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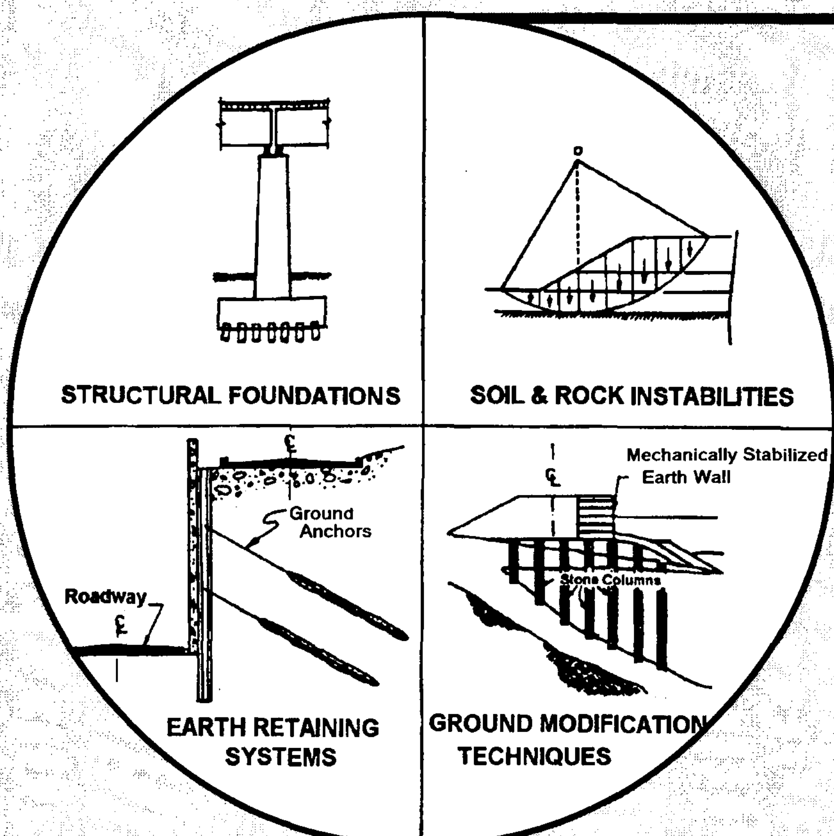
DRIVEN 1.0 User's Manual

A Program for Determining Ultimate Vertical Static Pile Capacity



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16. Abstract

The purpose of this manual is to provide instruction on the use of the computer program DRIVEN. This manual details the installation procedure, provides narration for each user input and output screen, discusses the engineering background used in the analytical development of the program, presents example problems, and finally provides a detailed description of the driveability analysis. This program is a significant step forward in pile design computing capability for the engineer. Please take the time to completely read through this manual. Only by reading through this manual can the DRIVEN software be utilized to its full potential.

The DRIVEN program follows the methods and equations presented by Nordlund (1963, 1979), Thurman (1964), Meyerhof (1976), Cheney and Chassie (1982), Tomlinson (1980, 1985), and Hannigan, et.al. (1997). The Nordlund and Tomlinson static analyses methods used by the program are semi-empirical methods and have limitations in terms of correlations with field measurements and pile variables which can be analyzed. The user is encouraged to review further information on this subject in the "Design and Construction of Driven Pile Foundations" manual (Hannigan, et.al. 1997).

Although DRIVEN has been completely rewritten from the ground up, its legacy lies in the SPILE program. Clearly, the most visible change is the move to a Windows based environment. The SPILE program was also developed by the FHWA and released in 1993. In SPILE, the user entered a soil profile to a planned pile toe depth and "ran" the program for the results of this input. When using the DRIVEN program, the user enters the entire sampled soil profile to the full depth of the profile. Based upon this input, DRIVEN will calculate pile capacities at predetermined depth intervals. This allows the user to view the pile capacity as a function of depth. There are many other new features that have been added. These options are discussed in full detail within the user's manual.

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INTRODUCTION

The purpose of this manual is to provide instruction on the use of the computer program DRIVEN. This manual details the installation procedure, provides narration for each user input and output screen, discusses the engineering background used in the analytical development of the program, presents example problems, and finally provides a detailed description of the driveability analysis. This program is a significant step forward in pile design computing capability for the engineer. Please take the time to completely read through this manual. Only by reading through this manual can the DRIVEN software be utilized to its full potential.

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The application of this software product is the responsibility of the user. It is imperative that the responsible engineer understands the potential accuracy limitations of the program results, independently cross checks those results with other methods, and examines the reasonableness of the results with engineering knowledge and experience. There are no expressed or implied warranties.

New DRIVEN Features

Although DRIVEN has been completely rewritten from the ground up, its legacy lies in the SPILE program. Clearly, the most visible change is the move to a Windows based environment. The SPILE program was also developed by the FHWA and released in 1993. In SPILE, the user entered a soil profile to a planned pile toe depth and "ran" the program for the results of this input. When using the DRIVEN program, the user enters the entire sampled soil profile to the full depth of the profile. Based upon this input, DRIVEN will calculate pile capacities at predetermined depth intervals. This allows the user to view the pile capacity as a function of depth. There are many other new features that have been added. They are discussed below. These options are discussed in full detail within the user's manual.

Multiple Water Tables

Support for three water tables is now included. One water table at the time of sampling, another water table for restrike/driving considerations, and one water table for ultimate capacity considerations.

Soft Compressible Soils/Negative Skin Friction

The user may specify the depth of a soft compressible soil layer at the top of the soil profile. For ultimate calculations, the shaft resistance from this layer can be considered in two different ways, as soft compressible soil or as negative skin friction. If the shaft resistance is considered to be soft compressible soil, the skin friction for this layer is not include in the ultimate skin friction capacity. If the resistance is negative skin friction, the skin friction from this layer is considered to be negative and is subtracted from the total skin friction for ultimate capacity computations. See Chapter 3 for a detail discussion on how the DRIVEN program calculates the ultimate capacity with soft compressible soils/negative skin friction conditions.

Scourable Soils

There are two kinds of scour conditions that the DRIVEN program can consider: short term (local) and long term (channel degradation and contraction) scour. In both cases, there is considered to be no shaft resistance. For the case of short term scour, the weight of the soil is still considered in the effective stress computation. For long term scour, the weight of the soil is not considered when computing effective stress. See Chapter 3 for a detail discussion on how the DRIVEN program calculates the ultimate capacity with scour conditions.

Open End Pipe Piles

The DRIVEN program supports the use of open-end pipe piles in its static analyses. For a detailed background on how DRIVEN computes open-end pipe pile capacities, refer to Chapter 7. This chapter provides comprehensive coverage of the engineering aspects of the DRIVEN software.

Capacities

The DRIVEN program computes three sets of capacities for three different conditions: *restrike*, *driving*, and *ultimate*.

Restrike

Restrike computes static skin and end bearing resistance for the entire soil profile. Restrike computations do not consider the effects of soft soils or scour conditions.

Driving

The user may enter a loss of soil strength in the soil profile for each soil layer due to the effects of driving. The driving computations are based upon the restrike calculations minus the soil strength loss due to driving.

Ultimate

Ultimate capacity computations consider the effects of soft soil conditions or scour. Hence, this is the ultimate capacity available to resist applied loads.

Output

The DRIVEN program presents the output in both tabular and graphical format. In the tabular format, the user can inspect each set of computations (restrike, driving, and ultimate) individually. The program presents each analysis depth in the profile with some of the contributing factors along with the skin, end, and total resistance. In graphical format, the program allows the user to select between the three sets of computations. The graphs plot the depth versus capacity for the skin, end, and total resistance. The tabular results may be printed using the report button, while the graphical output can be either printed or sent to the Windows clipboard.

Units

DRIVEN includes support of both English and SI units. While using the program, the appropriate units for each data entry field are shown. If desired, the user can change the unit system for a project at any time and the DRIVEN program will convert all the input and output parameters to the new unit system.

Driveability

Finally, DRIVEN will prepare a partial driveability file for use by the GRLWEAP software. DRIVEN requests a few input parameters from the user then generates a data file that contains the soil and pile data that can be used by the GRLWEAP software to perform a driveability study. Please see chapter 5 for a more detailed explanation.

New Windows Users

An important note about the user's manual: The DRIVEN project was begun prior to the release of the Windows 95 operating system. Therefore, the DRIVEN software was written for the Microsoft Windows 3.1 operating environment. In August of 1995, Windows 95 was released. Windows 95 is backward compatible with Windows 3.1 programs, and therefore, the DRIVEN software will correctly run under it. Because of the timing of the release of DRIVEN relative to the release of Windows 95 all of the screen shots in this manual were taken under Windows 95 in recognition of the transition from Windows 3.1 to Windows 95 that is currently taking place in the computer industry.

Portions of the engineering background chapter of this manual were adapted from the Federal Highway Administration Publication No. FHWA-SA-92-044, "SPILE: A Microcomputer Program for Determining Ultimate Vertical Static Pile Capacity".

CHAPTER 1 - INSTALLING THE DRIVEN SOFTWARE

The minimum system requirements for using the DRIVEN software are:

- IBM PC or 100% compatible
- 386 25MHz processor
- 4 MB RAM
- Hard Disk with 6 MB of space available
- 100% Microsoft compatible mouse
- Windows 3.1 (or later)

1. Make sure that Windows 3.1 (or later) is running (setup cannot be run from DOS).
2. Insert the first distribution disk into the floppy drive.
3. From the Program Manager run the "Setup.exe" program on the floppy disk, or Start → Run in Windows 95. When this program is run, the screen will show a blue background with the prompt shown in figure 1-1. To continue with the installation, press the button labeled "Continue"; otherwise press "Exit" to stop the installation.

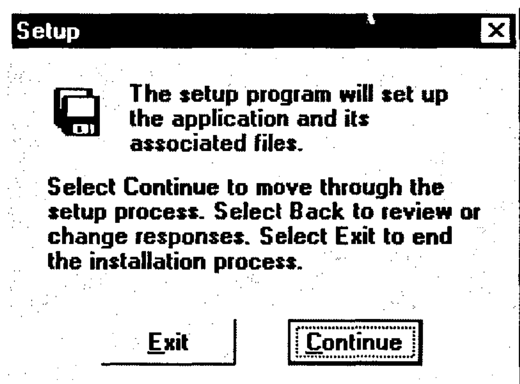


Figure 1-1. DRIVEN setup window.

4. The setup program will then prompt for the directory location to install the software, as shown by the example in figure 1-2. By default, the setup program will select the \DRIVEN directory. To have it installed in a different directory, simply type in the new directory name. If the directory does not already exist, the setup program will create it.

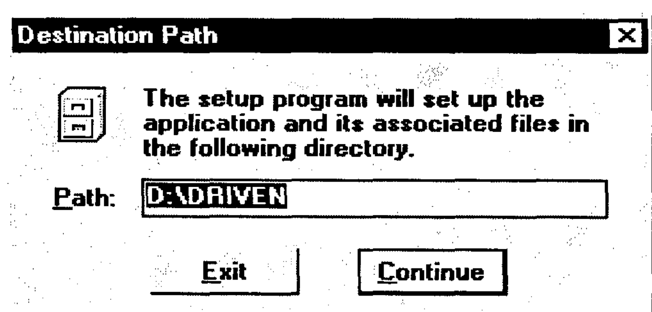


Figure 1-2. DRIVEN setup, destination path window.

5. The setup program will next prompt for the Program Group for the software. By default, the setup program will select "FHWA Software," as shown by the example in figure 1-3. The Program Group is the window in Program Manager (or Start menu in Windows 95) where the software icon will be located. To change this item, simply type in a new group name, or select the down arrow and choose an existing program group on the computer. Once the Program Group program group has been selected press the "Continue" button and the DRIVEN software will be installed onto the hard disk.

   While the DRIVEN software is being copied onto the hard disk, a progress window, as shown in figure 1-4, will be on the screen. Once this operation has completed, the DRIVEN software installation is finished and the program can be used.

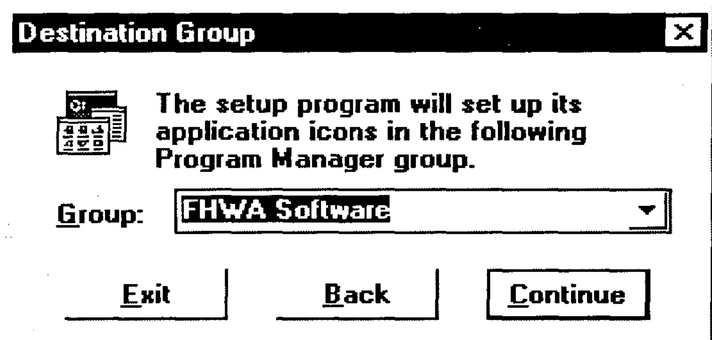


Figure 1-3. DRIVEN setup, destination group window.

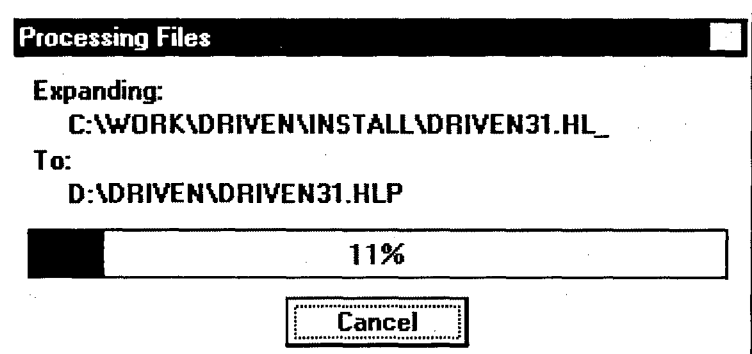


Figure 1-4. DRIVEN setup, processing files window.

6. The installation is now complete. Refer to the next chapter, entitled "**Getting started,**" for an introduction on how to run the DRIVEN program.

CHAPTER 2 - GETTING STARTED

Starting the Program

The DRIVEN program is a Microsoft Windows based program. Microsoft Windows must have first been started and the Program Manager should be active. Inside the Program Manager is a program group titled "**FHWA Software.**" Alternatively, if a different group name was selected during setup, that will be the program group to find the DRIVEN program. Within this program group is a program icon titled "**DRIVEN.**" Start the program by double clicking on this program icon. A window similar to the one shown in figure 2-1 will be displayed.

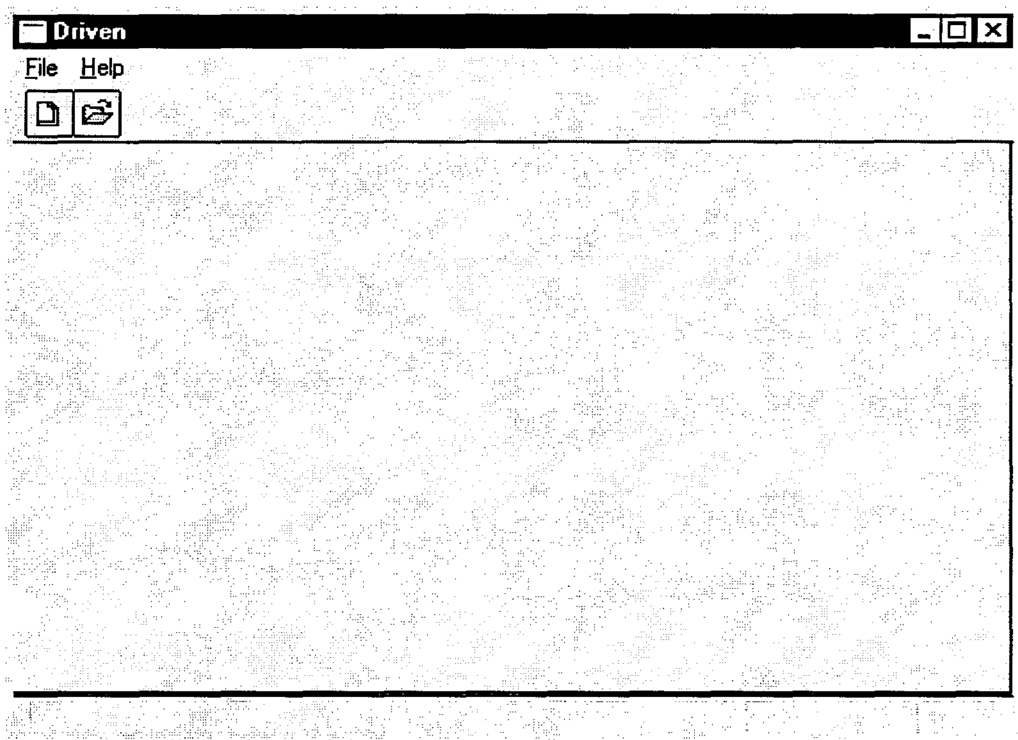


Figure 2-1. Main screen for the DRIVEN program.

