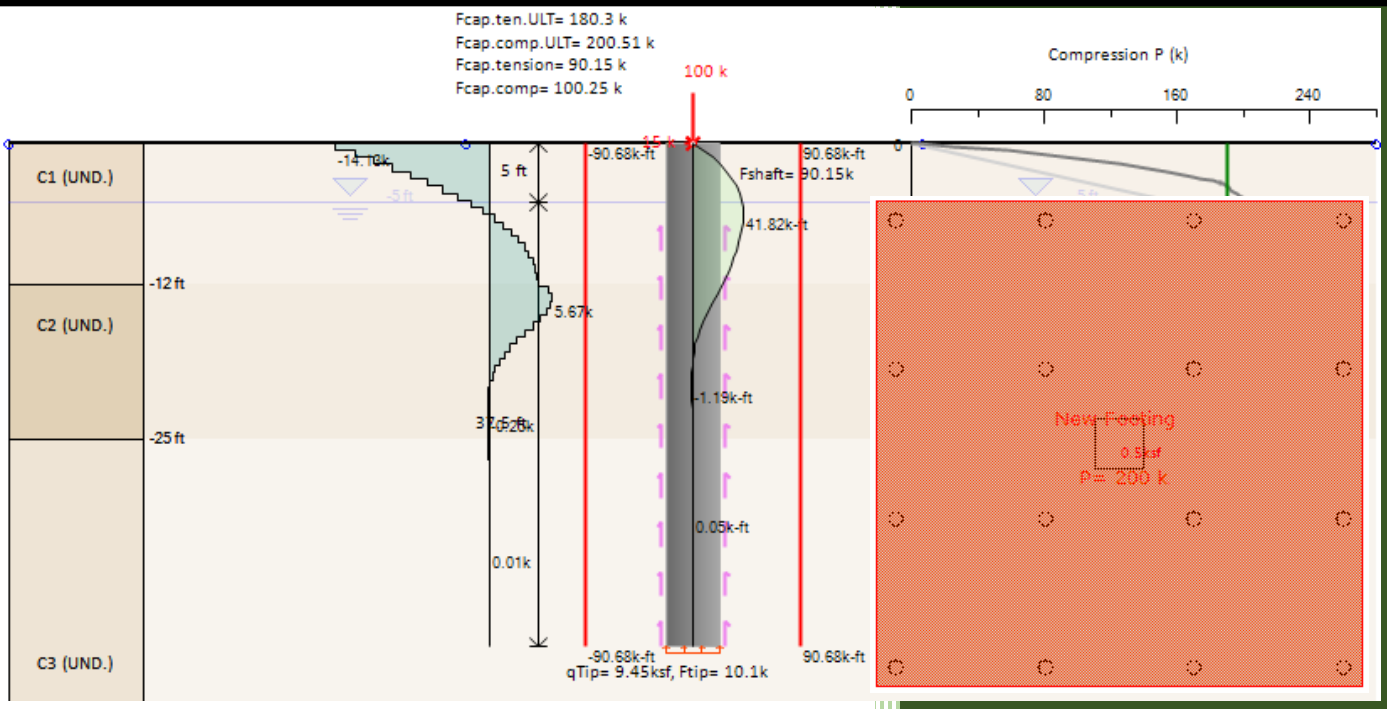
DEEP EXCAVATION

GEOTECHNICAL SOFTWARE & ENGINEERING

Driven Steel Piles Design – Single Piles and Pile Group

Driven Steel Pipes – Vertical and Lateral Analysis of a Single Pile and a Pile Cap with 16 Piles



DeepFND
Foundation Piles
Design Software

HelixPile
Helical Piles
Design Software

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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

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A. PROJECT DESCRIPTION – PILE SECTION – SOIL PROPERTIES

In this example we will design and optimize a steel pipe (PP14x0.281), driven to medium stiff to very stiff, overconsolidated clays.

Table 1 and Table 2 below present the soil properties and stratigraphy that has been estimated and used within the DeepFND software. Table 3 presents the pipe section properties. The water table is at El: -5ft.

Table 1: Soil properties.

Soil Layer	Soil Type	General properties						
		ϕ' (deg)	Su (psf)	γ (pcf)	γ_{dry} (pcf)	E_{LOAD} (ksf)	E_{RELOAD} (ksf)	e50
C1	Stiff Clay	-	2400	122	122	1110	3330	0.055
C2	Very Stiff Clay	-	3500	128	128	1700	5100	0.005
C3	Stiff Clay	-	2100	121	121	1030	3090	0.006

Table 2: Stratigraphy.

