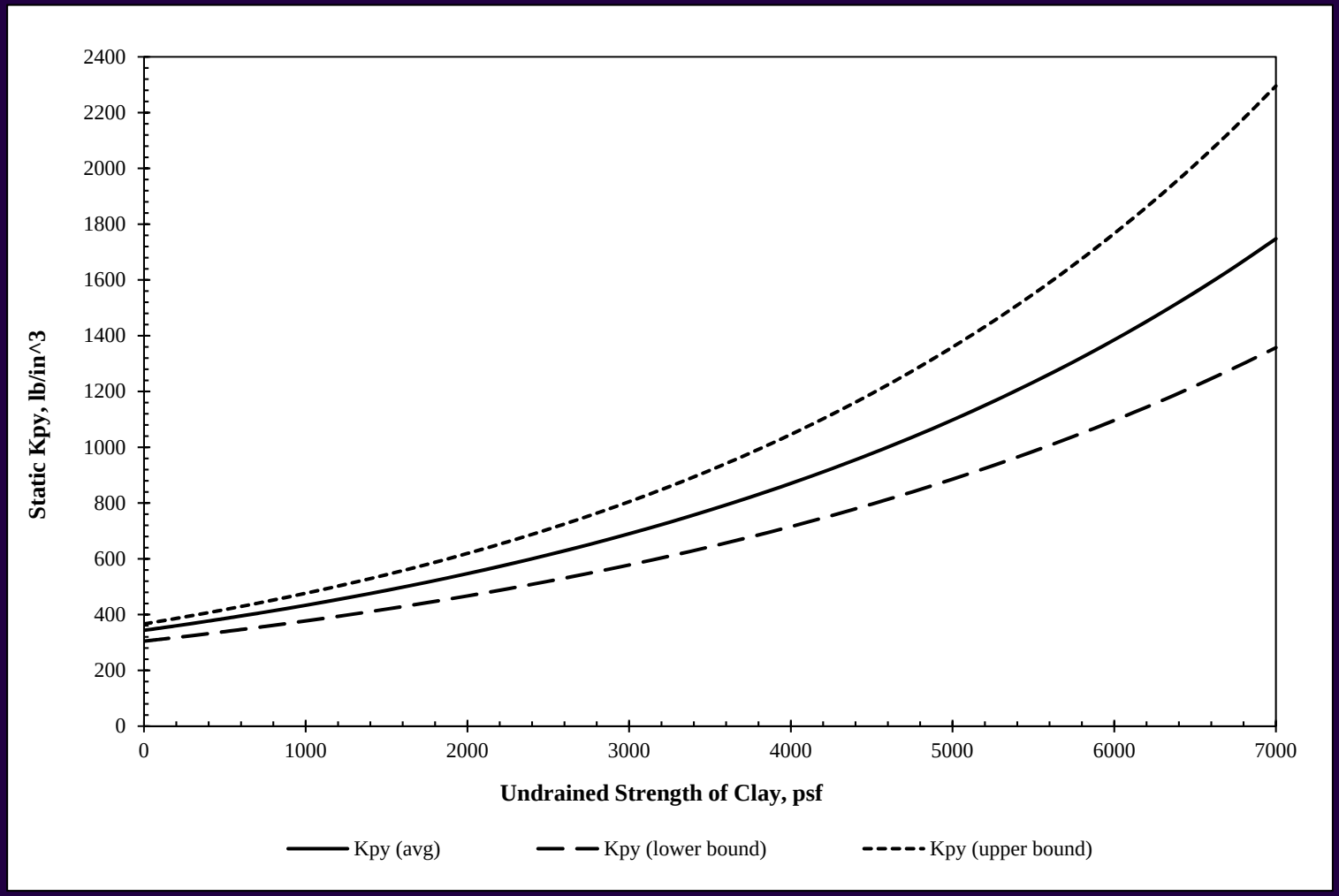


Passive Earth Pressures (P-Y Curves)

Measured p-y Curves versus p-y Model Curves



Initial Static Stiffness K_{py} versus S_u



Curves fit to data from Table 14.1, Reese et al. (2006)

Group Effects

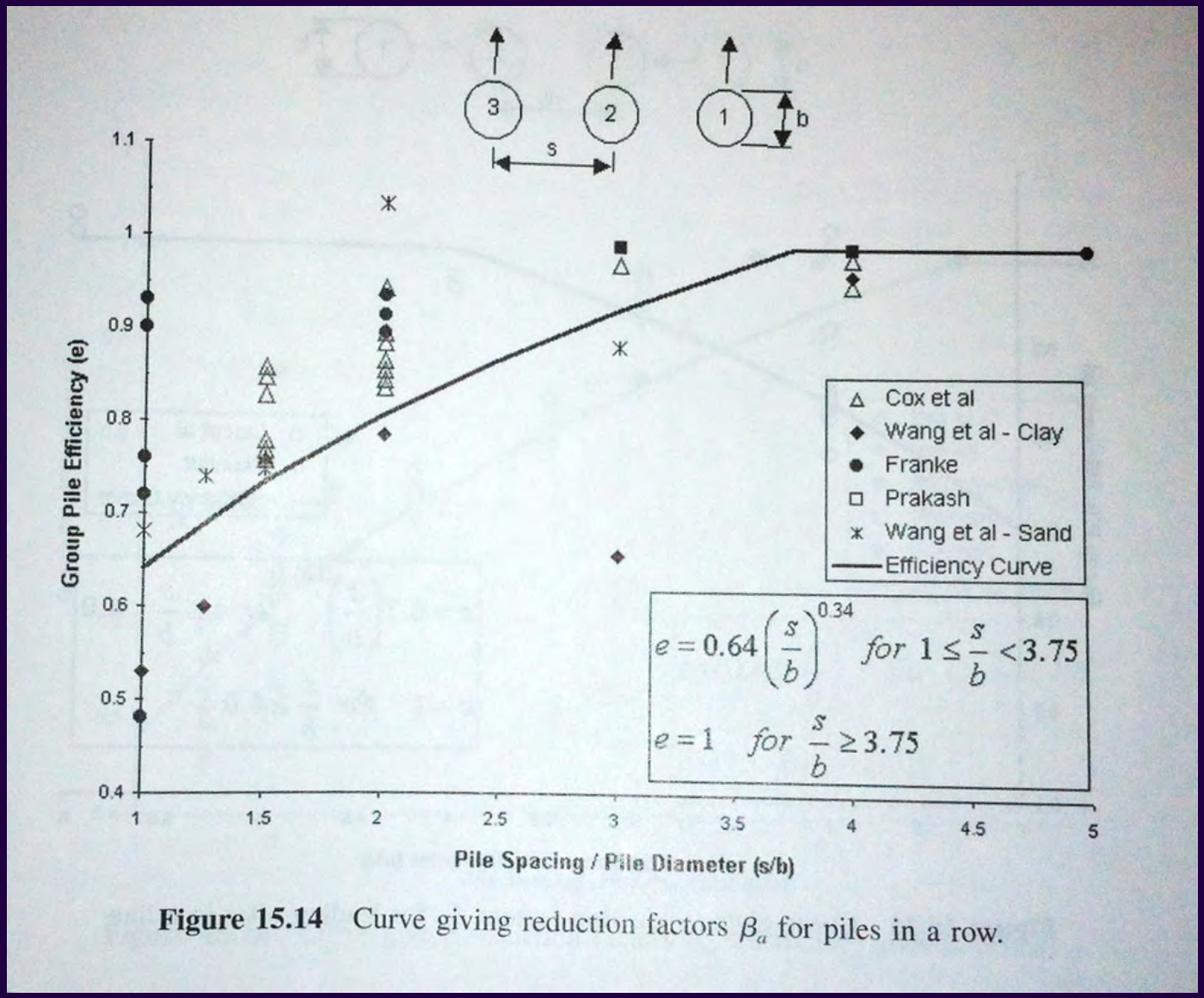
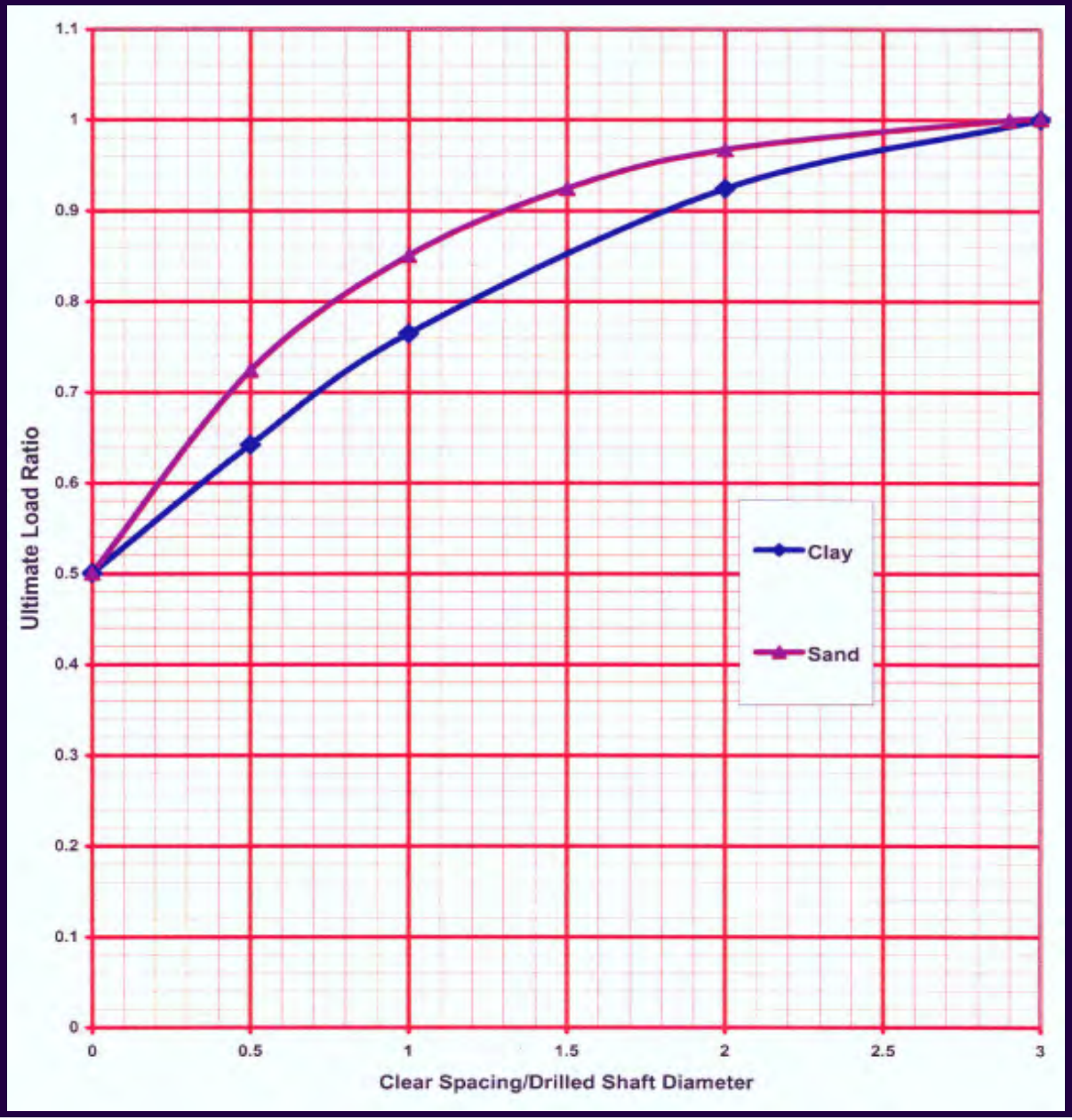
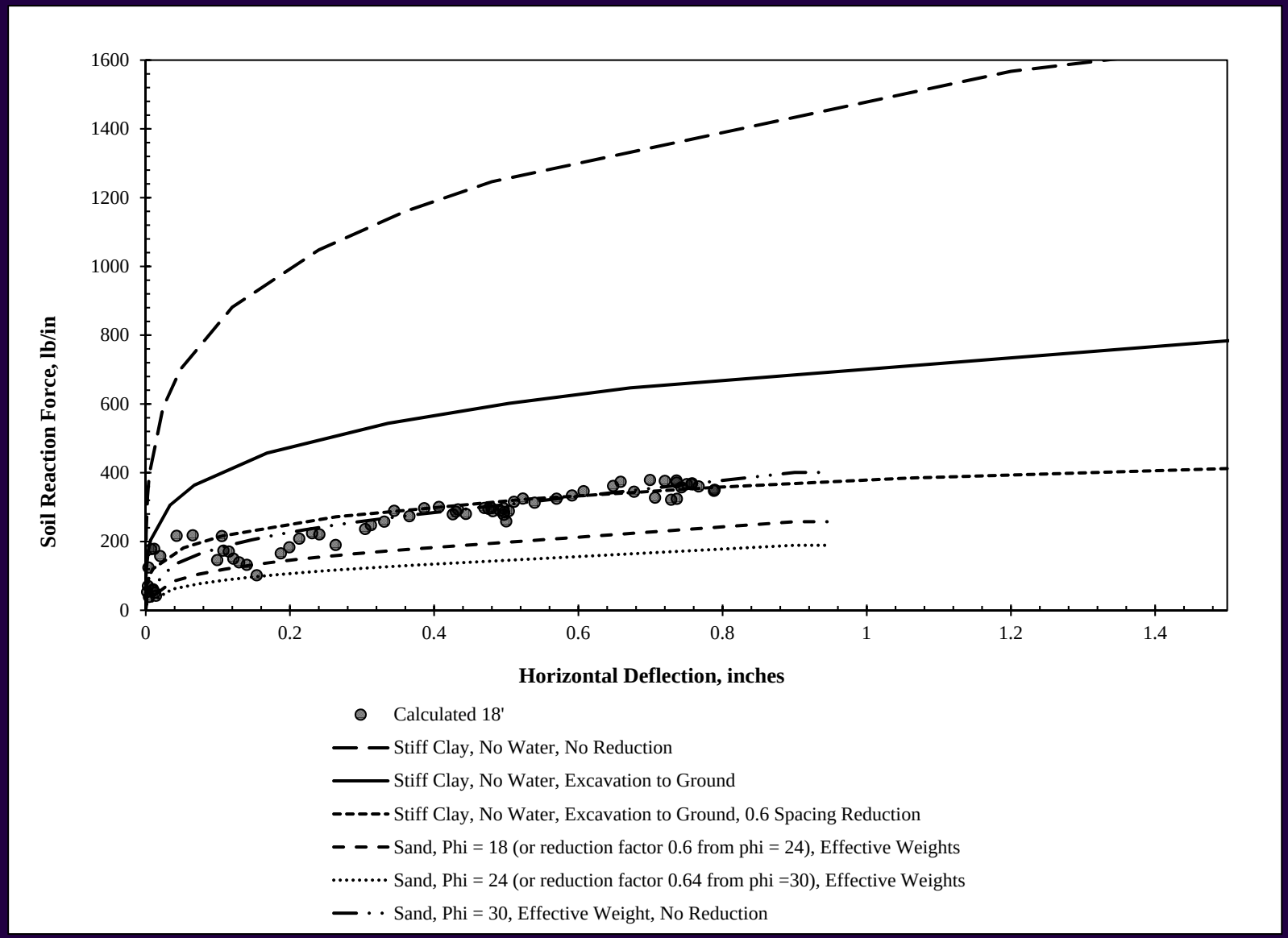


Figure 15.14 Curve giving reduction factors β_a for piles in a row.

