

UniSoft GS

Geotechnical Solutions

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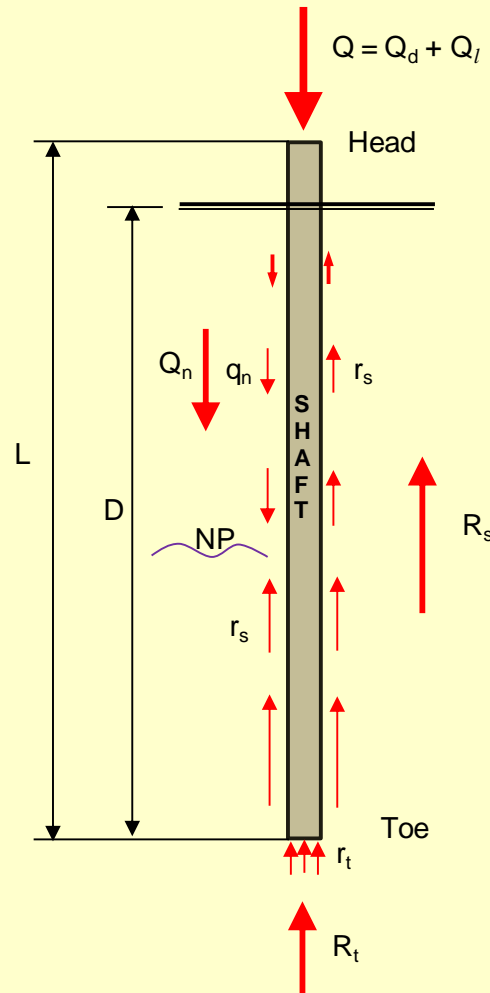
*A presentation of UniPile software for calculation of
Capacity, Drag Force, Downdrag, and Settlement
for Piles and Piled Foundations*

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and

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President, UniSoft Geotechnical Solutions Ltd.*

The Foundation Pile



$Q =$ Load

$Q_d =$ Dead load, Sustained load

$Q_l =$ Live load, Transient load

$r_s =$ Unit shaft resistance

$R_s =$ Total shaft resistance

$q_n =$ Unit negative skin friction

$Q_n =$ Drag force

$r_t =$ Unit toe resistance

$R_t =$ Total toe resistance

$L =$ Pile length

$D =$ Embedment depth

NP = Neutral Plane

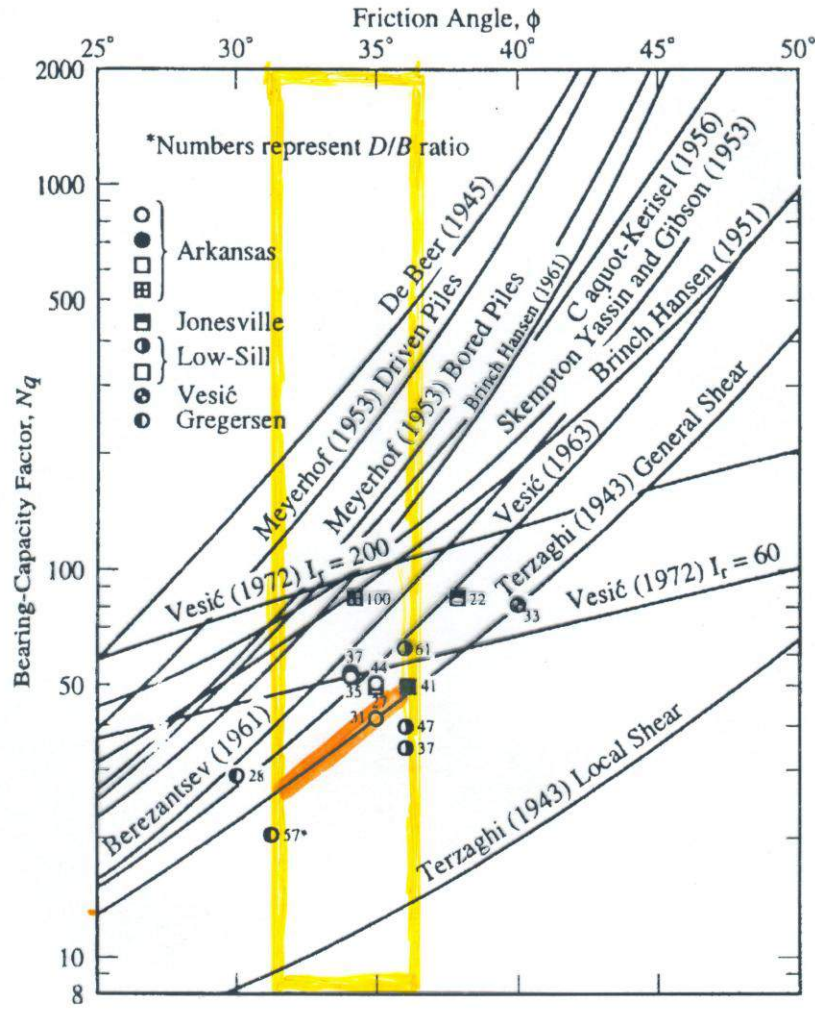
$A_s =$ Circumferential area (m^2/m ; ft^2/ft)

$A_t =$ Pile toe area (m^2 ; ft^2)

$$r_t = q' N_q$$

N_q was determined in tests—model-scale tests

N_q



ϕ'

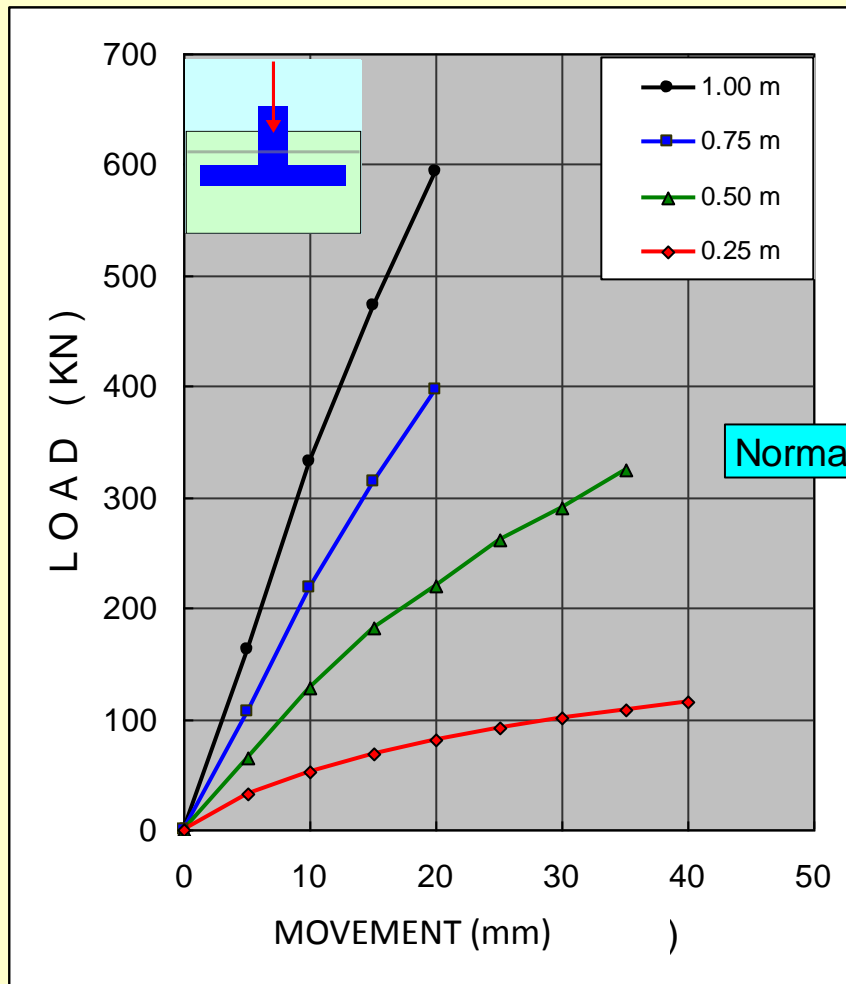
Min to max N_q ratio can be ≈ 200 for the same ϕ' !

The log-scale plot is necessary to show all curves with some degree of resolution.

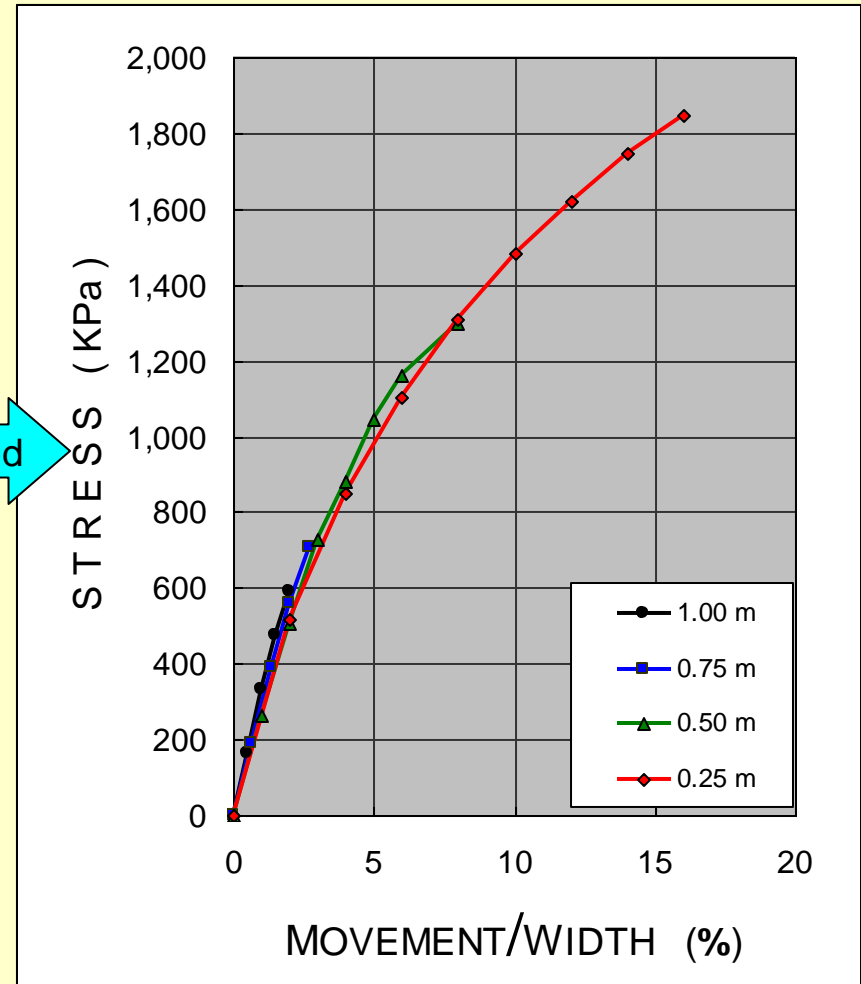
Why is it that nobody has realized that something must be wrong with the theory for the main factor, the N_q , to vary this much?

Let's compare to the reality?

Results of static loading tests on **0.25 m to 0.75 m** square **footings** in well graded **sand** (Data from Ismael, 1985)