From figure 2-1, note the following features on the DRIVEN software user interface. There is a title bar at the top of the window identifying the program as DRIVEN. Just below the title bar is a menu with two options, *File* and *Help*, that are available at program startup. Next, is a *SpeedBar* with two buttons corresponding to the menu options to create a new file and to open an existing file. At the bottom of the screen is a status bar that shows miscellaneous information about the program and the keyboard. For example, as the mouse passes over the SpeedBar, short informational messages will appear about the SpeedBar buttons functions. Additionally, the status bar will show the status of the Caps Lock, Num Lock, and Scroll Lock keys on the keyboard.

Accessing the Menu

Figure 2-2 shows an example of the DRIVEN *File* menu. At program startup, this menu contains options to create a new file, open an existing file, setup the printer, and exit the program. After choosing either to create a new file or to open an existing file, both the main menu and the *File* menu expand to include options available only when a project file is in the program memory.

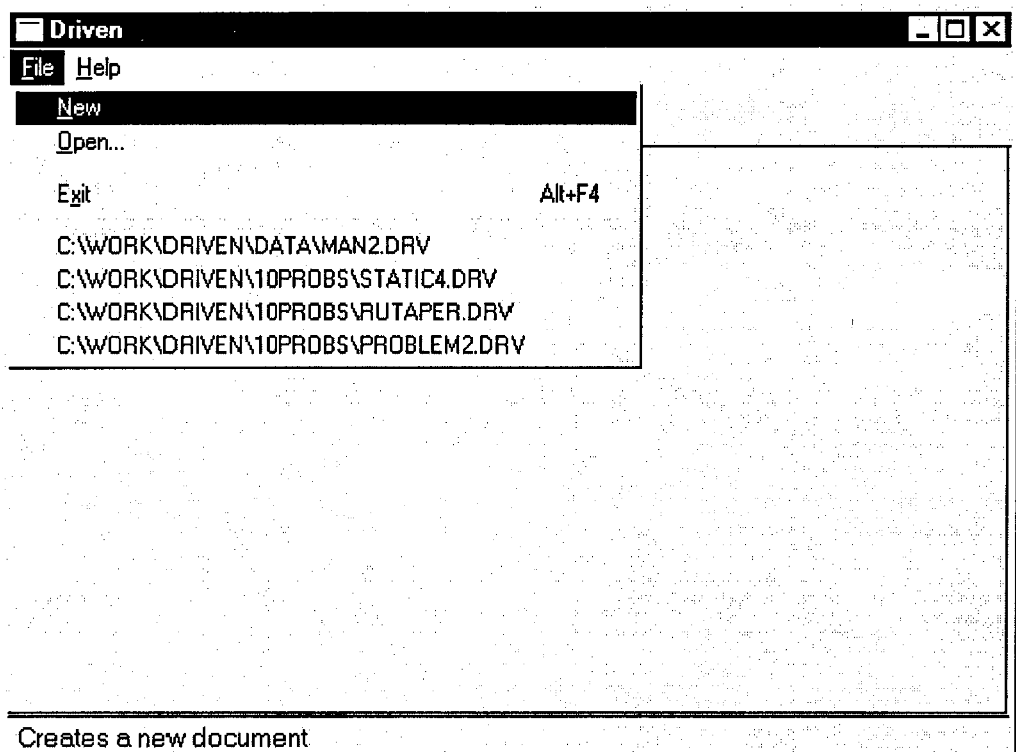


Figure 2-2. DRIVEN File menu contents at program startup.

To gain access to the main menu, use the mouse to single click the word *File* on the main menu. Alternatively, it is possible to open this menu by using the key combination of pressing <Alt> and the letter 'F' at the same time. To create a new project file, select the *New* menu option. To open an existing project file, select the *Open* menu option.

Refer to chapter 3, "**Input User Interface Description,**" for a detailed discussion on each of the user interface screens and dialog boxes. This chapter presents each screen, dialog box, and input field along with a detailed description of each item and how it is used by the DRIVEN software. Please refer to Appendix D for 10 DRIVEN examples. For more information on file management within DRIVEN, please refer to chapter 6, "**File Management.**" This chapter details the file management features of the DRIVEN software.

CHAPTER 3 - INPUT USER INTERFACE DESCRIPTION

This chapter provides a detailed description of each of the user interface components that are related to data input. Each screen, dialog box, and input field is demonstrated and described in detail.

Project Definition

The Project Definition is the location of the overall project design information and options. Figure 3-1 presents an example of the Project Definition input screen.

The Project Definition screen contains five important sections: *Client Information*, *Unit System*, *Soil Layers*, *Water Tables*, and *Optional Design Considerations*. Except for Client Information, each of these sections influences the overall project design. Each of these sections is discussed in more detail below.

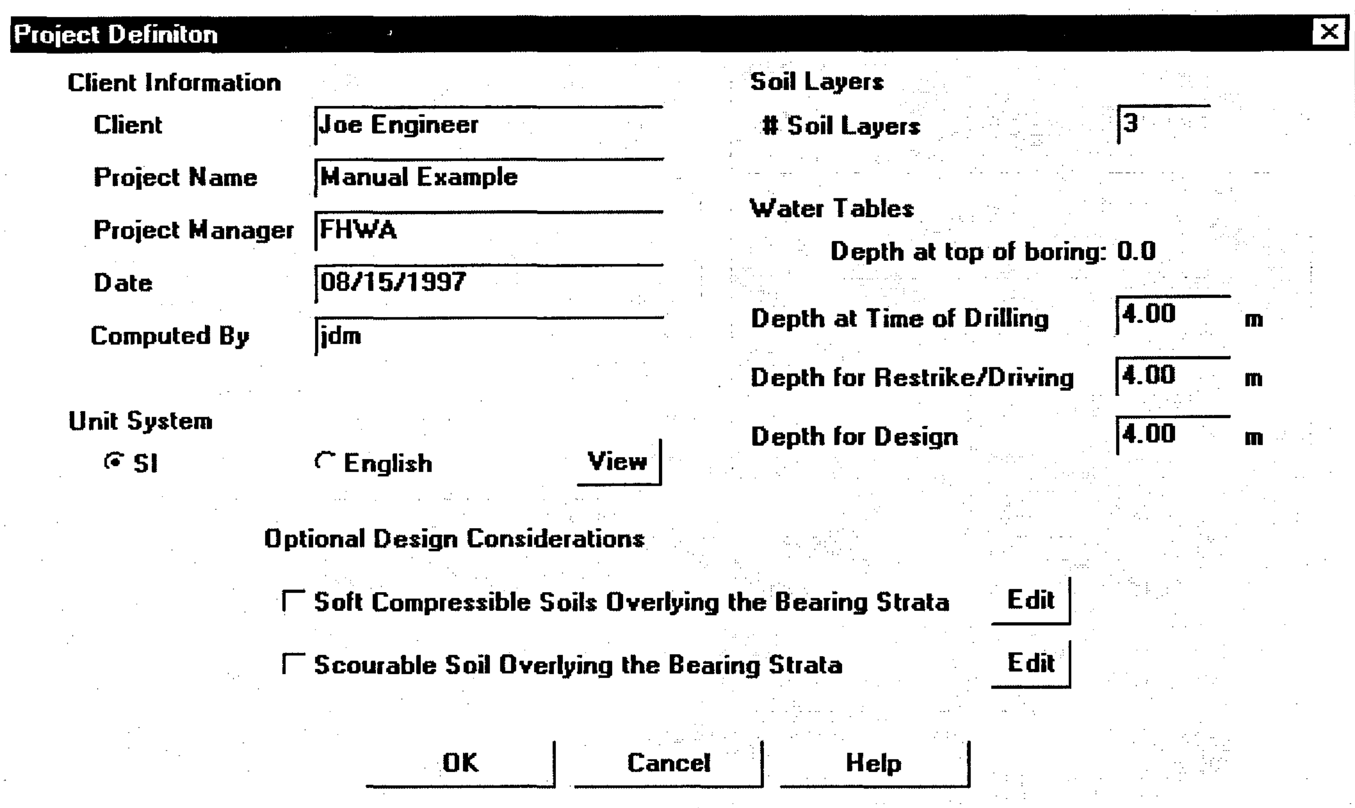


Figure 3-1. Project definition input screen.

Client Information

The Client Information section contains various data important to the management of the project. Obviously this data has no analytical bearing on the project; it is included to aid in the identification of the project. There are no "rules" for what may be entered into each of these fields. The following is a description of each input field.

Client	This field can be used to identify for whom the design is being performed.
Project Name	This field can be used to identify this project from all other projects.
Project Manager	This field can be used to identify who is responsible for the results of the design.
Date	This field generally represents the date the DRIVEN file was created on the computer. It is automatically filled in by the program when a project is created. The date can be changed, but the format of the date must follow the form of MM/DD/YYYY.
Computed By	This field can be used to identify the person who actually sat down at the computer, entered the data, and generated the results.

Unit System

The DRIVEN program works equally well in either SI or English units. This section identifies which unit system is currently being used by the program. The unit system may be toggled between SI and English by selecting the appropriately labeled radio button. When the unit system is toggled, the computer will convert all of the input data into the appropriate values for the new unit system. All the input screens and dialogs will also reflect the new unit system. Additionally, all of the output information will be shown according to the selected unit system.

Just to the right of the two unit system radio buttons is a button labeled *View*. If this button is pressed, a dialog box will appear that shows what the various parameters and their units are for the current unit system. Figure 3-2 shows the dialog box for SI units and figure 3-3 shows the dialog box for English units.

One final note to the Unit System: when a GRLWEAP driveability file is created by the DRIVEN software, the unit system will be that of the system currently selected.

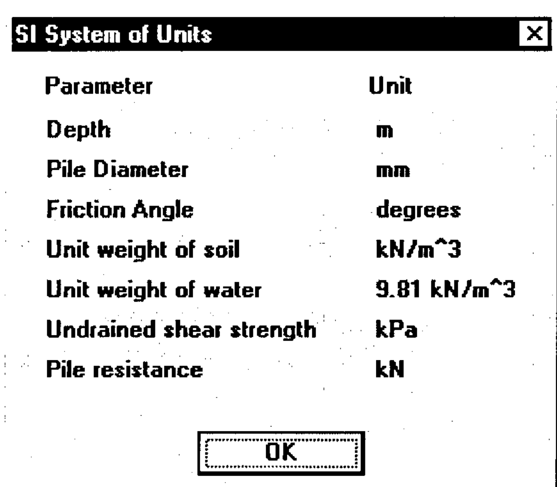


Figure 3-2. Dialog box for SI system of units.

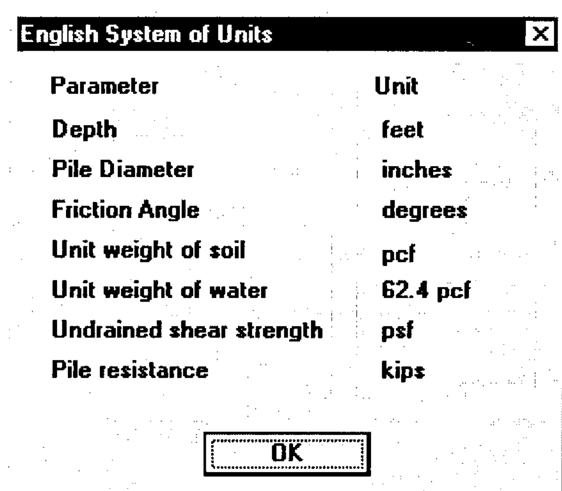


Figure 3-3. Dialog box for English system of units.

Water Tables

The DRIVEN software supports three different water tables: depth at time of drilling, depth at time of restrike/driving, and depth for ultimate considerations. The water table depth at the time of drilling is used in correcting SPT blows counts, if they are used. The water table depth for restrike/driving considerations is used for determining the effective stress in the soil layers below the water table for restrike and driving. The water table for ultimate considerations is used to determine the effective stress in soil layers below the water table for the ultimate condition.

Optional Ultimate Considerations

The DRIVEN software also supports the ability to use soft compressible soil/negative skin friction or scourable soil information as part of the ultimate capacity computations. These options only apply to the ultimate capacity computations, they do not apply to the restrike and driving computations. Each of these options may be selected by pressing the appropriately labeled checkbox. It is important to note that these two options are mutually exclusive. Therefore, the DRIVEN program does not allow both options to be selected at the same time. When selected, a dialog box will be presented for the specific soil information. Each of these options is discussed further below.

Note: It is important for the user to completely understand how the different ultimate condition considerations influence the ultimate capacity. The user needs to ensure that the effects of the ultimate considerations are applicable to their situation.

Soft Compressible Soil/Negative Skin Friction

Soft compressible soil information can be selected by pressing the checkbox labeled, *Soft Compressible Soils Overlying the Bearing Strata*. When selected, a dialog box will be displayed that requests the depth of the soft compressible soil layer.

Figure 3-4 shows an example of the dialog box that is displayed when the option is selected. There is a single parameter to input along with a computational option to select.

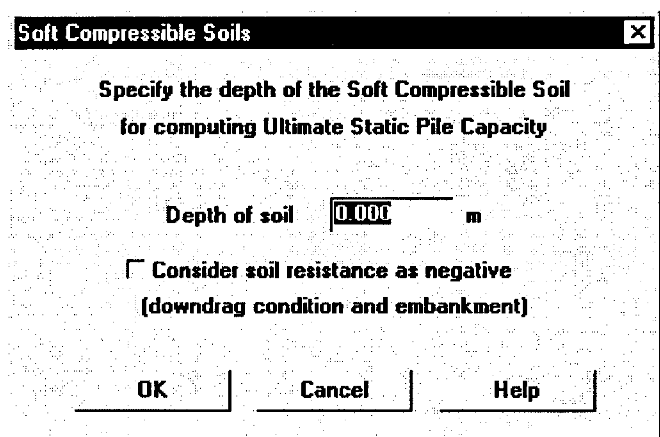


Figure 3-4. Soft compressible soils dialog box.

The Depth of soil field is the depth from the ground surface to the bottom of the soft compressible soil layer. (The ground surface is always considered to be at 0.0 ft or 0.0 m). The capacity contributions are ignored to this depth. However, the weight of the soil still contributes to the effective stress calculations for the lower soil layers.

Depending upon the nature of the ultimate condition, the *Consider soil resistance as negative* checkbox option can be selected. If this option is selected, the skin friction within the soft compressible soil layer will be considered negative resistance.

Scourable Soil

Scourable soil information can be selected by pressing the checkbox labeled '*Scourable Soil Overlying the Bearing Strata'*. When selected, a dialog box will be displayed that requests the depths of both short-term and long-term scour.

Figure 3-5 shows an example of the dialog box that is displayed when the option is selected. There are two parameters to select: Local Scour and Channel Degradation Scour and Contraction Scour, one or the other or both may be selected.

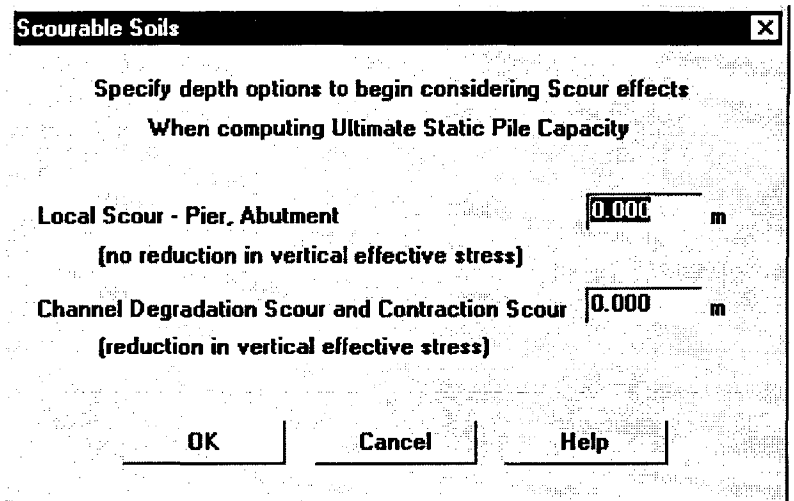


Figure 3-5. Scourable soils dialog box.

Figure 3-6 graphically displays each type of scour. The local scour in limited to an area generally around the pier or abutment. The long term degradation and contraction scour are considered to be widespread across the riverbed. The DRIVEN input requires that the long term degradation and contraction scour be added together since they affect the shaft resistance and effective stress in the same manner.

When the program is computing capacities for ultimate conditions, the depths of the Local Scour and Channel Degradation and Contraction Scour will be added together to determine the lowest depth for the scour conditions. Skin resistance will not be considered until after this combined depth has been reached for the ultimate capacity calculation. The effect of scour is not used in the computation of restrike or driving capacities

The local scour and the long-term degradation and contraction scour will influence the effective stress differently. The local scour occurs in a limited area around the pier or abutment. The soil outside of the local scour area is still considered to contribute to the effective stress for the computation of ultimate skin friction and end bearing capacities. However, since the long term degradation and contraction scour is over a wider area, the scoured soil is not considered in the effective stress calculations.

