

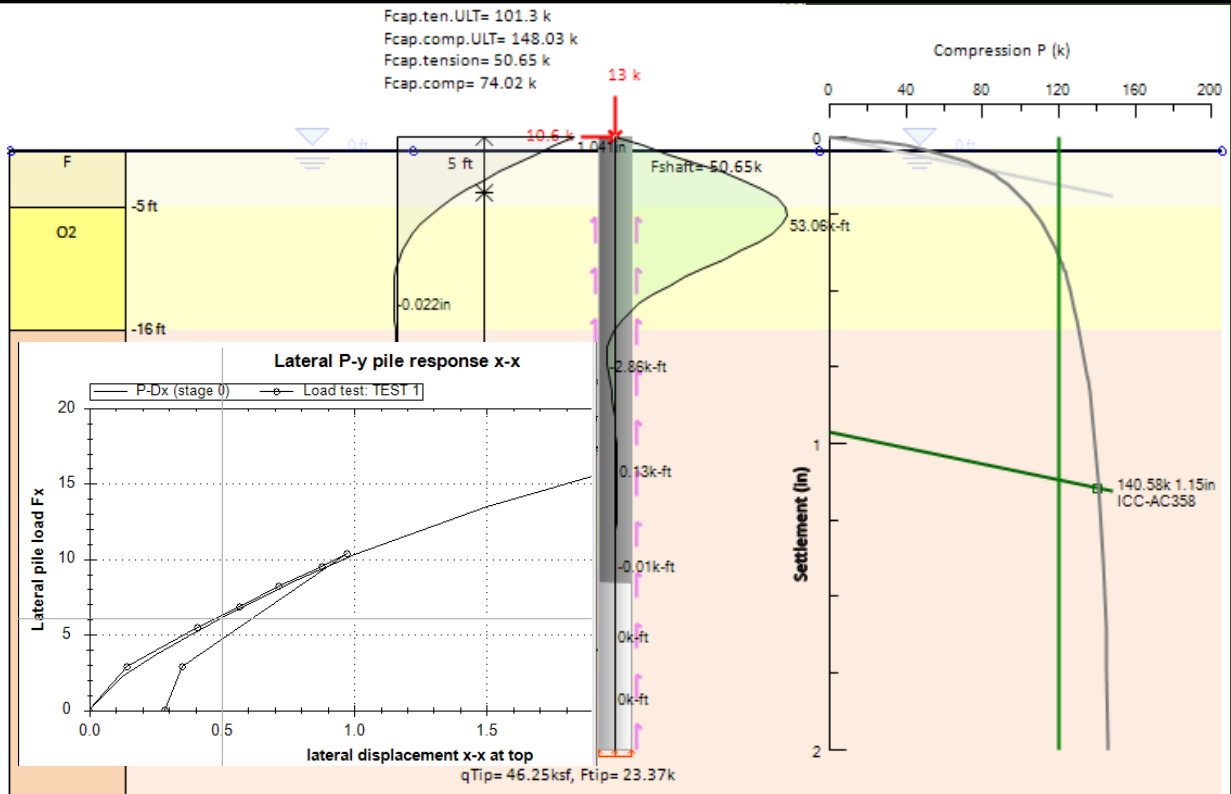


# DEEP EXCAVATION

GEOTECHNICAL SOFTWARE & ENGINEERING

## Lateral Load Tests in DeepFND and HelixPile

### Lateral Load Test Records – Lateral Soil Parameters Calibration



**DeepFND**  
Foundation Piles  
Design Software



**HelixPile**  
Helical Piles  
Design Software

Document Version: 1.0.2.3

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## INTRODUCTION: DEEPFND – FOUNDATION PILES DESIGN SOFTWARE HELIXPILE – HELICAL PILES DESIGN SOFTWARE

DeepFND and HelixPile are two similar, powerful software programs for the design and evaluation pile foundations. The programs can perform structural and geotechnical, lateral, and axial analysis of any foundation pile (single piles, pile groups and pile rafts).

The only difference between the two programs is the available pile types. DeepFND can design all pile sections and pile types (helical and non-helical – drilled, driven, caissons, micropiles, CFA piles and more), whereas HelixPile can design only helical piles.