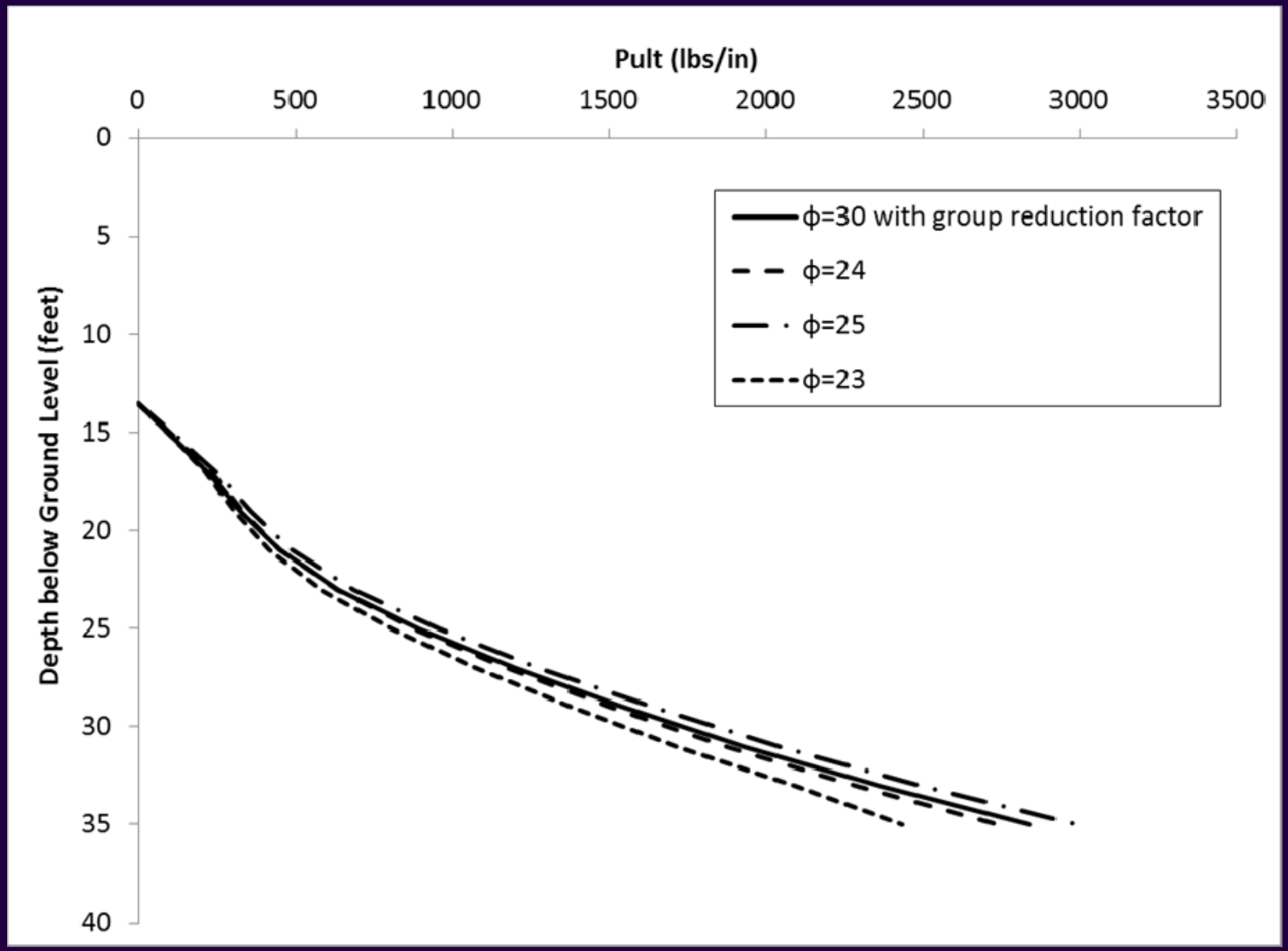
Group Reduction Factors (after TxDOT 2012)