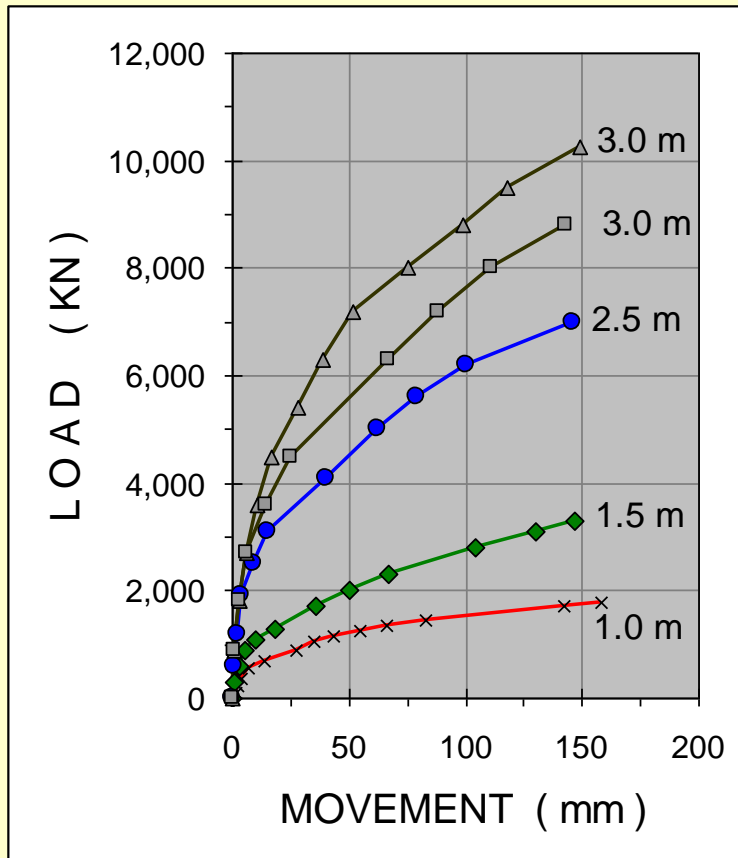


Normalized

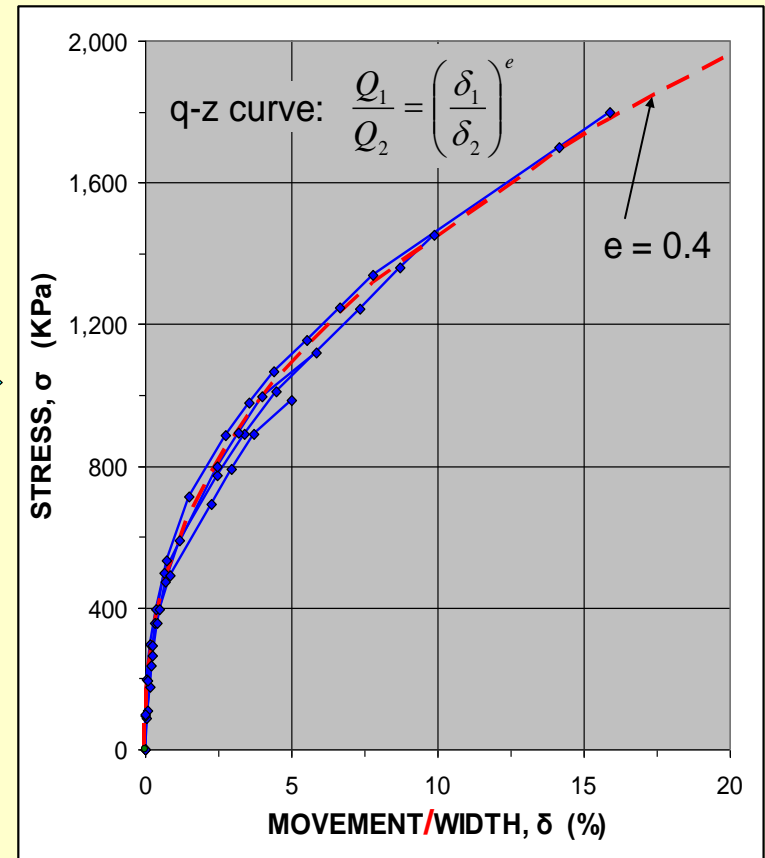


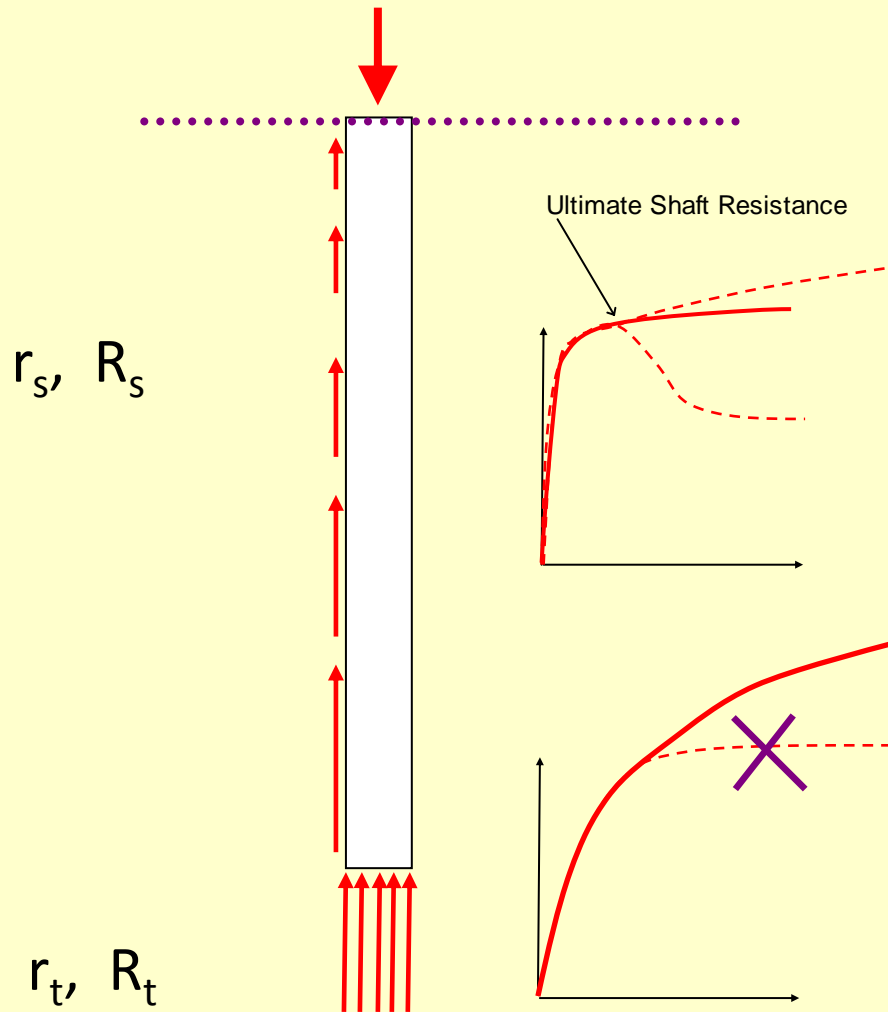
Load-Movement of Four Footings on Sand
 Texas A&M University Experimental Site
 J-L Briaud and R.M. Gibbens 1994,
 ASCE GSP 41

The measured data normalized
 and with a fit of a q-z curve



Normalized





Ultimate Shaft Resistance can be a reality. An ultimate value can be determined. However, the required movement for a specific case can vary between a mm or two through 50 mm and beyond!

Ultimate Toe Resistance does not exist other than as a definition of load at a certain movement

... , but Ultimate Toe Resistance can never be. Toe capacity is a myth!

Analysis Methods for Determining **Shaft Resistance, r_s**

The Total Stress Method

The SPT Method

The CPT and CPTU Methods

The **Beta Method**

Total Stress Method

$$r_s = \tau_u \quad \begin{matrix} \text{"Alpha analysis"} \\ [= \alpha \tau_u] \end{matrix}$$

- where
- r_s = unit shaft resistance
 - τ_u = undrained shear strength
 - α = reduction coefficient for $\tau_u > \approx 100$ KPa

The undrained shear strength can be obtained from unconfined compression tests, field vane shear tests, or, to be fancy, from consolidated, undrained triaxial tests. Or, better, back-calculated from the results of instrumented static loading tests. **However, if those tests indicate that the unit shaft resistance is constant with depth in a homogeneous soil, don't trust the records! Also, the analysis results would only fit a pile of the same embedment length as the test pile.**

The SPT Method

Meyerhof (1976)

$$r_s = n N D$$

where r_s = ultimate unit **shaft** resistance (N/m³)

n = a coefficient

N = average N-index along the pile shaft (taken as a pure number)

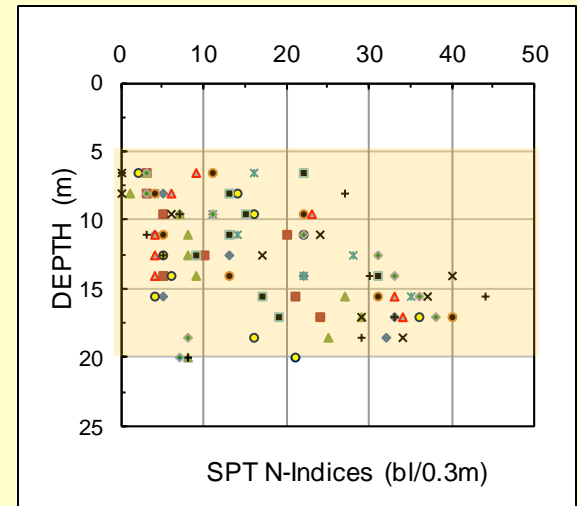
D = embedment depth

n = $2 \cdot 10^3$ for driven piles and $1 \cdot 10^3$ for bored piles (N/m³)

[English units: 0.02 for driven piles and 0.01 for bored piles (t/ft³)]

For unit toe resistance, r_t , Meyerhof's method applies the N-index at the pile toe times a toe coefficient = $400 \cdot 10^3$ for driven piles and $120 \cdot 10^3$ for bored piles (N/m³)

[English units: $n = 4$ for driven piles and $n = 1$ for bored piles (t/ft³)]



Which value would you pick for use in calculating pile capacity?

The SPT Method

Decourt (1988; 1995)

$$r_s = \alpha(2.8N + 10) D$$

where r_s = ultimate unit **shaft** resistance (N/m³)

α = a coefficient

N = average N-index along the pile shaft (taken as a pure number)

D = embedment depth

Shaft Coefficient α

Soil Type	Displacement Piles	Non-Displacement Piles
Sand	$1 \cdot 10^3$	$0.6 \cdot 10^3$
Sandy Silt	$1 \cdot 10^3$	$0.5 \cdot 10^3$
Clayey Silt	$1 \cdot 10^3$	$1 \cdot 10^3$
Clay	$1 \cdot 10^3$	$1 \cdot 10^3$

For unit toe resistance in sand, Decourt's method applies the N-index at the pile toe times a toe coefficient = $325 \cdot 10^3$ for driven piles and $165 \cdot 10^3$ for bored piles (N/m³)

CPT and CPTU Methods for Calculating the Ultimate Resistance (Capacity) of a Pile

Schmertmann and Nottingham (1975 and 1978)

deRuiter and Beringen (1979)

Meyerhof (1976)

LCPC, Bustamante and Gianceselli (1982)

ICP, Jardine, Chow, Overy, and Standing (2005)

Eslami and Fellenius (1997)

The CPT and CPTU Methods

Schmertmann and Nottingham
(1975 and 1978)

$$r_t = C_{OCR} q_{ca}$$

$$r_s = K_f f_s \quad \text{CLAY and SAND}$$

$$r_s = K_c q_c \quad \text{SAND (alternative)}$$

- where
- r_t = pile unit toe resistance (<15 MPa)
 - C_{OCR} = correlation coefficient governed by the overconsolidation ratio, OCR, of the soil
 - q_{ca} = arithmetic average of q_c in an influence zone^{*)}
 - K_f = a coefficient depends on pile shape and material, cone type, and embedment ratio. In sand, the coefficient ranges from 0.8 through 2.0, and, in clay, it ranges from 0.2 through 1.25.
 - K_c = a dimensionless coefficient; a function of the pile type, ranging from 0.8 % through 1.8 %
 - q_c = cone resistance (total; uncorrected for pore pressure on cone shoulder)

^{*)} The Influence zone is 8b above and 4b below pile toe

**Eslami and Fellenius
(1997)**

$$r_t = C_t q_{Eg}$$

$$r_s = C_s q_E$$

$$C_t = \frac{1}{3b} \quad \text{b in metre}$$

$$C_t = \frac{12}{b} \quad \text{b in inch}$$

b = pile diameter

r_t = pile unit toe resistance

C_t = toe correlation coefficient (toe adjustment factor)—equal to unity in most cases

q_{Eg} = **geometric** average of the cone stress over the influence*) zone after correction for pore pressure on the shoulder and adjustment to “effective” stress

r_s = pile unit shaft resistance

C_s = shaft correlation coefficient, which is a function of soil type determined **from the CPT/CPTU soil profiling chart**

q_E = cone stress after correction for pore pressure on the cone shoulder and adjustment to “effective” stress

*) The Influence zone is 8b above and 4b below pile toe

Shaft Correlation Coefficient

Soil Type)**

	C_s
Soft sensitive soils	8.0 %
Clay	5.0 %
Stiff clay and Clay and silt mixture	2.5 %
Sandy silt and silt	1.5 %
Fine sand and silty sand	1.0 %
Sand to sandy gravel	0.4 %

****)** determined directly from the **CPTU soil profiling**

Pile Capacity or, rather, **Load-Transfer** follows principles of effective stress and is best analyzed using the **Beta method**

Shaft Resistance in Sand and in Clay — Beta-method

Unit Shaft Resistance, r_s

$$r_s = \beta \sigma'_v$$

$$r_s = \tan \phi' K_s \sigma'_v$$

where

- r_s = unit shaft resistance
- β = Bjerrum-Burland coefficient
- σ'_v = effective overburden stress
- K_s = earth stress ratio = σ'_h / σ'_v

Approximate Range of Beta-coefficients

SOIL TYPE	Phi	Beta	
Clay	25 - 30	0.20 - 0.35	0.05 - 0.80+ !
Silt	28 - 34	0.25 - 0.50	
Sand	32 - 40	0.30 - 0.90	
Gravel	35 - 45	0.35 - 0.80	

These ranges are typical values found in some cases. In any given case, actual values may deviate considerably from those in the table.

Practice is to apply different values to driven as opposed to bored piles, but

Total Resistance (“Capacity”); Load Distribution

$$Q_{ult} = R_s + R_t$$

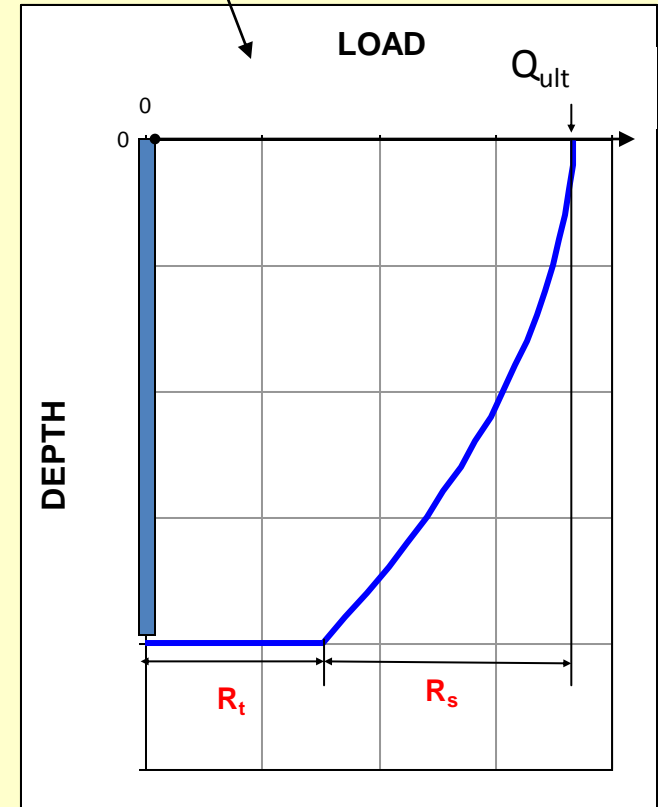
$Q_{ult} = Q_u$ = Ultimate resistance = Capacity

R_s = Shaft resistance

R_t = Toe resistance

$$Q_z = Q_u - \int A_s \beta \sigma'_z dz = Q_u - R_s$$

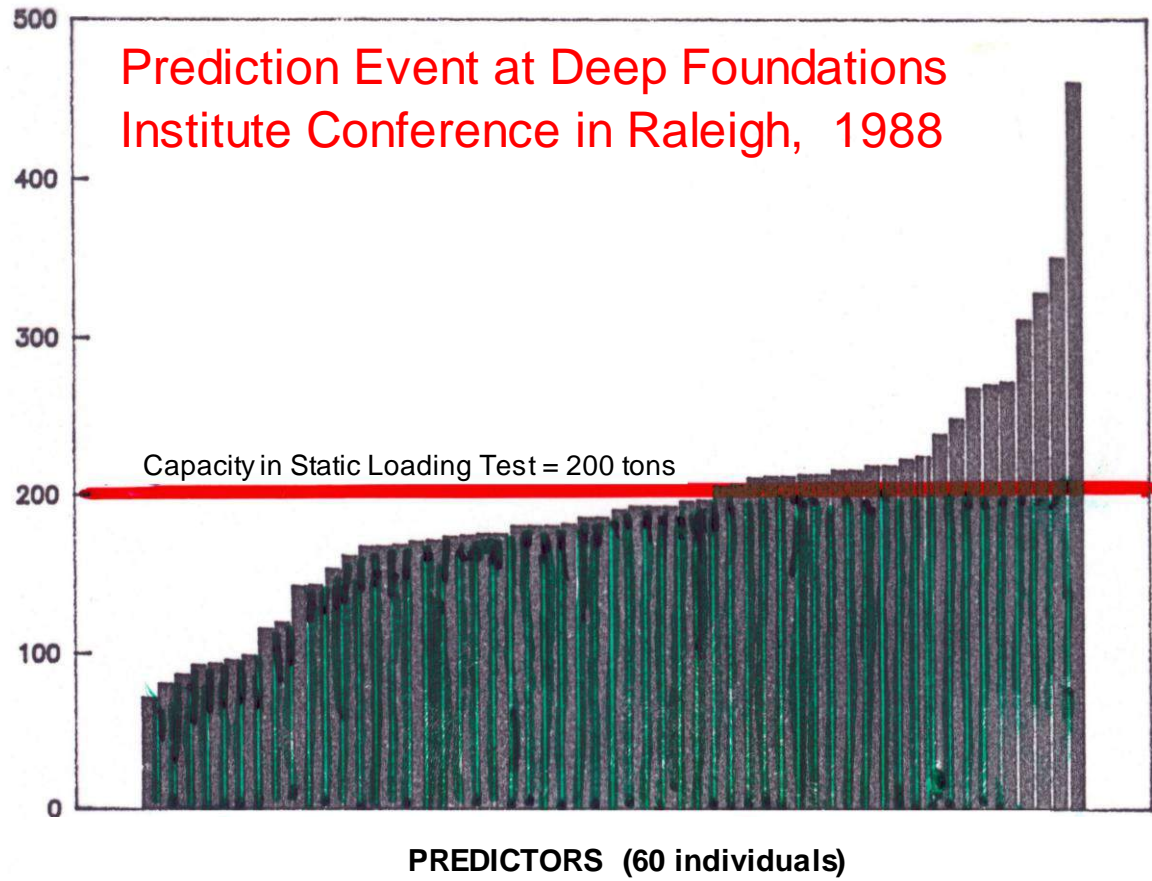
Effective stress–Beta-analysis–is the method closest to the real response of a pile to an imposed load