**Available Helical Pile Types (Both Programs):** Steel pipes, Square solid and square hollow piles with unlimited helical plate configurations.

**Available Non-Helical Pile Types (DeepFND Only):** Circular, rectangular, circular Hollow, Octagon, Reinforced Concrete Piles, Steel Beams (Pipes, H Beams, Rectangular Hollow Sections, Channel Sections), Composite Sections, Belled Bottom Piles, Timber Piles (Wood) and more.

**Pile Installation Methods:** Helical Piles, Drilled, Driven, Caissons, Micropiles, Continuous Flight Auger (CFA Piles), Drilled-In-Displacement Piles.

**Analysis Methods:** Vesic 1974, Meyerhoff/Hansen, Eurocode 7, Spangler/Handy, Brinch/Hansen and more.

**Bearing Capacity Equations:** General and Helicap Equations (Helical Piles), FHWA GEC8 (CFA Piles), GEC10 (Drilled Piles), AASHTO-Norlund (Driven Piles) and more.

**Lateral Pile Methods and PY Soil Models:** Exact lateral loads or pushover analysis. Implemented PY Models: API and Reese Models (Sands), Soft and Stiff Models (Clays), Weak Model (Rocks).

**Settlements and Pile Criteria:** Option to perform settlement analysis and calculate structural capacities from pile acceptance criteria (Davisson's, Butler-How, NYC code and more).

**Structural Codes:** ACI, AISC, ASD, LRFD, EUROCODES 2, 3 and 8, AS, CN and more.

**Geotechnical Codes:** AASHTO LRFD, EUROCODE 7, CN, DIN, BSEN and more.

**Printed Reports:** Reports exported in PDF and Word

**Model Creation:** Graphical (interactive interface), model wizard.

### DeepFND Features and Capabilities

DeepFND is a powerful software for the design and analysis of any pile type. Perform Structural and Geotechnical design of any pile (Single Piles, Pile Groups and Pile Rafts), Lateral and Vertical Analysis of piles in a unique software package!

[Click here to review all DeepFND Features and Capabilities](#)

### HelixPile Features and Capabilities

HelixPile is the ultimate program for the design and analysis of Helical Piles. Perform Structural and Geotechnical design of any Helical Pile (Single Piles, Pile Groups and Pile Rafts), Lateral and Vertical Analysis of piles in a unique software package!

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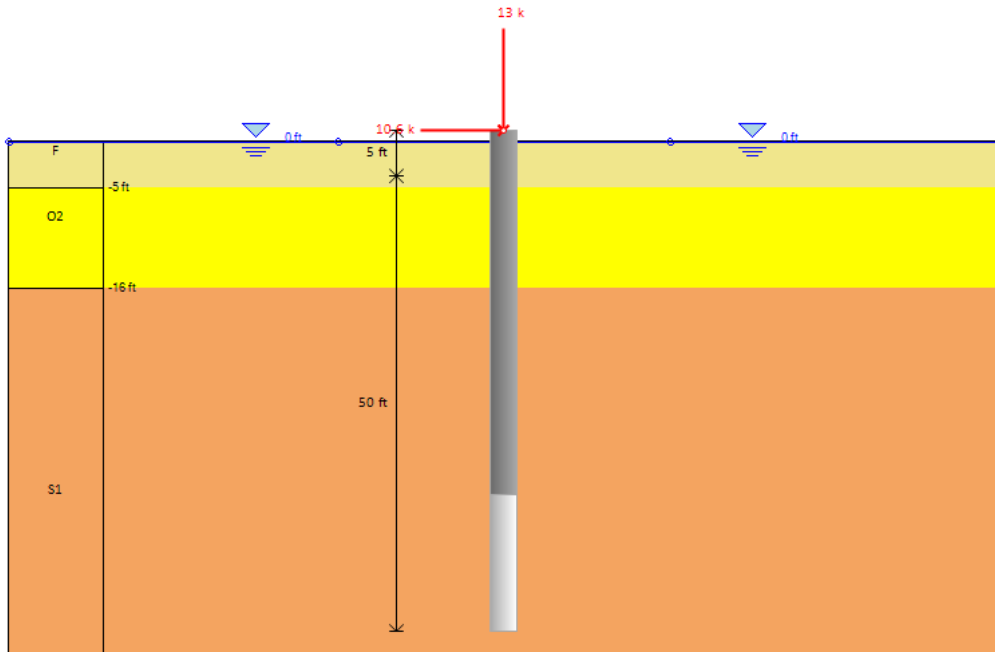
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**A. PROJECT DESCRIPTION – MODEL DATA**