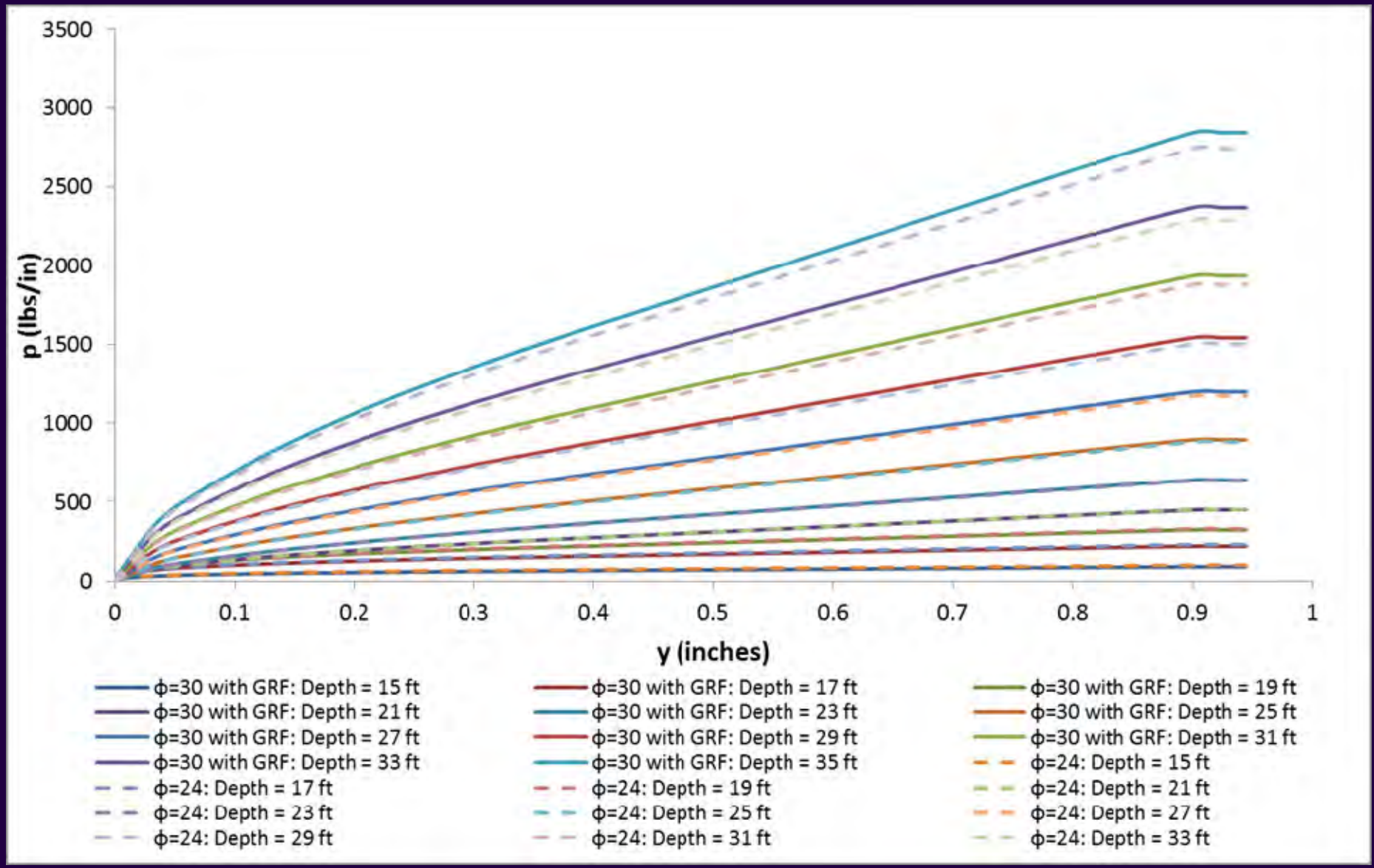
Effect of Reduction Factors



Application of Group Reduction Factors



Application of Group Reduction Factors

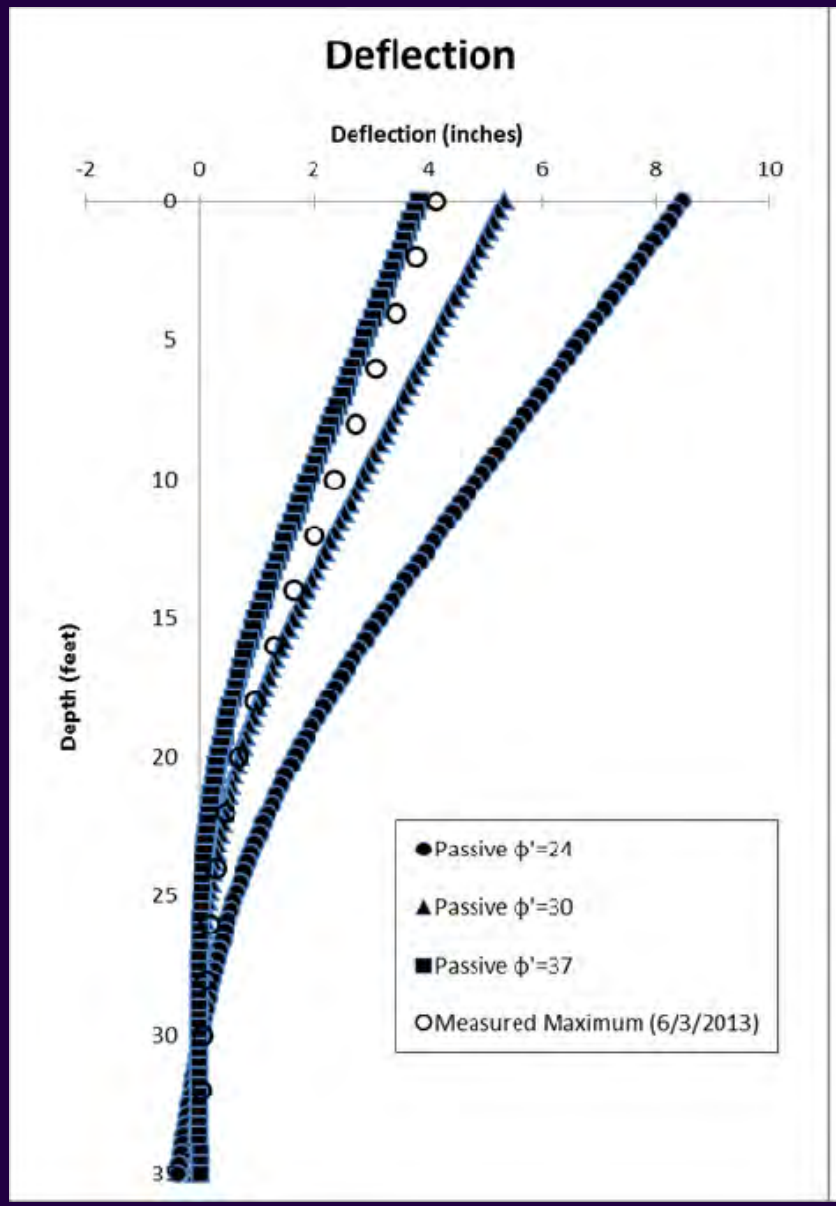


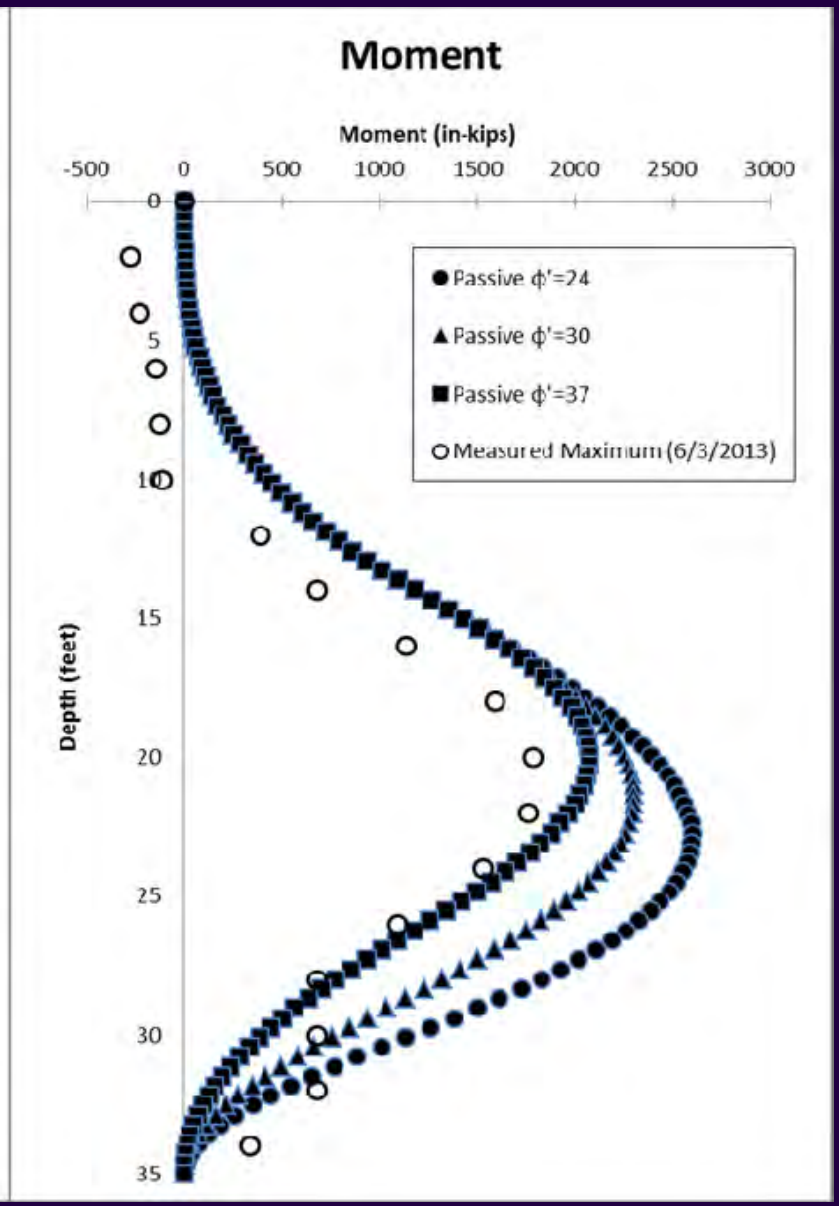
LPILE Analysis

Baseline Assumptions & Design Parameters for LPILE Analysis

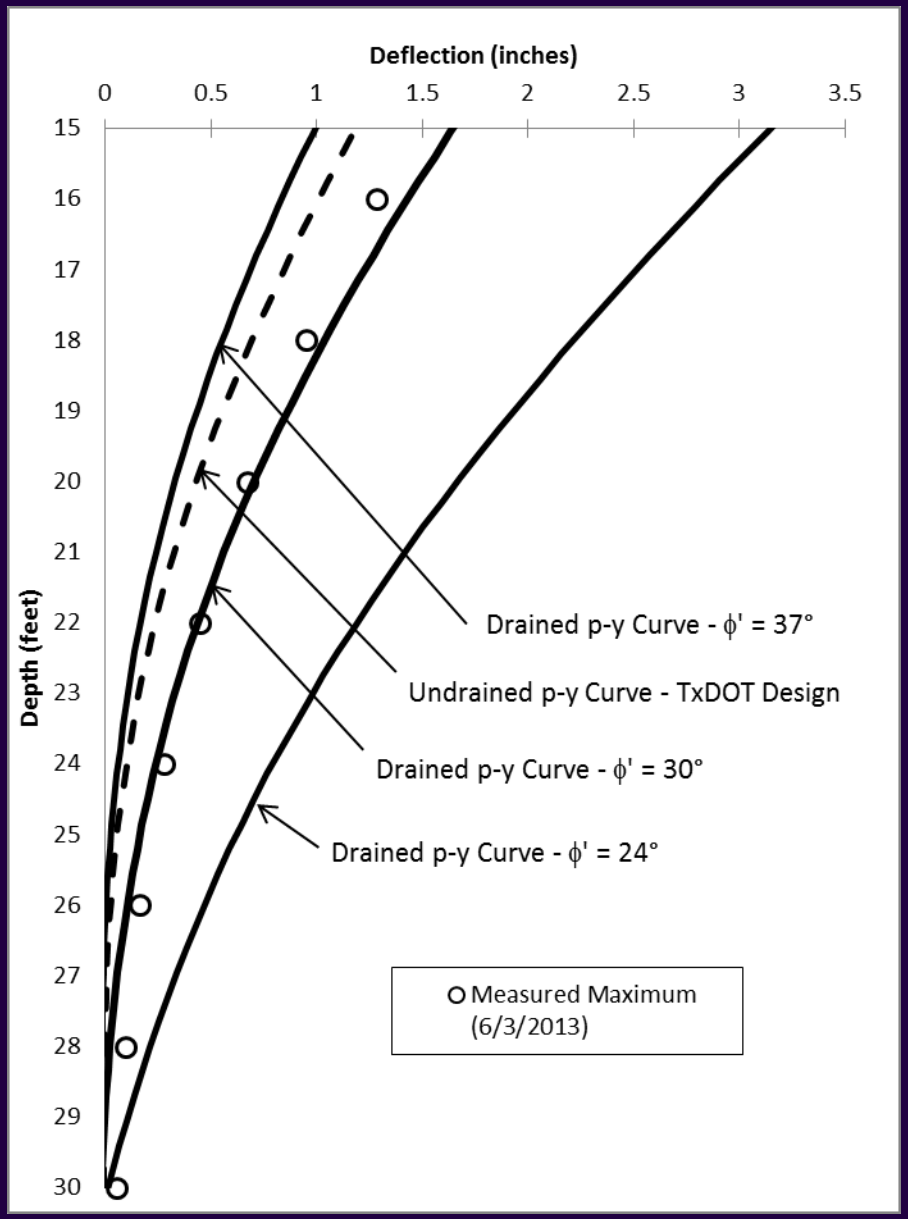
Parameter	Value
Effective Unit Weight of Soil, γ'	62.6 pcf
Earth Pressure Loading Above Excavation	Fully Softened (ϕ = 24) + Hydrostatic
Friction Angle of Foundation Soil	24, 30, and 37 degrees
Foundation Soil p-y Curves	Sand (Reese)
Non-Default Initial Stiffness, k_{py}	375 lb/in^3
Cracking Moment, M_{Cr}	680 k-in.
Yielding Moment, M_y	3,200 k-in.
Uncracked Bending Stiffness, EI_{uc}	67 x 10^6 k-in^2
Cracked Bending Stiffness, EI_{cr}	18 x 10^6 k-in^2
Shaft Diameter	24 in.
Height of Retained Soil, H	162 in.
Reinforcement	12 #7 bars (1.6% of gross area)

Calculated versus Measure Response

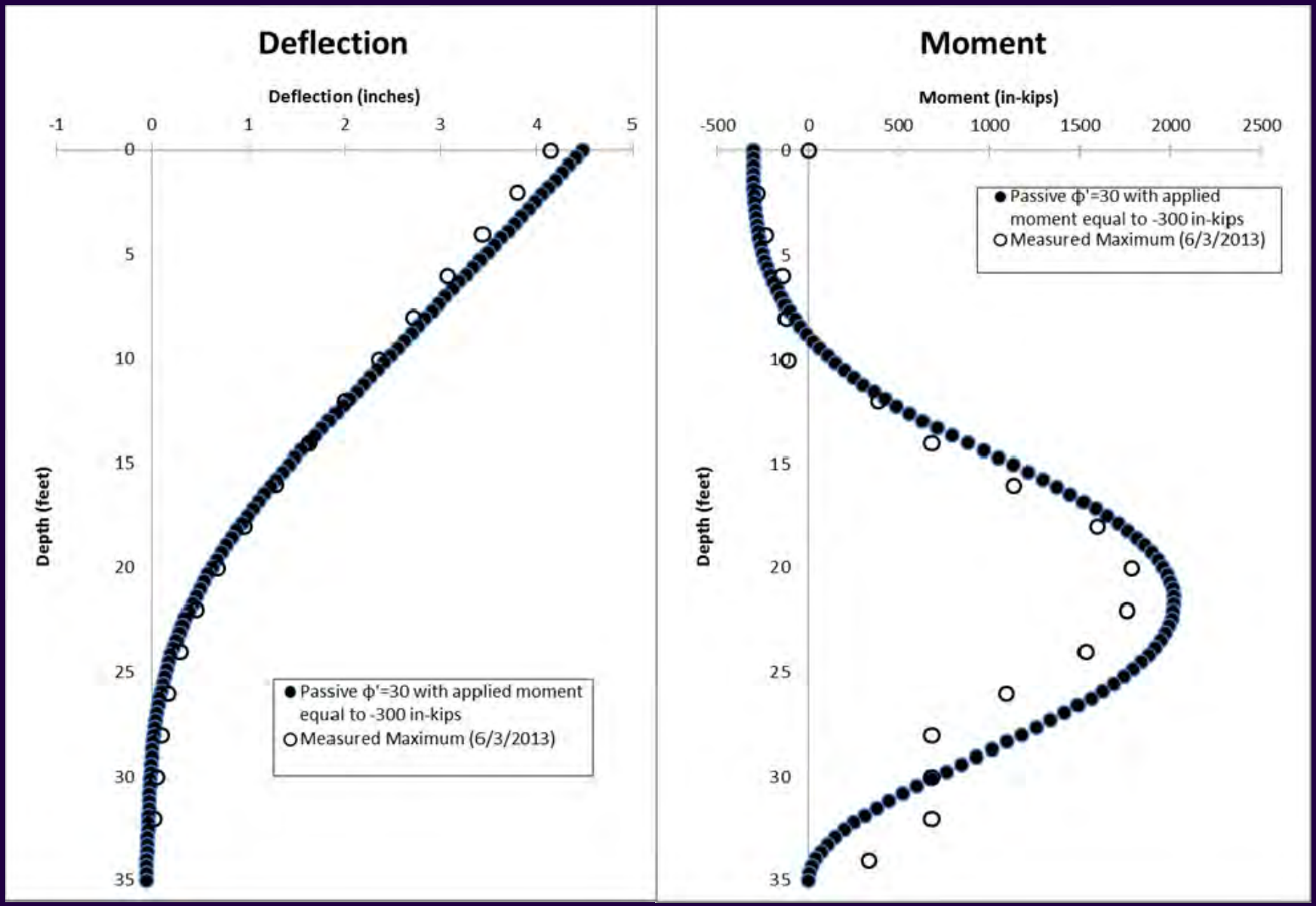




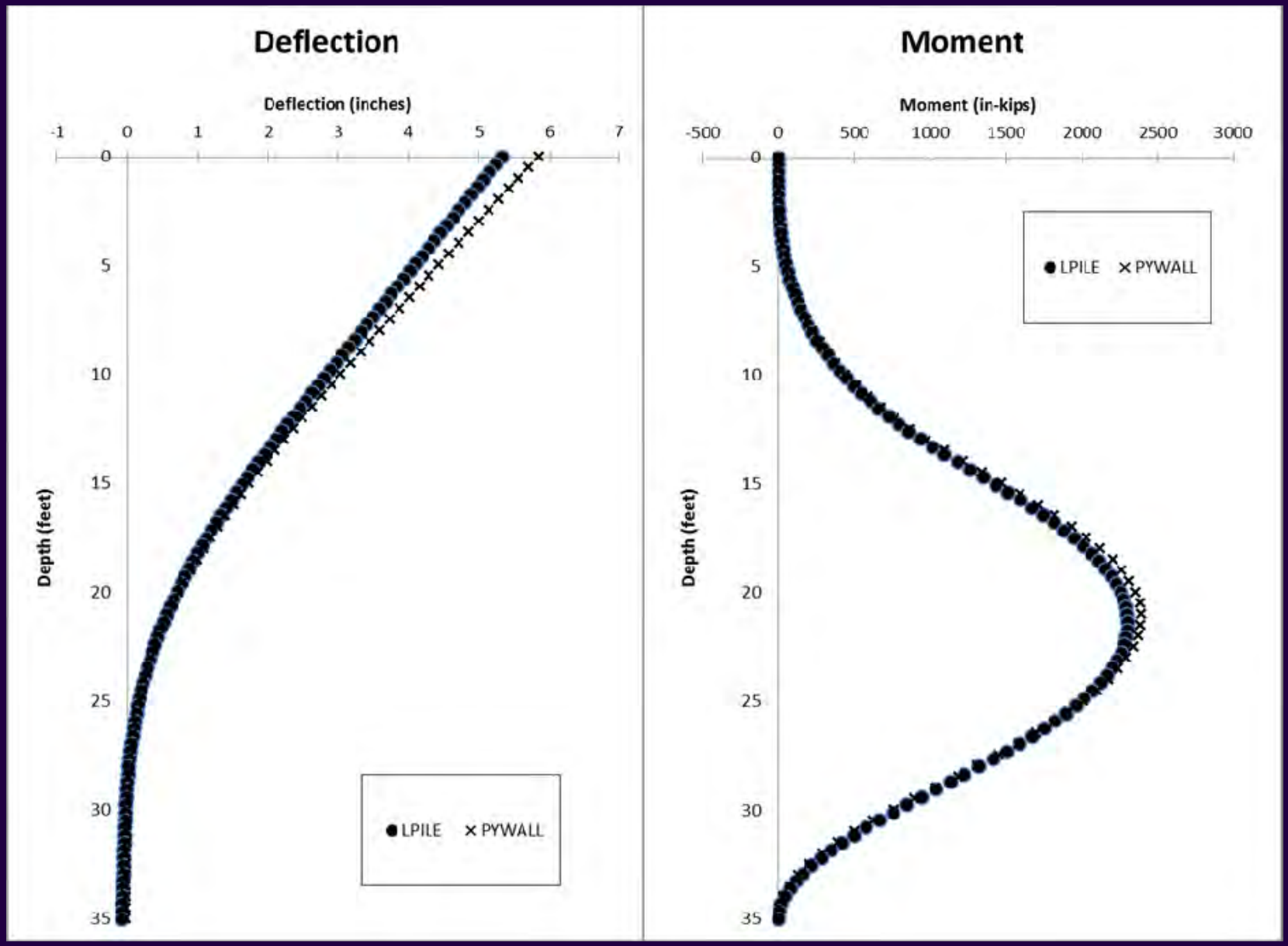
Calculated versus Measure Response



Calculated versus Measure Response (thermal "moment" applied at top)



PYWALL vs. LPILE



Design Examples

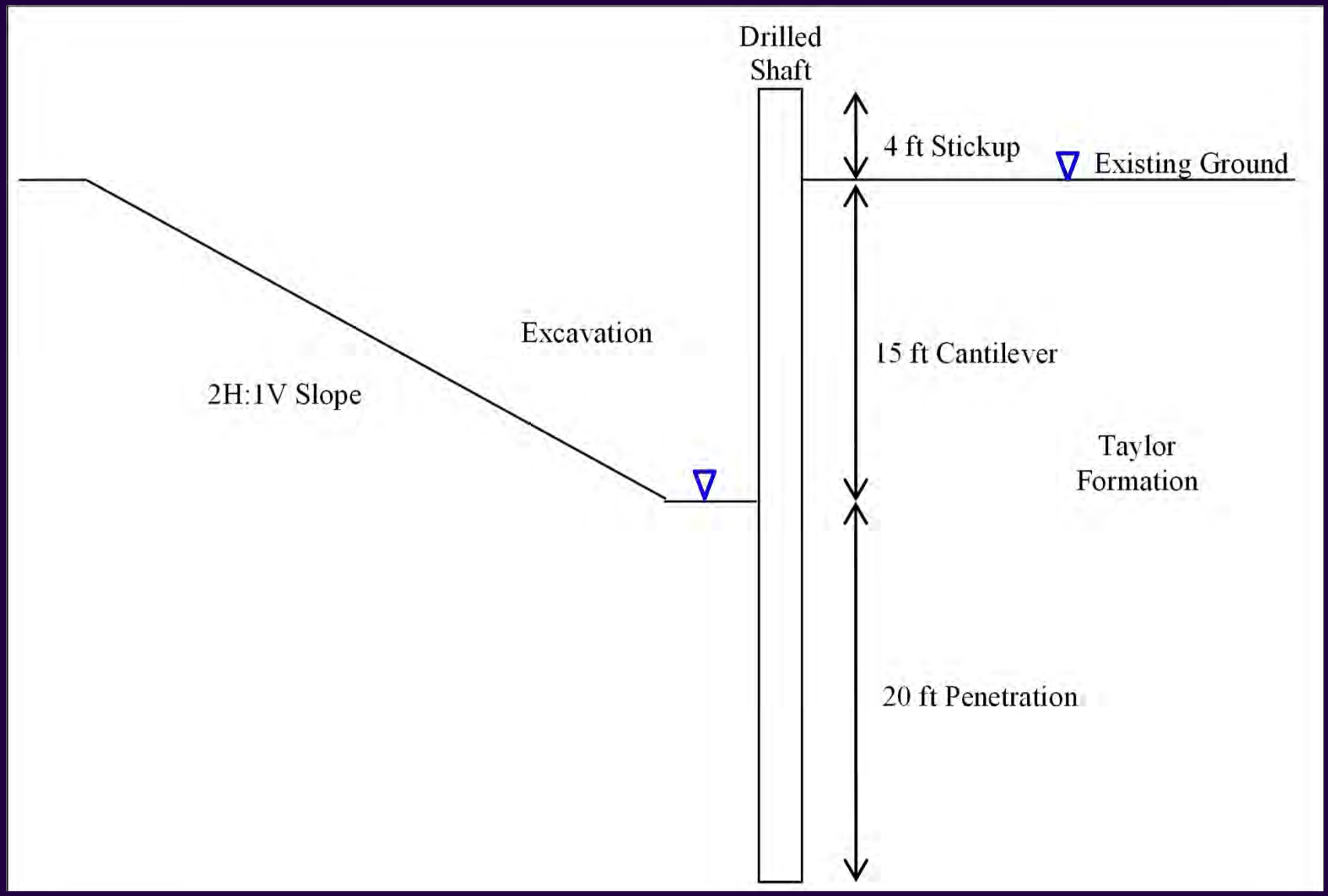
Manor Test Wall

&

US59 & Hazard St Wall

Manor Wall Redesign Example

Manor Wall


Drilled
Shaft
4 ft Stickup
Existing Ground
Excavation
2H:1V Slope
15 ft Cantilever
Taylor
Formation
20 ft Penetration