Soil Layer	Elevation (ft)	OCR	Ko
C1	0	2	0.751
C2	-12	3	0.92
C3	-25	3	0.92

Table 3: Steel Pile Section Properties

Pile Type	Driven Steel Pipe
Pile Section	PP14x0.281
Steel Material	Fy = 45ksi
Top Pile Elev.	0 ft
Initial Pile Depth	55 ft

B. DEEPFND SOFTWARE – SOIL TYPES AND BORINGS

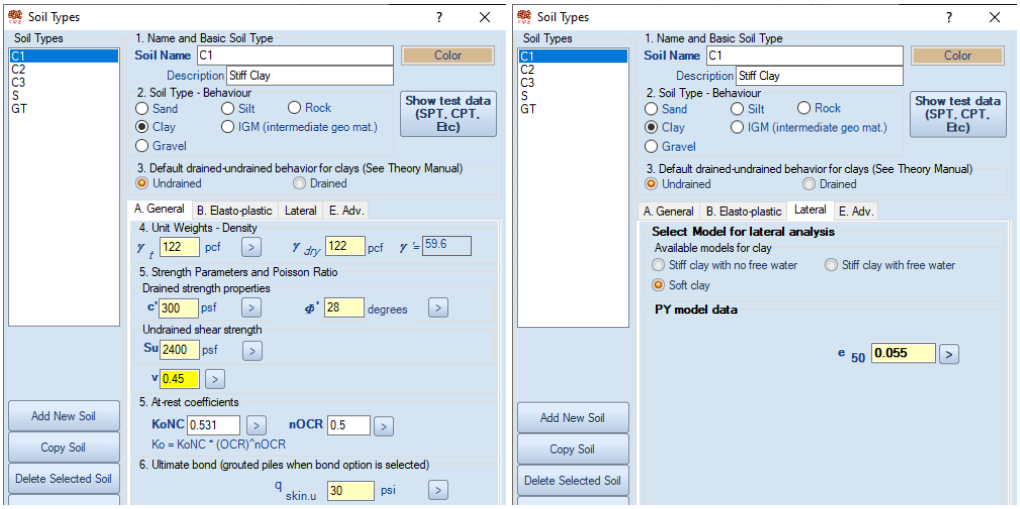

Figure 2: General soil properties – Top Clay Layer (Soil C1)

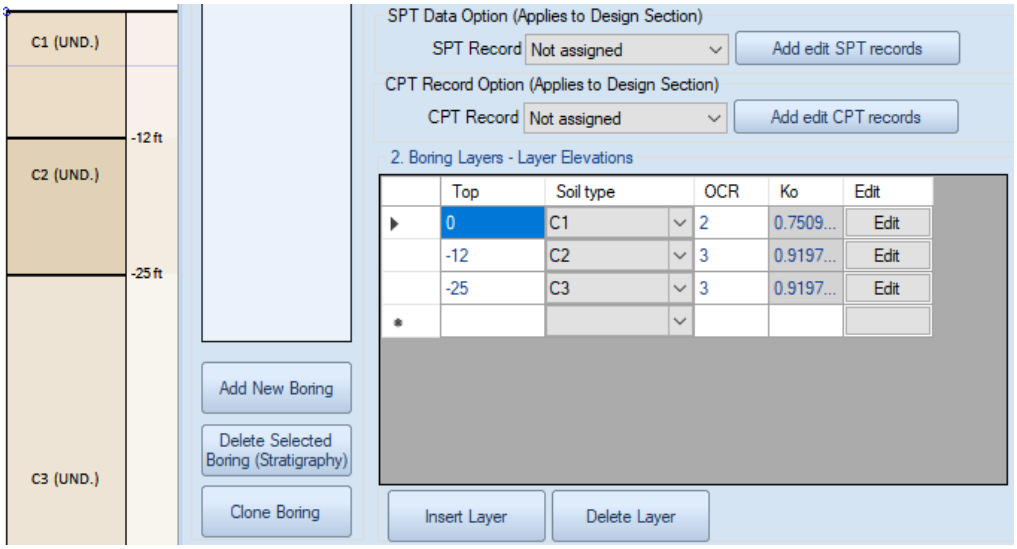

Figure 3: Soil Layers

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C. DEEPFND SOFTWARE – PILE SECTION PROPERTIES

The steel pipes (PP14x0.281 , Fy = 45 ksi), were driven to 53.5 ft depth, and they were taped with steel plates. Figures 4 and 5 present the pile type and length, and the pile section properties respectively.