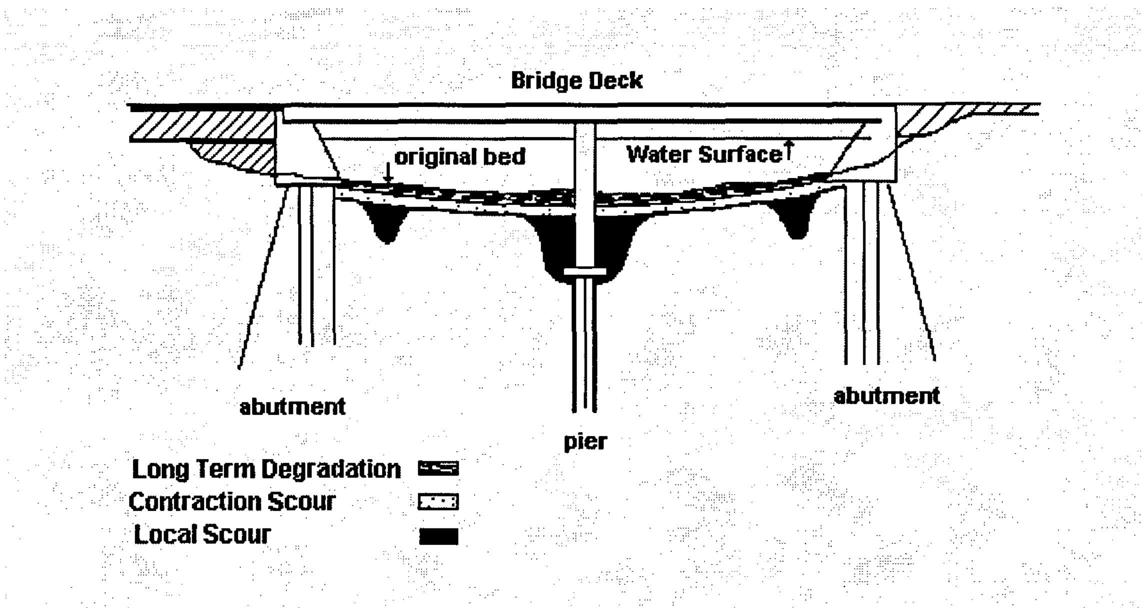


Figure 3-6. Diagram of long term degradation, contraction scour, and local scour.

This completes the discussion for the Project Definition screen. When creating a new project, press the *OK* button, and the DRIVEN program will automatically move to the Soil Profile screen. After a new project has been entered, the Project Definition screen can be brought back up by selecting it from the Project menu.

Soil Profile

The soil profile input screen is the heart of the data input for the DRIVEN software. This screen is where the soil profile is completed along with the pile parameters.

Figure 3-7 shows an example of the Soil Profile screen. The left-hand side of the screen presents a visual representation of the soil profile. The relative thickness of the layers is shown by the actual drawing size. In addition, a depth scale is drawn along the left-hand side of the soil profile drawing. As the depth to the bottom of each layer is updated, the soil profile drawing is automatically updated to reflect the relative size of the soil layer in comparison to all other soil layers. The right hand side of this screen contains two major grouping boxes labeled *Layer General Data* and *Layer Soil Type*. The information contained within each of these groupings is specific to each layer in the profile. The current soil layer is identified just above the *Layer General Data* group box. Additionally, the soil layer that is currently being worked with is highlighted with a blue highlight box around the layer on the visual profile representation.

Finally, the pile type selection is shown in a drop-down box just below the *Layer Soil Type* grouping box. Each of the major sections of this screen is discussed in further detail below.

Soil Layer Profile

A visual representation of the soil profile is shown on the left-hand side of the screen under the title *Soil Layer Profile.* This profile consists of two main features. The first is the visual representation in relative thickness and soil hatching of each layer. The soil hatching is based upon standard representation of cohesive or cohesionless soils; cohesive soils are represented with diagonal lines and cohesionless soils are represented with dots. The second is a profile depth axis on the left side of the soil layer drawing. The profile and axis size will remain the same size at all times, but the relative size of each layer and the scale on the axis will update according to the data entered.

The mouse can be used to select a layer in two ways. The first is to simply position the pointer over the desired layer and click with the left mouse button. The second is to use the scroll bar located just to the right of the profile drawing and either click on the up and down arrows, or move the scroll bar box to the select the layer desired. In either case, as a new layer is selected, the fields on the right hand side of the screen will update to show the data for the currently selected layer.

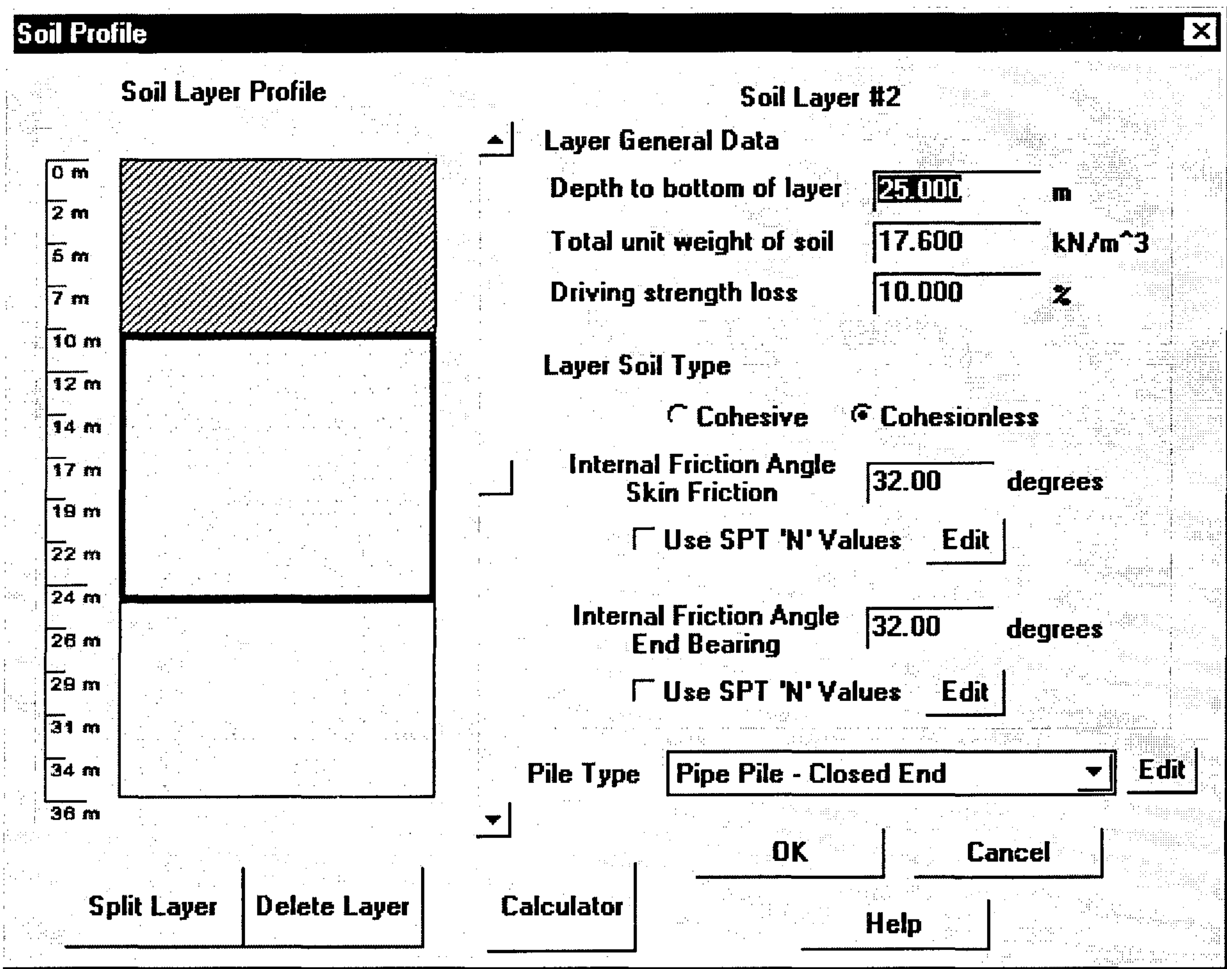


Figure 3-7. Soil profile input screen.

Layer General Data

The *Layer General Data* section defines three parameters common to all soil types used within the DRIVEN program. These are: *Depth to bottom of layer, Total unit weight of soil,* and *Driving strength loss.* Below is a discussion of each parameter.

Depth to bottom of layer

This input field is the depth at the bottom of the soil layer. It is not the thickness of the layer; instead, it is the depth value at the bottom of the layer measured from the ground surface, with the ground surface always considered to be at 0.0 m (ft). When a new project is first created, the DRIVEN program takes the number of soil layers entered in the Project Definition screen and evenly divides 100 m (ft) between the number of layers. For example, if three soil layers are chosen, initially DRIVEN will divide the soil profile into three 33 m (or 33 ft) layers. This is the starting point for the soil layer input. As the soil data is entered, the depth to the bottom of the layer profile is changed to reflect the actual soil profile.

Total unit weight

This is the total unit weight of the soil layer selected.

Driving strength loss

The driving strength loss is the estimated soil strength loss due to the effects of pile driving. During the actual driving of the pile, in some cases the strength of the soil will be different due to the effects of driving. This parameter is used to estimate the effects of driving on the pile capacity. Also, this strength loss parameter is later used in the preparation of the GRLWEAP driveability input file.

Layer Soil Type

The *Layer Soil Type* section is dependent upon the type of soil chosen for the current layer. If a soil layer is cohesionless, the program will prompt for two internal friction angles, one for skin friction and one for end bearing. If the soil layer is cohesive, the program will display a box for undrained shear strength, along with a button to select the appropriate adhesion curve.

The example shown in figure 3-7 demonstrates a cohesionless soil layer. For each cohesionless layer, two internal friction angles must be entered, one for skin resistance and one for end bearing. Alternatively, it is possible to define the internal friction angle by entering SPT 'N' values. If this is desired, check the *Use SPT 'N' Values* check box. When this check box is selected for the first time, the DRIVEN program will present a dialog box that allows for the entry of SPT 'N' values as shown in figure 3-8. Once these values have been entered and the dialog box is closed, the equivalent internal friction angle is computed and entered into the appropriately labeled edit field. At this time (or any time after entering the SPT data), the SPT 'N' values may be edited by selecting the *Edit* button. To stop using the SPT 'N' equivalent internal friction angle, simply uncheck the *Use SPT 'N' Values* check box and enter the desired internal friction angle in the edit box.
The dialog box shown in figure 3-8 allows SPT 'N' values to be entered so the DRIVEN program can determine equivalent internal friction angle for the soil layer. The software will allow a

maximum of five different depths within each layer for blow count values. The actual number of values used in the soil layer can be changed by pressing the up and down arrows located just to the right of the field labeled *Number of SPT 'N' values (five are allowed).* If desired, the program will correct the blow counts for the influence of the effective overburden pressure. Select either the *Yes* or *No* radio buttons at the top of the dialog box for the desired setting. Finally, the bottom section of the dialog box allows the input of the depth versus 'N' count values. The middle section of the dialog provides information about the valid range of depths for the soil layer. The program will not allow a depth parameter to be entered outside the limits of the valid range. When the data is entered for the layer, press the *OK* button to return to the Soil Profile screen. When this is done, the program will automatically compute the internal friction angle based upon the SPT data and place that value in the appropriate internal friction angle field. DRIVEN uses the relationship between standard penetration test values and the angle of internal friction for the soil as presented by Peck, Hanson, and Thornburn (1974).

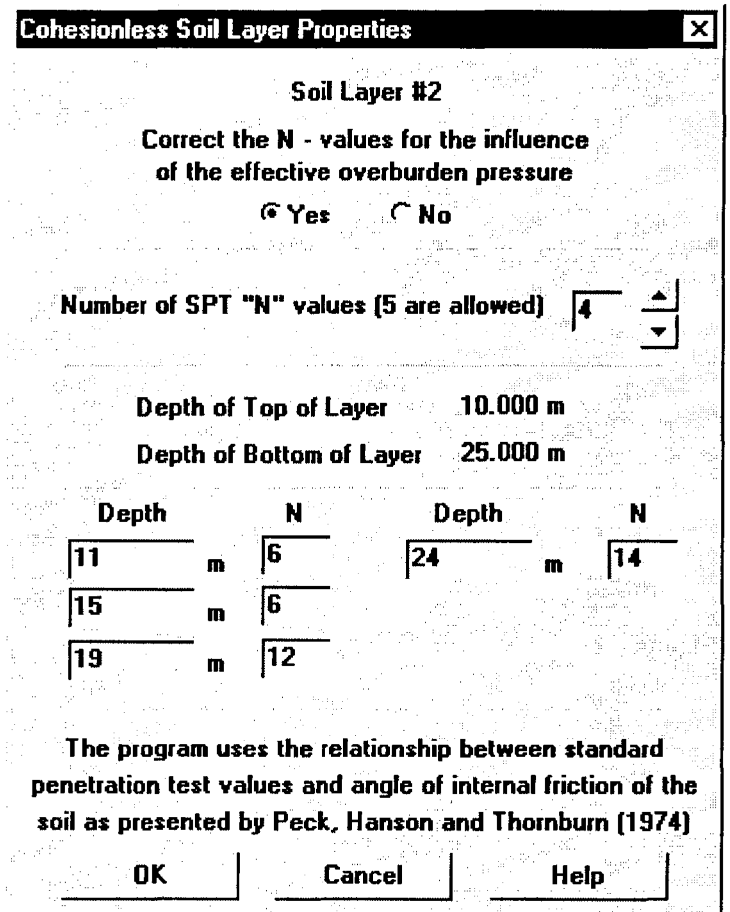


Figure 3-8. Dialog box for determining the internal friction angle from SPT 'N' values.

Alternatively, the soil layer may be cohesive. Figure 3-9 shows an example of how the program will display the information for a cohesive soil layer. For a cohesive soil layer, two input fields are available within the group box. The first is an edit field for the undrained shear strength of the soil. The second is a button that will bring up a dialog box allowing the user to select the appropriate adhesion curve as shown in figure 3-10.

Figure 3-10 shows an example of the adhesion curve selection dialog box. It is in this dialog box where the adhesion curve is selected. For detailed information about each of these adhesion curves, please refer to chapter 7 "**Engineering Background**" where each curve and table is presented. In the case of user defined adhesion, a single value will be used to represent the adhesion for that soil layer. When selected, an edit field becomes visible where the user-defined adhesion can be entered.

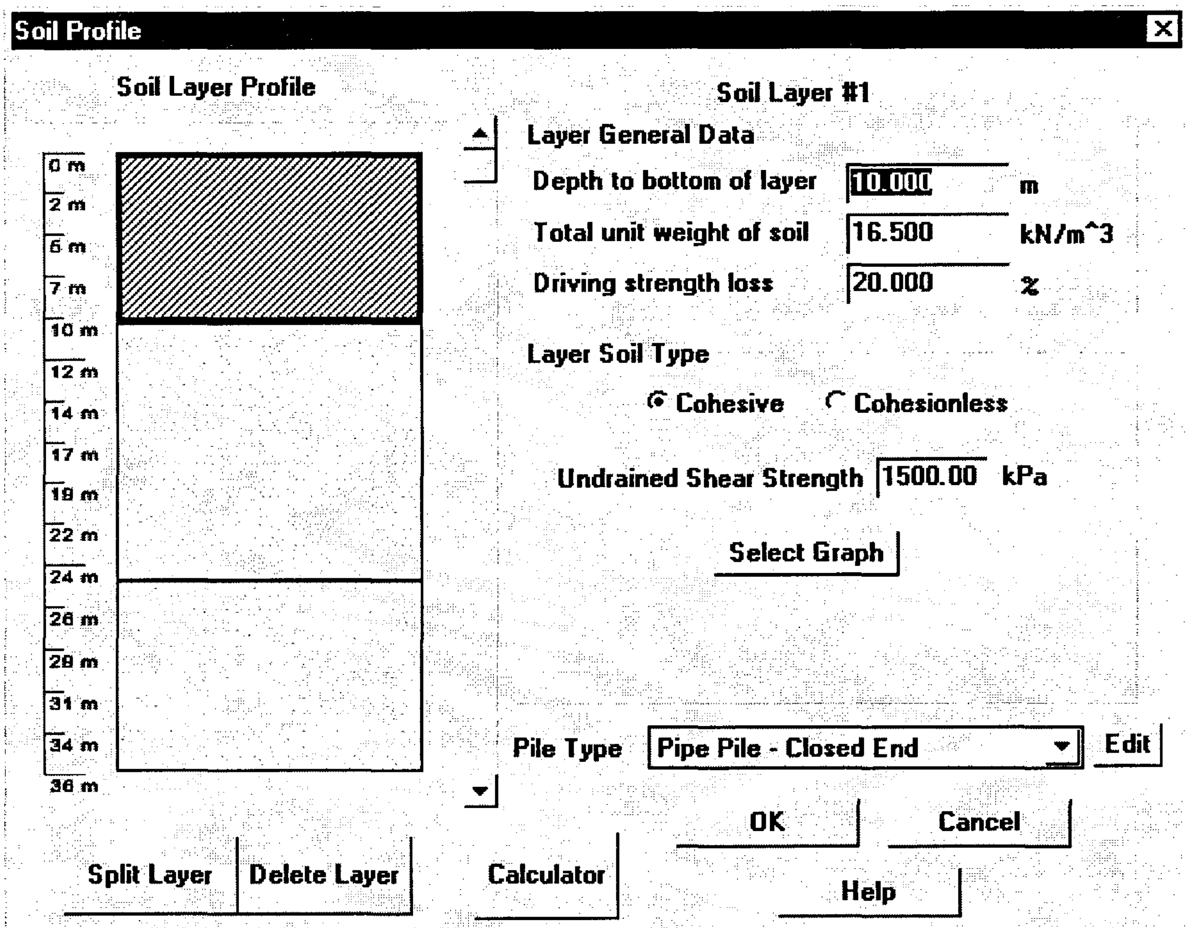


Figure 3-9. Soil profile input screen for cohesive soil.