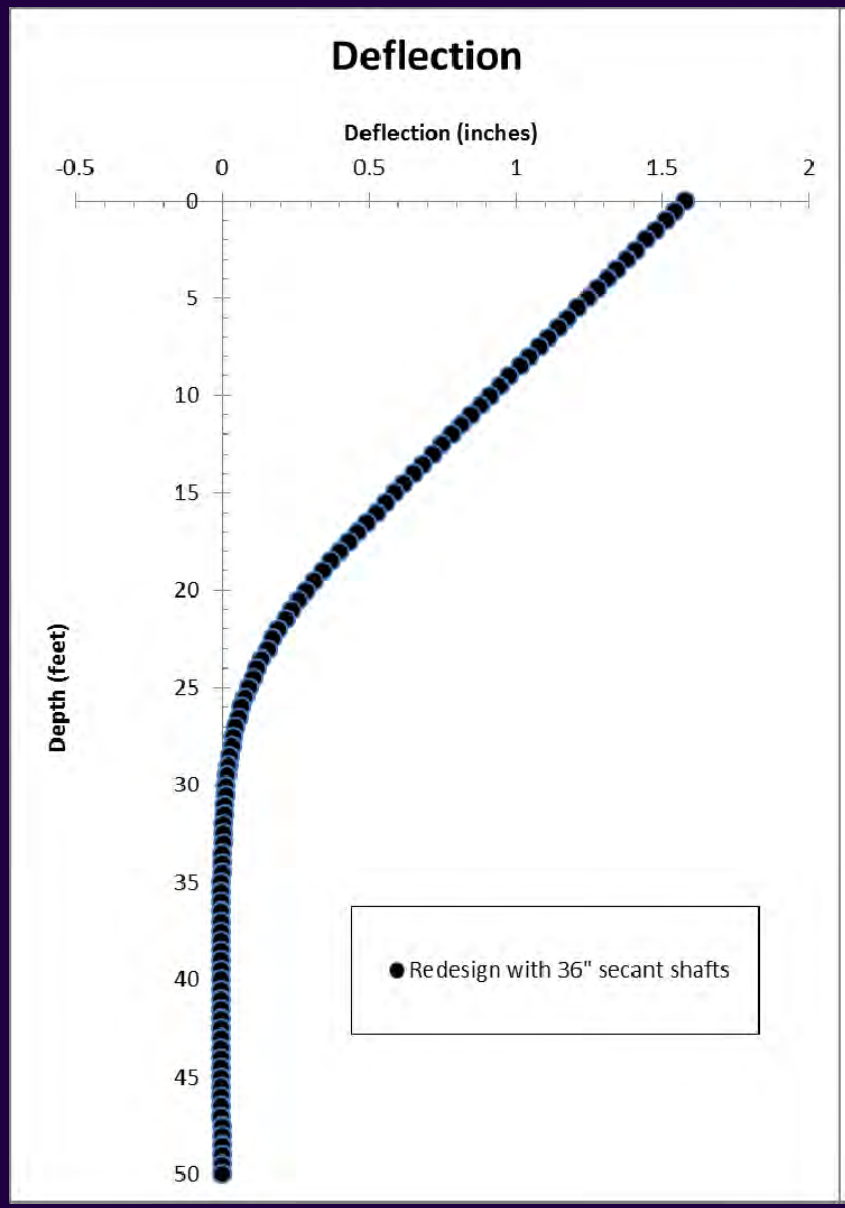
Design Parameters

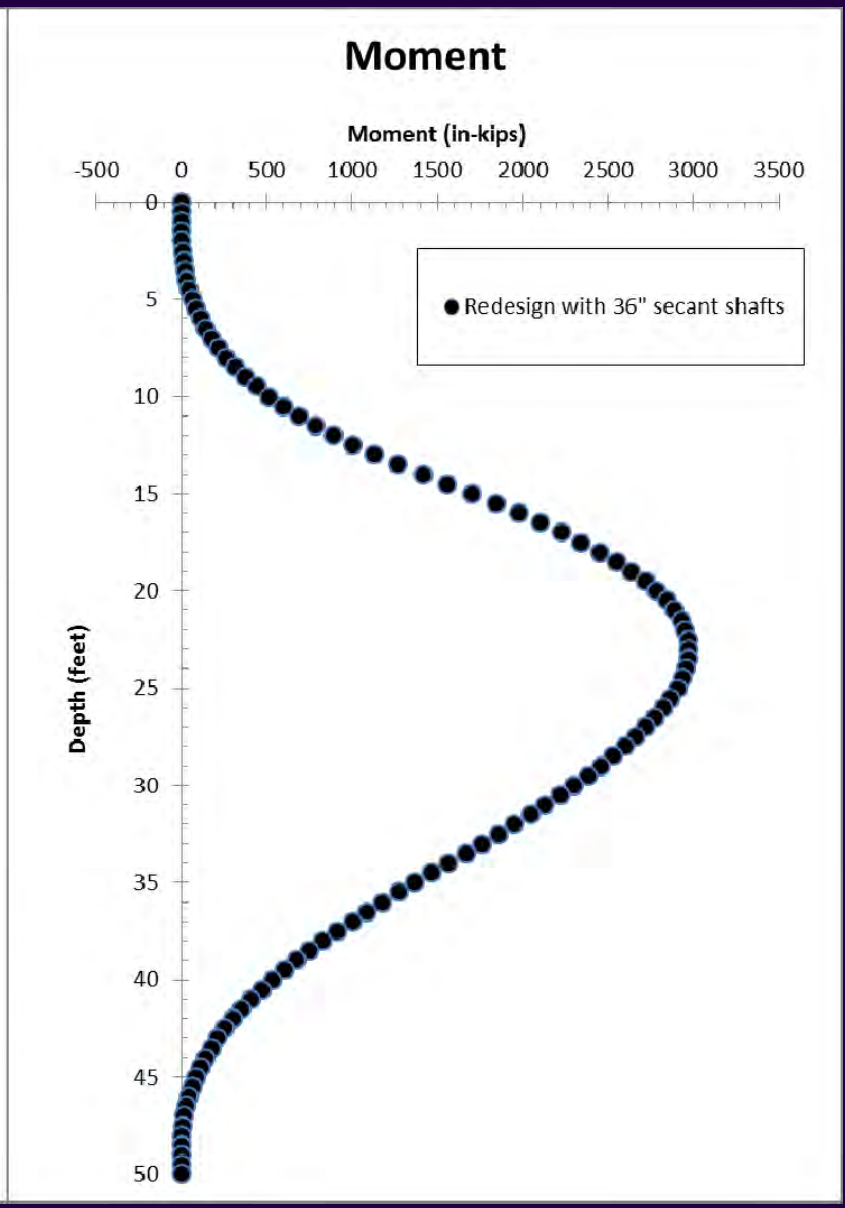
- Wall height = 13.5 feet
- Effective unit weight = 62.6 pcf
- Active loading: fully softened shear strength, $\phi'=24^{o}$, with water table at ground surface behind wall
- Passive resistance: drained p-y curves with $\phi'=30^{o}$
- Design check for 0.01H wall deflection

As-built vs. Redesign

- **As-Built (no water table behind wall)**
  - **24” shafts with 6” clear spacing**
  - **Shaft length = 35’**
  - **12 #7 rebar**
- **Redesign (highest possible water table)**
  - **36” shafts with 0” clear spacing**
  - **Shaft length = 50’**
  - **12 #9 rebar**