This example presents a procedure of calibrating lateral pile soil parameters to match measured lateral load test performance within DeepFND. A concrete pile with a single center rebar reinforcement (#9 bar) at the section center is examined. An external steel casing (PP9.625X0.545) was used at the first 40 ft of the pile. The pile is drilled in soft and medium sand and silt soils. The total pile depth is 55 ft, and the water table is at El: 0ft.



**Figure 1: Single Pile Model**

**Table 1: Soil Properties (Original Estimation) and Soil Layer Elevations**

Soil Layer Elev. (ft)	Soil (-)	Friction Angle (deg)	Cohesion (psf)	Total Unit Weight (pcf)	PY Model (-)	Subgrade Modulus (pci)
0	F	35	50	120	Reese	50
-5	O2	30	0	115	Silt	20
-16	S1	34	0	125	Reese	40

**Table 2: Pile Properties**

Property/Pile	Top Part	Bottom Part
Pile Type	Conc. Pile with Casing	Conc. Pile without Casing
Pile Diameter	9.625 in	9.625 in
Reinforcement	1 Rebar #9	1 Rebar #9
Casing	PP9.625X0.545	-
Materials	Conc.: 4 ksi, Rebars: Grade 60, Steel: A36	
Total Section Depth	40 ft	15 ft

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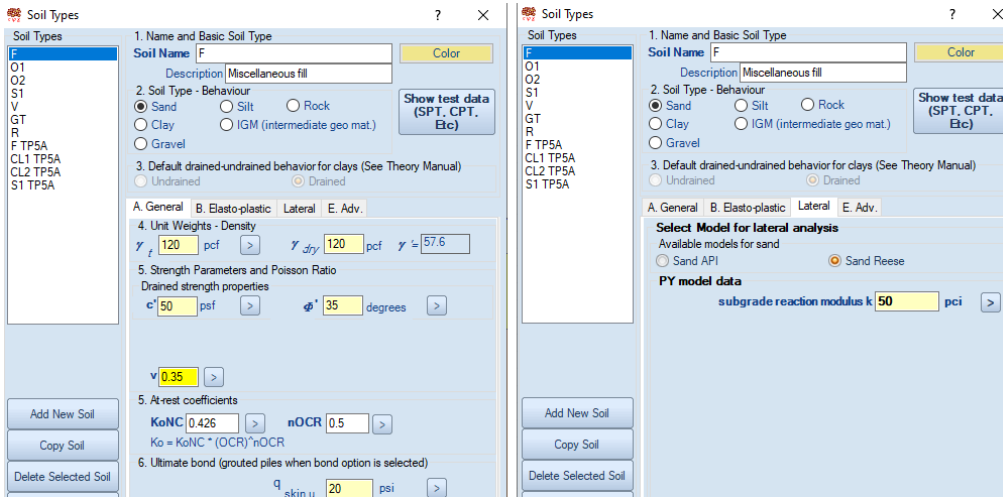
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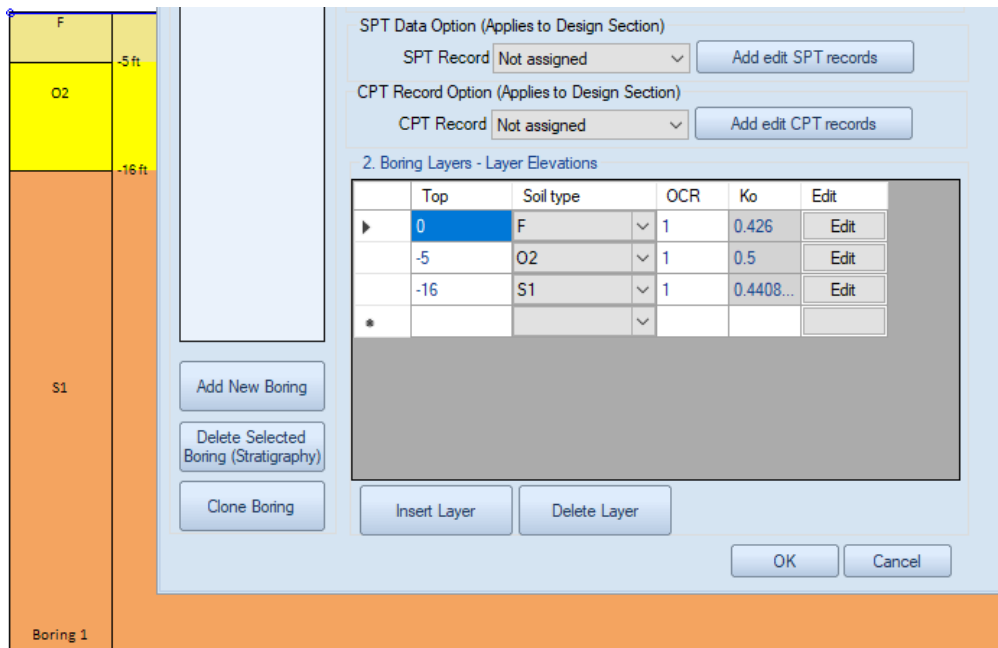
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**B. DEEPFND SOFTWARE – SOIL TYPES AND BORINGS**