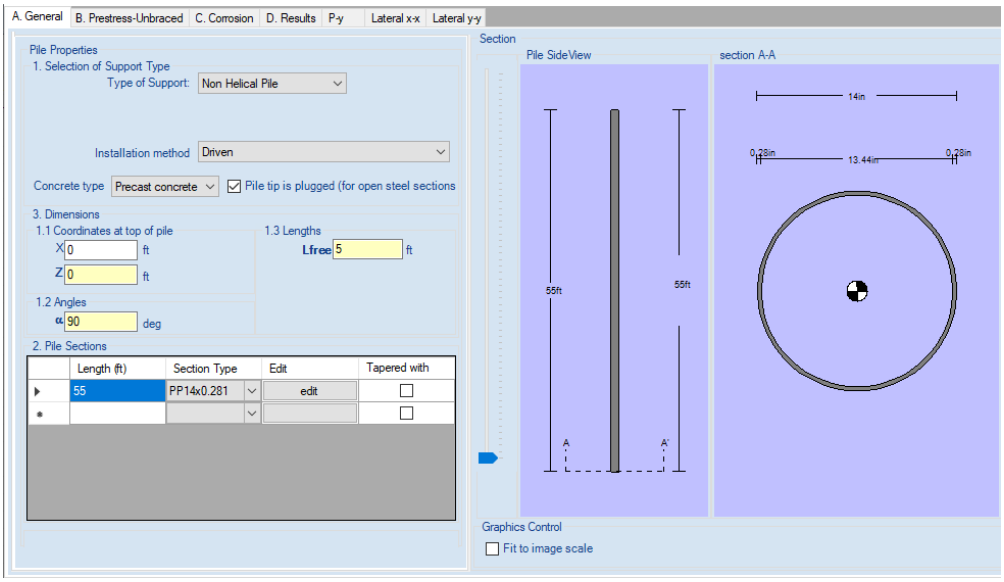

Figure 4: Pile Type, Position and Dimensions

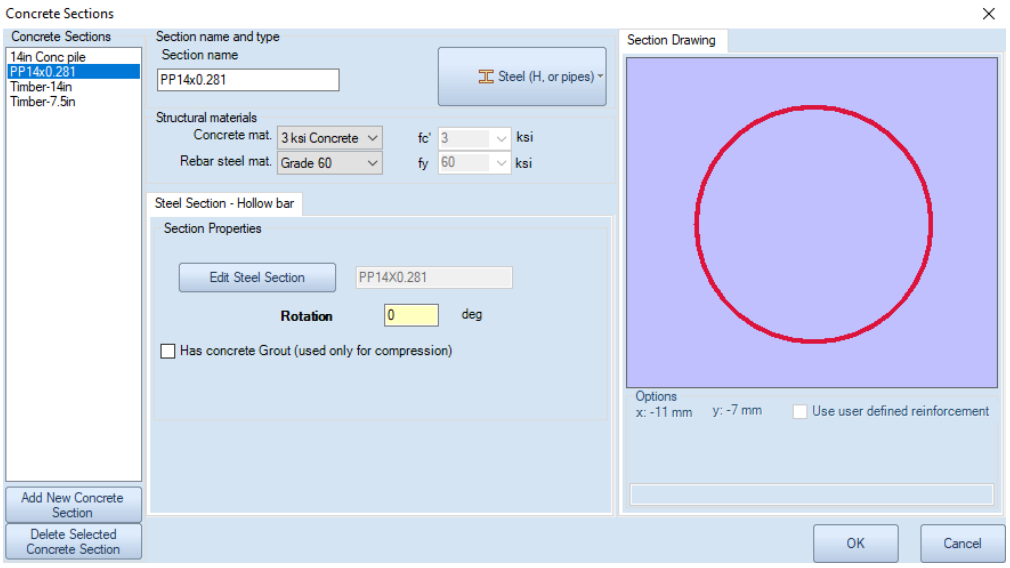

Figure 5: Pile Section Properties

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D.1. SINGLE PILE EXAMPLE – MODEL AND LOADS

In this case, we will design a single pile. Table 4 presents the external loads that are applied on the pile head. Figures 6 and 7 present the generated model and the pile depth optimization options respectively.

Table 4: Loads on the Pile Head (Tension and Compression)

STAGE/LOAD	Axial Load (Kips)	Lateral – X direction (Kips)	Lateral – Y direction (Kips)
Stage 0 (Compression)	100	15	15
Stage 1 (Tension)	-80	15	15

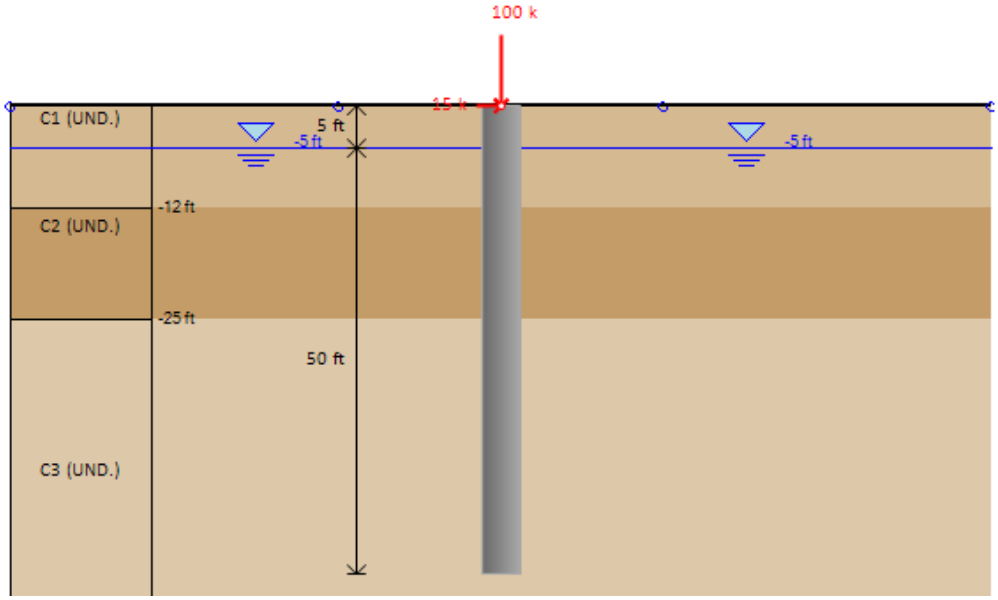


Figure 6: Single Pile – Generated Model (Stage 0 – Compression)