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Tons

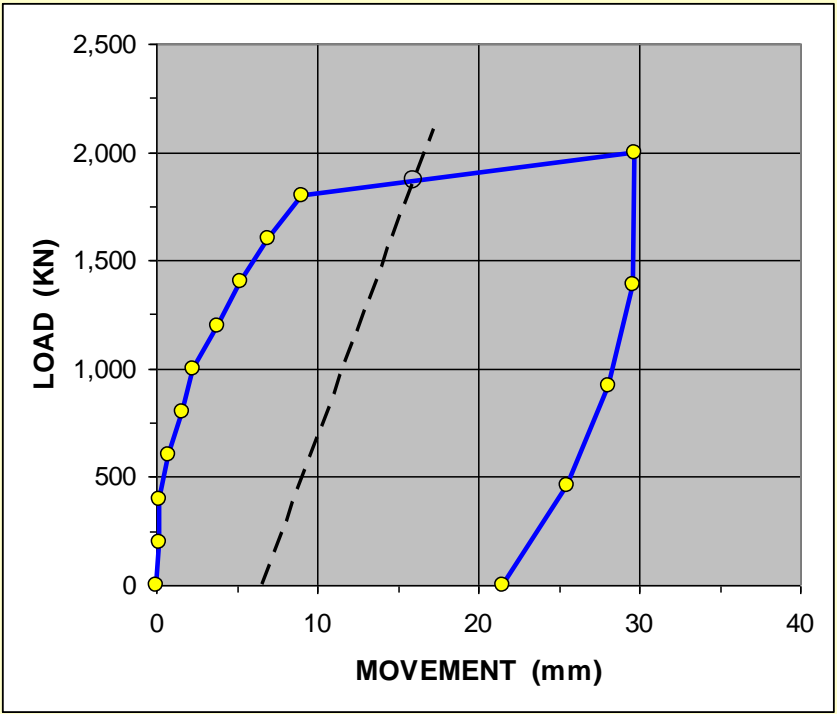


44 ft embedment,
12.5 inch square
precast concrete
driven through
compact silt and into
dense sand

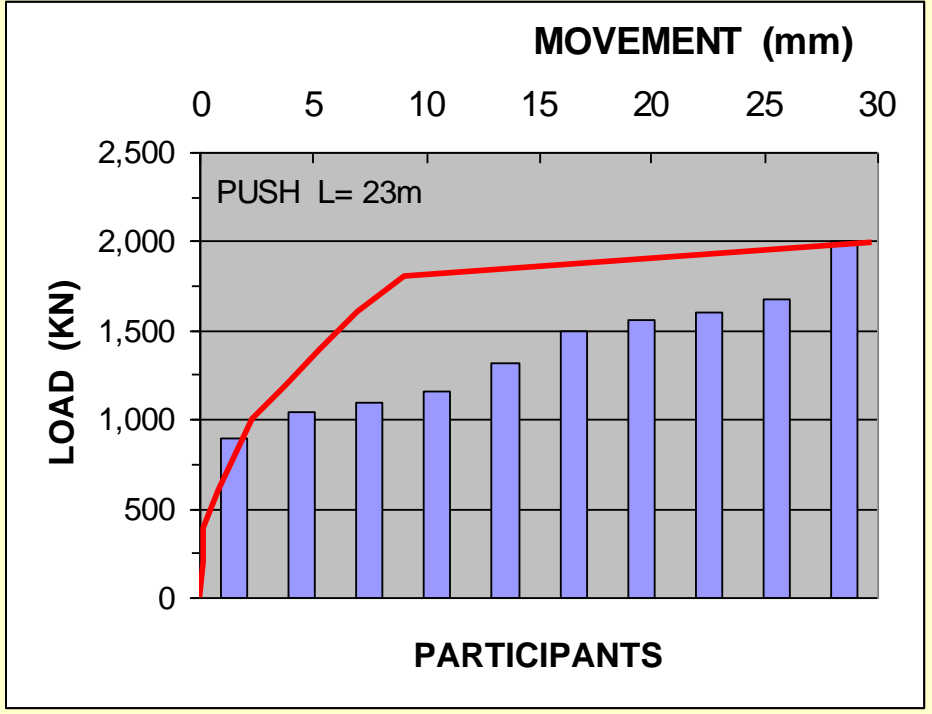
Brazil 2004: Bored pile (Omega screw pile) 23 m long, 310 mm diameter

Static Loading Test on a 23 m 310 mm bored pile

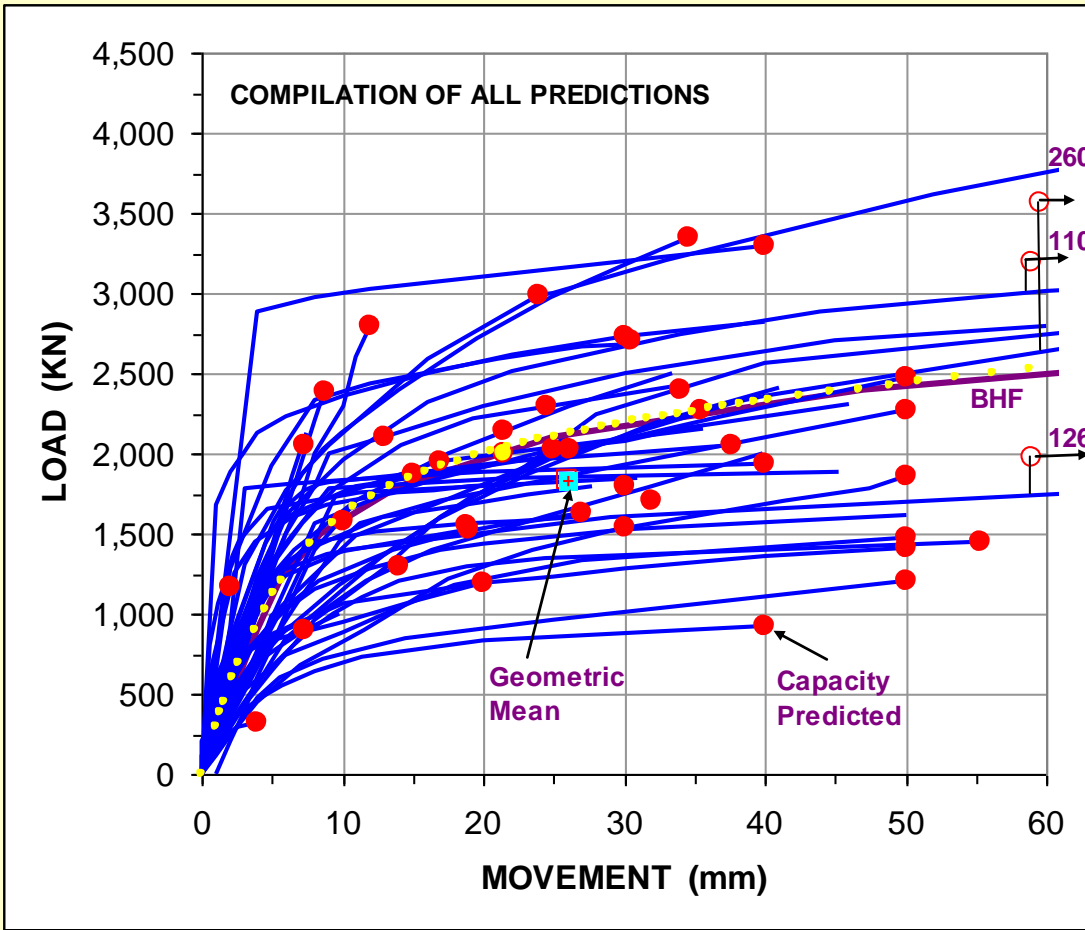
Load-Movement Response



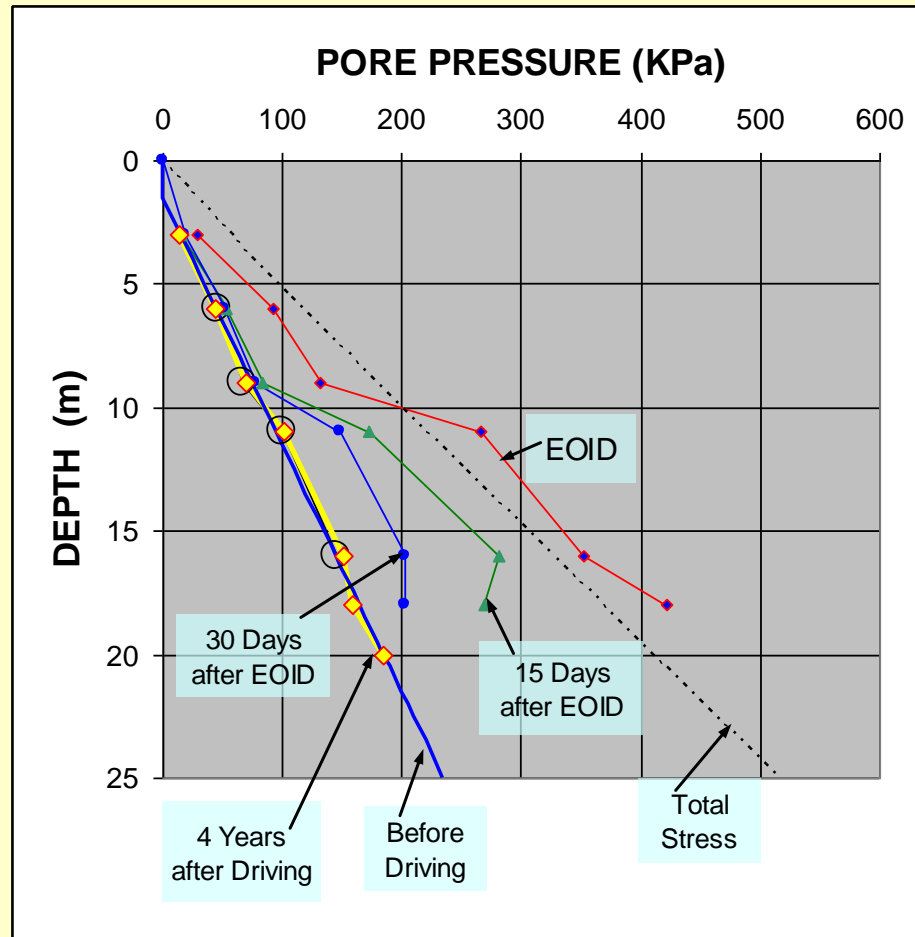
Prediction Compilation



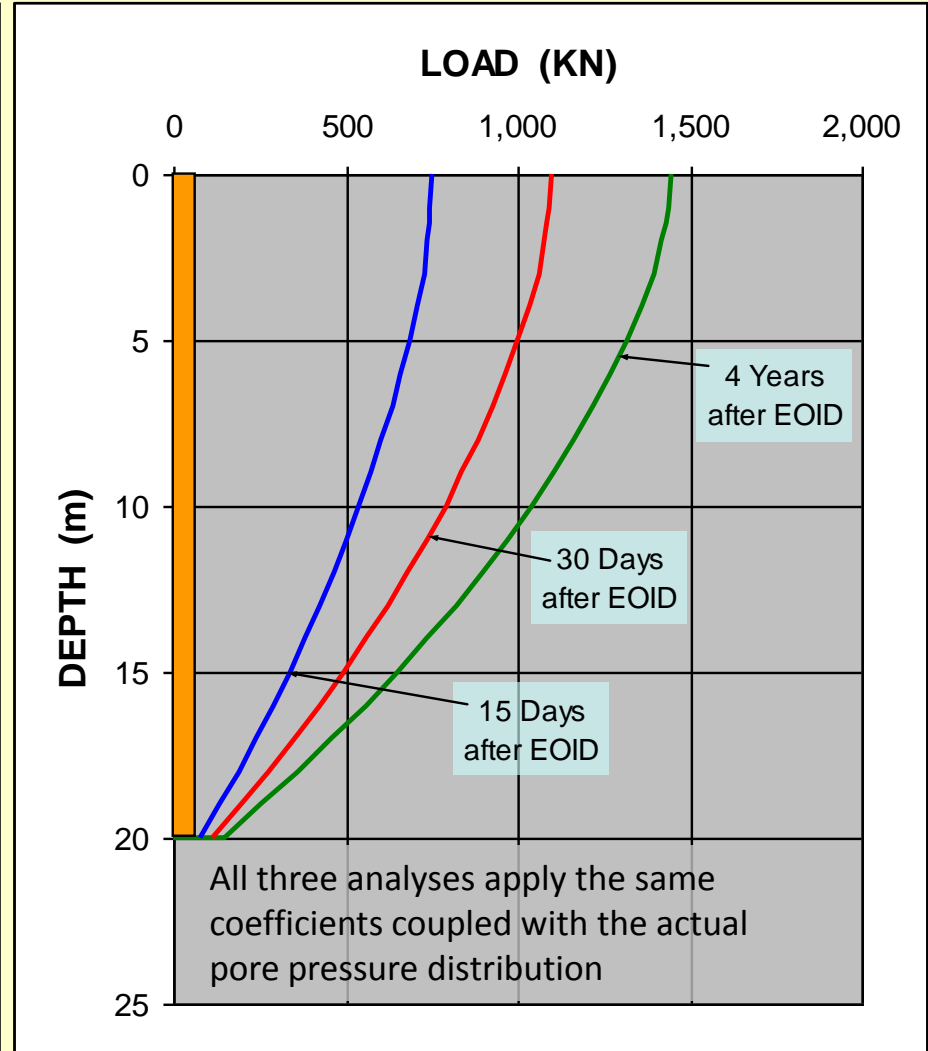
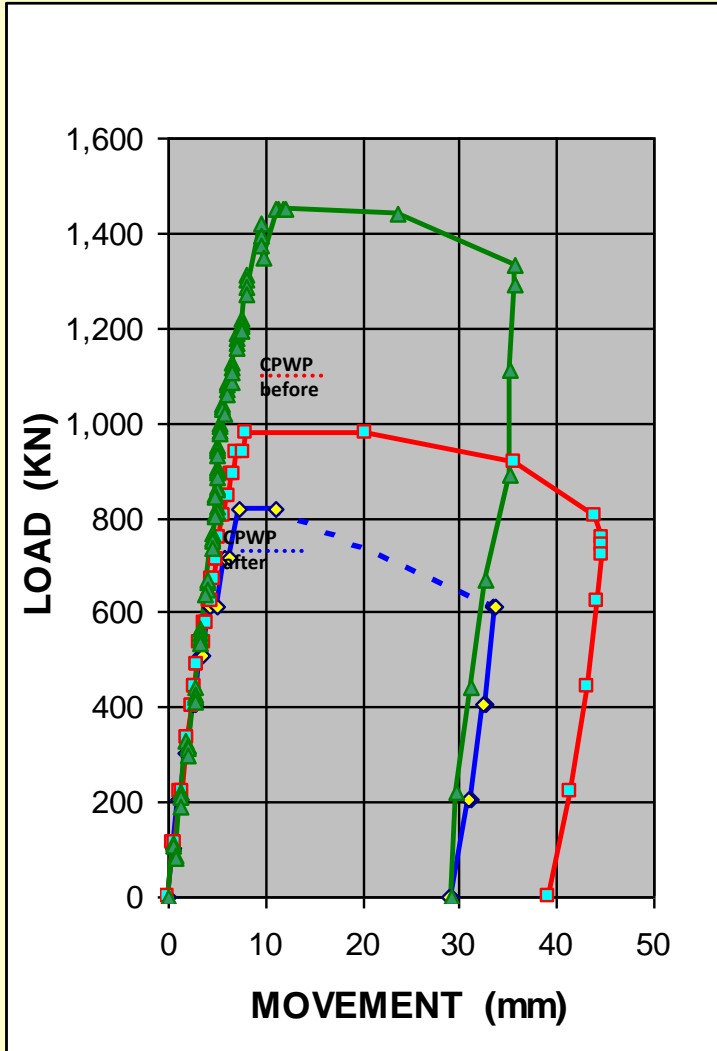
Compilation of predicted load-movement curves and capacities Bolivia 2013