**Figure 2: General soil properties – Top Sand Layer (Soil F)**



**Figure 3: Soil Layers**

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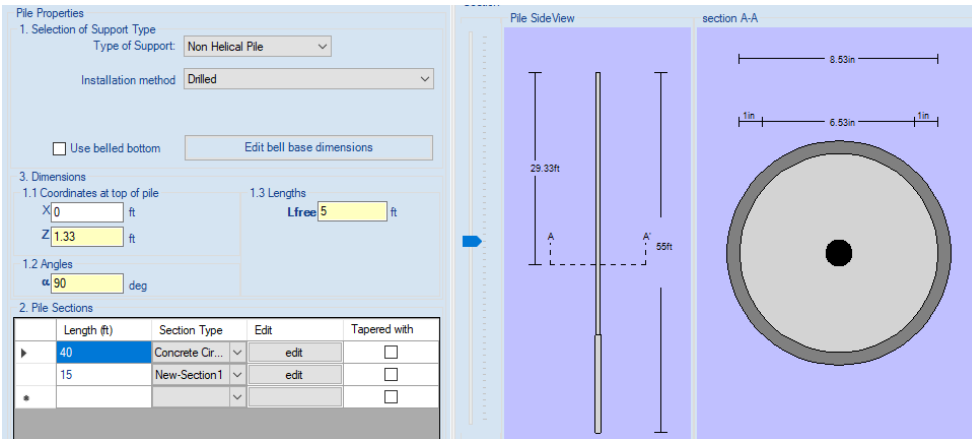
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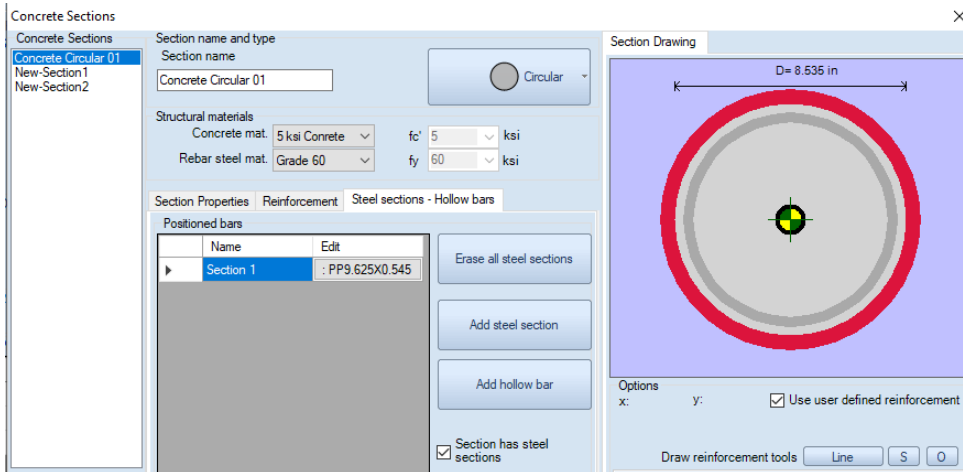
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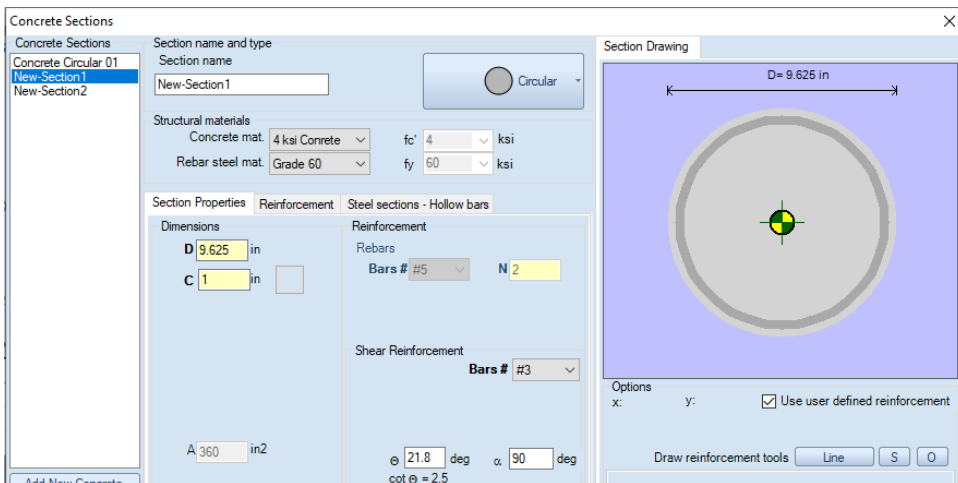
**C. DEEPFND SOFTWARE – PILE SECTION PROPERTIES**