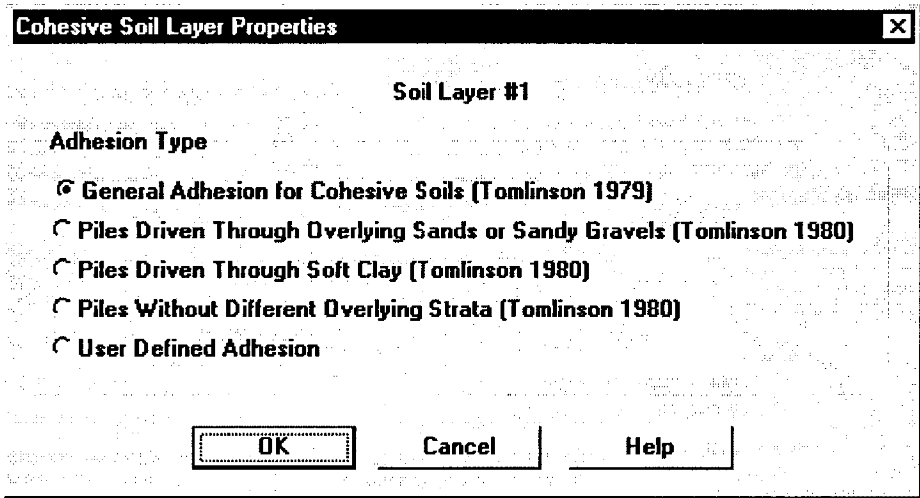


Figure 3-10. Adhesion curve selection dialog box.

Pile Type Selection

The *Pile Type* selection box displays the currently selected pile. If no pile has been selected, no pile type will be displayed. If a pile has already been selected, its parameters can be changed by pressing the *'Edit'* button located just to the right hand side of the pile name. If a new pile type is desired, press the down arrow button located inside the selection combo box and a list of supported pile types will be shown. Select the desired pile type from this list. When making a new pile selection, the DRIVEN program will automatically bring up the proper dialog box for the pile that allows the pile parameters to be edited.

Each type of pile supported by DRIVEN has its own unique input dialog box. The DRIVEN program supports seven different pile types: *Pipe Pile - Closed End*, *Pipe Pile - Open End*, *Timber Pile*, *Concrete Pile*, *Raymond Uniform Taper Pile*, *H-Pile,* and *Monotube Pile*.

Each of the pile type dialog boxes has a parameter that is common to all pile types. This parameter is the *Depth of Top of Pile*. The depth of pile top is the depth to which the top of the pile is embedded into the ground. The ground surface is always considered to be 0.0 m (ft). This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile. The analysis depths above this depth will have capacities equal to 0.0 kN (kips).

For the most part, each of the pile types includes either a diameter of the pile or a length of the side for the square section piles. Note that on tapered piles there will be two diameters to input. The first is the diameter at the top of the pile, which is also the diameter of the straight section of the pile. The second diameter is at the pile tip. The program will use the difference in the diameters (along with the tapered section length) to compute the taper angle for the internal computations. A taper angle input is not necessary as the program will compute this value.

Pipe Pile - Closed End

Figure 3-11 is the *Pipe Pile - Closed End* dialog box. There are two parameters for this dialog box: *Depth of Top of Pile* and *Diameter of Pile.*

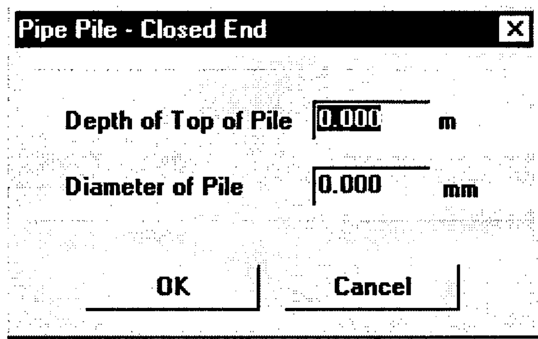


Figure 3-11. Pipe pile - closed end dialog box.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile.

Diameter of Pile

The diameter of the pile is the outside diameter of the pile. When creating the GRLWEAP driveability file, the DRIVEN program will request the wall thickness at that time.

Pipe Pile - Open End

Figure 3-12 is the *Pipe Pile - Open End* dialog box. There are three parameters for this dialog box: *Depth of Top of Pile, Diameter of Pile*, and *Shell Thickness.* There is also a note at the bottom of the dialog to refer to the manual for detailed information about plugging. Please refer to chapter 7, "**Engineering Background,**" for this information.

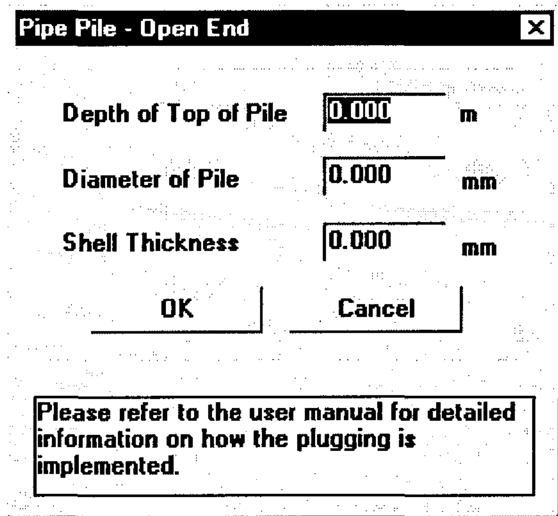


Figure 3-12. Pipe Pile – open end dialog box.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth at which the software will begin to consider skin friction and end bearing for the pile.

Diameter of Pile

The diameter of the pile is the outside diameter of the pile.

Shell Thickness

The shell thickness is the wall thickness of the pile.

Timber Pile

Figure 3-13 is the *Timber Pile* dialog box. There are four parameters for this dialog box: *Depth of Top of Pile*, *Diameter of Pile Top*, *Length of Tapered Portion*, and *Diameter of Pile Tip*.

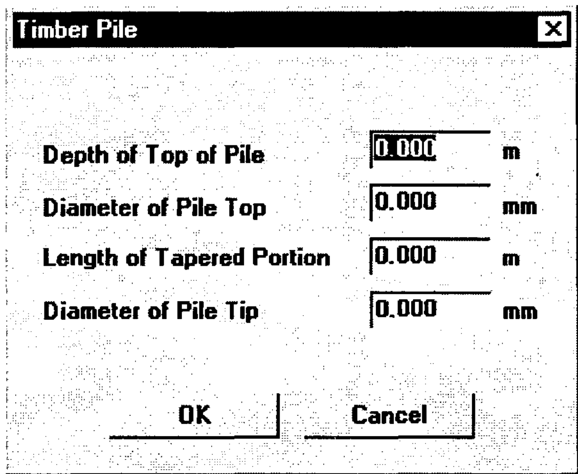


Figure 3-13. Timber pile dialog box.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile.

Diameter of Pile Top

The pile top diameter is the diameter of the timber pile at the top. This should be the largest diameter.

Length of Tapered Portion

The length of the tapered portion is the tapered length of section of the pile as measured to the pile tip.

Diameter of Pile Tip

The pile tip diameter is the diameter of the timber pile at the bottom. This should be the smallest diameter.

If a timber pile is to be used without a taper, enter 0.00 for the length of the tapered portion and make sure the diameter at the pile top is the same as the diameter at the pile tip. The DRIVEN program will then consider the pile to be straight and have no taper.

Precast Concrete Pile

Figure 3-14 demonstrates the *Precast Concrete Pile* dialog box. There are two inputs for this dialog box: *Depth of Top of Pile* and *Side of Square Section.*

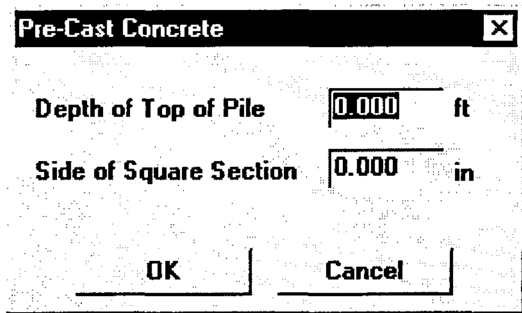


Figure 3-14. Dialog box for precast concrete pile.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile.

Side of Square Section

The side of square section input parameter is the width of the side of the square pile.

Raymond Uniform Taper Pile

Figure 3-15 is the *Raymond Uniform Taper Pile* dialog box. There are four parameters for this dialog box: *Depth of Top of Pile*, *Diameter of Pile Top*, *Length of Tapered Portion,* and *Diameter of Pile Tip.*

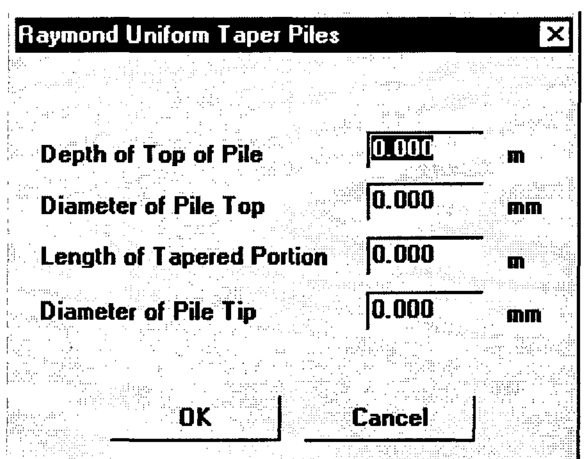


Figure 3-15. Raymond uniform taper pile dialog box.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile.

Diameter of Pile Top

The pile top diameter is the diameter of the uniform taper pile at the top. This should be the largest diameter.

Length of Tapered Portion

The length of the tapered portion is the tapered length of the pile as measured to the pile tip.

Diameter of Pile Tip

The pile tip diameter is the diameter of the pile at the bottom. This should be the smallest diameter.

If the pile is to be used without a taper, enter 0.00 for the length of the tapered portion and make sure the diameter at the pile top is the same as the diameter at the pile tip. The DRIVEN program will then consider the pile to be straight and have no taper.

H - Pile

Figure 3-16 is the H-Pile dialog box while working in SI units. There is a similar dialog box for English H-Pile sections to select. There are four areas where H-Pile options are chosen: *Depth of Top of Pile*, *Type of H-Pile*, *Pile Perimeter for Analysis,* and *Tip Area for Analysis.*

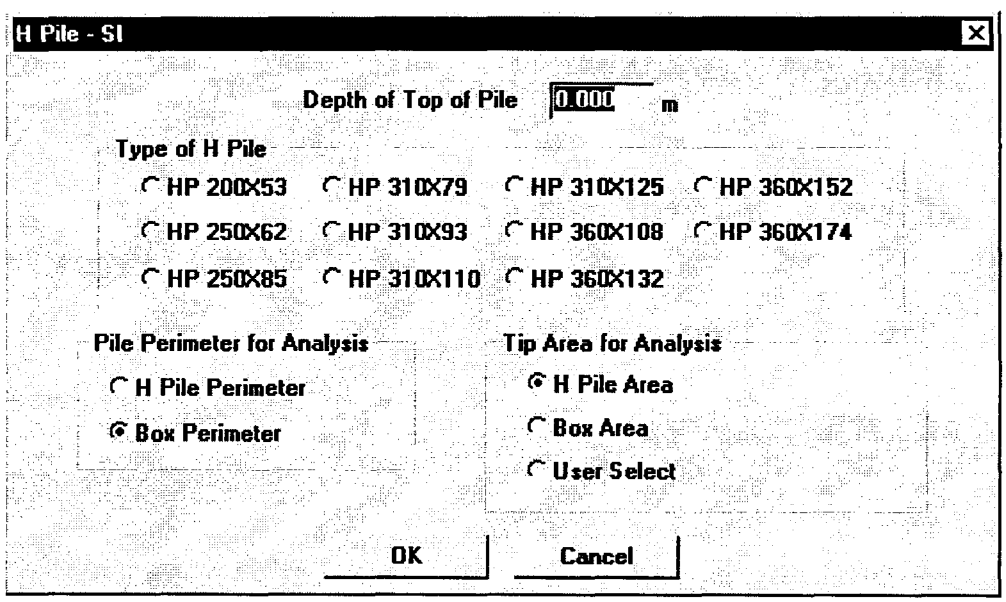


Figure 3-16. H-Pile dialog box for SI units.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile.

Type of H-Pile

This section is where the H-Pile section is chosen. Simply select the appropriately labeled radio button to choose the desired section.

Pile Perimeter for Analysis

The pile perimeter for analysis is the pile perimeter that will be used for the skin friction capacity computations. Choose the desired perimeter analysis radio button.

Tip Area for Analysis

The tip area for analysis is the bottom area of the pile that will be used for end bearing capacity. Choose the desired tip area radio button. If *User Select* is chosen, enter the tip area in the edit box that appears.

Monotube Pile

Figure 3-17 is the *Monotube Pile* dialog box. There are four parameters for this dialog box: *Depth of Top of Pile*, *Diameter of Pile Top*, *Length of Tapered Portion,* and *Diameter of Pile Tip*.

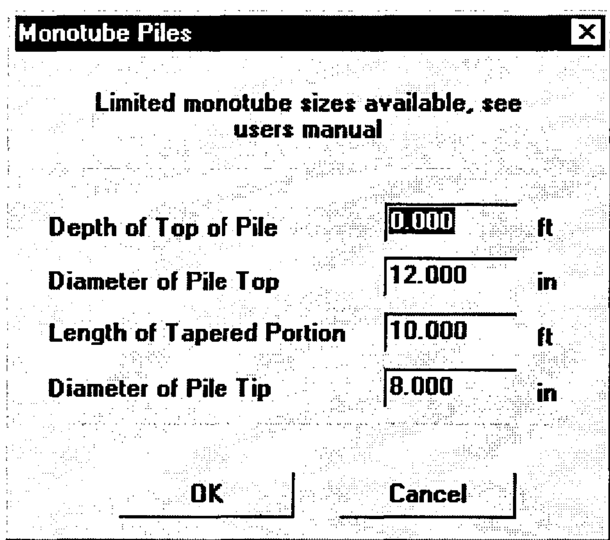


Figure 3-17. Monotube pile dialog box.

Depth of Top of Pile

The depth of the top of the pile is the depth from the ground surface to which the top of the pile is embedded into the ground. This parameter is the depth that the software will begin to consider skin friction and end bearing for the pile.

Diameter of Pile Top

The pile top diameter is the diameter of the monotube pile at the top. This should be the largest diameter.

Length of Tapered Portion

The length of the tapered portion is the length of the tapered section of the pile to the pile tip.

Diameter of Pile Tip

The pile tip diameter is the diameter of the pile at the bottom. This should be the smallest diameter.

NOTE: Limited amounts of monotube pile sections are available. A chart of standard monotube piles is included as Appendix E. It is recommended that the diameter and length of the tapered section be selected from this chart to ensure pile availability.

Soil Profile - Design

The soil profile design screen presents in a single view an overall picture of the soil information. It contains the relevant information about the soil profile. This representation is essentially the same as shown in the *Soil Profile* dialog box with the exception that the unit weight, strength parameters, and driving strength loss is shown for each layer.

Figure 3-18 shows an example of the soil profile design screen. This screen is only for viewing the overall soil profile information, there are no areas where user input is needed. Each of the soil layers in the representation is hatched according to the type of soil; dotted for cohesionless soils and diagonal lines for cohesive. Within each layer are three of the soil input parameters. For cohesive soils, unit weight, undrained shear strength, and driving loss. For cohesionless soils, unit weight, internal friction angles, and driving loss. Finally, the design representation displays an axis on the left-hand side of the soil profile allowing the overall depth of the soil profile to be visualized.

This screen also introduces the use of two program features; the ability to place the representation on the Windows clipboard or directly printed on the printer.

To copy the soil profile to the Windows clipboard, press the button labeled *Clipboard*. The soil profile representation will now be on the Windows clipboard and, therefore, it will be available to any other program that can copy data from the clipboard.