Pore Pressure Dissipation



Effective Stress Analysis

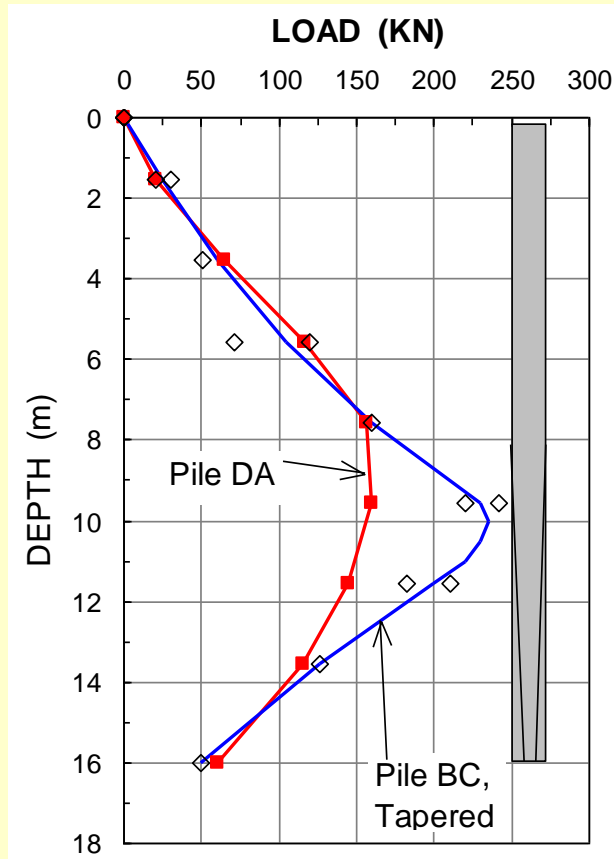


Load Distributions—Measured in the static loading tests and fitted to UniPile analysis

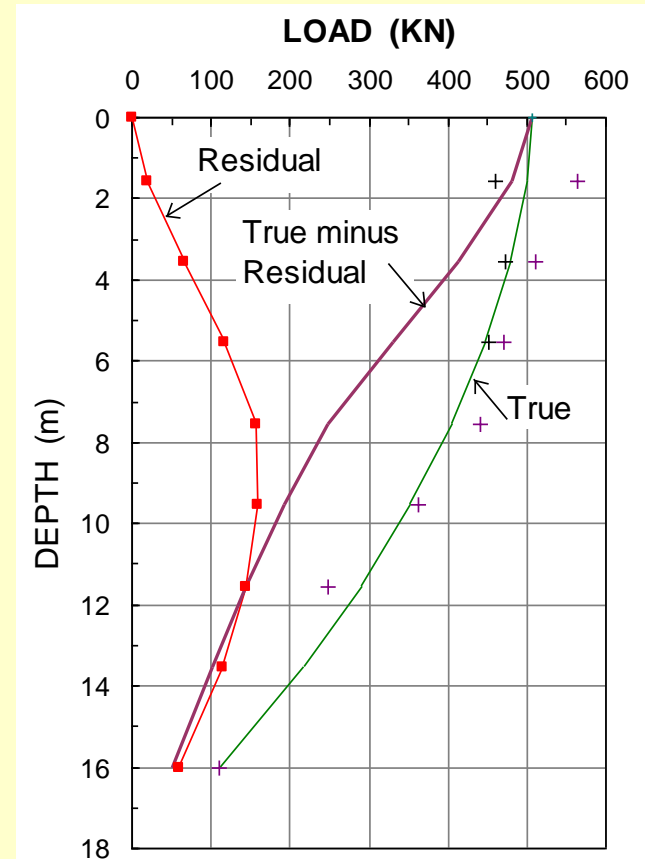
If we want to know the load distribution, we can measure it. But, what we measure is the increase of load in the pile due to the load applied to the pile head. What about the load in the pile that was there before we started the test?

That is, the Residual load.

Example from Gregersen et al., 1973

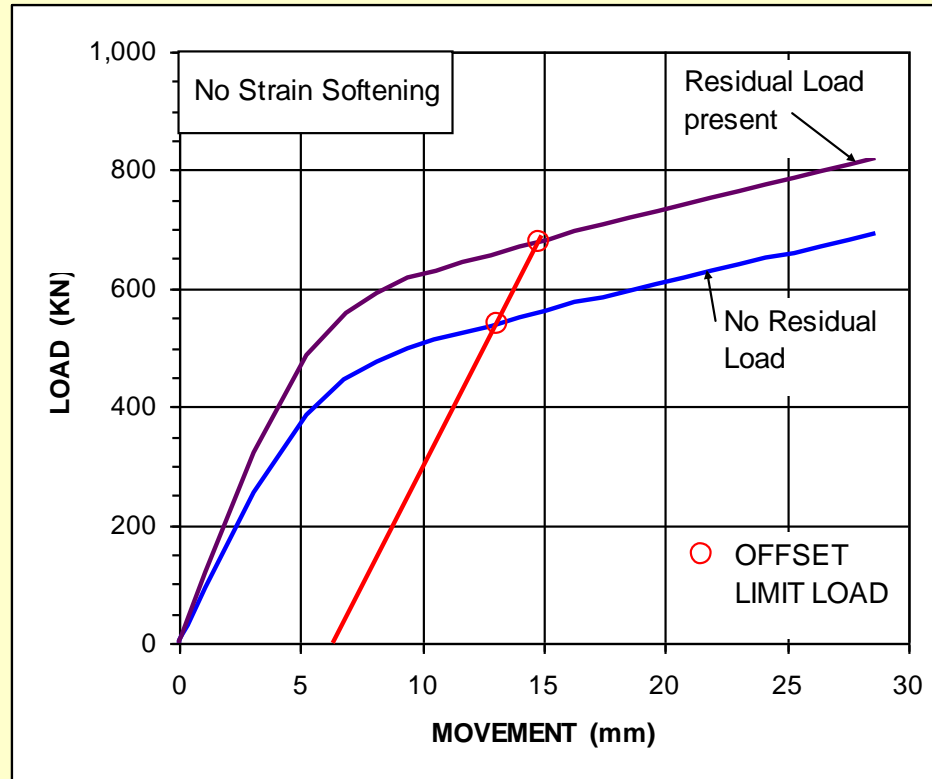


Distribution of residual load in Piles DA and BC before start of the loading test



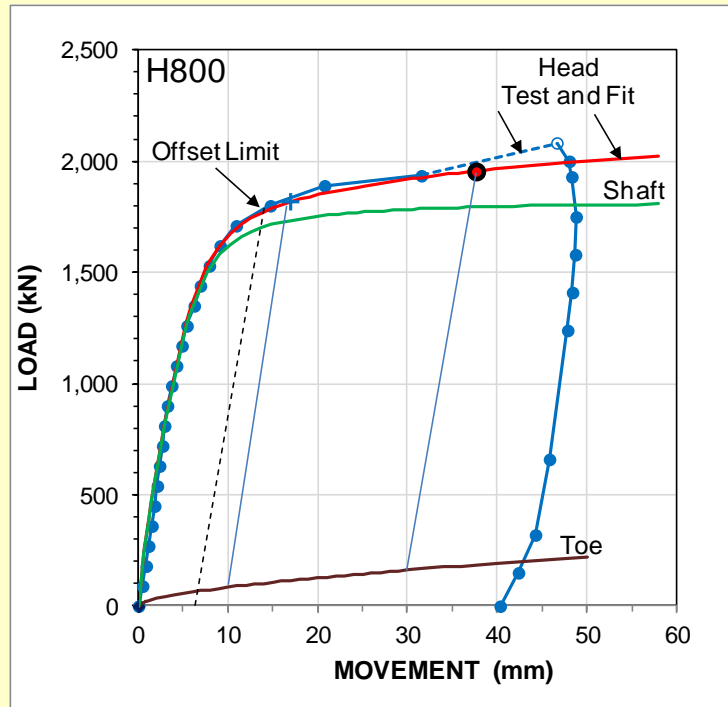
Load and resistance in Pile DA for the maximum test load

Presence of residual load is not just of academic interest

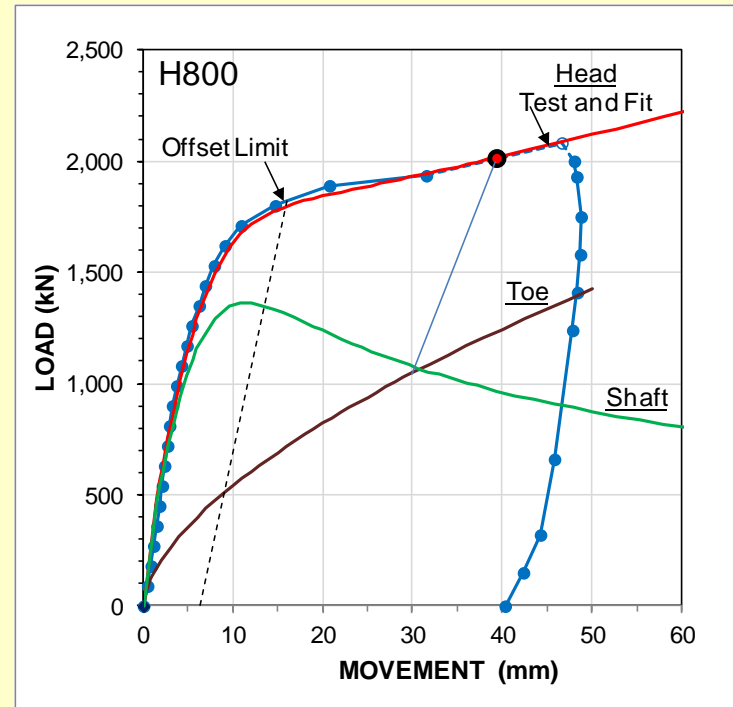


Separation of shaft and toe resistances

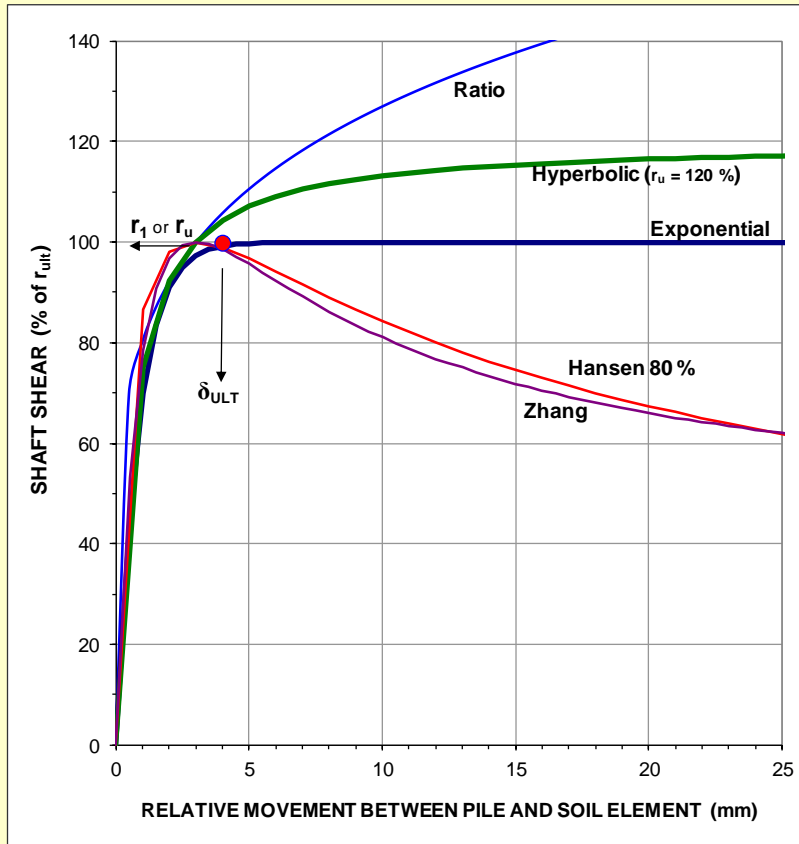
According to the Meyerhof et al.



More likely



t-z and q-z functions



Strain-hardening

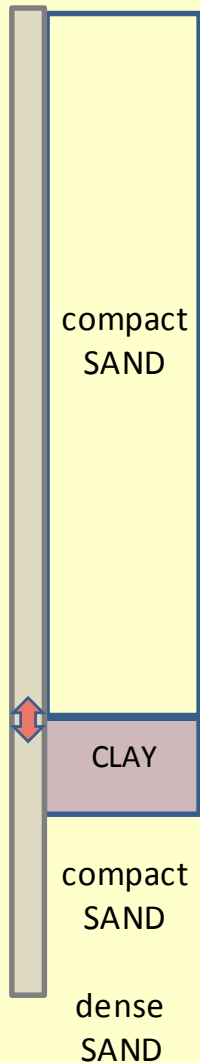
Elastic-plastic

Strain-softening

Note, the diagram assumes that all curves pass through the point for 100-% load and 5-mm movement. However, the movement can vary widely in a specific case .