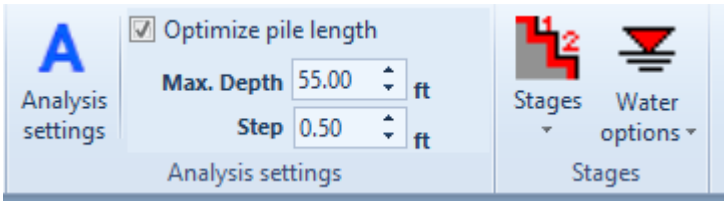


Figure 7: Pile Depth Optimization Settings

With the Pile Length Optimization option selected, the software starts from the pile free length Lfree (5 ft in this example – defined in the Pile Properties dialog), and increased with the user-defined step length. On each step, the software calculates the design capacities (compression and tension), and compares them with the applied loads. The analysis stops when both the applied tension and compression loads are covered with the pile capacities at the examined depth, or when the maximum defined pile depth is reached.

D.2. SINGLE PILE EXAMPLE – VERTICAL AND LATERAL ANALYSIS RESULTS

The optimized pile depth is 42.5 ft. Figures 8 to 10 present the calculated results in tables and graphs.

Extended vs Stage

	Factored load comp. (k)	Factored load tension (k)	Capacity GEO. Comp. (k)	Capacity GEO. Tension (k)	Capacity STR. (k)	Stress check	Stress check STR	Stress check GEO	Lat. Dx (in)	Lat. Fx (k)	Lat. M (k-ft)
Stage 0	100	0	100.25	90.15	190.73	0.997	0.626	0.997	0.663	14.13	41.82
Stage 1	0	80	100.25	90.15	190.73	0.887	0.441	0.887	0.663	14.13	41.82

Figure 8: Analysis And Checking Summary Table

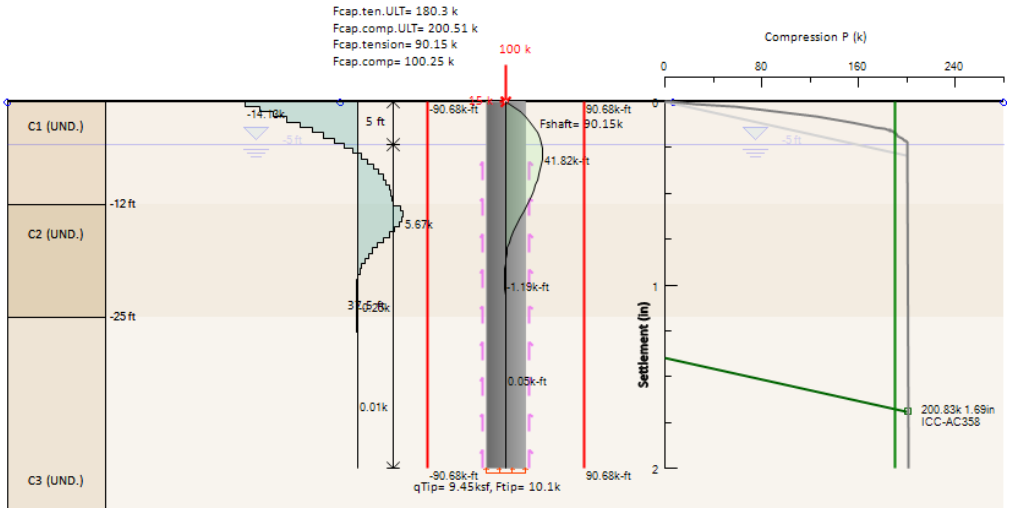


Figure 9: Pile Ultimate and Design Capacities, Wall Moment and Shear Graphs, Estimated Pile Settlements