To send the soil profile to the printer, press the button labeled *Printer.* A printer setup dialog box will appear for printer selection, then a small dialog box that identifies printing is taking place will be displayed while the computer is preparing the image to be sent to the printer. While this dialog box is displayed, the program will be unavailable for use. When this dialog box disappears the program may be used again.

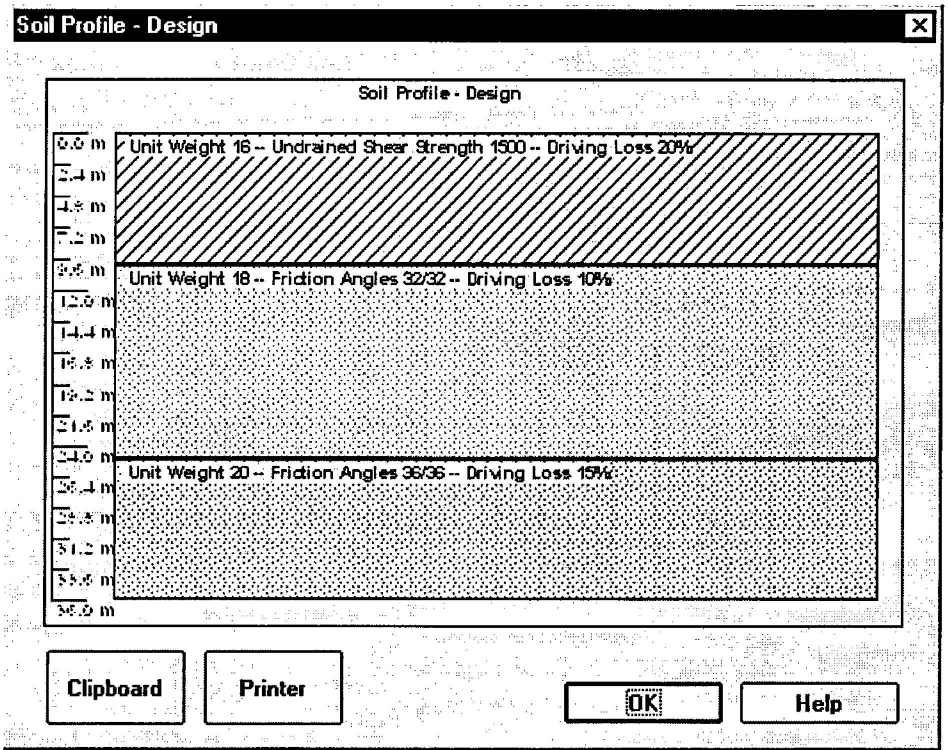


Figure 3-18. Soil profile design screen.

CHAPTER 4 - OUTPUT USER INTERFACE DESCRIPTION

This chapter discusses the output generation aspects of the DRIVEN software. Although the output of the software is all contained within two views, there is a lot of data that can be seen.

The DRIVEN software provides two different views of the same computation results. The first view is a tabular or textual representation of the results and the second is a graphical. The tabular representation allows the user to view the actual values that are the results of the computations. The graphical representation allows the user to examine the data in a qualitative manner. In the graphical view, the software generates various plots based upon the results of the computations. The values used to generate the graphs are the same as those shown in the tabular output.

One important item to note at this point: there is no concept of "running" the program to generate the output. The DRIVEN software will compute the output results when they are needed. This saves the user the step of "running" the computations each time an input parameter is changed. The computer is fast enough to perform all the calculations without the user being aware of them taking place.

The DRIVEN program's computational basis is outlined in detail in Chapter 7, "**Engineering Background**". This section discusses in detail how DRIVEN computes its results.

Computational Note: A computational error was discovered in DRIVEN just prior to its release. The error occurs when computing the skin friction driving resistance for tapered piles. This error could not be corrected for this version of the program. The user will need to independently compute the skin friction driving resistance for tapered piles. The restrike and ultimate capacities are not affected, nor are the capacities for piles that are not tapered

Tabular Output

The tabular output is used to view the actual numerical results of the computations. The tabular output screen can be accessed either from the main menu or by a button on the SpeedBar. The menu choice for the tabular output is the *Tabular* selection under the *Output* choice on the main menu. The SpeedBar button is the eighth button from the left. This button is gray with several black lines running through it. Once the tabular screen has been selected, a window similar to the one shown in figure 4-1 will be displayed. This screen contains a great deal of information. There are three main areas of information displayed in the tabular output: *Pile Type Data, Contribution Elements,* and *Total Capacity.*

Pile Type

The pile selected for the input is shown.

Contribution Elements

The contribution elements section is located in the middle of the screen. This section displays a few (not all) of the important internal computed parameters that were used to determine the skin friction and end bearing. The skin friction elements are: *Depth, Soil Type, Effective Stress,* *Sliding Friction Angle*, and *Adhesion*. The end bearing elements are: *Depth, Soil Type, Effective Stress, Limiting Factor,* and *Bearing Capacity Factor.* Of course, depending upon the soil type, some of these parameters may not be valid. In this case, a "N/A" symbol is placed instead of an actual value.

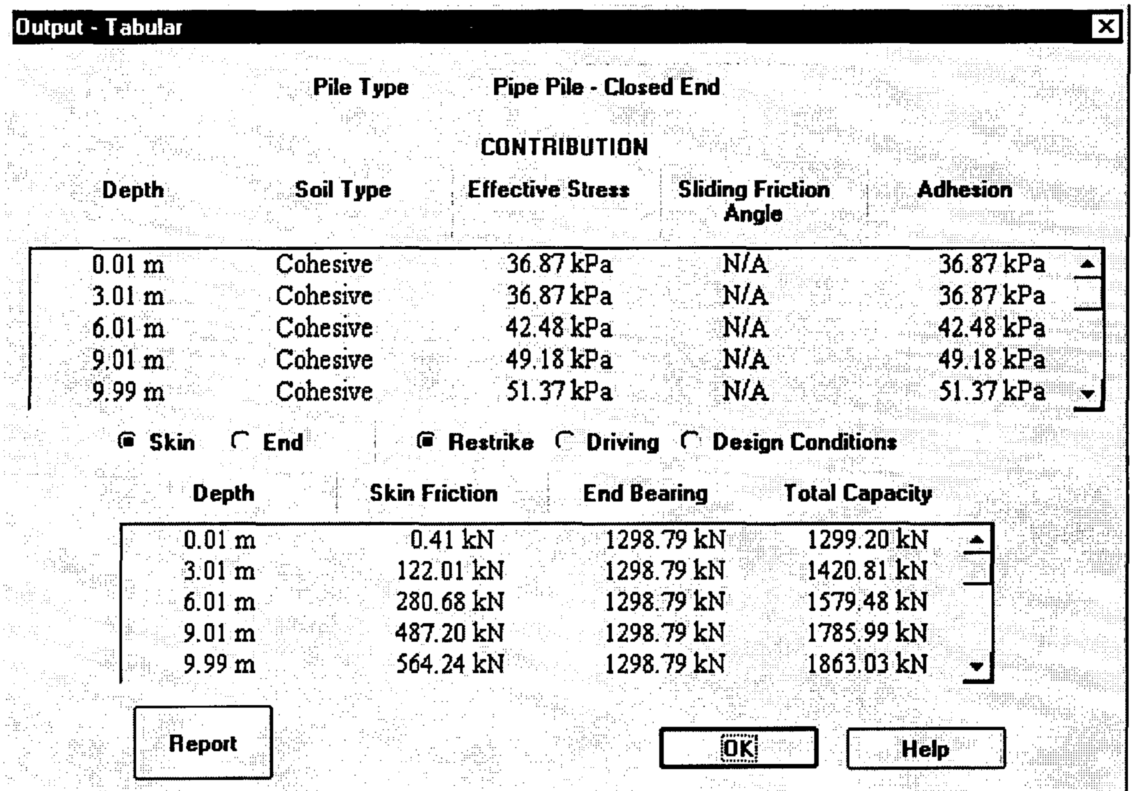


Figure 4-1. Tabular output screen.

Total Capacity

The capacity section is located in the bottom part of the screen. This section displays the results versus depth for the *Skin Friction* and *End Bearing* computations, along with the *Total Capacity*.

Not all of the capacity computations can fit into the small viewing boxes. Both the contribution and total capacity sections have scrollbars located on the right hand sides. To view all the results, use the mouse to press the up and down arrow buttons to scroll through all the values.

User control of output results to be displayed is located between the contribution elements section and the total capacity section. There are a series of five labeled radio buttons that provide the control. These radio buttons are grouped into two sections. The first section contains radio buttons for selecting either skin or end bearing in the contributing elements section. Depending upon the selection of these two radio buttons, the contribution elements will change to show either results for skin or end bearing computations. These two buttons do not affect the capacity results. The next series of radio buttons control which type of capacity computations is displayed: Restrike, Driving, or Ultimate. Selecting one of these three radio buttons will change the results displayed in both sections of the output screen.

When the dialog box first opens, it defaults to the skin friction results for the restrike computations. The *Skin* radio button and the *Restrike* radio button will be highlighted. The contributions and computations that are shown can be changed by selecting the appropriate buttons as described in the previous paragraph. For example, to view the end bearing results for the driving computations, select the radio button labeled *End* and select the radio button *Driving*. Whenever a new radio button is selected, the program will automatically display the results for that combination.

One additional important feature of this dialog box is the ability to directly send this information in a report form to the printer. To send the information to the printer, press the button labeled *Report*. When this is done, DRIVEN will generate a full report of all input parameters and output results.

Graphical Output

The graphical output screen shows the results of the computations in a series of plots. The graphical output screen can be accessed either from the main menu or by selecting the appropriate button on the SpeedBar. The menu choice for the graphical output is the *Graphical* selection under the *Output* choice on the main menu. The SpeedBar button is the ninth button from the left that looks like it has three graphs plotted on it. Once the graphical screen has been selected, a window similar to the one shown in figure 4-2 will be displayed.

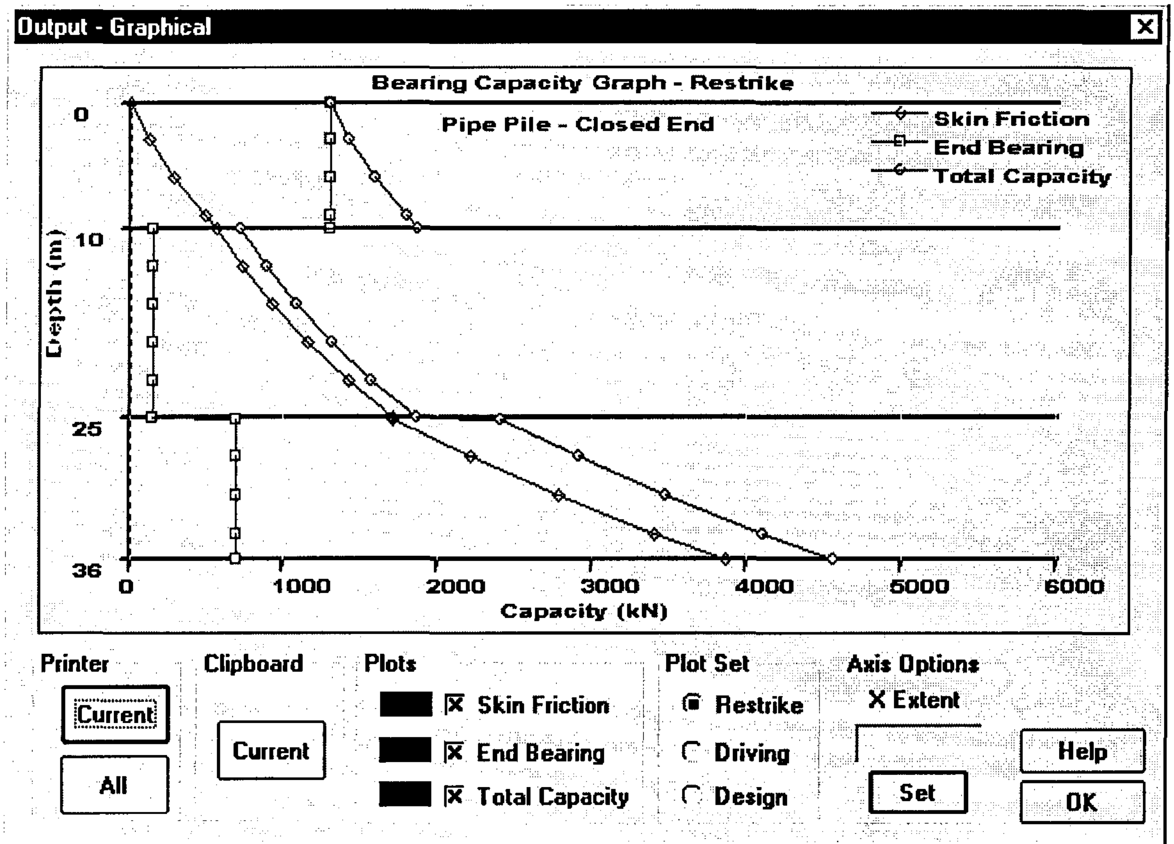


Figure 4-2. Graphical output screen.

This screen is similar to the tabular output screen. However, instead of displaying the results in numeric form, the screen displays a series of plots to represent the results. It shows the results of the skin friction, end bearing, and total capacity for restrike, driving, and ultimate conditions. The X-axis of the plot is the capacity and the Y-axis is the depth of the soil profile. Notice that the Y-axis draws a horizontal line at each of the soil layer boundaries. Each plot also displays a series of small symbols to represent computation points in the soil profile. Finally, a small legend is located in the upper right hand side of the plotting window that identifies each individual plot.

The graphical output screen offers three sections for user control of the output: *Plots, Plot Set,* and *Axis Options.*

Plots

The group labeled *Plots* allows the user to choose which combination of the three (Skin, End, and Total) plots to be displayed. These plots may be selected by pressing the checkbox located to the left of the plot label. Located to the left of each labeled plot checkbox is a box that shows the color of that plot in the plotting window. Any combination of the three plots may be selected.

Plot Set

The plot set section offers the ability to select either the Restrike, Driving, or Ultimate condition plot sets. These selections are made through a series of radio buttons. Only one set of plots can be displayed at a time. However, as described above, any combination of the three graphs can be selected in the *Plots* section.

Axis Options

The axis options section allows the user to define the X-axis extent. To rescale the X-axis, enter a value in the edit box and press *Set*. Once this value has been set, it will be in effect throughout the graphical output viewing session. The user defined X-axis value must be greater than the original default X value. The DRIVEN program will not rescale the axis using any value smaller than the original default X value. To discontinue the use of the user defined X-axis Extent, simply type in a 0 in the edit box and press the *Set* button.

When this dialog box first comes up, it defaults to showing all three bearing graphs for the restrike computations. All three graphs or any combination may be displayed by selecting the appropriate check boxes for the skin friction, end bearing, or total capacity. When one of the Plot Set radio buttons (Restrike, Driving, or Ultimate) is pressed, the current set of graphs being displayed is changed to reflect the new group of graphs selected.

The graphical output can be pasted to the Windows clipboard or directly sent to the printer. To paste the current graph to the clipboard, press the button labeled *Current* within the *Clipboard* section. When printing, either the current plot can be printed, or all three plots' sets (restrike, driving, and ultimate) can be printed on the same page. To print only the current plot, press the *Current* button within the *Printer* section. To print all three plot sets on the same page, press the *All* button within the *Printer* section.

CHAPTER 5 - CREATING GRLWEAP INPUT FILE

The DRIVEN software has the ability to create a partial input file for the GRLWEAP software package. This section is not meant to be a discussion on how to use the file in the GRLWEAP software. Please refer to the GRLWEAP documentation for information on how this file is used in that package. The driveability input file can be generated once the input of the soil and pile information has been completed. The GRLWEAP file that is created contains only the soil and pile information. To run the GRLWEAP program using this input file, the user must edit the GRLWEAP file and complete the file information, such as the hammer information. To access this feature of the DRIVEN software, select Driveability from the main menu and then select Generate from the Driveability menu. Alternatively, press the SpeedBar button with the lightning bolt symbol on it. Once this menu choice has been made, a window similar to figures 5-1, 5-2, and 5-3, based on pile type will be displayed. DRIVEN does not allow driveability files to be created for tapered piles.