LPILE Analysis for Redesign

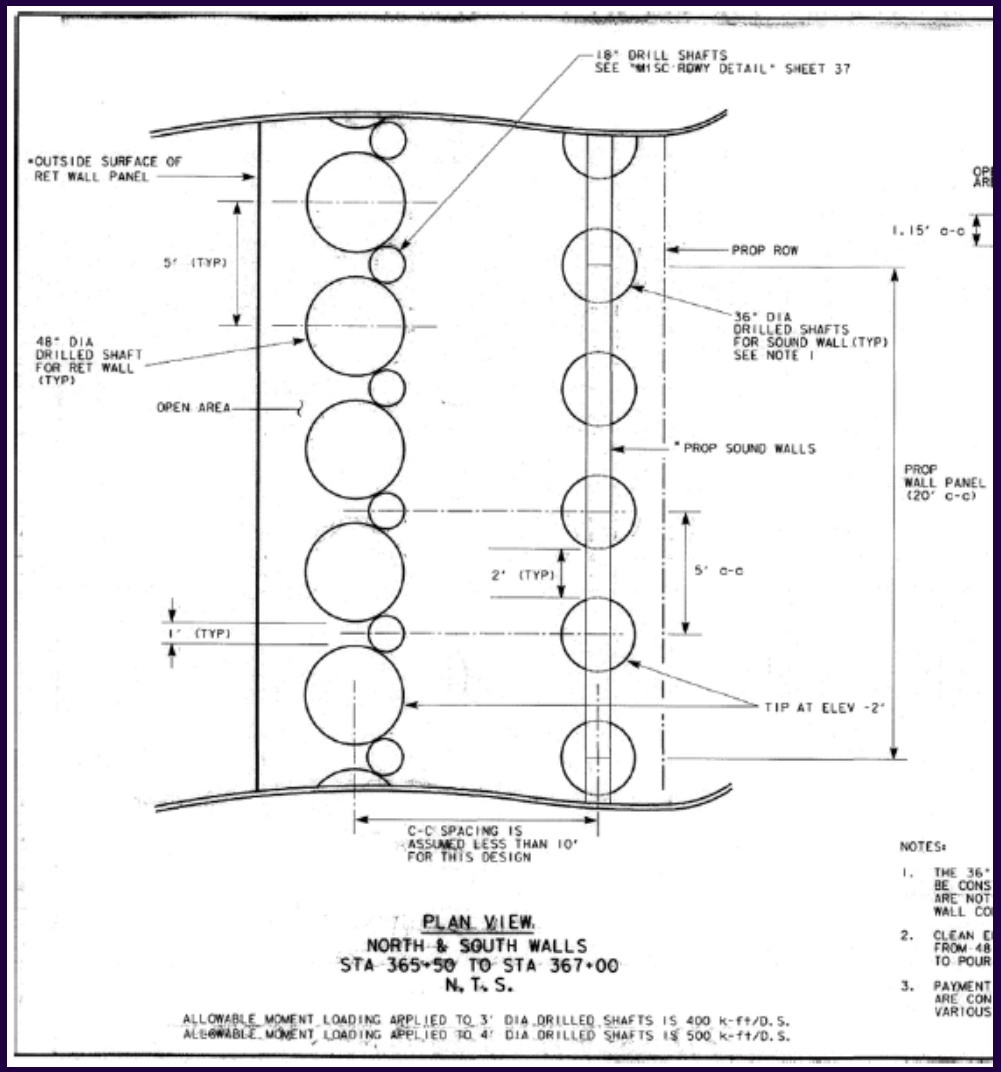




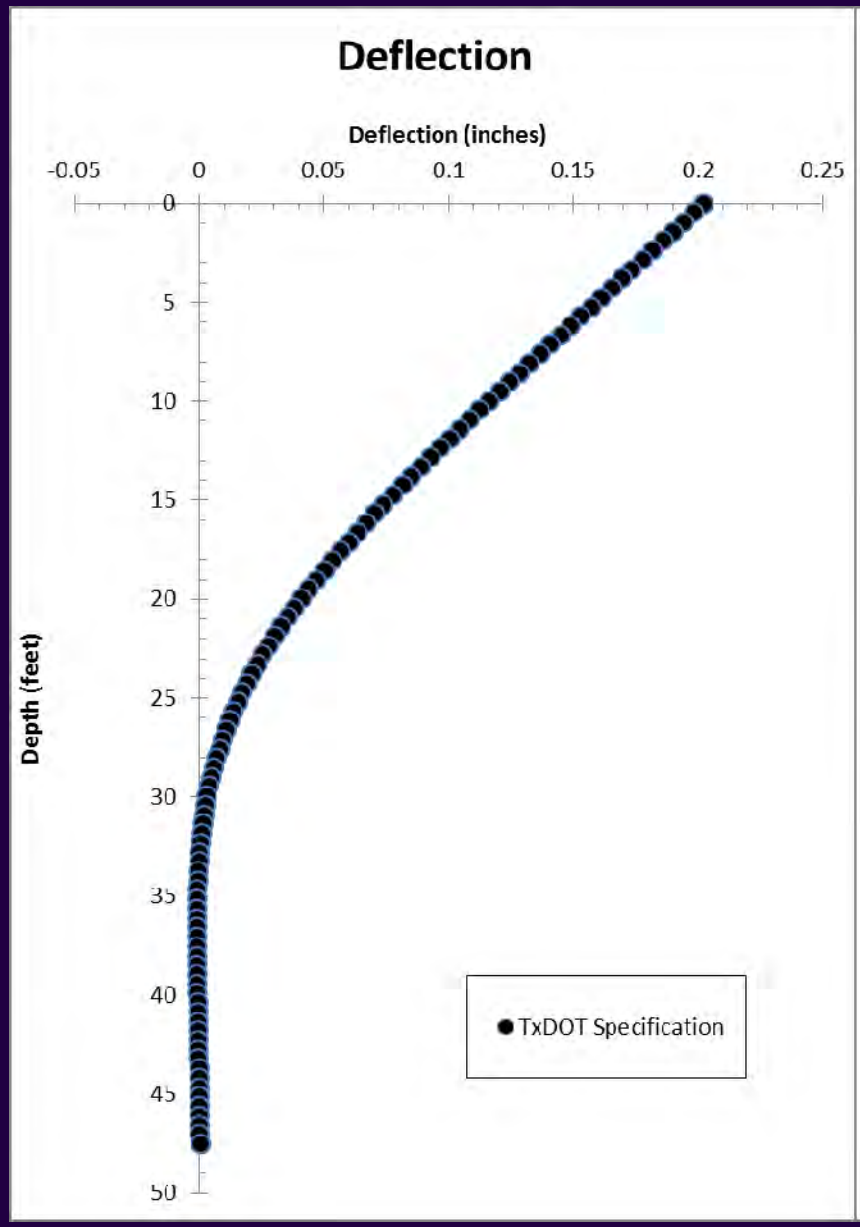
Hazard Street Wall Design

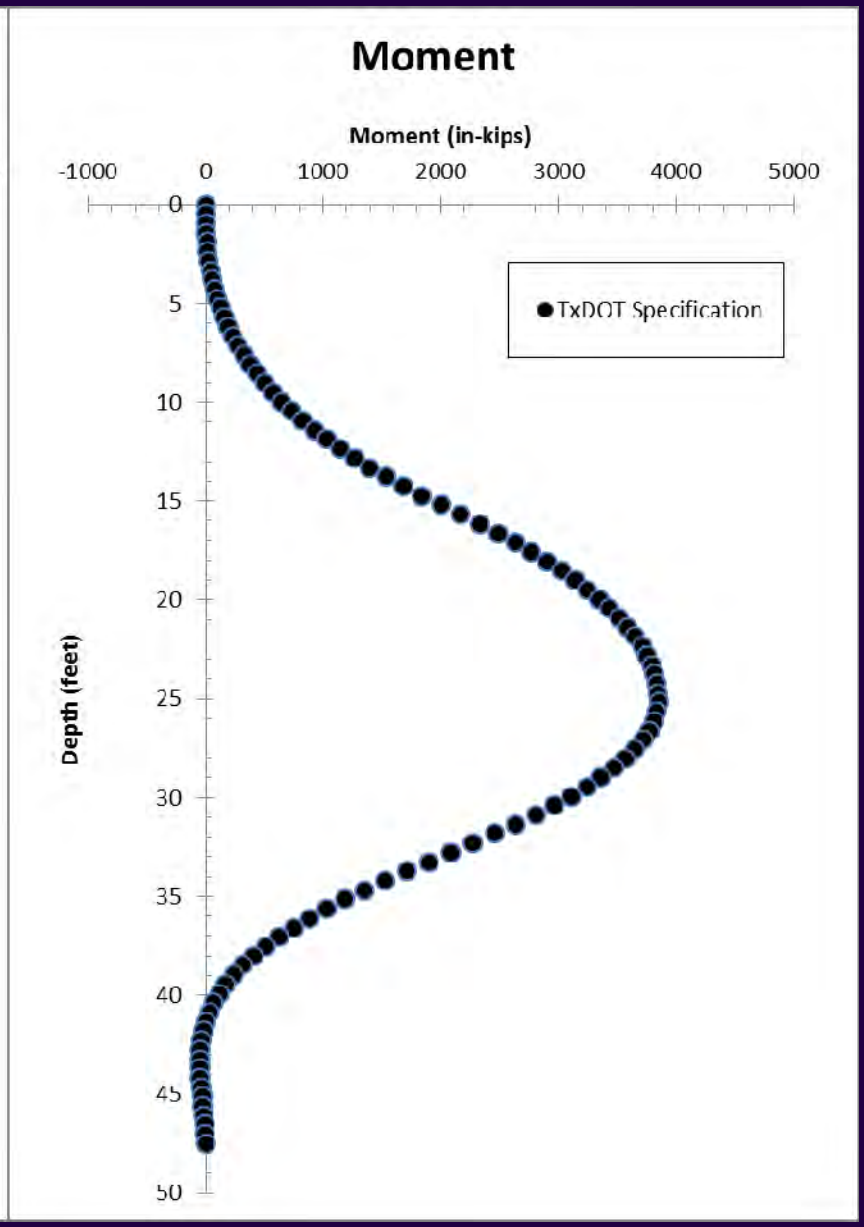
Design Information

- Existing shafts are 48” diameter with 18” secant shafts
- 15’ wall height
- 47.5’ shaft length
- Average PI ≈ 40
- Average Su≈ 3000 psf
- Average γ_T=125 pcf



Current TxDOT Design Practice

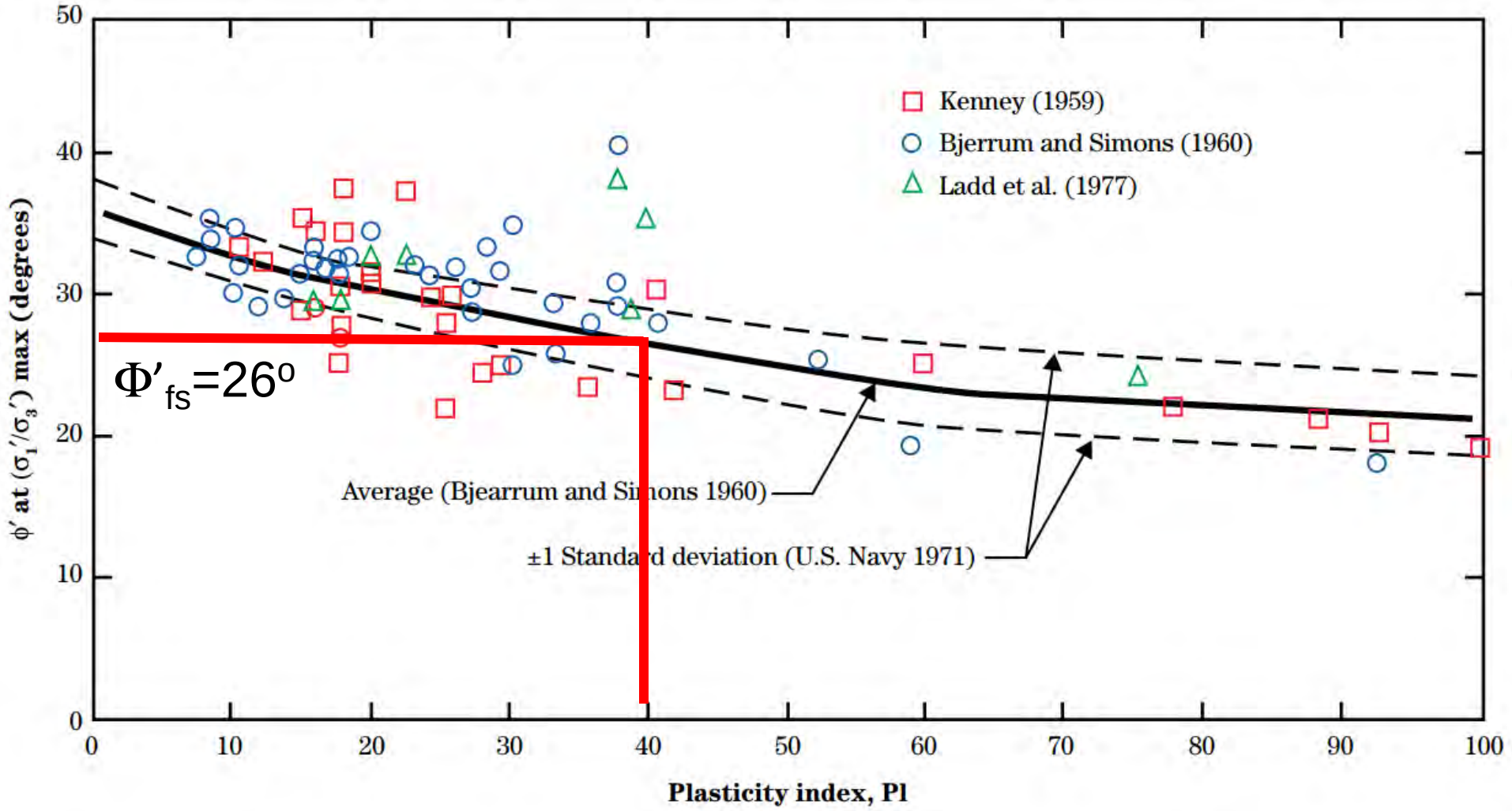




Active Loading

- **Scenario #1**
  - **2 feet of Surcharge**
  - **Φ'_{fs}= 26 degrees**
  - **High Water Table (Depth = 0 feet)**
- **Scenario #2**
  - **2 feet of Surcharge**
  - **Φ'_{fs}= 26 degrees**
  - **Natural Water Table (Depth= 8 feet)**
- **Scenario #3**
  - **2 feet of surcharge**
  - **Φ'_{fs}= 26 degrees**
  - **No Water**

Fully Softened Shear Strength

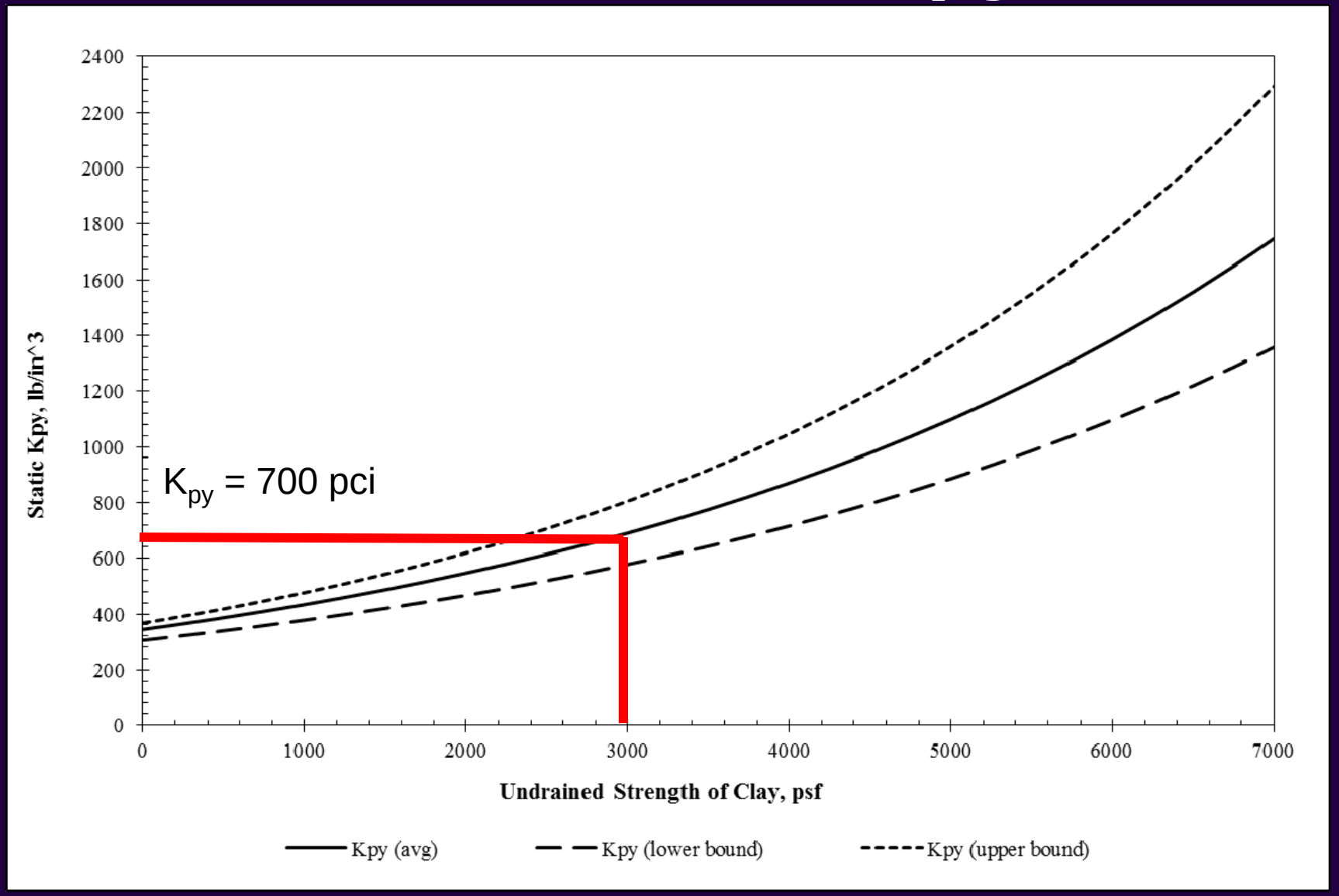


Passive Resistance

- Sand p-y curves
- K_{py} = 700 pci
- Group Reduction Factor = 0.62
- Neglect 1’ secant shafts
- Water table surface at depth of excavation