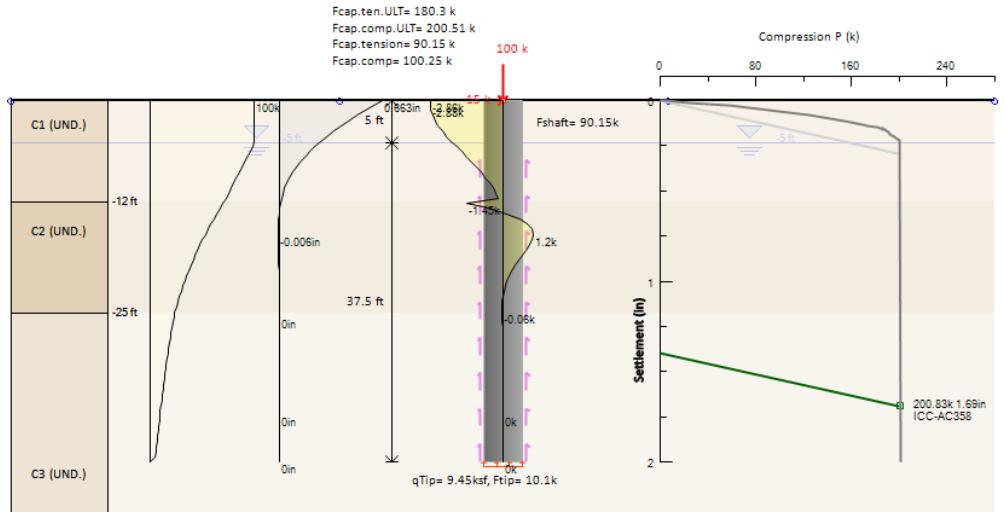


Figure 10: Axial load Distribution Along the Pile, Horizontal Soil Pressures and Pile Displacement Diagrams

E.1. PILE GROUP EXAMPLE – DIMENSIONS AND LOADS

In this case, we will design a 3ft thick concrete rectangular pile cap (40ft x 40ft), supported by 16 driven steel pipes (PP14x0.281). A 0.5ksf area load is applied to the full cap surface. An additional 200 Kips vertical load and two 300 Kips lateral loads (one to each local x and y directions) are applied on the pile cap centroid. Figure 11 presents the pile cap dimensions and the loads applied on the cap centroid. Figure 12 presents the area load, distributed on the cap surface.