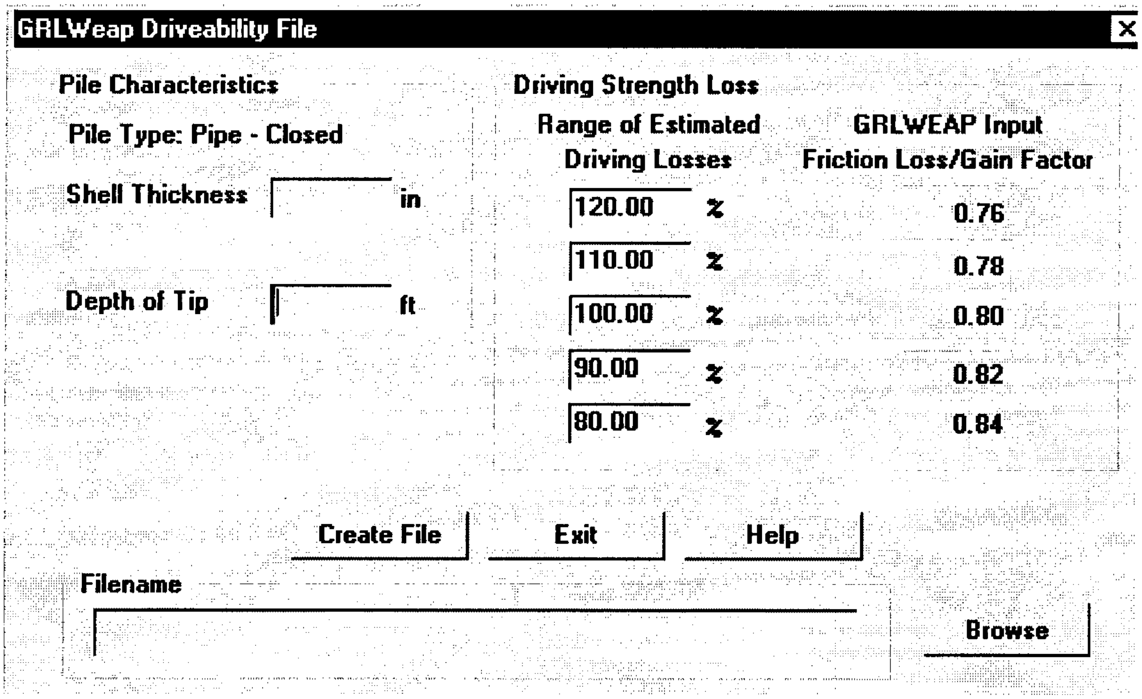


Figure 5-1. GRLWEAP driveability file dialog box for a pipe pile – closed end.

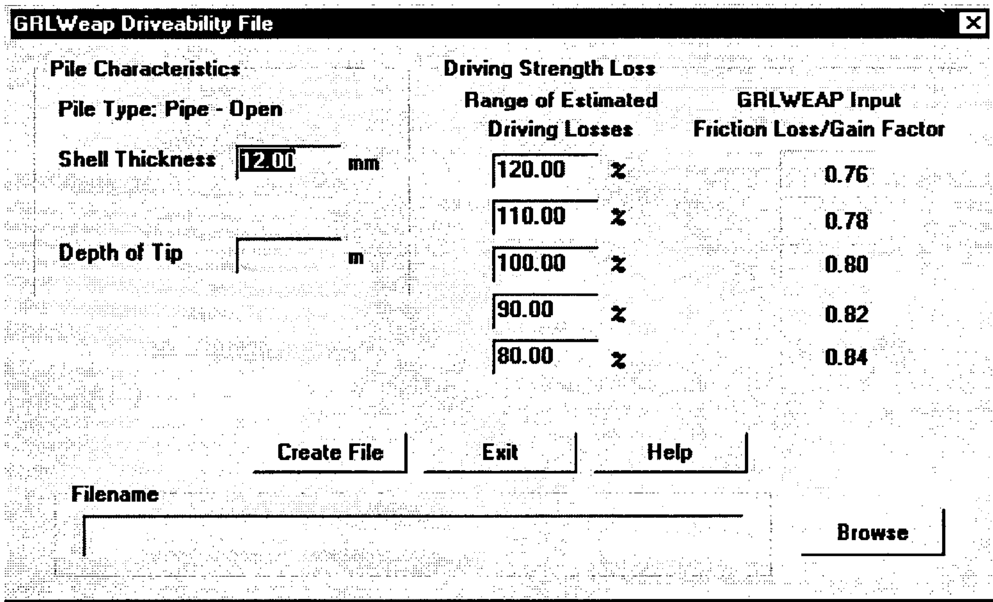


Figure 5-2. GRLWEAP driveability file dialog box for a pipe pile – open end.

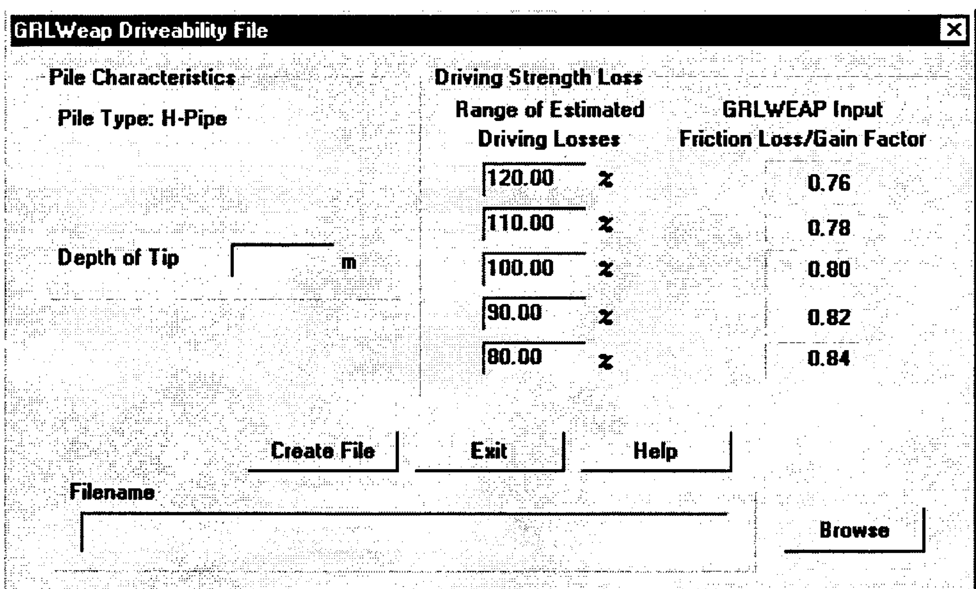


Figure 5-3. GRLWEAP driveability file dialog box for an H-Pile.

Figures 5-1, 5-2, and 5-3 show examples of the GRLWEAP file creation dialog box. This dialog box facilitates the creation of a driveability input file. There are three main input sections: *Pile Characteristics, Driving Strength Loss,* and *Filename.* Each of these sections is discussed below.

Pile Characteristics

Depending upon the type of pile selected for analysis, there will be one or two parameters required. In the case of open-end and closed end steel pipe piles: *Shell Thickness* and *Depth of Tip*. In the case of concrete piles and H-Piles: *Depth of Tip.* All other pile types are tapered and are not supported.

Shell Thickness

The shell thickness is the wall thickness of the pipe pile. This parameter is used to compute the cross sectional area of the pile.

Depth of Tip

The depth of the tip is used to locate the bottom of the pile. The ground surface is always considered to be 0.0 m (ft).

Driving Strength Loss

The five inputs under the title *"Range of Estimated Driving Losses"* are used by DRIVEN to compute the "*GRLWEAP Input Friction Loss/Gain Factor values".* These values are written to the driveability file and used by the GRLWEAP software to perform its driveability analysis. This section will briefly overview the loss/gain factors and discuss how the five friction loss/gain factors are determined by the DRIVEN program.

One to 10 friction gain/loss factors for both skin friction (shaft resistance in GRLWEAP) and end bearing (toe resistance in GRLWEAP) can be entered into the GRLWEAP program. The DRIVEN program will write five friction gain/loss factors as discussed below. DRIVEN also writes five values of 1.0 for the end bearing friction gain/loss factors. This means the end bearing is assumed to have no strength loss during driving. The remainder of this section will concentrate on the skin friction gain/loss factors.

Each of the friction gain/loss factors in GRLWEAP are analyzed separately. If there are five friction gain/loss factors, there will be five driveability analyses. An individual gain/loss factor is the estimated percent strength remaining during driving in the soil layer that loses the most strength during driving, (expressed as a decimal). For example, assume a soil profile having three layers and the following strength losses:

Layer	Estimated strength loss during driving
1	20%
2	35%
3	10%

The layer that loses the most strength during driving is layer No. 2. It is estimated that this layer loses 35% of its strength. So there is 65% (100% -35%) of the strength remaining in this layer during driving. The shaft resistance gain/loss factor for this soil profile is 0.65.

During the driveability analysis, the GRLWEAP program uses a setup factor to account for the different soil layer strength losses.

The Driven program writes five friction gain/loss factors -- the initial one and four others based on the initial factor. The *"Range of Estimated Driving Losses"* is used to determine the remaining four friction gain/loss. The remainder of the section will discuss how these are calculated.

In the example soil profile above, the percent strength loss during driving was estimated. This estimate may be too high, or it may be to low. Therefore, in the driveability analysis a range of friction gain/loss factors are used. This process allows the user to evaluate a set of estimated driving losses.

The GRLWEAP driveability analysis is a set of one to 10 analyses depending on the number of gain/loss factors specified. If there are five friction gain/loss factors, there will be five separate analyses during the driveability analysis each using a different gain/loss factor. Each analysis will use the same basic soil profile, the same hammer, and the same pile. The difference between each analysis is the loss/gain factor. There will be a different strength loss in the layer that loses the most strength as defined by the set of friction gain/loss factors. The strength loss in the other soil layers will be adjusted by the setup.

By default, the Driven program will write the five friction gain/loss factors as:

20% more strength loss in the layer that loses the most strength (120% of loss)
10% more strength loss in the layer that loses the most strength (110% of loss)
Estimated strength loss in the layer that loses the most strength (100% of loss)
10% less strength loss in the layer that loses the most strength (90% of loss)
20% less strength loss in the layer that loses the most strength (80% of loss)

In the example above, the layer that lost the strength during driving lost 35% so the friction gain/loss factors would be calculated as:

RANGE	CALCULATION	DRIVING LOSS	FRICTION GAIN/LOSS FACTOR (1-Driving loss)
20% more strength loss	0.35(120%)	0.420	0.580
10% more strength loss	0.35(110%)	0.385	0.615
Estimated strength loss	0.35(100%)	0.350	0.650
10% less strength loss	0.35(90%)	0.315	0.685
20% less strength loss	0.35(80%)	0.280	0.720

Within the GRLWEAP driveability analysis, the first analysis will assume that the layer which losses the most strength will loses 42% of it strength. For the second analysis, the same layer will lose 38.5% of its strength, and so on until all five analyses are done. The strength loss in the remaining soil layers will be accounted for by the setup factor.

The user can change the range of friction gain/loss factors by entering a new value in the "*Range of Estimated Driving Losses.*" A value greater that 100% increases the strength loss, a value less than 100% reduces the strength loss. For further explanation of the friction loss/gain factors, please refer to the GRLWEAP manual.

Filename

The filename is the name of the driveability file. This can be any name, as long as it has the extension ".gwi". The extension can be omitted when saving the file and the DRIVEN program will automatically add it when the file is created. The GRLWEAP software will recognize the ".gwi" extension and display the file for use.

The *Browse* button can be pressed to bring up a standard Windows file selection dialog box. This dialog box is used to select the location and name for the driveability file.

Once all the options for the driveability file have been set, press the *Create File* button. When DRIVEN is finished writing the file, it will display a message acknowledging that the driveability file has been created. Additional files may be created at this time or press the *Exit* button to return to the main menu of the program.

CHAPTER 6 - FILE MANAGEMENT

There are three situations when it is appropriate to use the file management capabilities of the DRIVEN software: immediately after creating a new project, after editing an existing project, and when loading an existing project. DRIVEN handles file management in the same standardized manner as other Windows programs.

Figure 6-1 shows the File dropdown menu when a project is in memory. There are five specific file management options available along with a "Most Recently Used" (referred to as MRU) file list. The five file operations are: *New, Open, Close, Save,* and *Save As*. The DRIVEN program maintains an internal list of the last four files that have been accessed, with the most recent files located at the top of the list. Any of these four files can be chosen by selecting it from the menu. DRIVEN will load the file into memory when the menu choice is made.

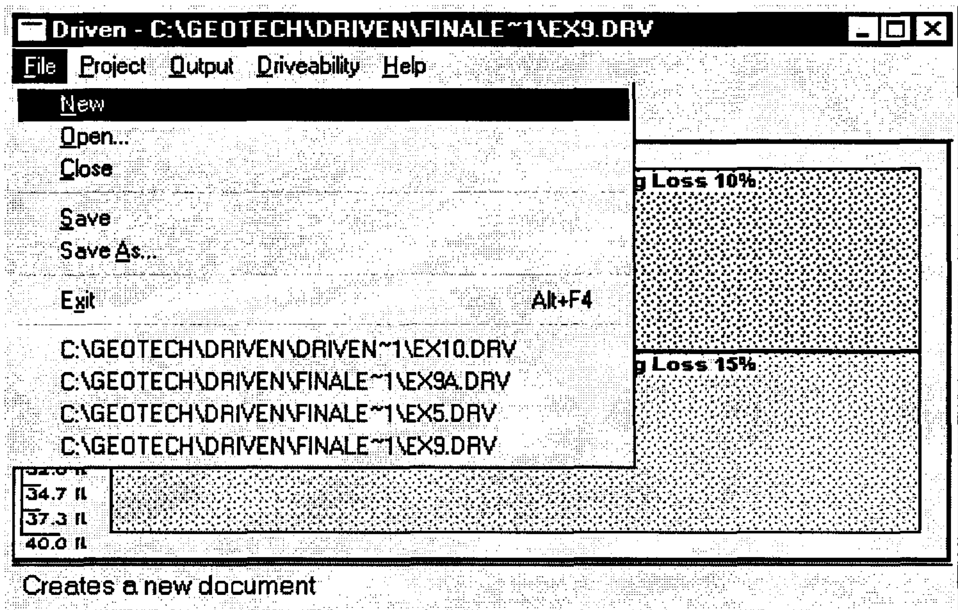


Figure 6-1. File drop down menu when a project is in memory.

Open

This menu choice allows a previously saved DRIVEN project to be loaded into the program memory. When chosen, DRIVEN will present a standard Windows open file management dialog box. Figure 6-2 shows an example of this dialog box.

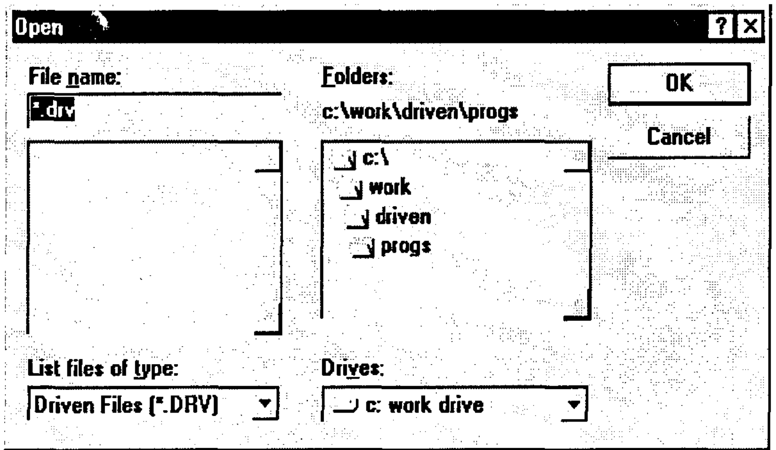


Figure 6-2. Open dialog box.

Figure 6-2 is an example of the standard Windows file management dialog box that DRIVEN will display. This dialog box is used to navigate through the directory structure and find the place where the data files are located. Using the mouse, select the desired file and press the *OK* button. DRIVEN will load the file and place it into memory for use. When a project is in memory, the name of the file is identified in the title bar of the DRIVEN program. For examples, **"DRIVEN - D:\DRIVEN\DATA\FILE1.DRV."** When no project is in memory, the title bar will only show the name of the DRIVEN program.

Close

When finished using the project in memory, select the *Close* menu choice to close the data file. The program will first prompt the user to save the file. To keep the changes made to the data file, press Yes, otherwise, the file will be closed and the updated items not saved. When DRIVEN closes the project, it will update the MRU list with the name of the file.

Save

If changes have been made to an existing project, select the *Save* menu item to save the data file. DRIVEN will use the current filename and save the project. If creating a new project and no filename has yet been selected, DRIVEN will automatically select the Save As function so that a filename for the project can be entered.

Save As

Select the *Save As* function after creating a new project, or modifying an existing project that is to be saved under a different filename. When this menu choice is selected, a standard Windows dialog box similar to the one shown in figure 6-3 will be displayed.