**Figure 4.1: Pile Type, Position and Section Lengths**



**Figure 4.2: Pile Section Properties – External Casing**



**Figure 4.3: Pile Section Properties: Dimensions and Rebars**

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### D. DEEPFND SOFTWARE – LATERAL LOAD TESTS

In this example a lateral pile analysis load test record will be added in the software. The lateral load tests can be added in the Lateral Tab of the program. If we perform a pushover analysis on the model, we will be able to review both the software calculated lateral displacements with load, and the lateral load test curve. This allows us to modify and calibrate the lateral soil parameters easily, so that we can achieve realistic results in similar soil stratigraphies.

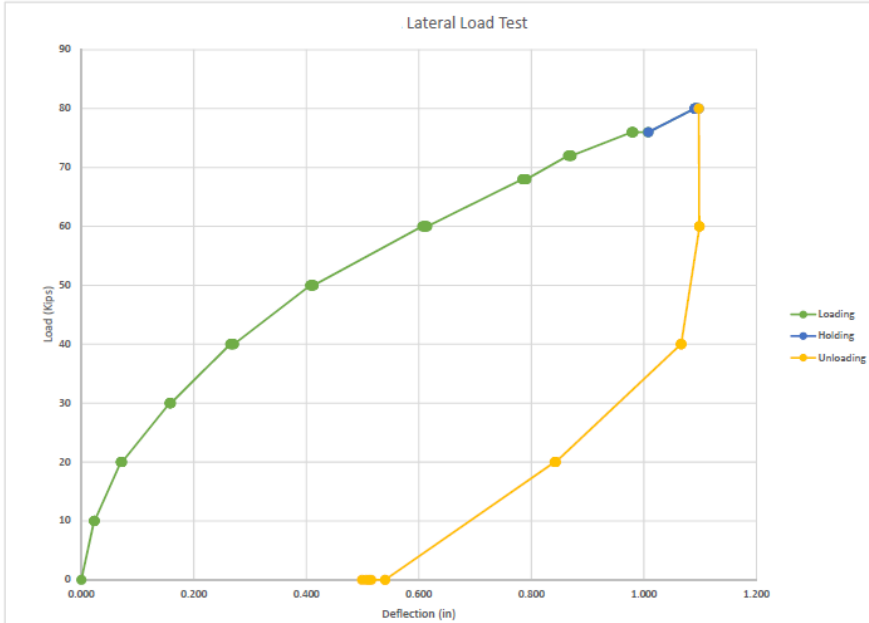


Figure 5: Lateral Load Test, used in this Example

Lateral load test records

TEST 1

Lateral load test data

c'	Su	φ	Ksub	e50	Qu
(psf)	(psf)	(deg)	(pci)	-	(ksf)
50	-	35	50	-	-
0	-	30	20	-	-
0	-	34	40	-	-