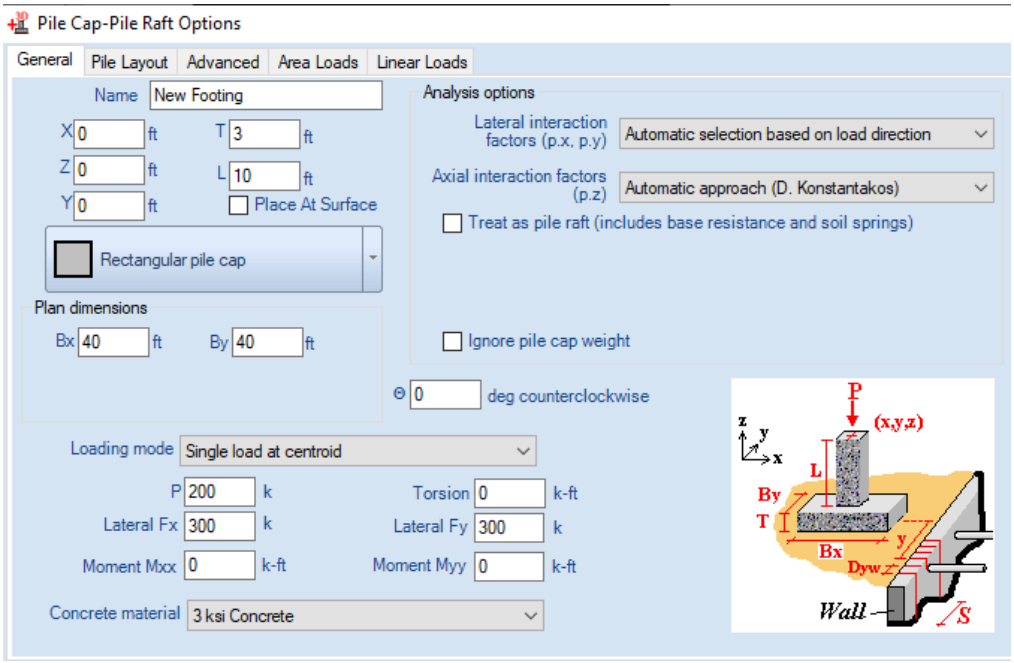


Figure 11: Pile Cap Dimensions and Loads at Centroid

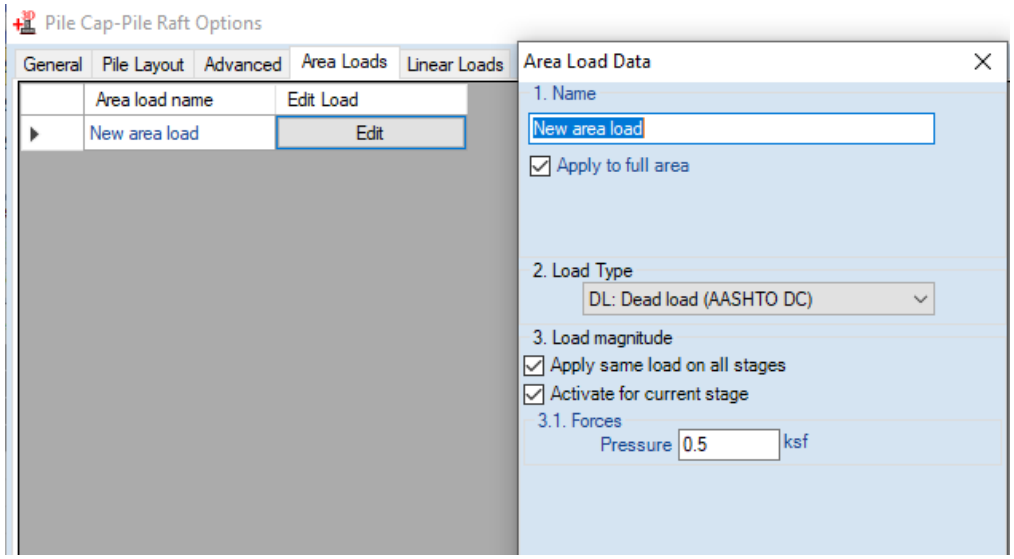
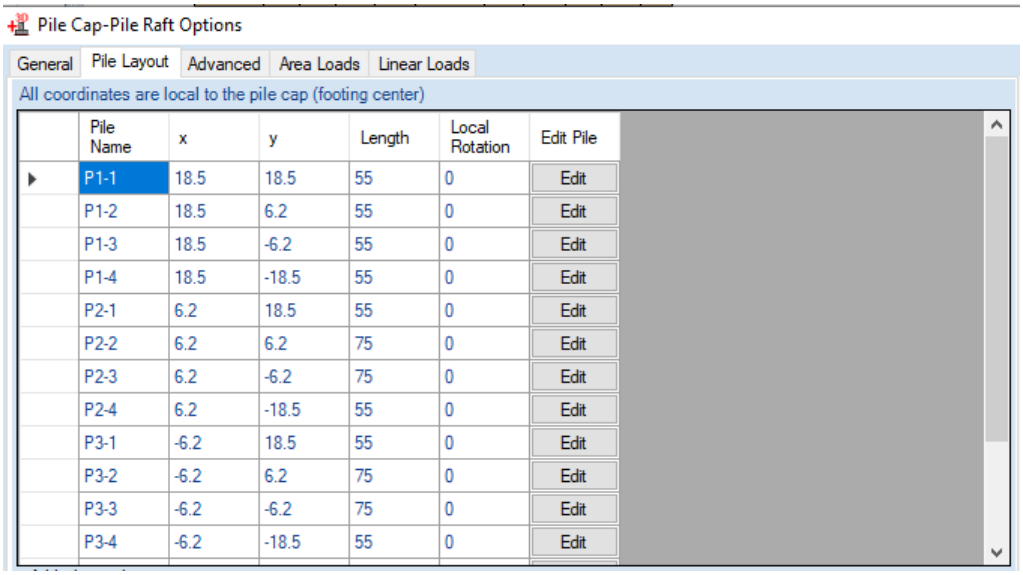


Figure 12: Area Load on the Pile Cap

E.2. PILE GROUP – PILE LOCATIONS AND GENERATED MODEL

In this case, 16 pipes (PP14x0.281) have been distributed to the pile cap. The four central piles have been driven to 75ft depth, and all other piles have been driven to 55ft depth. Figures 13 and 14 present the piles layout (pile center local x and y coordinates) and the generated model (2D section – side view) respectively.



	Pile Name	x	y	Length	Local Rotation	Edit Pile
▶	P1-1	18.5	18.5	55	0	Edit
	P1-2	18.5	6.2	55	0	Edit
	P1-3	18.5	-6.2	55	0	Edit
	P1-4	18.5	-18.5	55	0	Edit
	P2-1	6.2	18.5	55	0	Edit
	P2-2	6.2	6.2	75	0	Edit
	P2-3	6.2	-6.2	75	0	Edit
	P2-4	6.2	-18.5	55	0	Edit
	P3-1	-6.2	18.5	55	0	Edit
	P3-2	-6.2	6.2	75	0	Edit
	P3-3	-6.2	-6.2	75	0	Edit
	P3-4	-6.2	-18.5	55	0	Edit

Figure 13: Pile Locations (Local X and Y Coordinates)

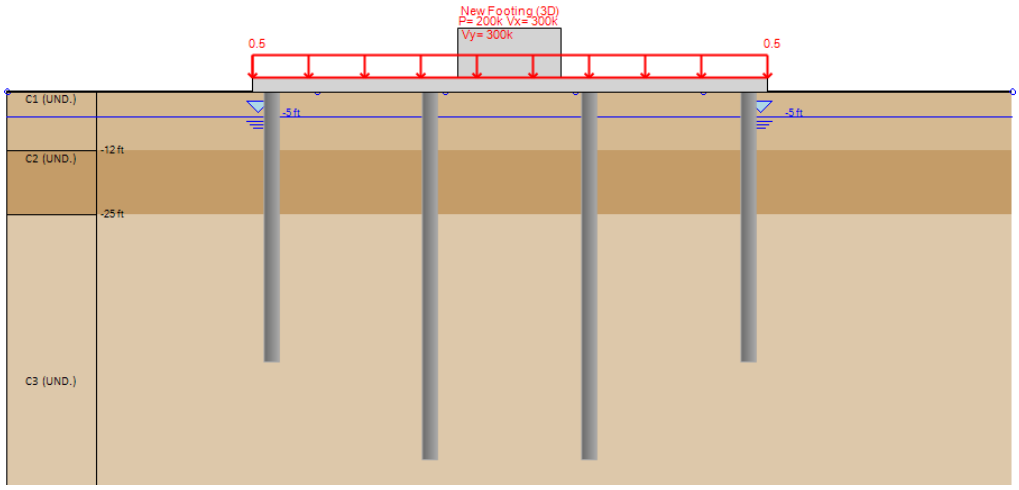


Figure 14: Generated Model – 2D Section Side View – Middle Pile Row

E.3. PILE GROUP – ANALYSIS RESULTS (PILES SIDE VIEW)