Assigning applicable t-z and q-z functions is fundamental to the analysis and vital for determining pile response and achieving reliable design of piled foundations. Confidence in a design is obtained from back-analysis of results of static loading tests. Next is an example of such analysis

Analysis of the results of a bidirectional test on a 21 m long bored pile

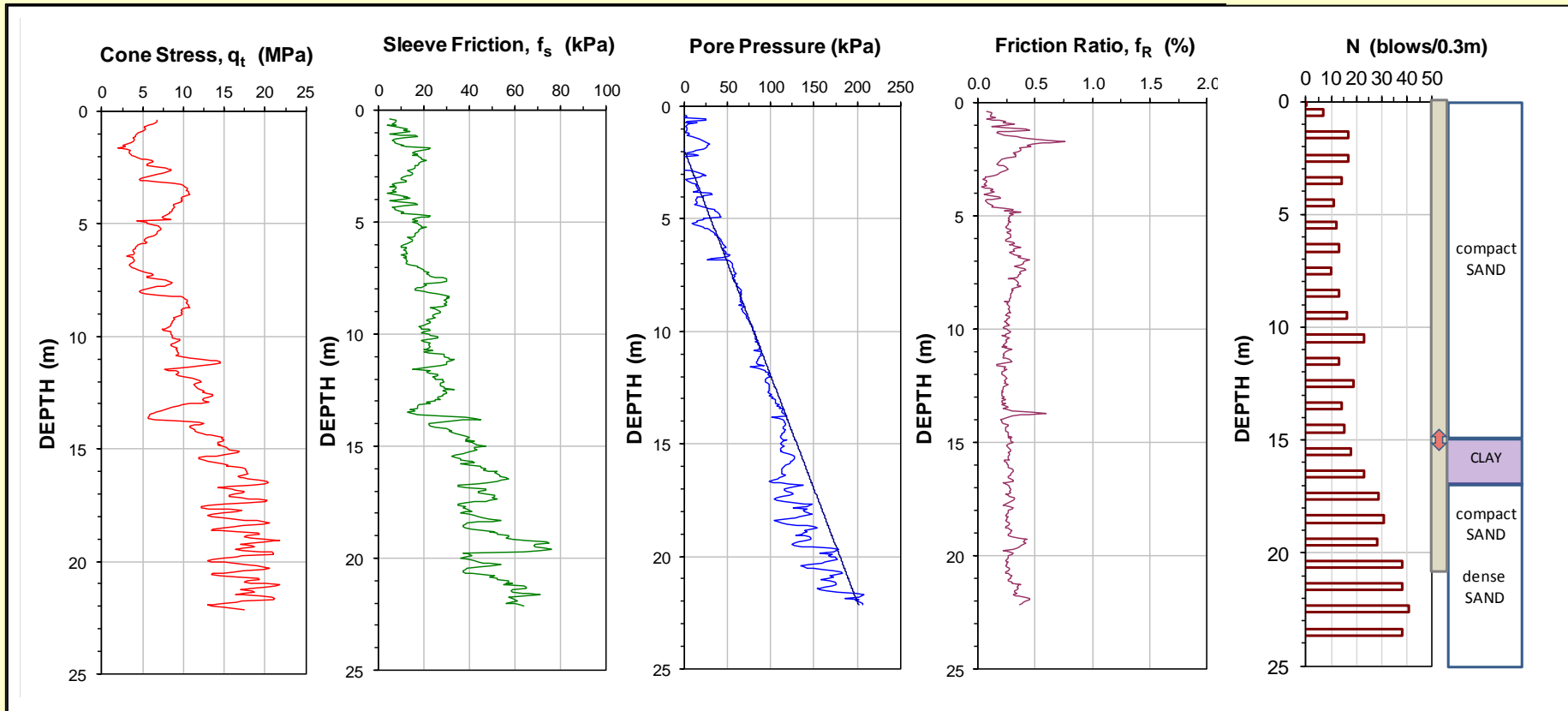


A bidirectional test was performed on a 500-mm diameter, 21 m long, bored pile constructed through compact to dense sand by driving a steel-pipe to full depth, cleaning out the pipe, while keeping the pipe filled with betonite slurry, withdrawing the pipe, and, finally, tremie-replacing the slurry with concrete. The bidirectional cell (BDC) was attached to the reinforcing cage inserted into the fresh concrete. The BDC was placed at 15 m depth below the ground surface.

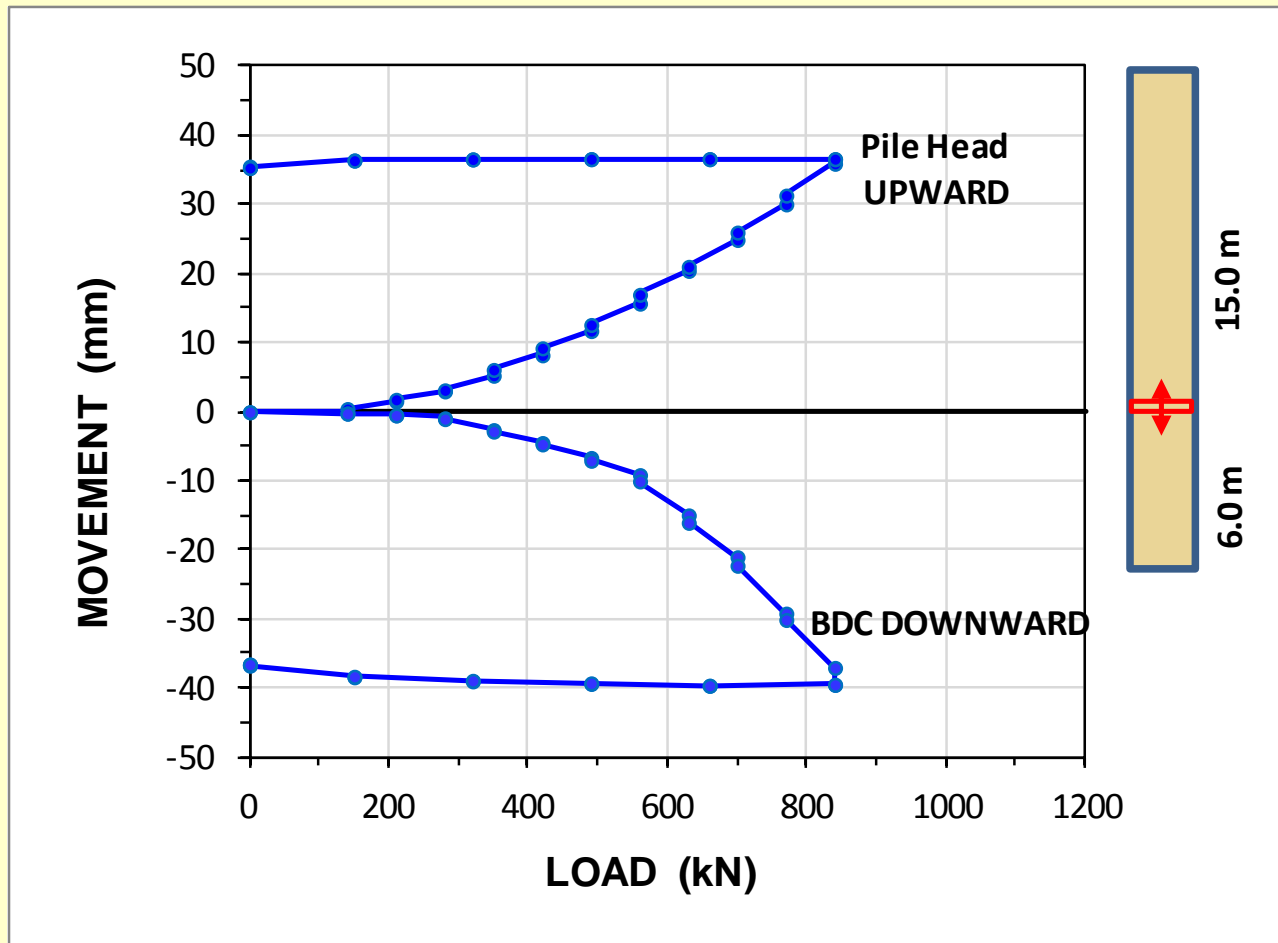
The pile will be one a group of 16 piles (4 rows by 4 columns) installed at a 4-diameter center-to-center distance. Each pile is assigned a working load of 1,000 kN.

The sand becomes very dense at about 35 m depth

The soil profile determined by CPTU and SPT

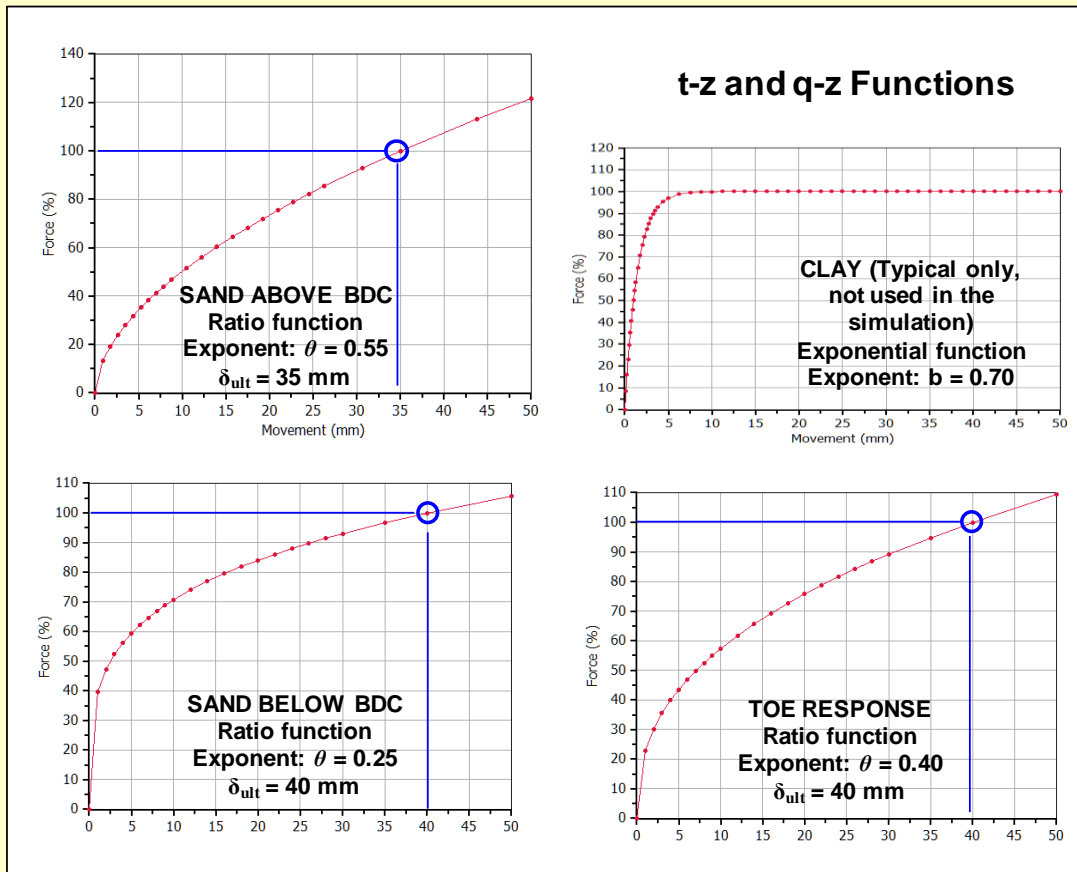


The results of the bidirectional test



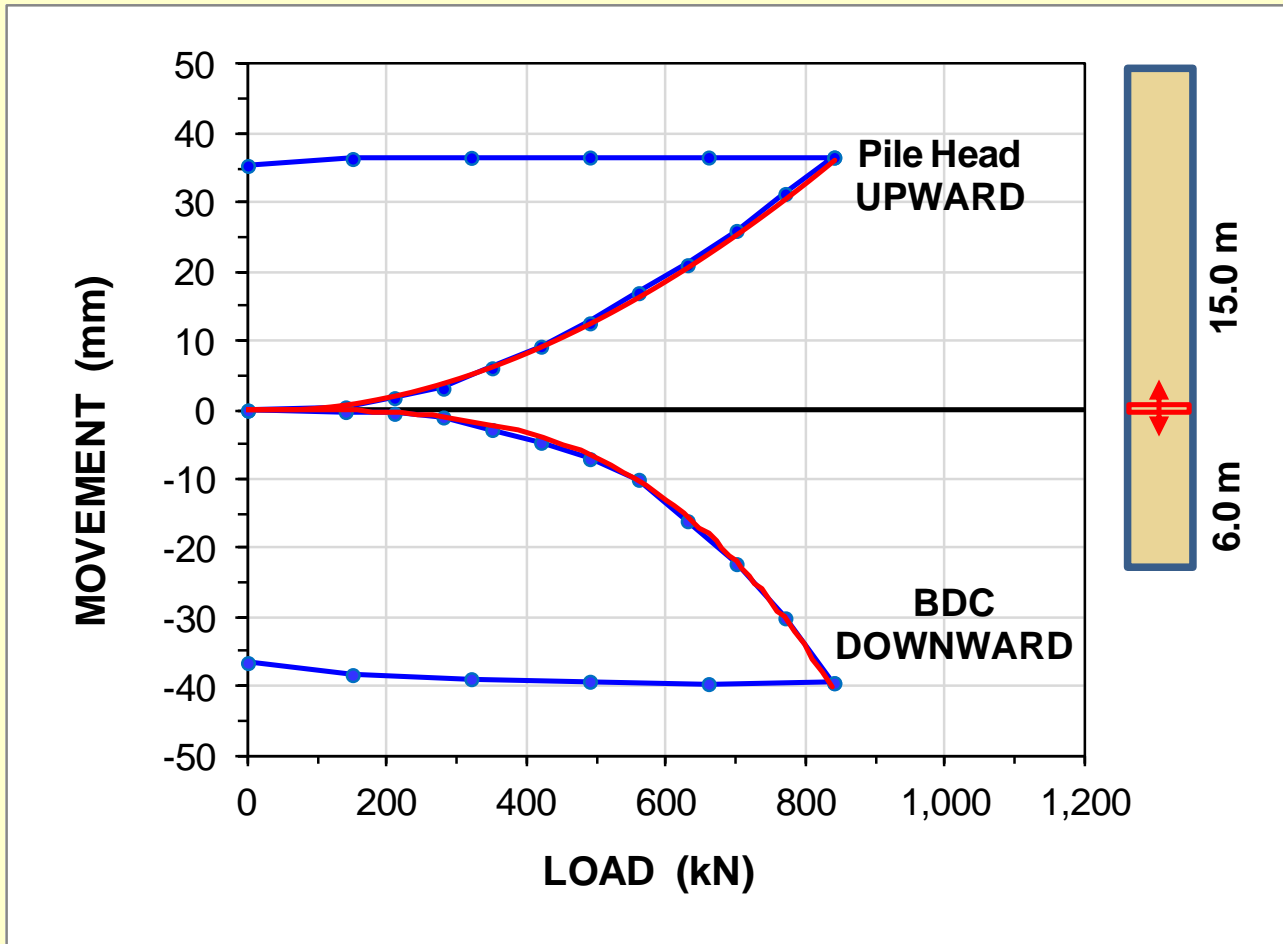
Acknowledgment: The bidirectional test data are courtesy of Arcos Engenharia de Solos Ltda., Belo Horizonte, Brazil.

To fit a simulation of the test to the results, first input is the effective stress parameter (β) that returns the maximum measured upward load (840 kN), which was measured at the maximum upward movement (35 mm). Then, “promising” t-z curves are tried until one is obtained that, for a specific coefficient returns a fit to the measured upward curve. Then, for the downward fit, t-z and q-z curves have to be tried until a fit of the downward load (840 kN) and the downward movement (40 mm) is obtained.