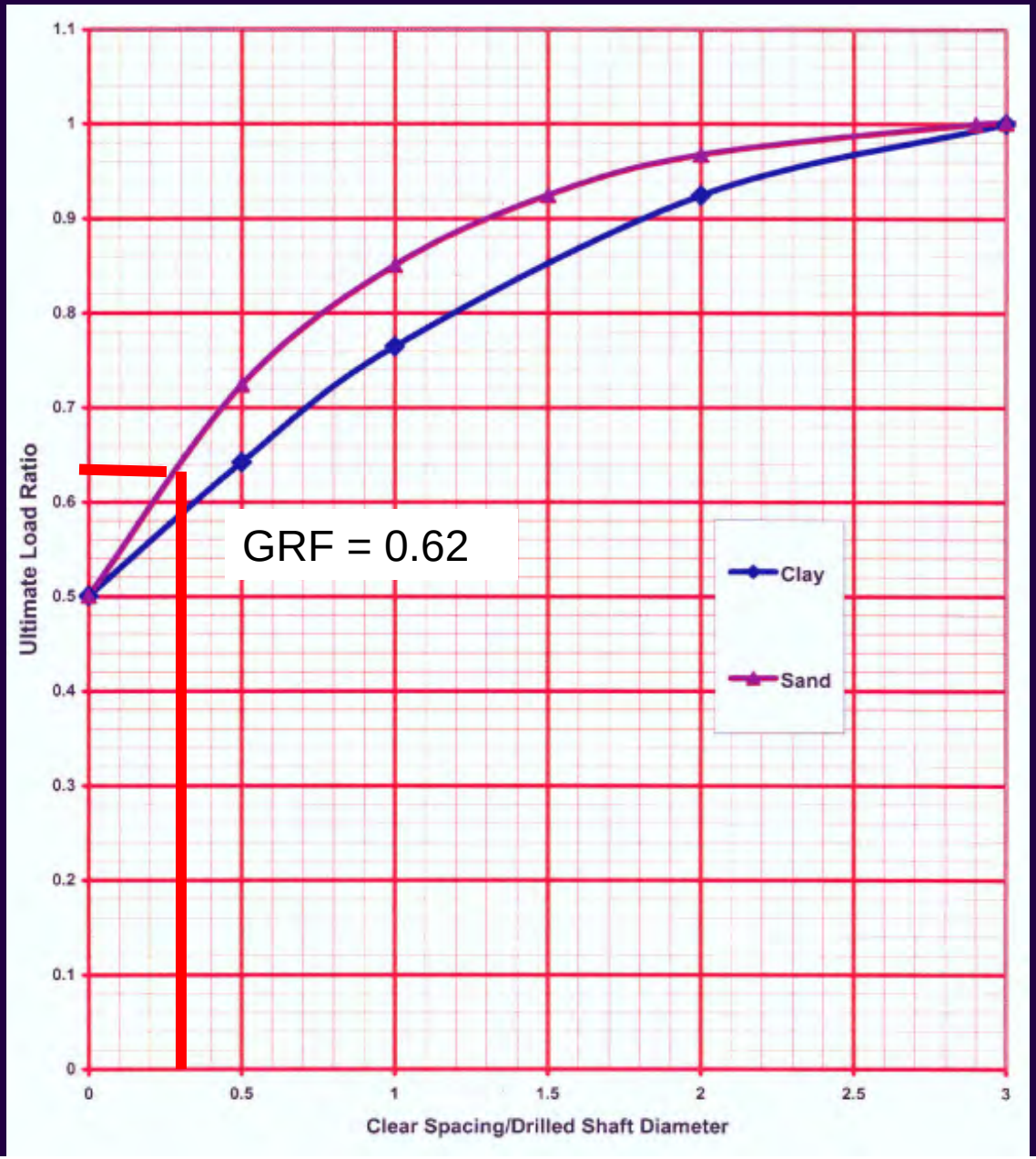
- Scenario #1
  - Foundation Φ’ = 26 degrees
- Scenario #2
  - Foundation Φ’= 30 degrees

Selection of Kpy

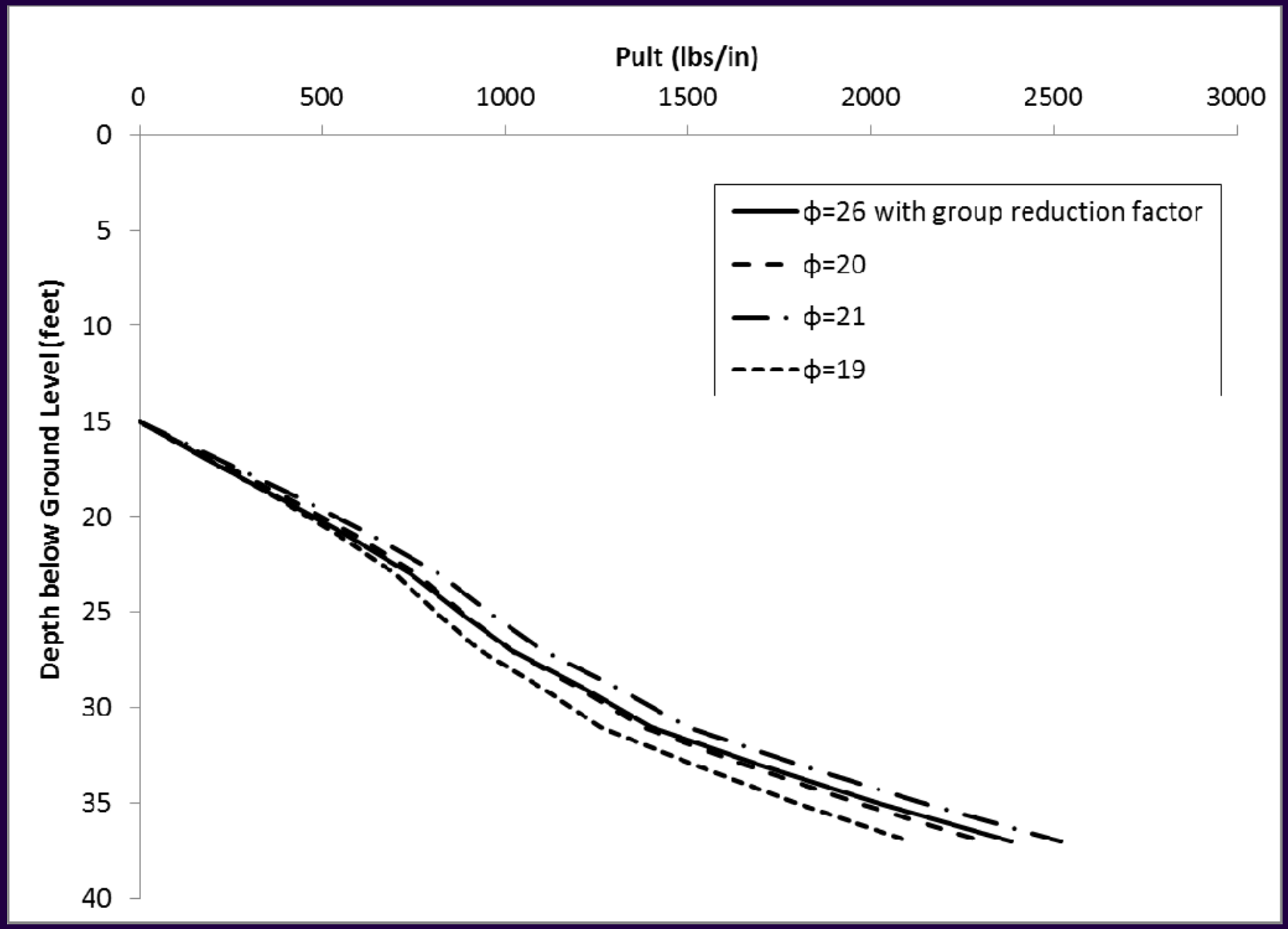


Curves fit to data from Table 14.1, Reese et al. (2006)

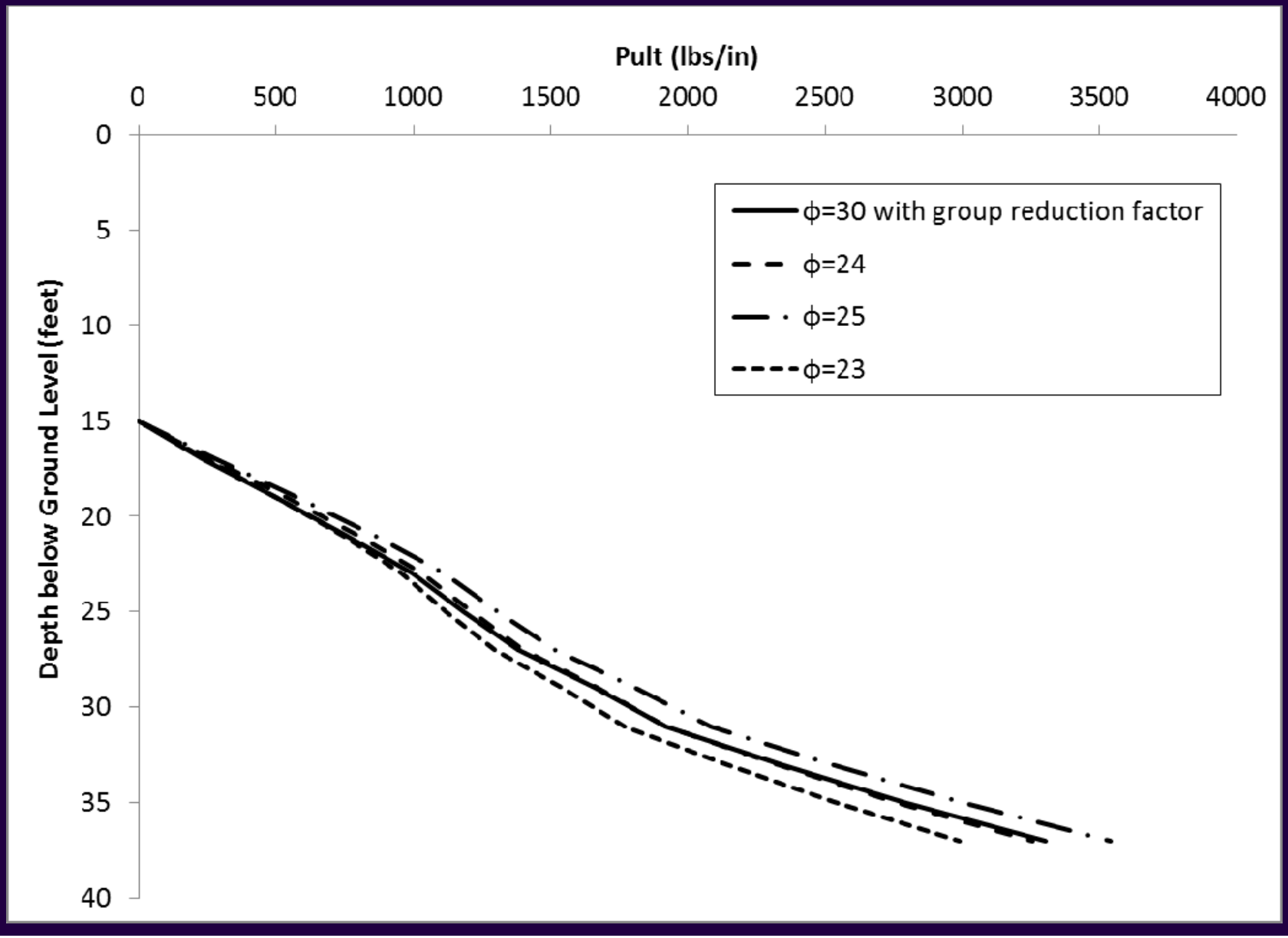
Group Reduction Factor (after TxDOT 2012)