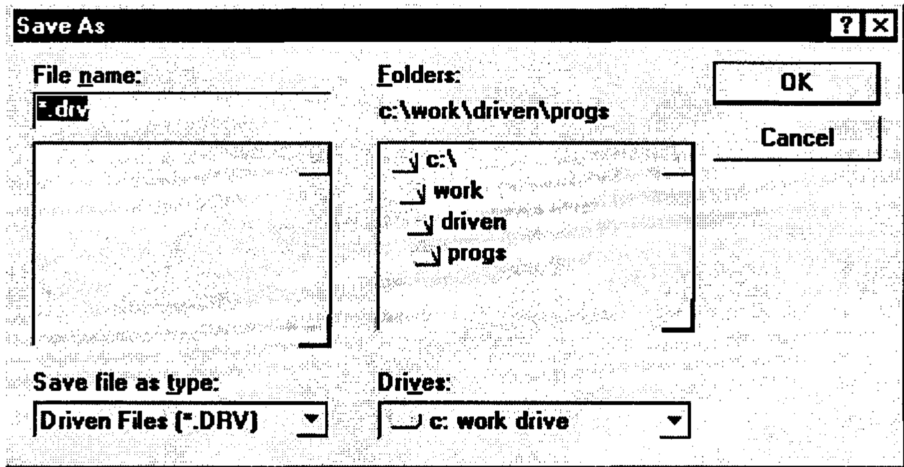


Figure 6-3. Save As dialog box.

Figure 6-3 demonstrates the Save As dialog box. This dialog box functions just like the Open file dialog box. It can be used to navigate the directory structure to locate the desired directory. When the desired location has been identified, type in a new filename making sure the file extension used is ".drv" and press the OK button The extension can be omitted and the DRIVEN program will add it automatically. The specific details of where to locate the data file are left up to the user.

CHAPTER 7 - ENGINEERING BACKGROUND

This section discusses the engineering background used for the development of the analytical aspects of the DRIVEN software.

The DRIVEN program follows the methods and equations presented by Nordlund (1963, 1979), Thurman (1964), Meyerhof (1976), Cheney and Chassie (1982), Tomlinson (1980, 1985), and Hannigan, et.al. (1997). The Nordlund and Tomlinson static analyses methods used by the program are semi-empirical methods and have limitations in terms of correlations with field measurements and pile variables which can be analyzed. The user is encouraged to review further information on this subject in the "Design and Construction of Driven Pile Foundations" manual (Hannigan, et.al. 1997).

Ultimate Vertical Load Capacity

A single pile derives its load-carrying ability from the frictional resistance of the soil around the shaft and the bearing capacity at the pile tip:

$$Q = Q_p + Q_s \qquad [1]$$

where:

$$Q_p = A_p * q_p \qquad [2]$$

and:

$$Q_s = \int_0^L f_s C_d dz \qquad [3]$$

in which:

A_p = area of pile tip
q_p = bearing capacity at pile tip
f_s = ultimate skin resistance per unit area of shaft
C_d = effective perimeter of pile
L = length of pile in contact with soil
z = depth coordinate

The main requirement for design is to estimate the magnitude of f_s with depth for friction piles and q_p for end bearing piles.

Point Resistance

The point bearing capacity can be obtained from the equation:

$$q_p = cN_c + qN_q + \frac{\gamma B}{2} N_\gamma \qquad [4]$$

Where N_c, N_q, and N_γ are dimensionless parameters that depend on the soil friction angle ϕ. The term c is the cohesion of the soil, q is the vertical stress at pile tip level, B is the pile diameter (width), and γ is the unit weight of the soil.

The soil strength parameters, c and ϕ, the unit weight γ, and the vertical stress q may be considered in terms of effective stress or total stress.

Total Stress Analysis

For an undrained analysis, ϕ equals zero and c equals the undrained shear strength, S_u. With $\phi = 0$, $N_\gamma = 0$ and $N_q = 1$. Combining equations [2] and [4], and considering the pile weight the following equation applies:

$$Q_p = A_p S_u N_c \qquad [5]$$

Values of N_c lie between 7 and 16. A value of $N_c = 9$ is typically used.

Effective Stress Analysis

For these conditions, equations [2] and [4] combine as follows:

$$\overline{Q}_p = A_p\left(\frac{\overline{\gamma} B}{2} N_\gamma + \overline{q} N_q + \overline{c} N_c\right) \qquad [6]$$

In most cases, $\frac{1}{2}\overline{\gamma} B N_\gamma$ and $\overline{c} N_c$ are small when compared to $\overline{q} N_q$. The net point bearing capacity can be approximated as:

$$Qpnet \cong A_p \overline{q} N'_q \qquad [7]$$

where $\overline{q} = \overline{\sigma}_{vo}$, the effective vertical stress at tip level, and N_q is a dimensionless bearing capacity factor that varies with $\overline{\phi}$.

DRIVEN uses a variation of [7] (Thurman 1964):

$$Qpnet = A_p \overline{q} \alpha N'_q \qquad [8]$$

where:
N'_q = bearing capacity factor from figure 7-1
α = a dimensionless factor dependent on the depth-width relationship of the pile

If DRIVEN computes a pile point resistance exceeding the limiting value suggested by Meyerhof (1976)(figure 7-2), then the limiting value is used by the program.

Shaft Resistance

The ultimate skin resistance per unit area of shaft is calculated as follows:

$$f_s = c_a + \sigma_h * \tan(\delta) \quad [9]$$

in which:

c_a = pile soil adhesion
σ_h = normal component of stress at pile-soil interface
δ = pile-soil friction angle

The normal stress σ_h is related to the vertical stress σ_v as $\sigma_h = K * \sigma_v$, where K is a coefficient of lateral stress. Substituting into equation [9] produces this result:

$$f_s = c_a + K * \sigma_v * \tan(\delta) \quad [10]$$

Total Stress Analysis

For a $\phi = 0$ or total stress analysis, equation [10] reduces as follows:

$$f_s = c_a \quad [11]$$

where the adhesion c_a is usually related to the undrained shear strength s_u in the following way:

$$c_a = \alpha * s_u \quad [12]$$

where α is an empirical adhesion coefficient that depends mainly upon the following factors: nature and strength of the soil, type of pile, method of installation, and time effects. Figures 7-3 and 7-4 present the α values used by the program as suggested by Tomlinson (1979, 1980).

Effective Stress Analysis

Equation [10] reduces to

$$f_s = \bar{c}_a + K * \bar{\sigma}_v * \tan(\delta) \cong K * \bar{\sigma}_v * \tan(\delta) \quad [13]$$

Because $\bar{c}_a$ is either zero or small compared to $K * \bar{\sigma}_v * \tan(\delta)$.

The main difficulty in applying the effective stress approach lies in having to predict the normal effective stress on the pile shaft $(\bar{\sigma}_h = K * \bar{\sigma}_v)$.

Nordlund (1963,1979) developed a method of calculating skin friction based on field observations and results of several pile load tests in cohesionless soils. Several pile types are used, including timber, H, pipe, monotube, etc. The method accounts for pile taper and for differences in pile materials.

Nordlund (1963,1979) suggests the following equation for calculating the ultimate skin resistance per unit area:

$$f_s = K_\delta C_f \bar{P}_d \frac{\sin(\omega + \delta)}{\cos(\omega)} \qquad [14]$$

combine [3] with [14] to calculate the frictional resistance of the soil around the pile shaft as follows:

$$Q_s = \int_0^L K_\delta C_f \bar{P}_d \frac{\sin(\omega + \delta)}{\cos(\omega)} C_d dz \qquad [15]$$

which simplifies for non-tapered piles $(\omega = 0)$ as follows:

$$Q_s = \int_0^L K_\delta C_f \bar{P}_d \sin(\delta) C_d dz \qquad [16]$$

in which:

Q_s = total skin friction capacity
K_δ = coefficient of lateral stress at depth z
$\bar{P}_d$ = effective overburden pressure
ω = angle of pile taper
δ = pile-soil friction angle
C_d = effective pile perimeter
C_f = correction factor for K_δ when $\delta \neq 0$

To avoid numerical integration, computations are performed for pile segments within soil layers of the same effective unit weight and friction angle. The equation [16] becomes

$$Q_s = \sum_{i=1}^{n} K_{\delta i} C_{fi} \bar{P}_{di} \sin(\delta_i) C_{di} D_i \qquad [17]$$

where:

n = number of segments
D_i = thickness of single segment

Figures 7-5, 7-6, 7-7 and 7-8 give values of K_δ versus ϕ with δ equal to ϕ. Figure 7-9 gives a correction factor to be applied to K_δ when δ is not equal to ϕ. Figure 7-10 gives δ/ϕ for different pile types and sizes.

Figure 7-11 shows the correction factor of field SPT N-Values for the influence of effective overburden pressure.

These figures and equations [8] and [17] are used to calculate the ultimate bearing capacity of a pile in sand. For a step-by-step application of Nordlund's method, the reader is referred to Hannigan et. al (1997).

The remainder of this section presents graphs and tables of the above-described curves as used by the DRIVEN program.

Plugging of Open End Pipe Piles

The DRIVEN computer program follows the guidelines below for the analysis of open-end pipe piles with regard to plugging. As with other soil types, the skin friction and end bearing depend on the soil type. However, the skin friction and end bearing for the open end pipe piles in cohesive material is also dependant on whether it's during driving, or at a time after setup has occurred (restrike, ultimate). In granular materials, skin friction and end bearing are also dependent on the ratio of pile width to pile toe depth.

The open-ended pipe pile is considered to be either unplugged, acting like a non-displacement pile (i.e., H-pile), or plugged, acting like a displacement pile (i.e., closed end pipe pile). The chart below describes when the pile is considered to be plugged or unplugged.

In this chart, D = B = pile width and L = pile length.

Cohesive

<u>Skin Friction</u>

Driving - Unplugged (Use alpha for L > 40B in Tomlinson's charts)
Restrike/Ultimate - Plugged (use actual L/B)

<u>End Bearing</u>

Driving - Unplugged (No end bearing)
Restrike/Ultimate - Plugged (use actual L/B)

Granular

Skin Friction

Driving/Restrike/Ultimate
L < 30 D No plug (non displacement pile)
L > 30 D Plugged (displacement pile)

End Bearing

Driving
L < 30 D No plug (no end bearing)
L > 30 D Plugged (full end bearing)

Static/Ultimate
Plugged (full end bearing)

Table 7-1a. Nq factor for point resistance contribution
(digitized curve from figure 7-1a)

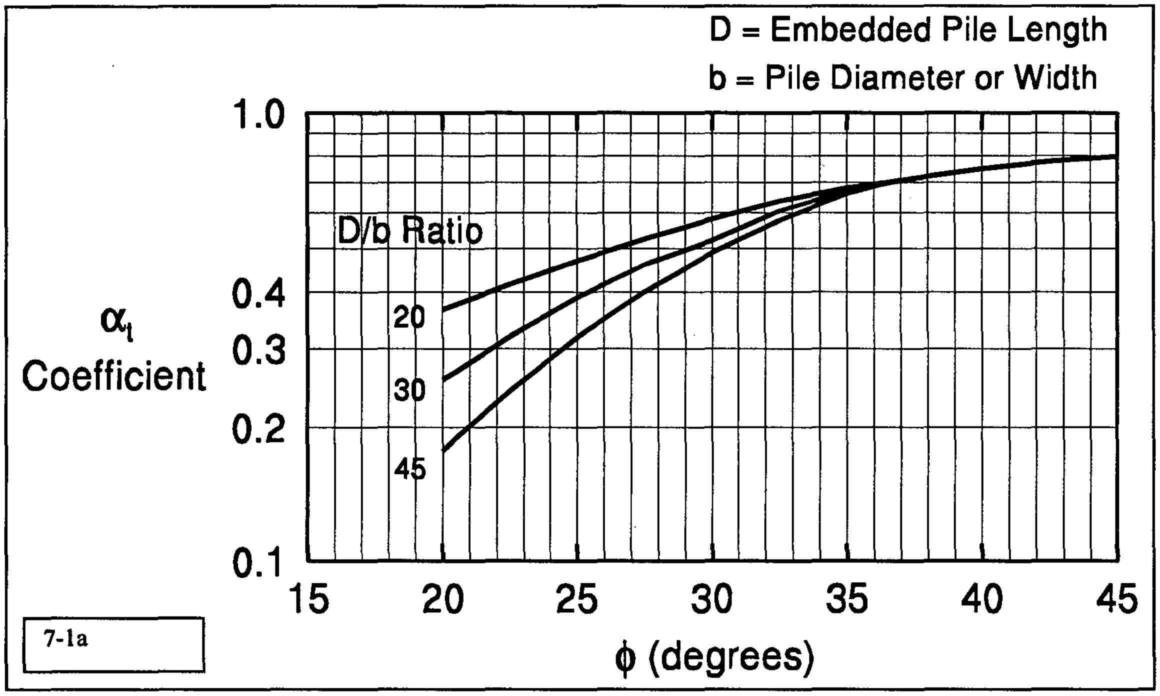
ϕ (degrees)	Value of Nq
15.0	4.8
17.5	6.2
20.0	8.2
22.5	12.0
25.0	15.0
27.5	21.0
30.0	30.0
32.5	43.0
35.0	64.0
37.5	98.0
40.0	160.0
42.5	265.0
45.0	475.0

Note: The friction angle permitted by DRIVEN varies between 15 and 45 degrees.

Table 7-1b. α factor for point resistance contribution
(digitized curves from figure 7-1b)

ϕ (degrees)	Values of α D/B = 45	D/B=30	D/B=20
20.0	0.177	0.256	0.365
20.5	0.190	0.276	0.375
22.5	0.242	0.319	0.416
25.0	0.318	0.389	0.470
27.5	0.400	0.460	0.525
30.0	0.490	0.520	0.580
32.5	0.578	0.605	0.637
35.0	0.660	0.670	0.680
36.5	0.700	0.700	0.700
37.5	0.715	0.715	0.715
40.0	0.750	0.750	0.750
42.5	0.780	0.780	0.780
45.0	0.800	0.800	0.800

Note:
1. If $\phi < 20.5^{o}$, DRIVEN uses $\phi = 20.5^{o}$
2. If $\phi > 45^{o}$, DRIVEN uses $\phi = 45^{o}$



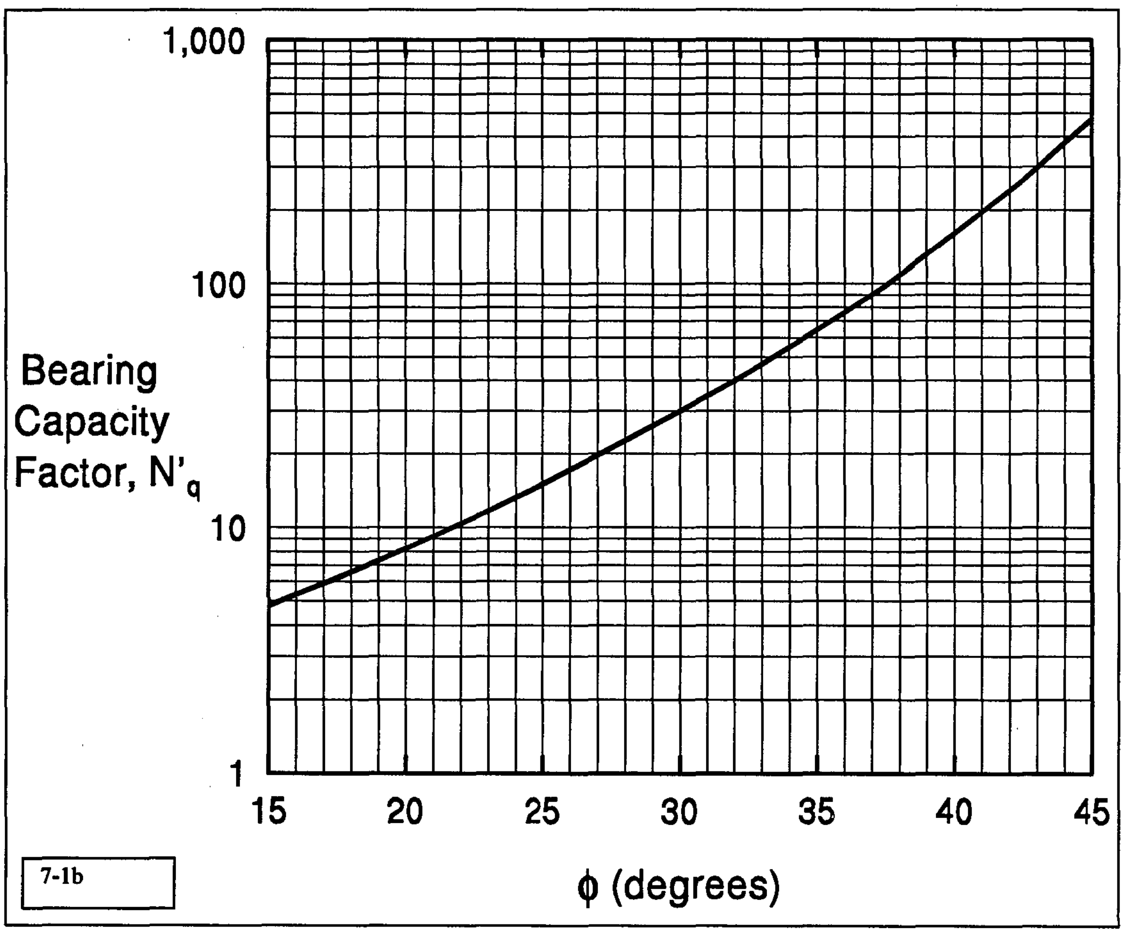


Figure 7-1. Chart for Estimating α_t Coefficient and Bearing Capacity Factor N'_q (Chart modified from Bowles, 1977).