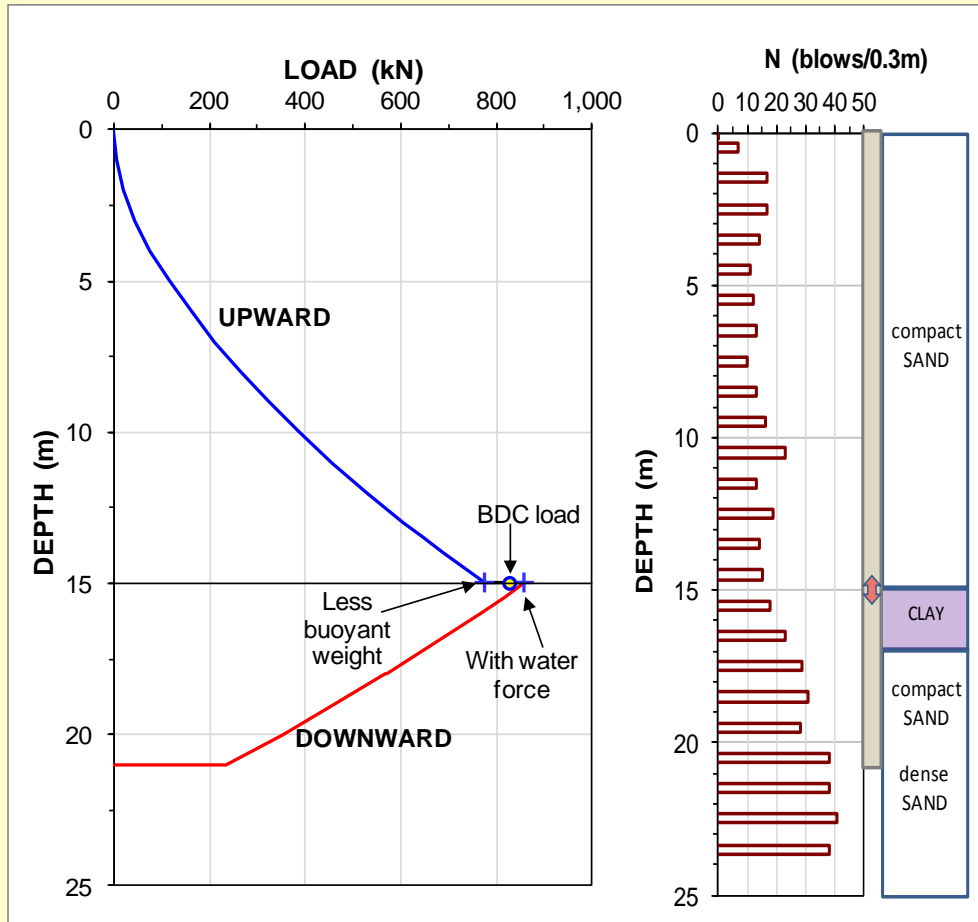


Usually for large movements, as in the example case, the t-z functions show a elastic-plastic response. However, for the example case, no such assumption fitted the results. In fact, the best fit was obtained with the Ratio Function for the entire length of the pile shaft.

The final fit of simulated curves to the measured

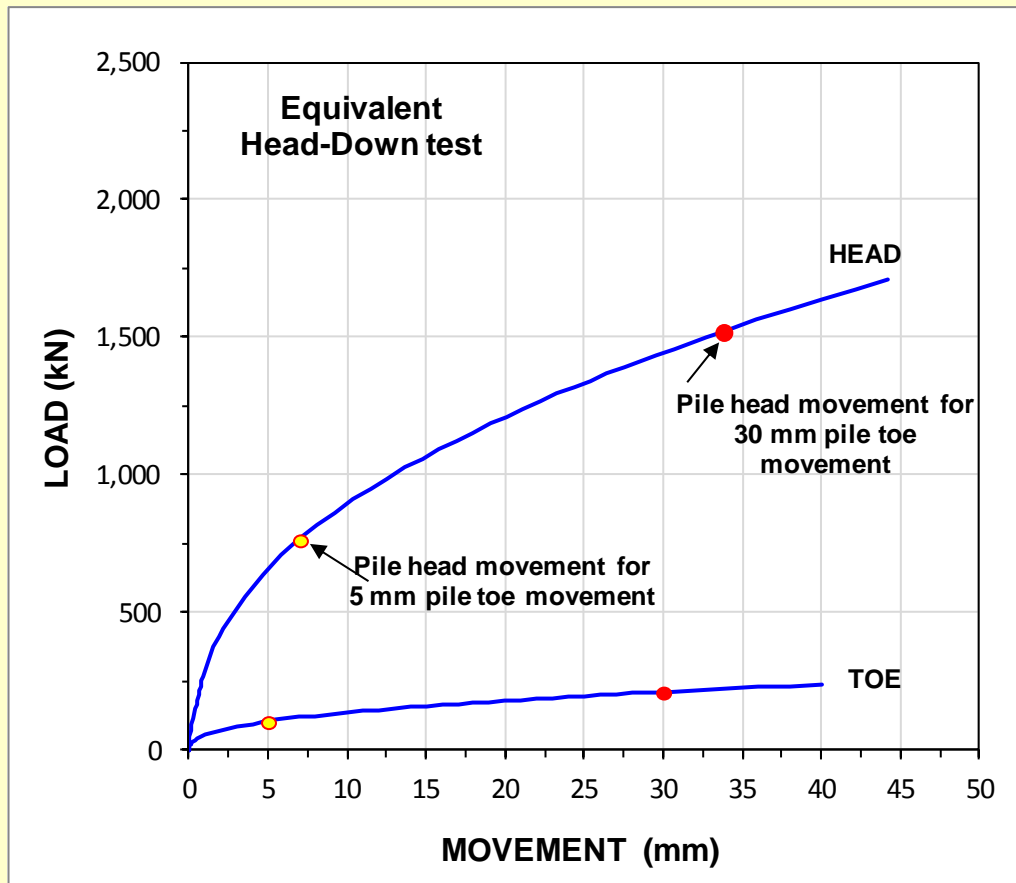


The test pile was not instrumented. Had it been, the load distribution of the bidirectional test as determined from the gage records, would have served to further detail the evaluation results. Note the below adjustment of the BDC load for the buoyant weight (upward) of the pile and the added water force (downward).



The analysis results appear to suggest that the pile is affected by a filter cake along the shaft and probably also a reduced toe resistance due to debris having collected at the pile toe between final cleaning and the placing of the concrete.

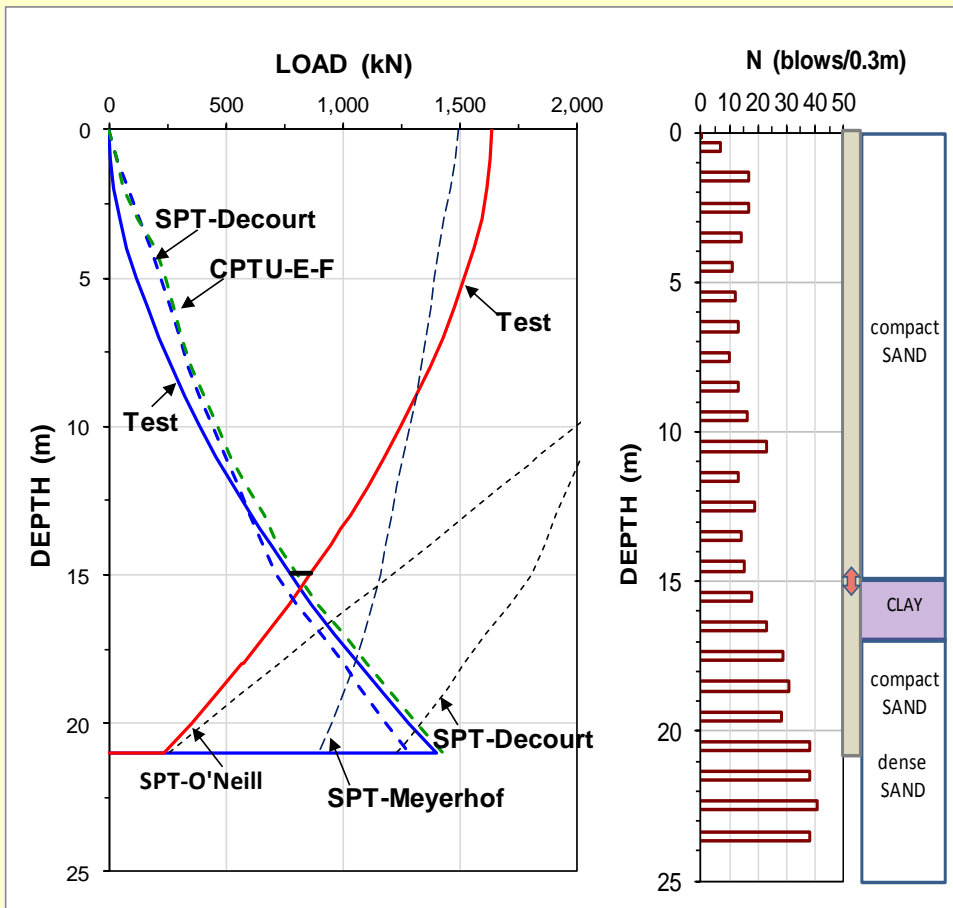
The final fit establishes the soil response and allows the equivalent head-down loading- test to be calculated



When there is no obvious point on the pile-head load-movement curve, the “capacity” of the pile has to be determined by one definition or other—there are dozens of such around. The first author prefers to define it as the pile-head load that resulted in a 30-mm pile toe movement. As to what safe working load to assign to a test, it often fits quite well to the pile head load that resulted in a 5-mm toe movement.

The most important aspect for a safe design is not the “capacity” found from the test data, but what the settlement of the structure supported by the pile(s) might be. How to calculate the settlement of a piled foundation is addressed a few slides down.

The final fit establishes also the equivalent head-down distributions of shaft resistance and equivalent head-down load distribution for the maximum load (and of any load in-between, for that matter). Load distributions have also been calculated from the SPT-indices using the Decourt, Meyerhof, and O'Neil-Reese methods, as well that from the Eslami-Fellenius CPTU-method.

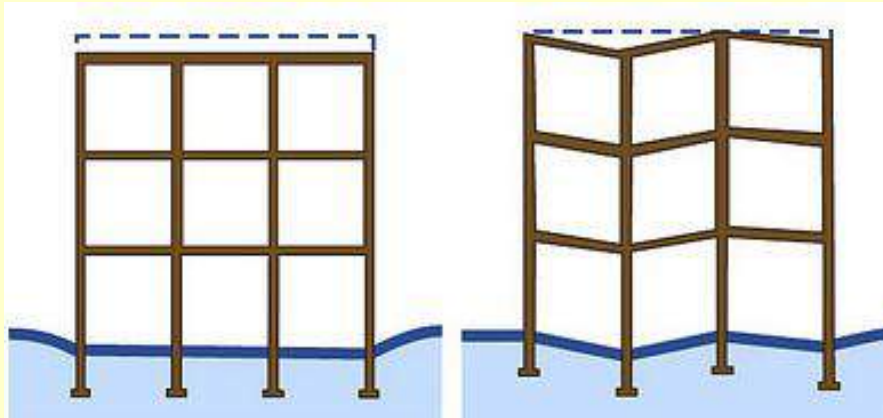


By fitting a UniPile simulation to the measured curves, we can determine all pertinent soil parameters, the applicable t-z and q-z functions, and the distribution of the equivalent head-down load-distribution. The results also enable making a comparison of the measured pile response to that calculated from the in-situ test methods.

However, capacity of the single pile is just one aspect of a piled foundation design. As mentioned, the key aspect is the foundation settlement.

Note, the analysis results suggest that the pile was more than usually affected by presence of a filter cake along the pile shaft and by some debris being present at the bottom of the shaft when the concrete was placed in the hole. An additional benefit of a UniPile analysis.

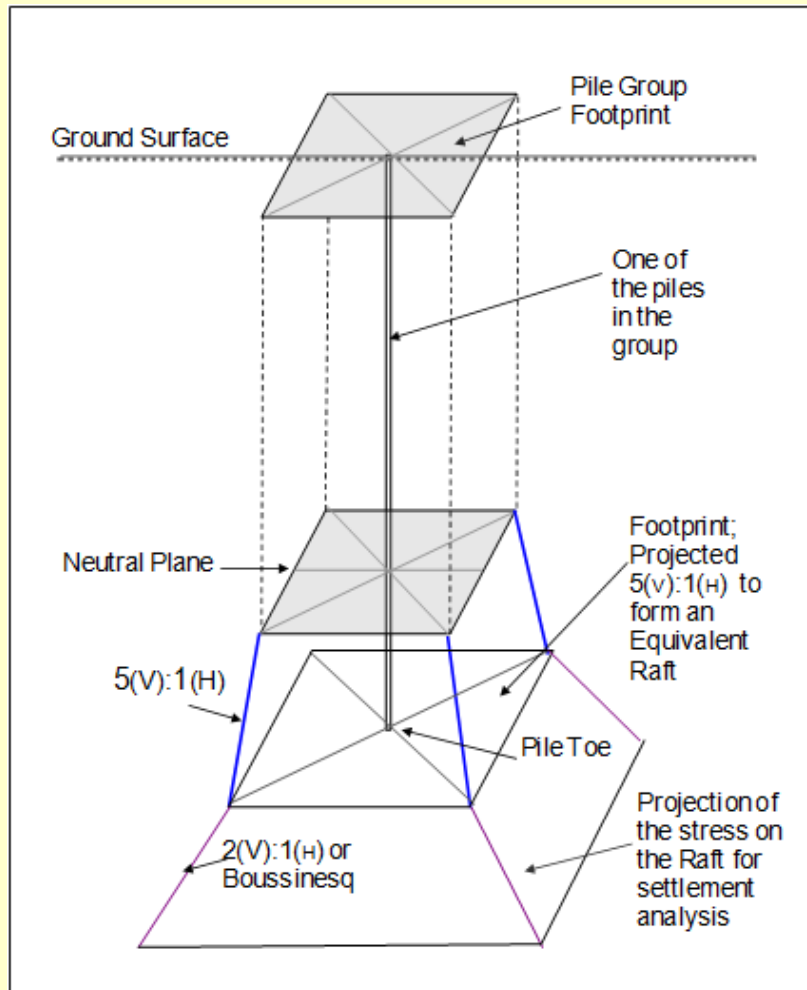
SETTLEMENT



Load placed on a pile causes downward movements of the pile head due to:

1. **'Elastic' compression** of the pile.
2. **Load transfer movement** -- the movement response of the soil.
3. **Settlement below the pile toe** due to the increase of stress in the soil. This is not important for single piles or small pile groups, but can be decisive for large pile groups, and where thick soil layers exist below the piles that receive increase of stress from sources other than the piles.