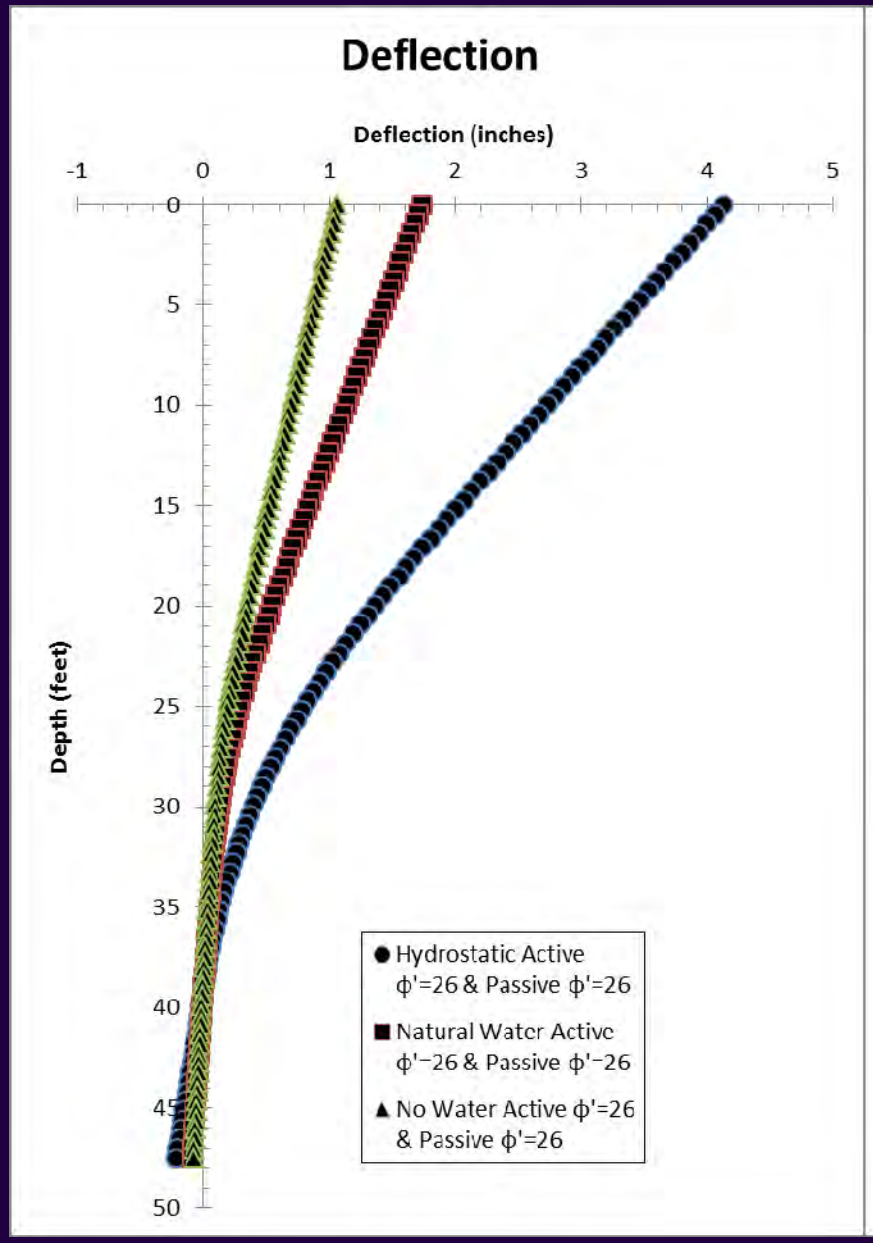
Applying Group Reduction Factor

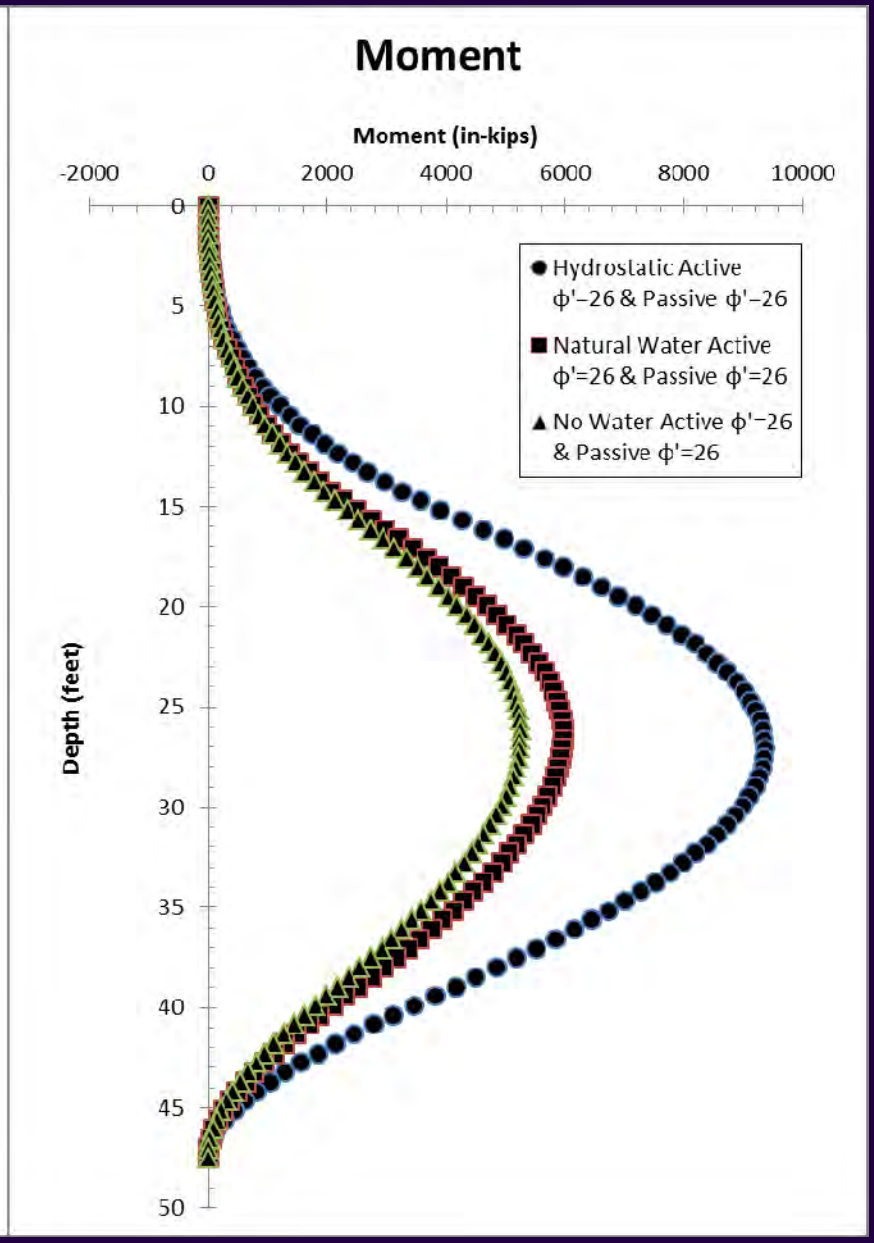


Applying Group Reduction Factor

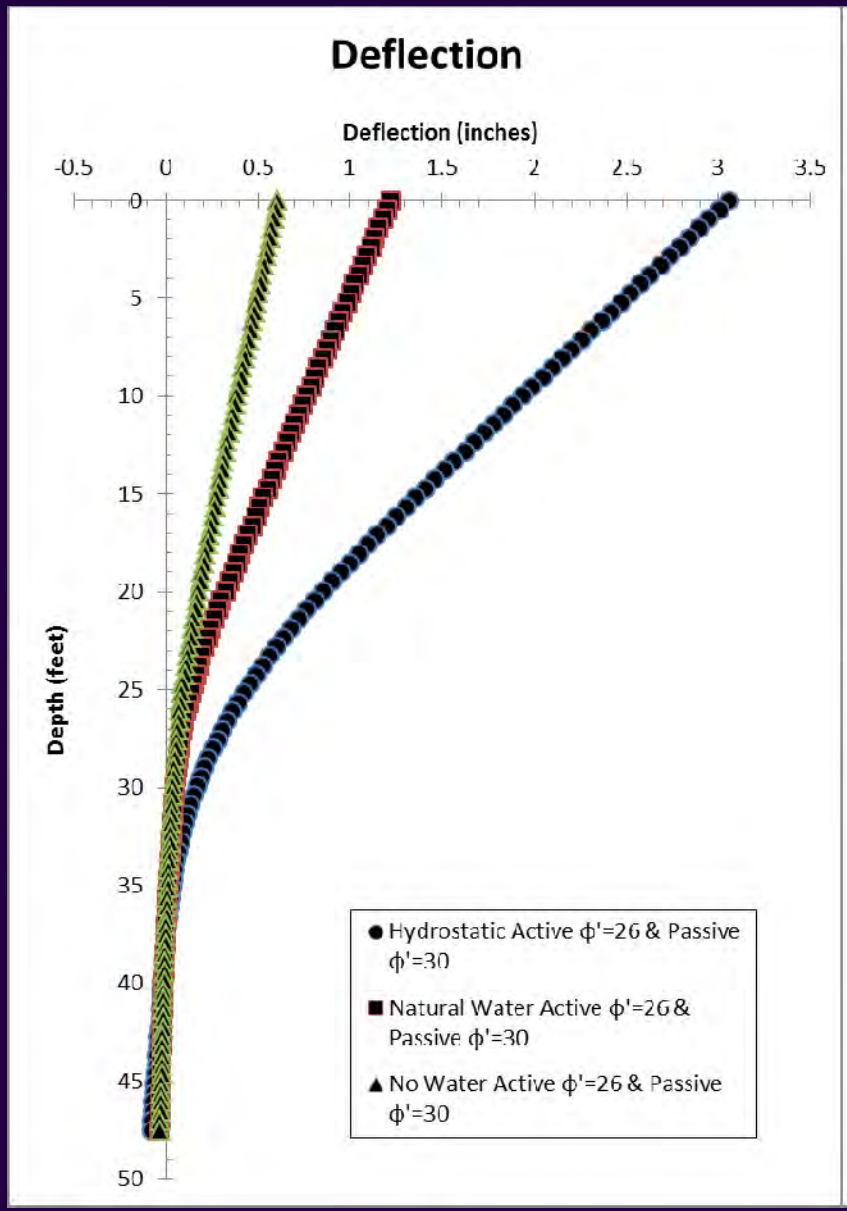


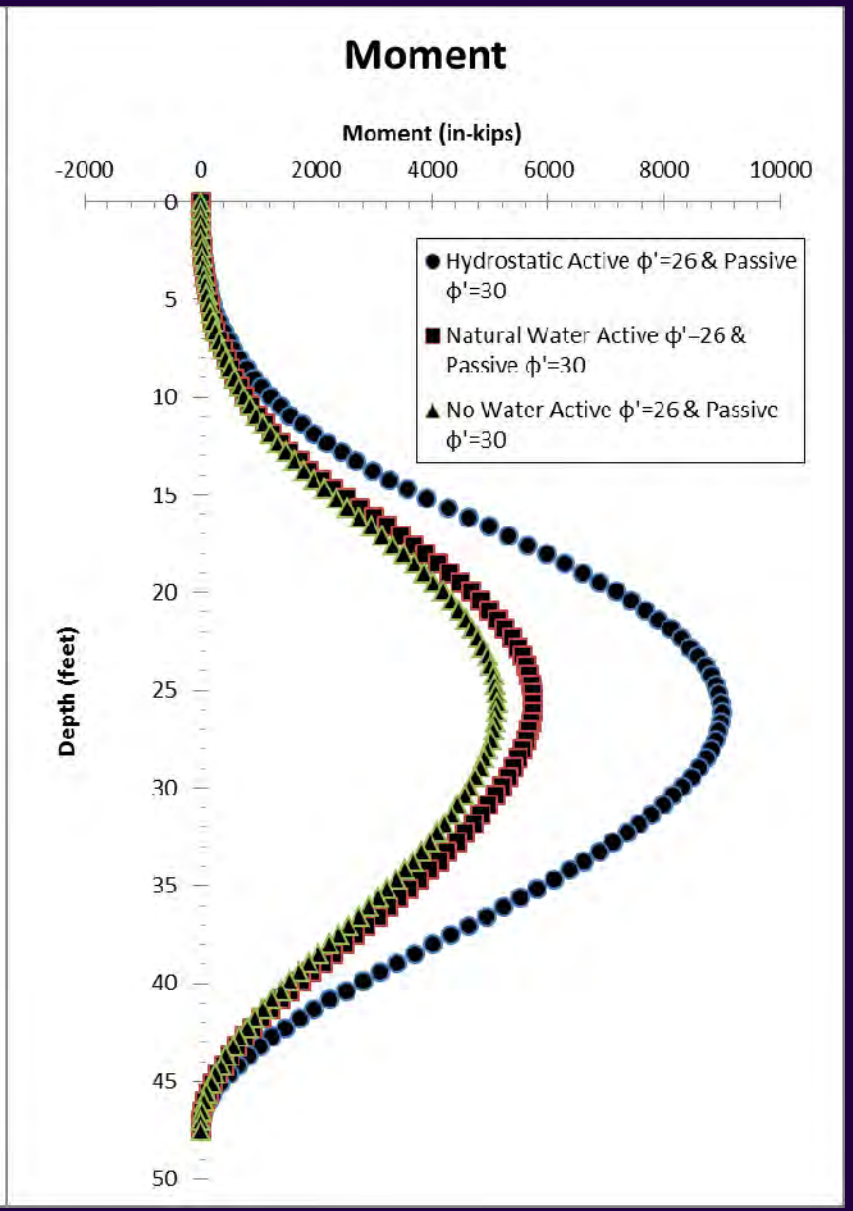
Existing Wall with Passive ϕ'=26°





Existing Wall with Passive ϕ'=30°

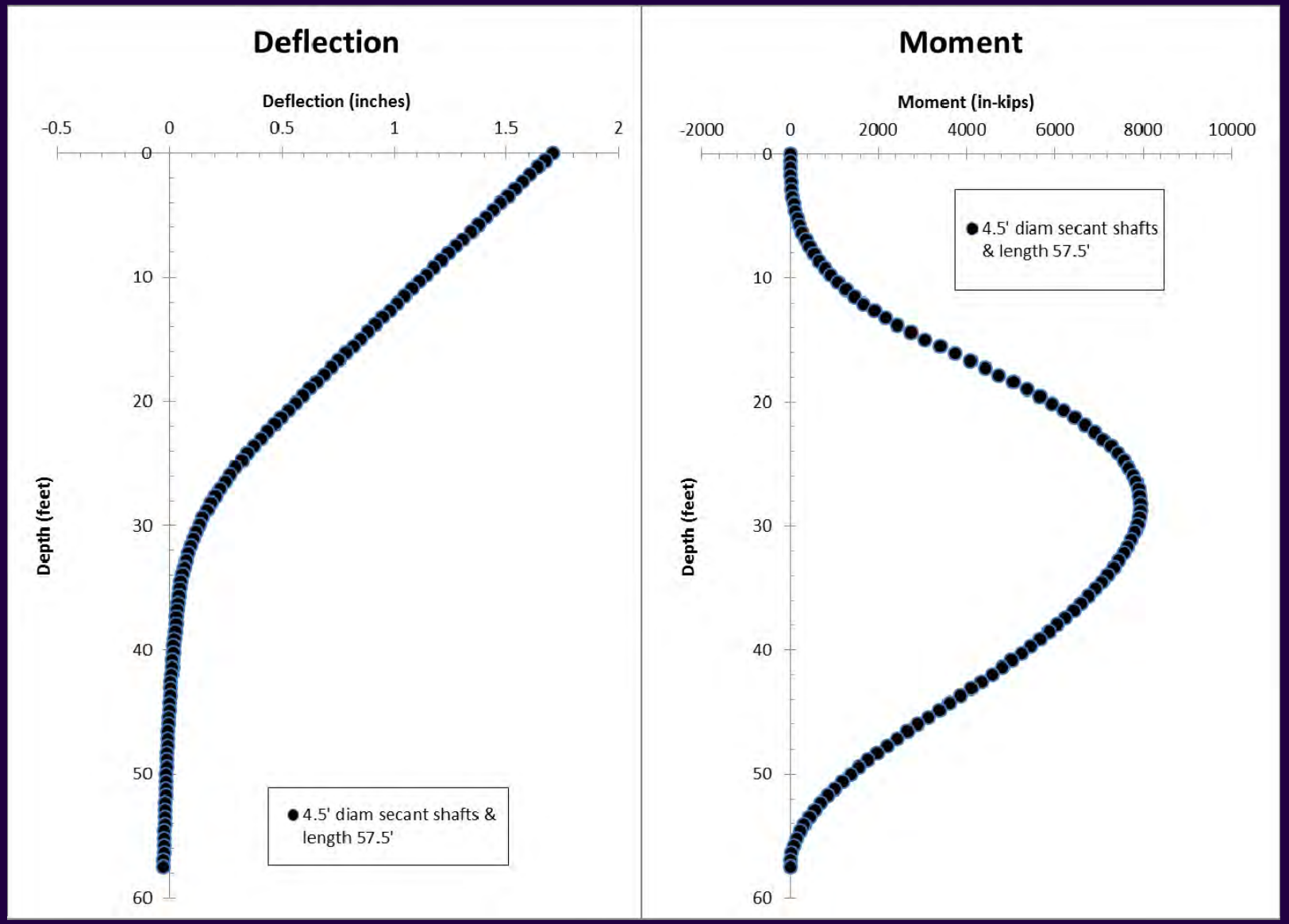




Re-Design of Hazard Street Wall for Different Water Tables

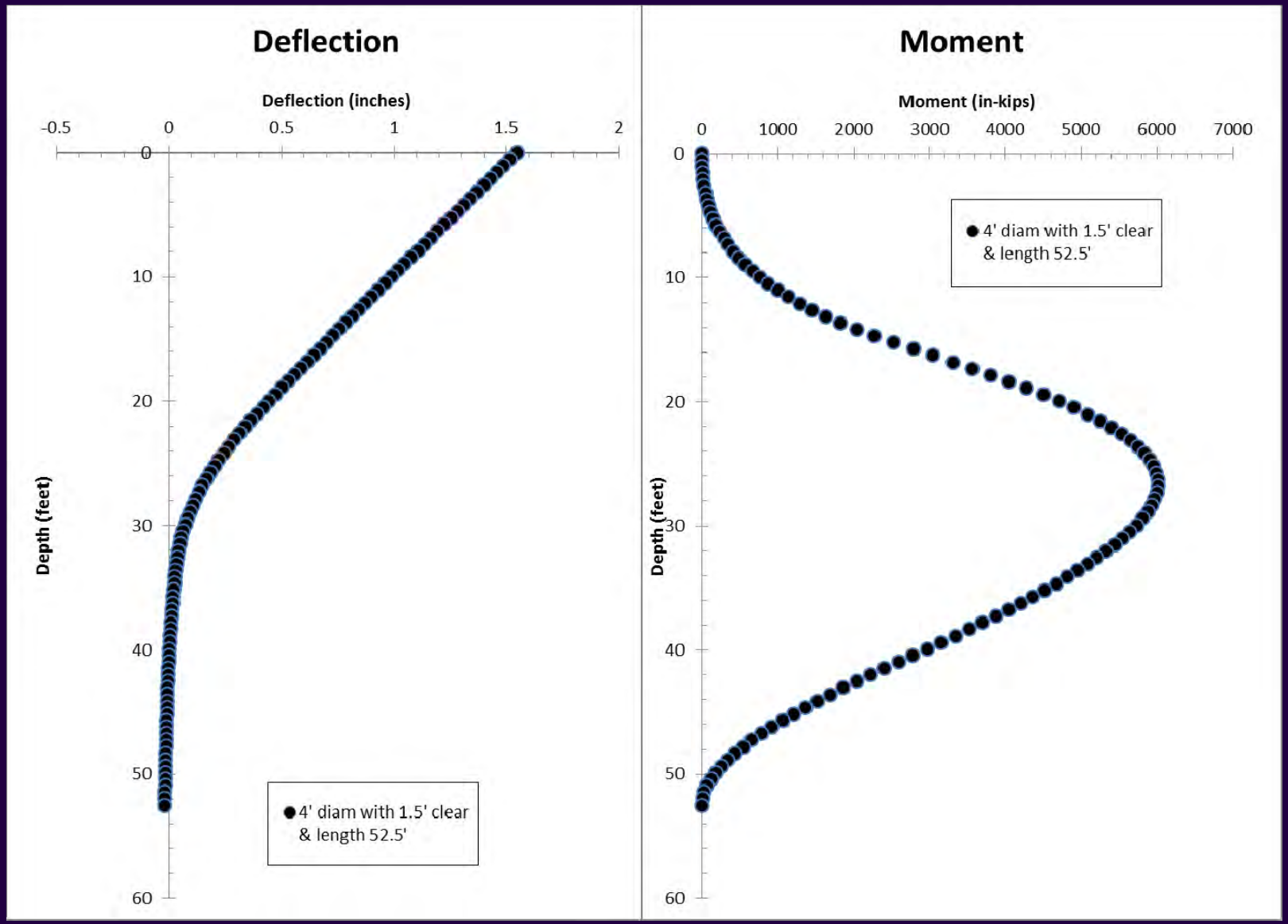
High Water Table with Passive ϕ'=26º

4.5' diameter secant shafts & shaft length of 57.5'



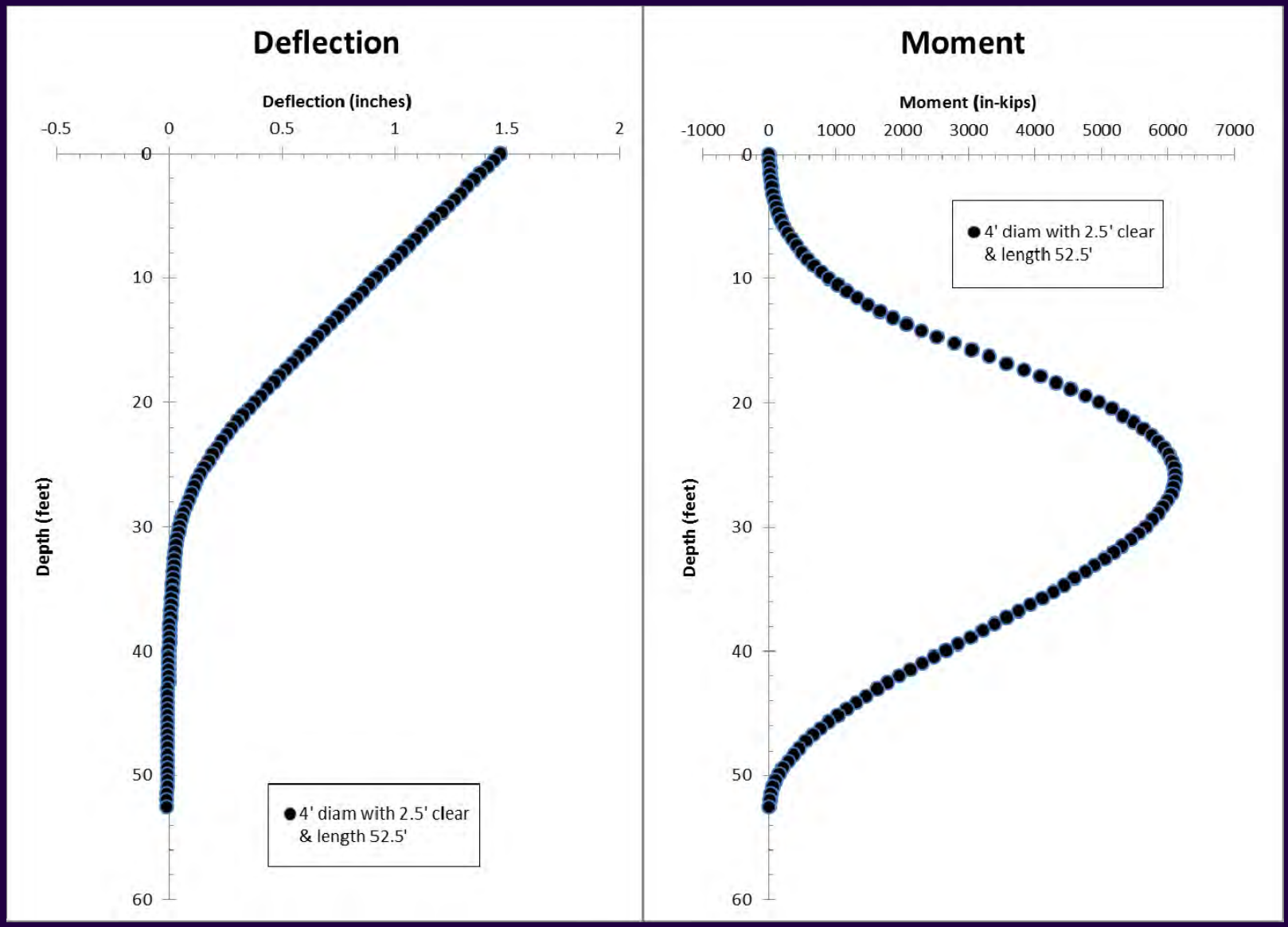