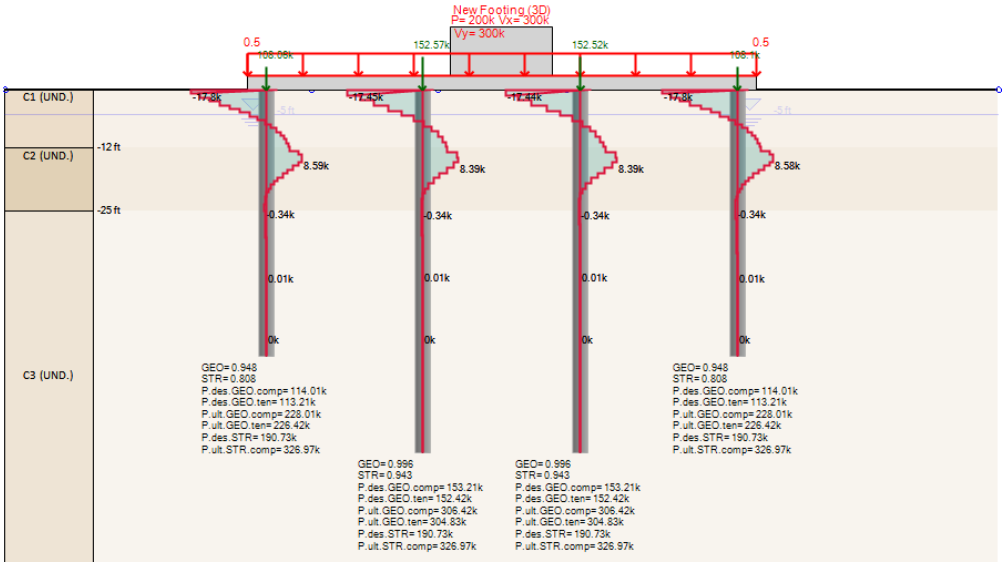


Figure 15: Pile Check Ratios, Shear Diagrams and Axial Forces (Middle Pile Row)

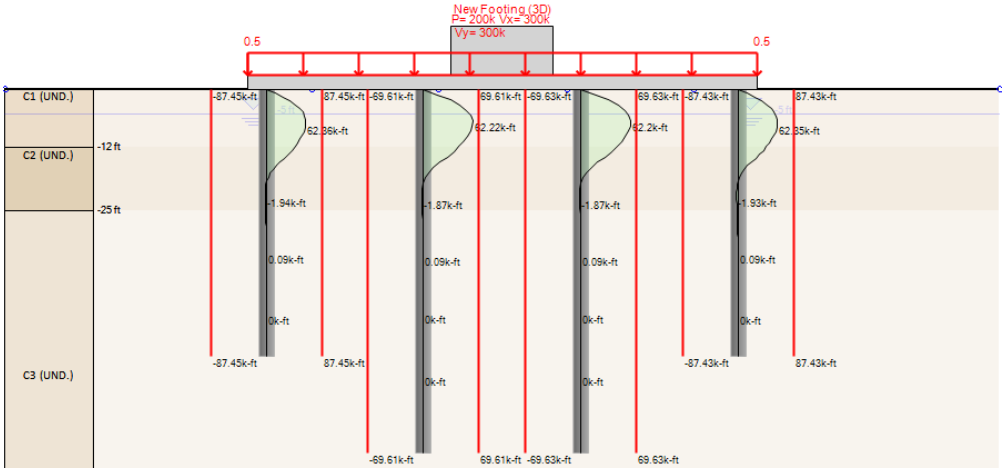


Figure 16: Pile Moment Diagrams and Moment Capacities (Middle Pile Row)

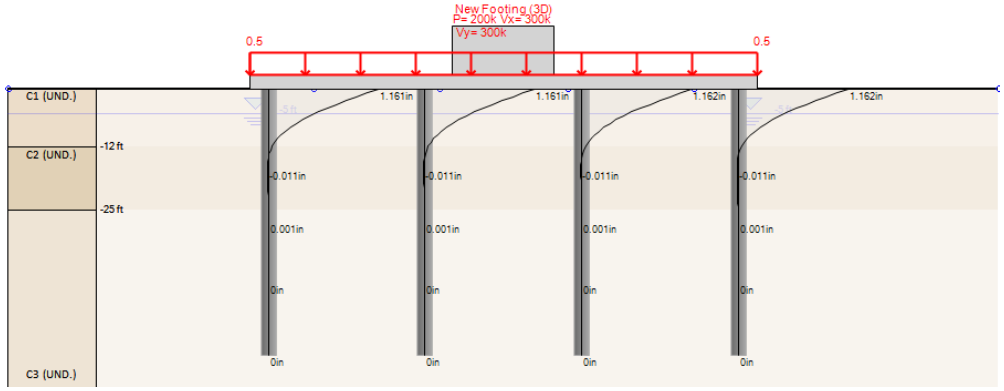


Figure 17: Pile Displacement Diagrams (Edge Pile Row)