Settlement of a piled foundation



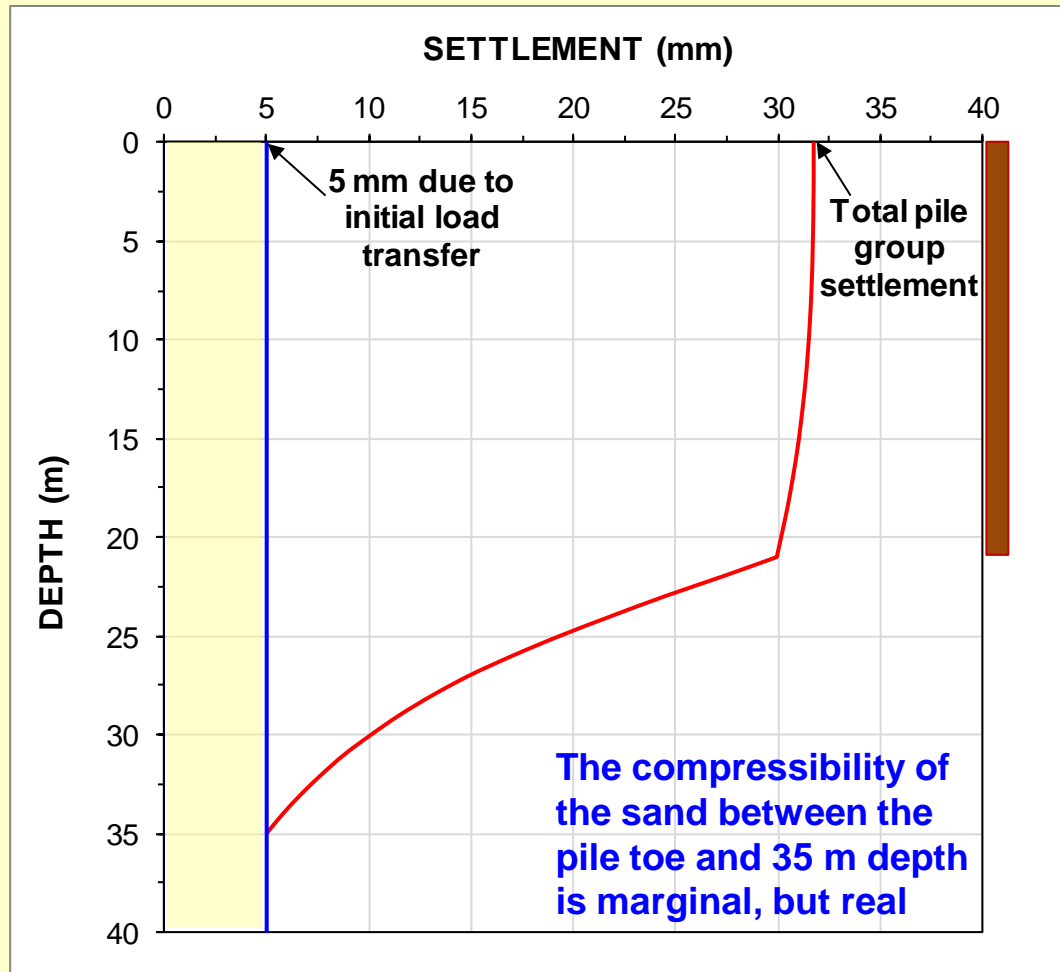
Distribution of stress for calculation of settlement

The depth to the Neutral Plane is 15.5 m. That depth is where the dead load applied to the pile starts to be distributed out into the soil.

The Unified Design Method developed by the first author considers this effect by widening the pile group foot-print area by a 5(V):1(H) from the N.P to the pile toe into an “Equivalent Raft” and applying the dead load to the raft.

Many other, very similar “Equivalent-Raft” approaches to calculating settlement of piled foundation are common in the industry. UniPile can also perform any such analysis as per the User preference and input.

The pile group (piled foundation) settlement as calculated by UniPile



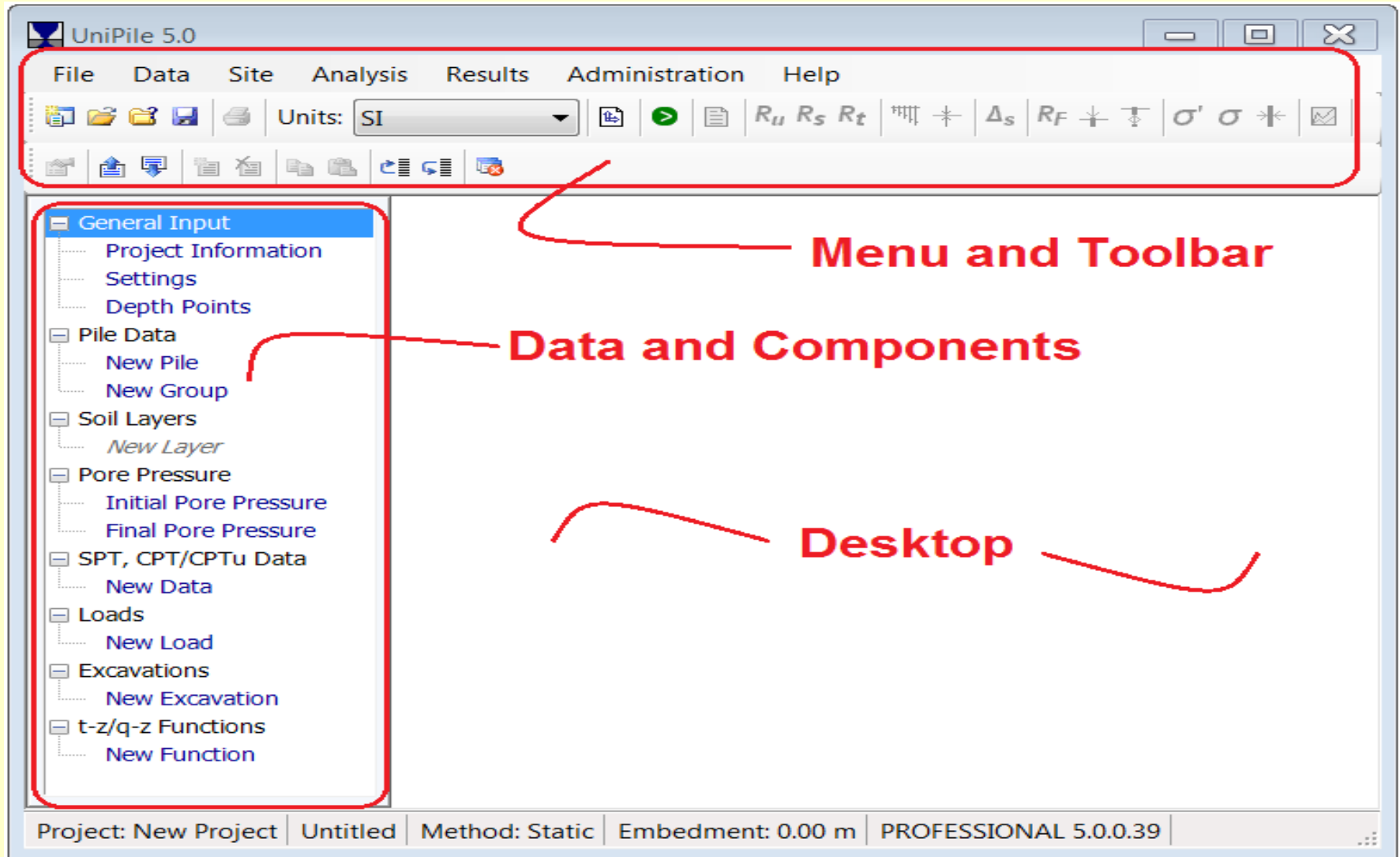
For settlement calculations that include aspects of time, i.e., consolidation and secondary compression, the analysis is best performed in UniSettle, UniPile's "companion".

Uni**Soft** GS
Geotechnical Solutions

Using UniPile 5.0

UniPile 5.0

UniPile 5.0 Interface



Project General Information

The screenshot displays the UniPile 5.0 software interface. The main window has a menu bar (File, Data, Site, Analysis, Results, Administration, Help) and a toolbar with various icons. A left-hand navigation pane lists several categories: General Input, Pile Data, Soil Layers, Pore Pressure, SPT, CPT/CPTu Data, Loads, Excavations, and t-z/q-z Functions. The 'Project Information' option under 'General Input' is selected and highlighted in blue. A red line connects this selection to a floating dialog box titled 'Project Information'. This dialog box contains a table with the following data:

Project	
Name	C.F.P.B. Bolivia - UniPile 5.0 Demonstration
Number	
Description	
Date	
Address	
Client	
Name	Classified
Contact	
Address	
Engineer	
Name	Pierre Goudreault, P.Eng.
Firm	UniSoft Geotechnical Solutions Ltd.
Department	

Below the table, the dialog box indicates a 'Custom' information category.

At the bottom of the software window, a status bar shows: Project: C.F.P.B. Bolivia - UniPile 5.0 Demonstration | CFPB Bolivia UniPile Demo.Unipile5 | Method: Static

Settings and Defaults

The screenshot shows a software interface with a left-hand navigation tree and a main settings window. The 'Settings' option in the tree is highlighted in blue. The main window, titled 'Settings', contains several sections:

- General Settings**
 - Water Density (kg/m³): 1,000
 - Gravity (m/s²): 9.81
- General Analysis**
 - Period: Final
 - Stress Distribution: Boussinesq
 - Pile Resistance Method: Static
- Residual Load**
 - Status: Disregard
- Loading Test Simulation**
 - Max. Toe Mvmt (mm): 40.0
 - Depth of Cell (m): 15.00
 - Shaft Buoyant Weight: Include
- Analysis Options**
 - Embedment vs Depth: Yes
 - Neutral Plane vs D.L.: Yes
 - Pile Settlement: Yes
 - Head-Down Loading Test: Yes
 - Bidirectional Loading Test: Yes

A dropdown menu is open for the 'Pile Resistance Method' field, showing the following options: Static (selected), Eslami & Fellenius (CPTu), Schmertmann & Nottingham (CPT), deRuiter & Beringen - Dutch (CPT), Bustamente - LCPC (CPT), Meyerhof (SPT), Decourt (SPT), and O'Neill & Reese (SPT).

Additional Depth Points

The screenshot shows a software interface with a left sidebar and a main dialog box. The sidebar contains a tree view with the following items:

- General Input
 - Project Information
 - Settings
 - Depth Points**
- Pile Data
 - New Pile
 - New Group
- Soil Layers
 - New Layer*
- Pore Pressure
 - Initial Pore Pressure
 - Final Pore Pressure
- SPT, CPT/CPTu Data
 - New Data
- Loads
 - New Load
- Excavations
 - New Excavation
- t-z/q-z Functions
 - New Function

The main dialog box is titled "Depth Points" and has a close button (X) in the top right corner. Below the title bar is a toolbar with four icons: a plus sign with a horizontal line through it, a plus sign, a multiplication sign, and a division sign. Below the toolbar is a section titled "Additional Depths, Z" which contains a table with two columns: "Depth, Z (m)" and "Description". The table has one row with the value "1." in the first column and "0.00" in the second column. Below the table is a section titled "Depth, Z (m)" with the text "User defined depth, Z".

Pile Properties and Geometry

The screenshot displays a software interface for defining pile properties. On the left is a tree view with categories like 'General Input', 'Pile Data', 'Soil Layers', etc. The 'Bolivia Demo Pile' is selected under 'Pile Data'. The main window shows a table of properties for this pile, with red boxes highlighting the title bar and two sections of the table.

Pile: Bolivia Demo Pile	
General	
Name	Bolivia Demo Pile
Description	21 m, 500 mm Dia. Concrete Pile
X Coordinate (m)	0.00
Y Coordinate (m)	0.00
Dead Load (kN)	1,000.0
Live Load (kN)	0.0
Transition Height (m)	0.00
Pile Density (kg/m ³)	2,400
Geometry	
Longitudinal Profile	Uniform
Cross-Section	Round
Embedment, D (m)	21.00
Diameter, b (mm)	500
Toe Area, A _t (m ²)	0.1963
Modulus, E (MPa)	30,000

Pile Group Properties and Geometry (For Pile Group Settlement Analysis)

The screenshot displays a software interface for configuring a pile group. The left sidebar shows a tree view with '16-Pile Group' selected. The main window, titled 'Pile Group: 16-Pile Group', shows the following properties and geometry:

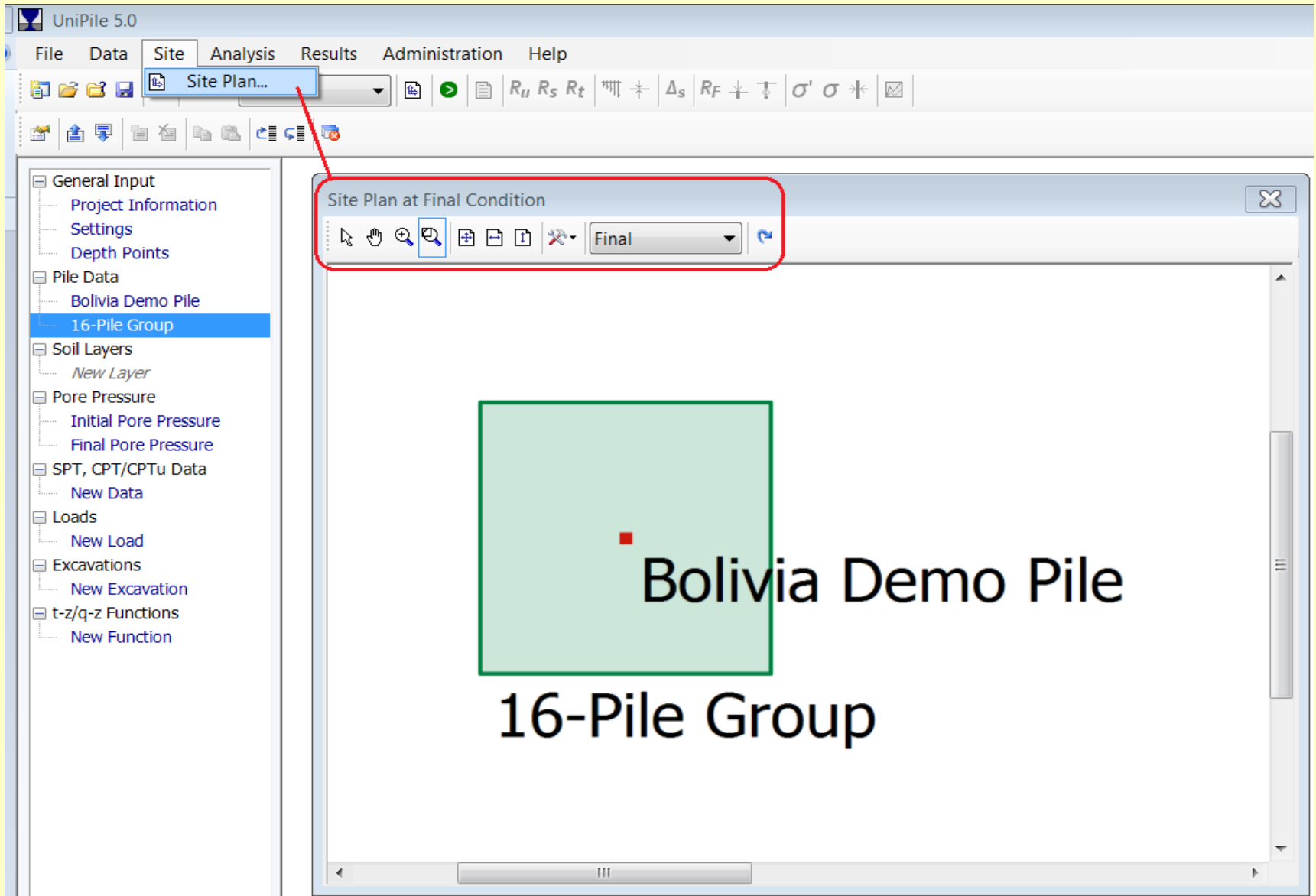
General	
Name	16-Pile Group
Description	Pile Group Foot Print