Test Records

TEST 1  
TEST 2

1. General Load Test Information - Coordinal

Name TEST 1

Company

2. Load test data

	Load P	Lateral displacement (in)
▶	0	0
	2.88	0.141
	5.5	0.407
	6.86	0.567
	8.2	0.713
	9.5	0.877
	10.4	0.971
	2.88	0.35
	0	0.284

Add New Record

Figure 6: Lateral Load Test, Defined within DeepFND Software

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E. DEEPFND SOFTWARE – AXIAL AND LATERAL ANALYSIS RESULTS

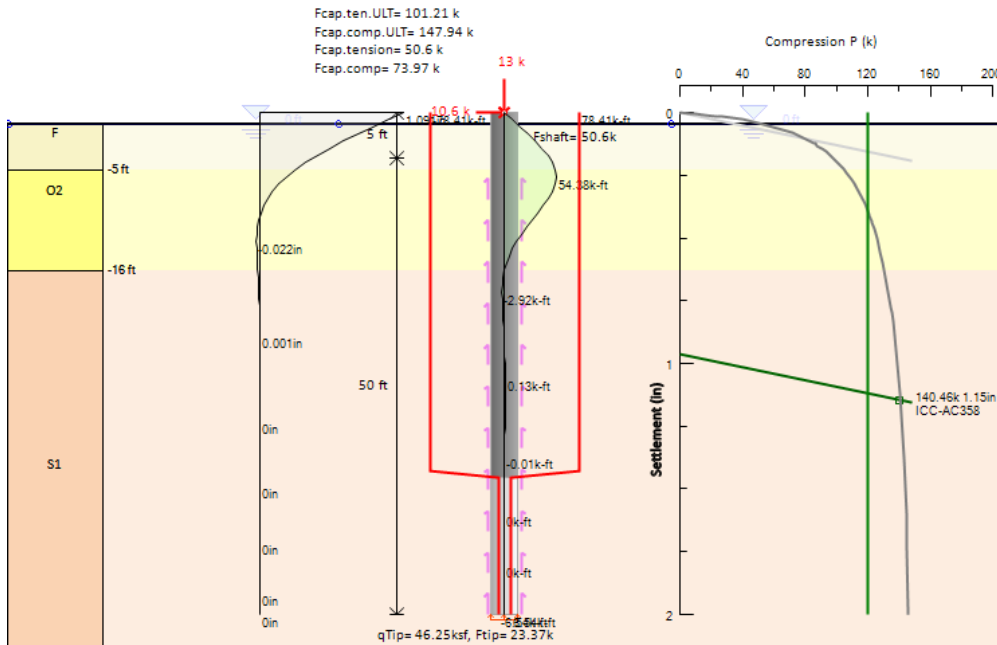


Figure 7: Bearing Capacities (Design and Ultimate), Pile Moment and Moment Capacity, Displacement and Pile Head Settlements Diagrams