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E.4. PILE GROUP – ANALYSIS RESULTS (PILE CAP AND 3D MODEL)

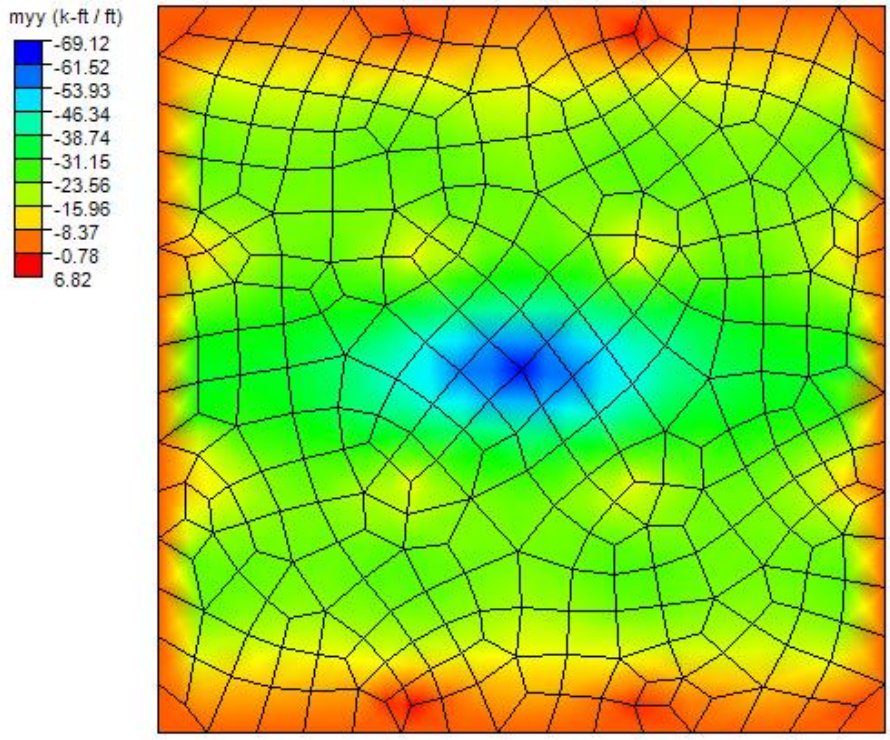

Figure 18: Pile Cap – Moments Shading (X-Direction)

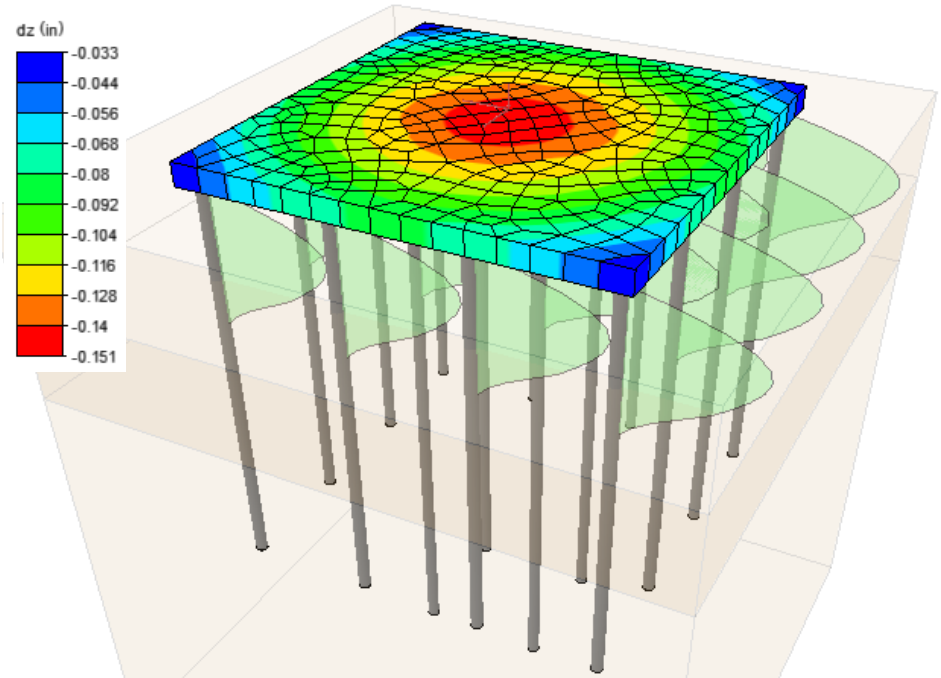

Figure 19: 3D Model – Pile Cap Settlements and Pile Moment Diagrams

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