Properties	
Total Dead Load (kN)	16,000.0
Equivalent Raft	Neutral plane
Shape	Rectangle

Geometry	
Breadth, B (m)	12.00
Length, L (m)	12.00

	x (m)	y (m)
1.	0.00	0.00

Project Site Plan View

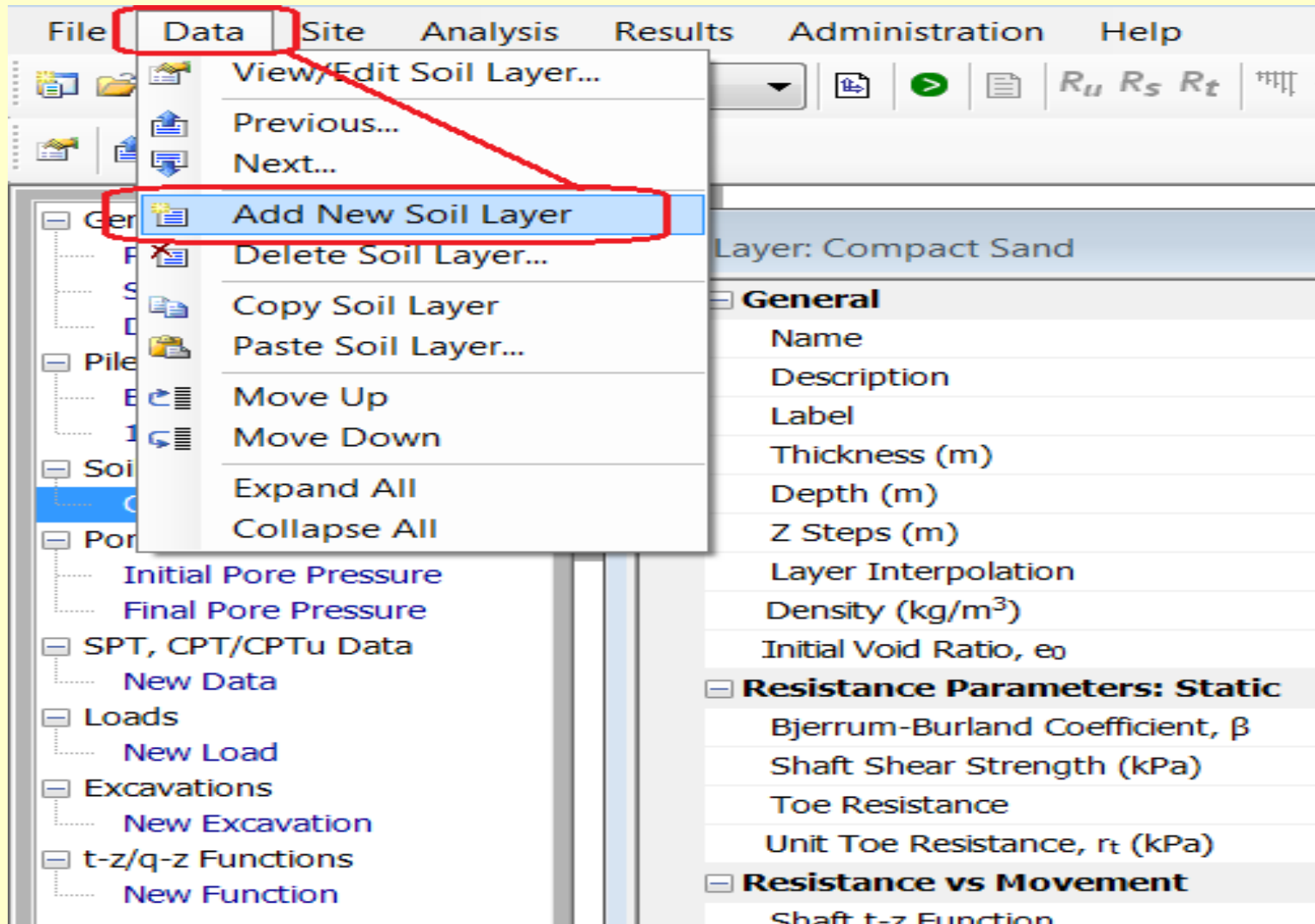


Soil Layer(s) Input

The screenshot displays a software interface for defining soil layers. On the left, a tree view shows the project structure, with 'Soil Layers' expanded and 'Compact Sand (15m)' selected. The main window, titled 'Soil Layer: Compact Sand (15m)', contains the following input fields:

Parameter	Value
General	
Name	Compact Sand (15m)
Description	
Label	
Thickness (m)	15.00
Depth (m)	15.00
Z Steps (m)	1.00
Layer Interpolation	Use layer average values
Density (kg/m ³)	2,000
Initial Void Ratio, e ₀	0.000
Resistance Parameters: Static	
Bjerrum-Burland Coefficient, β	0.300
Shaft Shear Strength (kPa)	0.0
Toe Resistance	Use unit resistance, r _t
Unit Toe Resistance, r _t (kPa)	20.0
Resistance vs Movement	
Shaft t-z Function	New Function
Toe q-z Function	New Function
Compressibility	
Compressibility	Janbu j and modulus number
Stress Exponent, j	1.00 - Elastic response soils
Preconsolidation Parameter	Use preconsolidation margin, $\Delta\sigma'$
Preconsolidation Margin, $\Delta\sigma'$ (kPa)	0.0
Virgin Modulus Number, m	300.0
Recompression Modulus Number, m _r	300.0

Add New Soil Layer



New Soil Layer Input

Units: SI

Soil Layer: Compact Sand (18 m)

General	
Name	Compact Sand (18 m)
Description	
Label	
Thickness (m)	18.00
Depth (m)	35.00
Z Steps (m)	1.00
Layer Interpolation	Use layer average values
Density (kg/m ³)	2,000
Initial Void Ratio, e ₀	0.000
Resistance Parameters: Static	
Bjerrum-Burland Coefficient, β	0.300
Shaft Shear Strength (kPa)	0.0
Toe Resistance	Use resistance coefficient, N _t
Bearing Coefficient, N _t	30.0
Resistance vs Movement	
Shaft t-z Function	New Function
Toe q-z Function	New Function
Compressibility	
Compressibility	Janbu j and modulus number
Stress Exponent, j	1.00 - Elastic response soils
Preconsolidation Parameter	Use preconsolidation margin, $\Delta\sigma'$
Preconsolidation Margin, $\Delta\sigma'$ (kPa)	0.0
Virgin Modulus Number, m	400.0
Recompression Modulus Number, m _r	400.0

Enter Pore Pressures

The screenshot displays a software interface for entering pore pressures. On the left, a tree view shows the following structure:

- General Input
 - Project Information
 - Settings
 - Depth Points
- Pile Data
 - Bolivia Demo Pile
 - 16-Pile Group
- Soil Layers
 - Compact Sand (15m)
 - Clay (2m)
 - Compact Sand (18 m)
- Pore Pressure
 - Initial Pore Pressure** (highlighted)
 - Final Pore Pressure
- SPT, CPT/CPTu Data
 - New Data

The main window shows a dialog box titled "Pore Pressure: Initial Pore Pressure". The dialog contains a table with the following data:

General	
Name	Initial Pore Pressure
Description	
Period	Initial
Profile Type	Hydrostatic
Hydrostatic Profile	
G.W.T. Depth (m)	4.00

Import CPT, CPTu, SPT Data

File Data Site Analysis Results Administration Help

- New Project... Ctrl+N
- Open Project... Ctrl+O
- Recent Projects...
- Save... Ctrl+S
- Save As...
- Import Unisort Files...
- Import SPT and CPT/CPTu Data...**
- Export...
- Page Setup...
- Printer Setup...
- Print Bolivia Demo CPTu + SPT N.txt... Ctrl+P
- Exit... Ctrl-X

Import Standard/Cone Penetration Data

File Format

Number of Header Rows: 2 rows

Numerical Format: ####.##

Data Delimiter: Tab

Treat consecutive delimiters as one

Records Capture: All Records

Cone Penetration Data

Depth: Col 1 m

Cone Stress, qc: Col 2 bar

Sleeve Friction, fs: Col 3 bar

Pore Pressure, U2: Col 4 m of water

Standard Penetration Data

N-Index: Col 5

R...	File Content
1	Depth qc fs U2
2	m bar bar m
3	0.00 0.00 0.00
4	0.40 67.75 0.05
5	0.45 67.44 0.08
6	0.50 66.28 0.08
7	0.55 63.60 0.07
8	0.60 56.82 0.06
9	0.65 52.92 0.08
10	0.70 51.04 0.04

Show Space character as • Show Tab character as »

CPT, CPTu, SPT Data

The screenshot displays a software interface with a left-hand navigation tree and a main data view. The navigation tree includes categories like 'General Input', 'Pile Data', 'Soil Layers', 'Pore Pressure', 'SPT, CPT/CPTu Data', 'Loads', 'Excavations', and 't-z/q-z Functions'. The 'SPT, CPT/CPTu Data' category is expanded, and 'Bolivia Demo CPTu + SPT N.txt' is selected. The main view shows a window titled 'Bolivia Demo CPTu + SPT N.txt' with a 'General' section containing a table of parameters and a 'Standard/Cone Penetration Data' section containing a table of depth-based data. Red circles highlight the file name in the window title, the 'Shoulder Area Ratio, a' value of 0.800, and the selected file in the navigation tree.

General

Name	Bolivia Demo CPTu + SPT N.txt
Description	
Shoulder Area Ratio, a	0.800

Standard/Cone Penetration Data

	Depth, d (m)	qc (kPa)	fs (kPa)	U2 (kPa)
1.	0.000	0.000	0.000	0.000
2.	0.400	6,775.000	5.000	0.294
3.	0.450	6,744.000	8.000	2.060
4.	0.500	6,628.000	8.000	0.098
5.	0.550	6,360.000	7.000	24.721
6.	0.600	5,682.000	6.000	23.838
7.	0.650	5,292.000	8.000	2.354
8.	0.700	5,194.000	4.000	0.589
9.	0.750	5,249.000	7.000	13.440
10.	0.800	5,432.000	10.000	3.826
11.	0.850	5,280.000	13.000	2.354
12.	0.900	4,938.000	11.000	1.570
13.	0.950	4,462.000	14.000	2.551
14.	1.000	4,218.000	10.000	3.041
15.	1.050	4,163.000	5.000	1.864
16.	1.100	4,122.000	10.000	0.000

Enter Loads and Excavations

General Input

- Project Information
- Settings
- Depth Points

Pile Data

- Bolivia Demo Pile
- 16-Pile Group

Soil Layers

- Compact Sand (15m)
- Clay (2m)
- Compact Sand (18 m)

Pore Pressure

- Initial Pore Pressure
- Final Pore Pressure

SPT, CPT/CPTu Data

- Bolivia Demo CPTu - SPT N.txt

Loads

- Berm**

Excavations

- New Excavation

t-z/q-z Functions

- New Function

Load: Berm

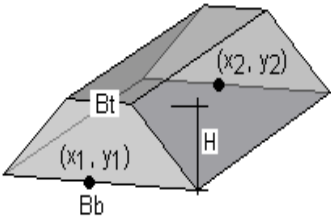
General

Name	Berm
Description	
Period	Final
Status	Disable
Shape	Embankment - Symmetrical

Geometry

Depth, Z (m)	
Breadth, B _t (m)	
Breadth, B _b (m)	
Height, H (m)	
Density (kg/m ³)	

	x (m)	y (m)
1.	20.00	-100.00
2.	20.00	100.00



Define t-z and q-z Functions

General Input

- Project Information
- Settings
- Depth Points

Pile Data

- Bolivia Demo Pile
- 16-Pile Group

Soil Layers

- Compact Sand (15m)
- Clay (2m)
- Compact Sand (18 m)

Pore Pressure

- Initial Pore Pressure
- Final Pore Pressure

SPT, CPT/CPTu Data

- Bolivia Demo CPTu + SPT N.txt

Loads

- Berm

Excavations

- New Excavation

t-z/q-z Functions

- Compact Sand (0 - 15m)

t-z/q-z Function: Compact Sand (0 - 15m)

General	
Name	Compact Sand (0 - 15m)
Description	
Model	Ratio
Maximum X-Axis Value (mm)	50.0

Model Parameters	
Movement at r_u, δ_u (mm)	35.0
Ratio Exponent	0.550

Ratio

- Ratio
- Chin-Kondner Hyperbolic
- Exponential
- Hansen 80%
- Zhang
- User defined

Ratio Exponent
Exponent used in Ratio function

**Compact Sand (0 - 15m)
Ratio Function**

Movement (mm)	Force (%)
0	0
5	35
10	50
15	60
20	70
25	80
30	90
35	100
40	110
45	115
50	125

Apply t-z and q-z to Soil Layer(s)

General Input

- Project Information
- Settings
- Depth Points

Pile Data

- Bolivia Demo Pile
- 16-Pile Group

Soil Layers

- Compact Sand (15m)
- Clay (2m)
- Compact Sand (18m)**

Pore Pressure

- Initial Pore Pressure
- Final Pore Pressure

SPT, CPT/CPTu Data

- Bolivia Demo CPTu + SPT N.txt

Loads

- Berm

Excavations

- New Excavation

t-z/q-z Functions

- Shaft: Compact Sand (0 - 15m)
- Shaft: Clay (15m-17m)
- Shaft: Compact Sand (17m - 35m)
- Toe
- N/A

Soil Layer: Compact Sand (18m)

General

Name	Compact Sand (18m)
Description	
Label	
Thickness (m)	18.00
Depth (m)	35.00
Z Steps (m)	1.00
Layer Interpolation	Use layer a
Density (kg/m ³)	2,000
Initial Void Ratio, e ₀	0.000

Resistance Parameters: Static

Bjerrum-Burland Coefficient, β	0.300
Shaft Shear Strength (kPa)	0.0
Toe Resistance	Use resistance coefficient, N _t
Bearing Coefficient, N _t	30.0

Resistance vs Movement

Shaft t-z Function	Shaft: Compact Sand (17m - 35m)
Toe q-z Function	Toe

Compressibility

Compressibility	Janbu j and modulus number
Stress Exponent, j	1.00 - Elastic response soils
Preconsolidation Parameter	Use preconsolidation margin, $\Delta\sigma'$
Preconsolidation Margin, $\Delta\sigma'$ (kPa)	0.0
Virgin Modulus Number, m	400.0
Recompression Modulus Number, m _r	400.0

Dropdown menu options:

- Shaft: Compact Sand (17m - 35m)
- Shaft: Compact Sand (0 - 15m)
- Shaft: Clay (15m-17m)
- Shaft: Compact Sand (17m - 35m)**
- Toe
- N/A

YES! But Does It Work?

- **Static vs CPT, CPTu, SPT Analysis**
- **Embedment Analysis**
- **Add Transition Zone**
- **Pile group Settlement Analysis**
- **Head-Down Loading Test Simulation**
- **Bidirectional Loading Test Simulation**

But What If?

- **Non-Hydrostatic Pore Pressure**
- **Loads and Excavations are included**
- **Expanded-Base Pile**
- **Export results to Excel**

*Thank you for your
attention*

We'd welcome your questions