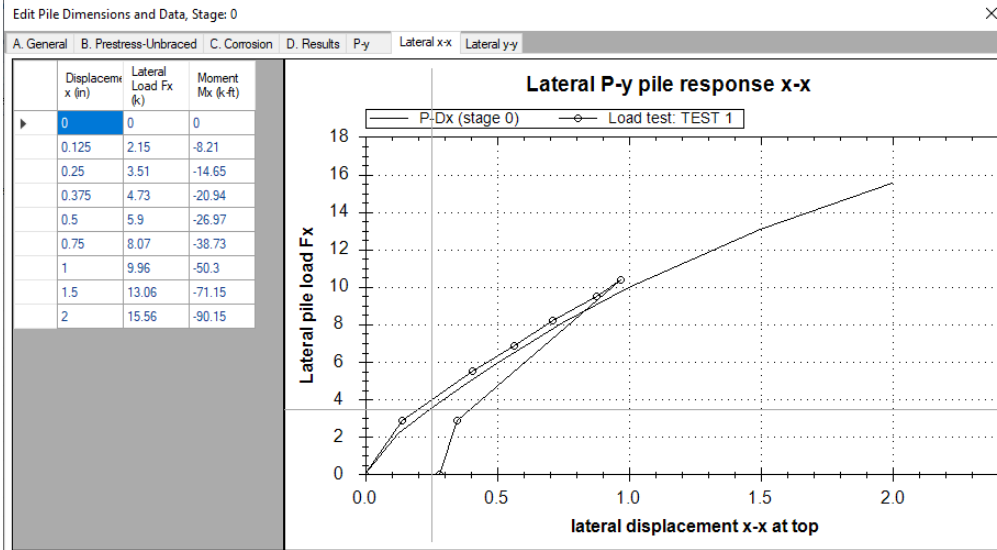


Figure 8: Pile Displacements – Pushover Analysis and Lateral Load Test

In Figure 8 we can see that the estimated displacements and the lateral load test displacements are closely matching. We can potentially further adjust the soil properties, and run the analysis again, to investigate potentially provide a closer match. The target is to bring the two graphs as close as possible. However, one needs to also be reasonably considerate in using the calibrated soil properties.

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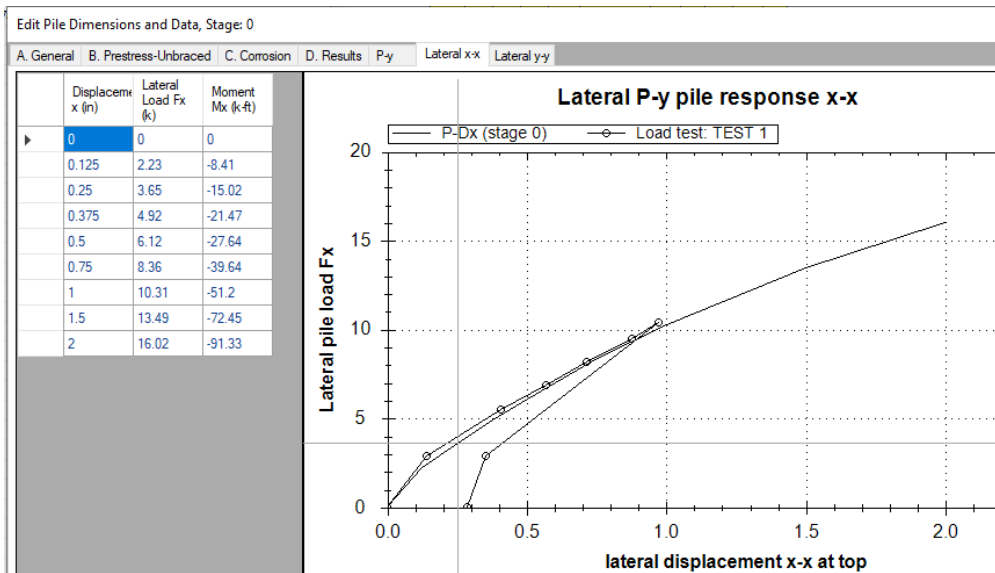
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**F. DEEPFND SOFTWARE – SOIL PROPERTIES CALIBRATION**

Table 3 summarizes the calibrated soil properties. As it can be seen, a slight increase in the subgrade reaction modulus and strength of all three soils produces results that closely match the measured lateral pile load test.

**Table 3: Soil Properties (Calibrated) and Soil Layer Elevations**

Soil Layer Elev. (ft)	Soil (-)	Friction Angle (deg)	Cohesion (psf)	Total Unit Weight (pcf)	PY Model (-)	Subgrade Modulus (pci)
0	F	36	70	120	Reese	60
-5	O2	30	0	115	Silt	30
-16	S1	34	0	125	Reese	50



**Figure 9: Pile Displacements – Pushover Analysis and Lateral Load Test (Calibrated)**

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