Natural Water Table with Passive ϕ'=26º

4' diameter shafts with 1.5' clear & shaft length of 52.5'



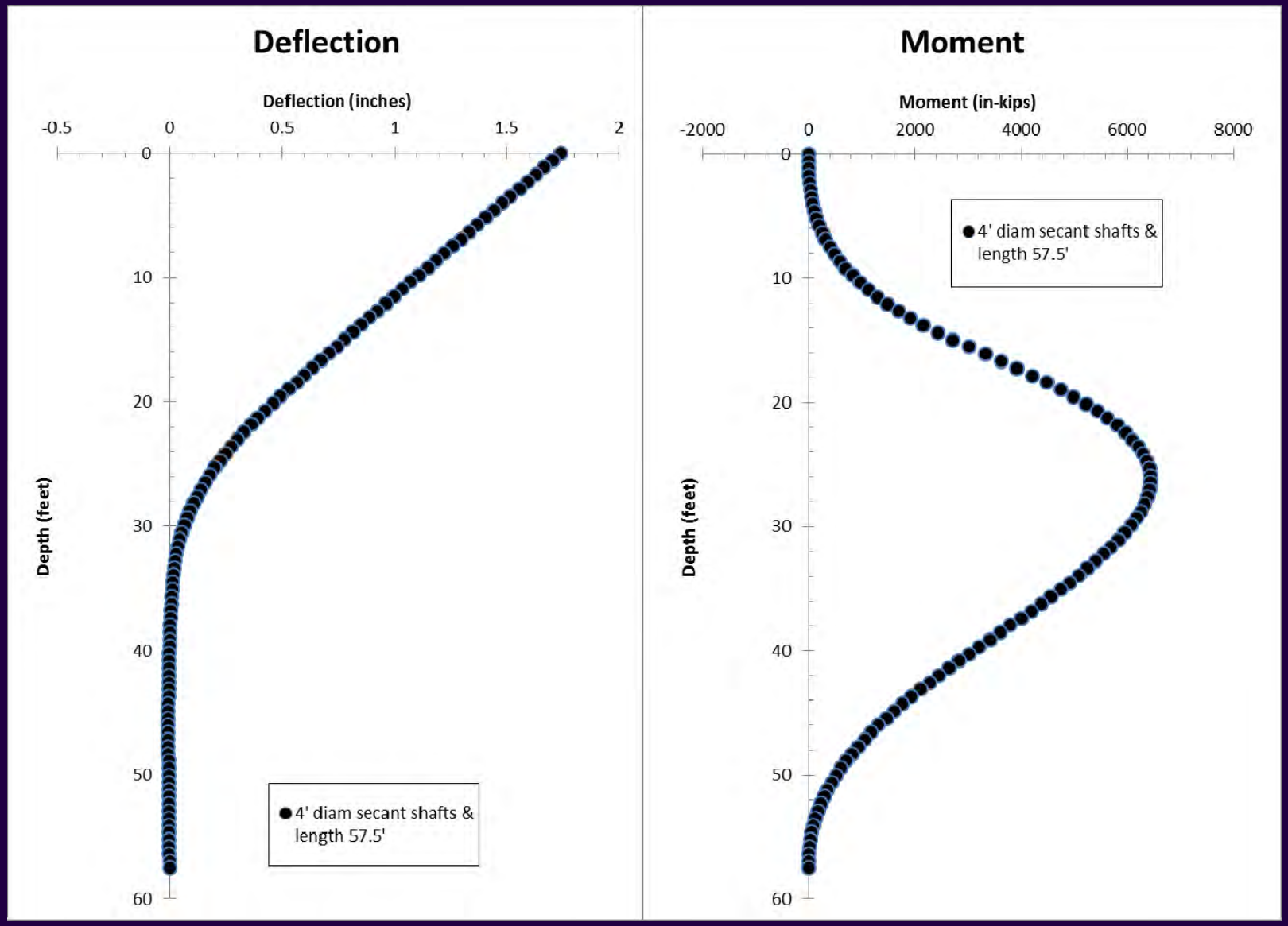
No Water with Passive ϕ'=26º

4' diameter shafts with 2.5' clear & shaft length of 52.5'



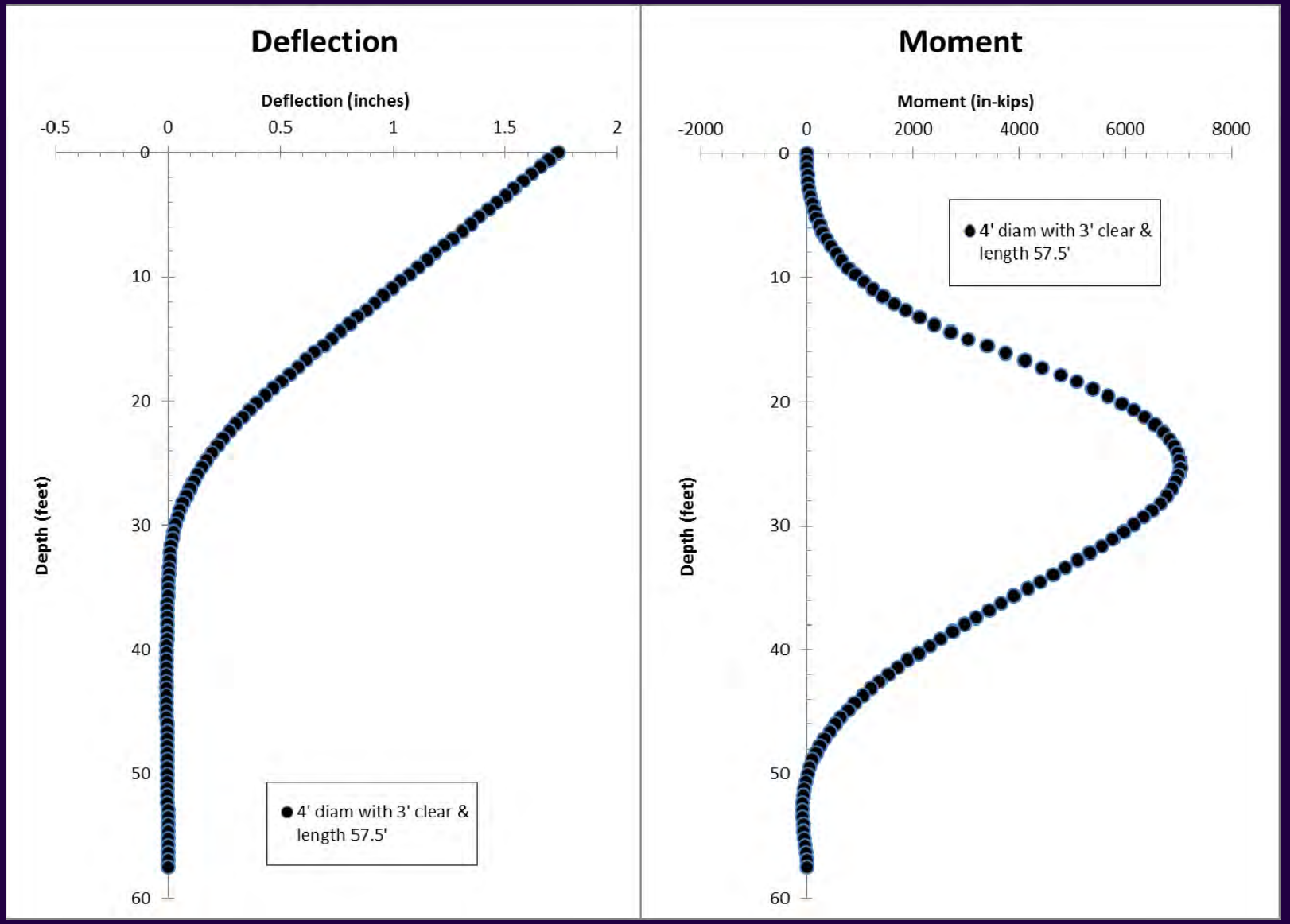
High Water Table with Passive ϕ'=30º

4' diameter secant shafts & shaft length of 57.5'



Natural Water Table with Passive ϕ'=30º

4' diameter shafts with 3' clear & shaft length of 57.5'



No Water with Passive ϕ'=30º

4' diameter shafts with 4' clear & shaft length of 47.5'