Table 7-2. Relationship between maximum unit pile point resistance and ϕ for cohesionless soils

(digitized curve from figure 7-2)

ϕ (degrees)	Limiting Unit Point Resistance (kPa)
30.00	637.8
31.25	1077.3
32.50	1915.2
33.75	3112.2
35.00	5151.9
36.25	7785.3
37.50	11251.8
38.75	15273.7
40.00	19994.7
41.25	25137.0
42.50	30528.3
43.75	35316.3

Note: 1. If $\phi < 30^{o}$, DRIVEN uses the value for $\phi = 30^{o}$

2. If $\phi > 43.75^{o}$, DRIVEN uses the value for $\phi = 43.75^{o}$

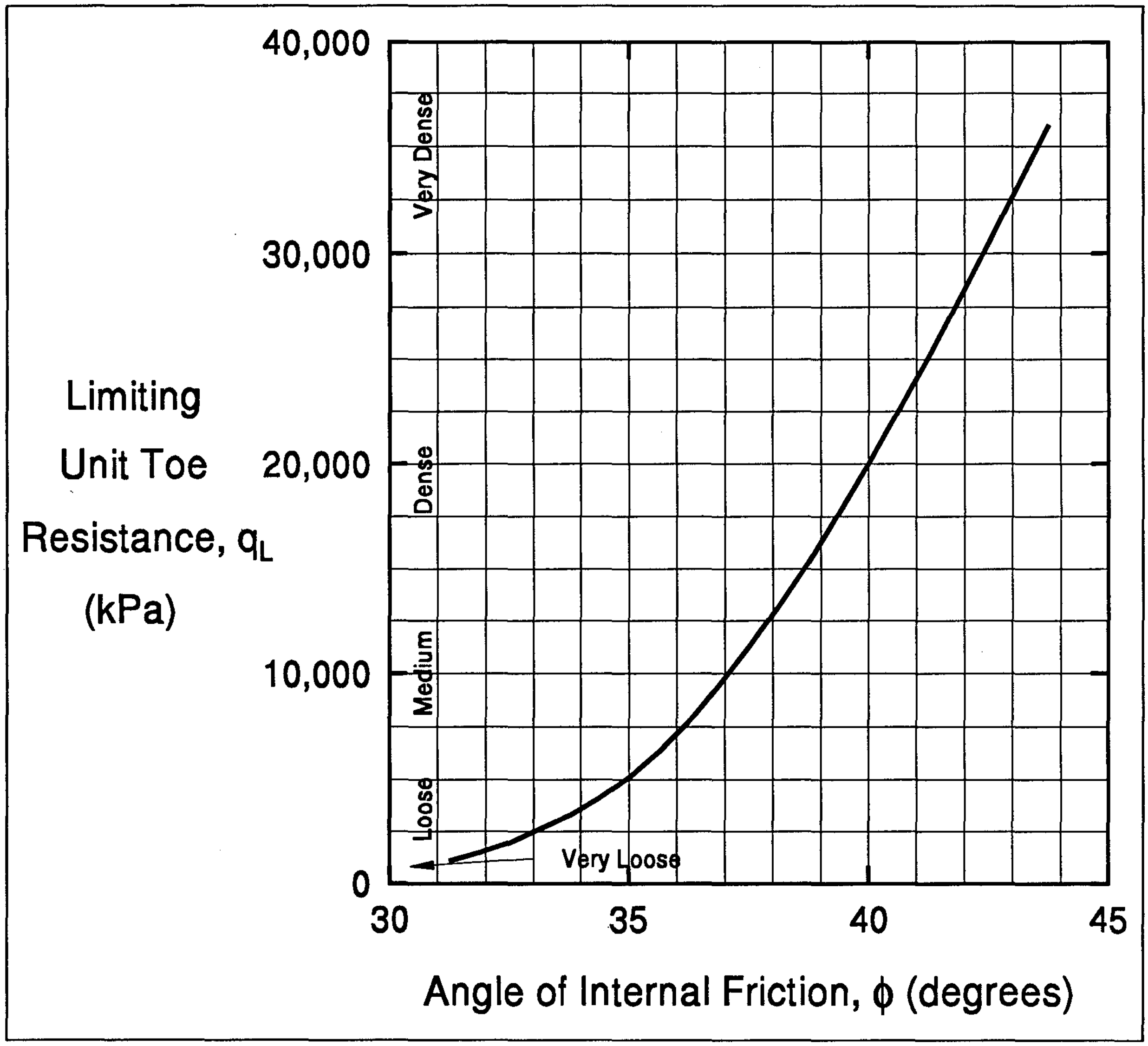
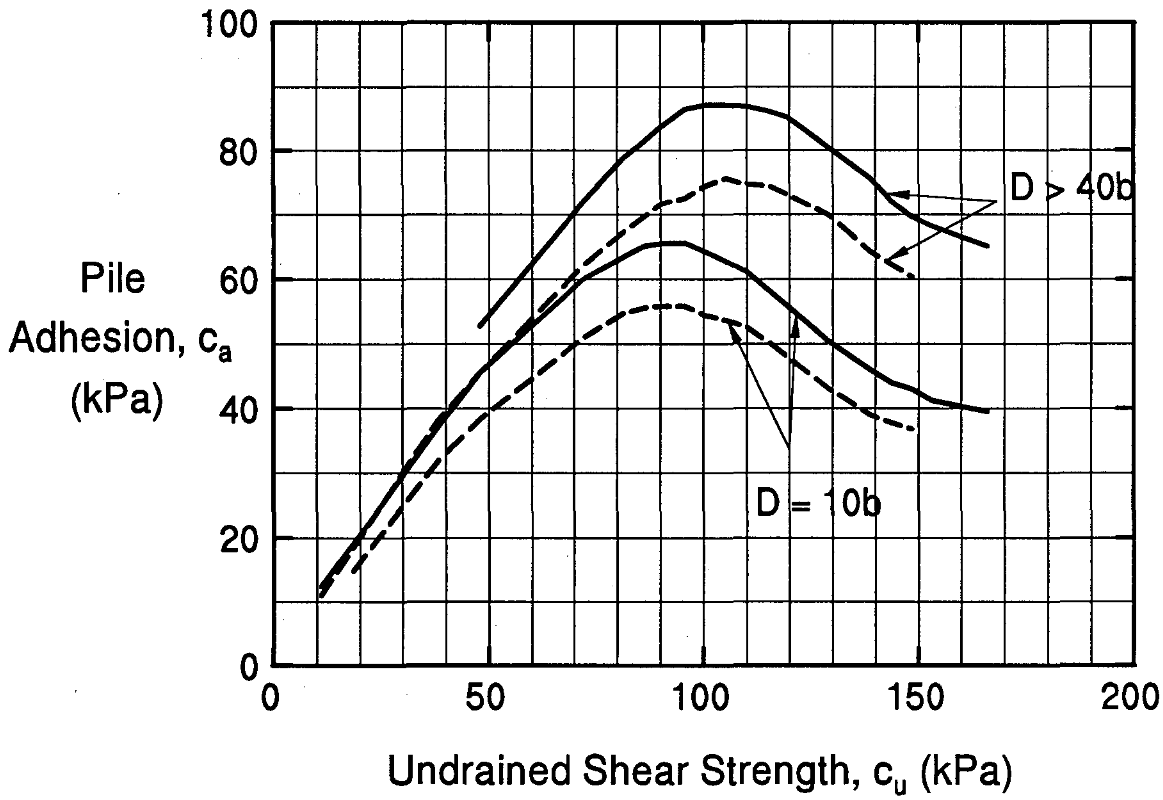


Figure 7-2. Relationship Between Maximum Unit Pile Toe Resistance and Friction Angle for Cohesionless Soils (after Meyerhof, 1976).

Table 7-3. Adhesion values for piles in cohesive soils (Tomlinson 1979) as presented by FHWA, 1982

(digitized curves from figure 7-3)

Undrained Shear Strength (kPa)	**Concrete, Timber, Corrugated Steel Piles** L > 40B	L = 10B	**Smooth Steel Piles** L > 40B	L = 10B
11.0	11.01	12.45	11.01	11.01
18.4	18.43	19.15	18.43	14.84
23.9	23.94	23.94	23.94	19.63
38.3	38.30	37.11	38.30	31.84
47.9	47.88	45.49	45.49	38.30
71.8	71.82	59.85	62.00	50.75
81.4	77.57	63.44	67.27	53.63
86.2	81.40	65.12	69.67	55.54
95.8	86.42	65.60	72.54	55.78
100.5	87.14	64.16	74.45	54.34
105.3	87.14	62.72	75.65	53.63
110.1	86.90	61.77	74.69	52.43
114.9	86.18	58.41	74.45	50.27
119.7	85.71	55.78	73.02	47.88
129.3	80.44	50.27	69.90	43.09
138.9	75.65	45.96	64.16	39.02
143.6	72.06	44.05	62.24	37.83
148.4	69.67	43.09	60.33	36.87
153.2	68.23	41.18		
165.9	65.12	39.50		



——— Concrete, Timber, Corrugated Steel Piles

- - - - Smooth Steel Piles

D = Distance From Ground Surface to Bottom of Clay Layer or Pile Toe; Whichever is Less

b = Pile Diameter

Figure 7-3. Adhesion Values for Piles in Cohesive Soils (after Tomlinson, 1979).

Table 7-4a. Adhesion factors for Driven piles in clay

(α method, Tomlinson 1980)

(digitized curves from figure 7-4a)

Piles Driven Through Overlying Sands or Sandy Gravels

L < 10B S_u (kPa)	α	L = 20B S_u (kPa)	α	L > 40B S_u (kPa)	α
0.00	1.00	0.00	1.000	0.00	1.000
478.8	1.00	23.69	1.000	23.69	1.000
		75.79	1.000	35.49	0.972
		88.17	0.972	46.08	0.941
		99.97	0.935	57.88	0.896
		108.96	0.899	68.38	0.845
		117.96	0.845	77.87	0.789
		128.96	0.789	88.17	0.727
		141.95	0.750	99.97	0.648
		238.92	0.750	108.96	0.592
				118.96	0.535
				131.95	0.451
				142.95	0.414
				157.95	0.389
				238.92	0.389

Table 7-4b. Adhesion factors for Driven piles in clay

(α method, Tomlinson 1980)

(digitized curves from figure 7-4b)

Piles Driven Through Overlying Soft Clay

L > 20B S_u (kPa)	α	L = 10B S_u (kPa)	α
24.19	0.838	21.59	0.532
36.79	0.778	33.89	0.466
49.98	0.740	42.59	0.416
63.88	0.707	53.88	0.378
77.57	0.685	65.78	0.345
92.57	0.677	77.57	0.323
104.96	0.671	90.27	0.301
117.96	0.658	102.96	0.293
133.95	0.641	115.96	0.274
149.95	0.616	128.96	0.266
227.92	0.526	141.95	0.247
		217.92	0.184

Table 7-4c. Adhesion factors for Driven piles in clay

(α method, Tomlinson 1980)

(digitized curves from figure 7-4c)

Piles Without Different Overlying Strata

L > 40B S_u (kPa)	α	L = 10B S_u (kPa)	α
73.37	1.000	23.69	0.984
83.37	0.973	33.19	0.959
93.67	0.918	42.86	0.940
104.96	0.822	52.58	0.907
114.96	0.740	62.58	0.874
124.96	0.658	73.17	0.822
134.95	0.564	84.17	0.767
146.95	0.479	93.67	0.707
160.94	0.411	101.96	0.630
172.94	0.370	108.96	0.548
184.94	0.329	116.96	0.466
197.93	0.301	125.96	0.392
211.93	0.299	136.95	0.332
238.92	0.299	146.95	0.288
		160.94	0.250
		175.94	0.238
		238.92	0.238

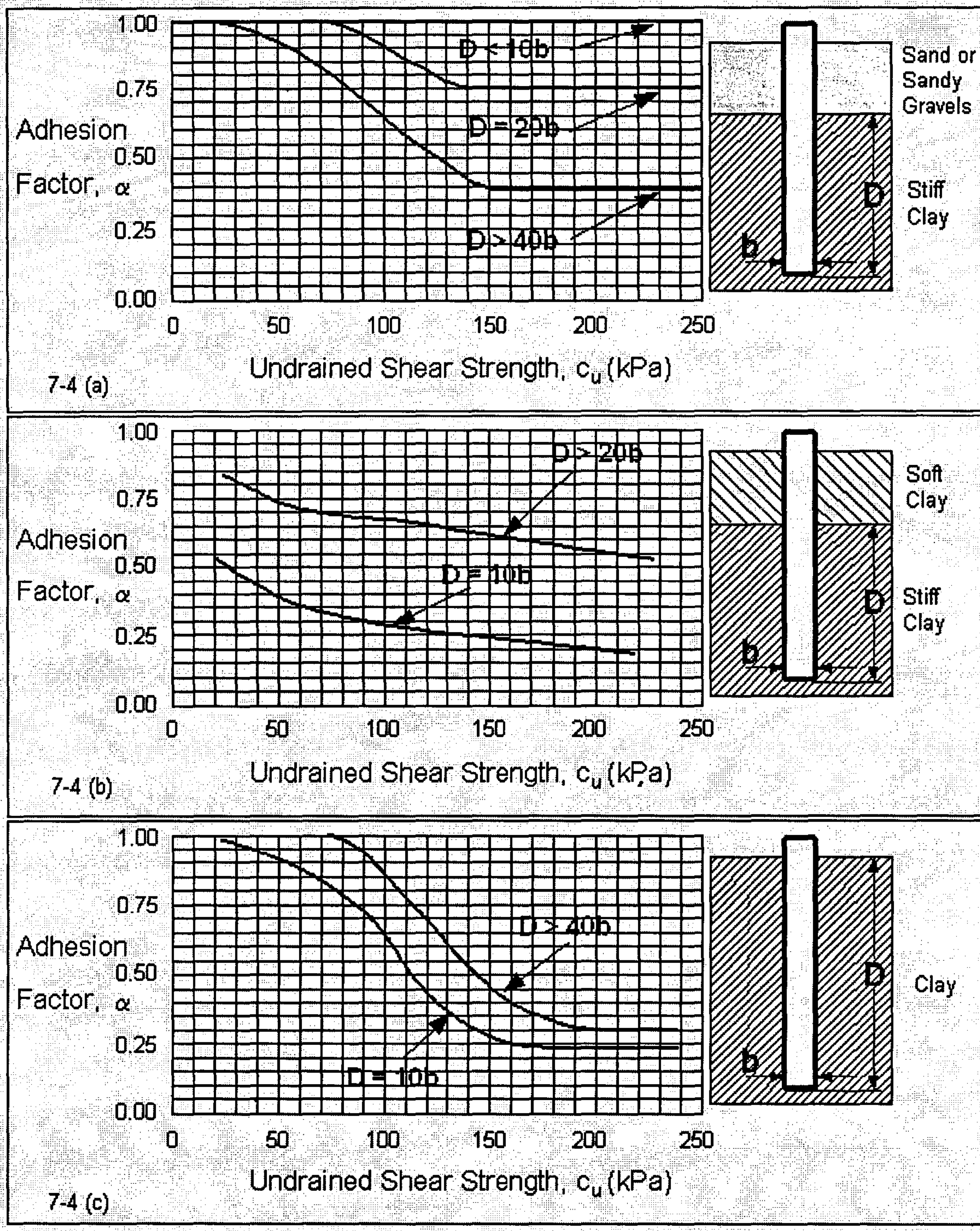


Figure 7-4. Adhesion factors for driven piles in clay (α method, Tomlinson 1980).

Table 7-5. Design curves for evaluating K_δ for piles when

$\phi = 25°$

(digitized curves from figure 7-5)

Taper ω (degrees)	K_δ values V = 0.0093	V = 0.093	V = 0.93
0.00	0.700	0.850	1.000
0.10	0.739	0.902	1.050
0.20	0.817	0.992	1.136
0.30	0.922	1.085	1.237
0.40	1.042	1.206	1.349
0.50	1.194	1.353	1.478
0.60	1.400	1.536	1.646
0.70	1.614	1.703	1.789
0.80	1.808	1.886	1.944
0.90	2.073	2.116	2.147
1.00	2.322	2.337	2.361
1.07	2.559	2.559	2.559
1.20	2.917	2.917	2.917
1.30	3.169	3.169	3.169
1.40	3.383	3.383	3.383
1.50	3.578	3.578	3.578
1.60	3.733	3.733	3.733
1.70	3.869	3.869	3.869
1.80	3.986	3.986	3.986
1.90	4.072	4.072	4.072
2.00	4.130	4.130	4.130

Notes: 1. Volume in m^3/m
2. If $\phi < 25°$ then DRIVEN uses the $\phi = 25°$ curve

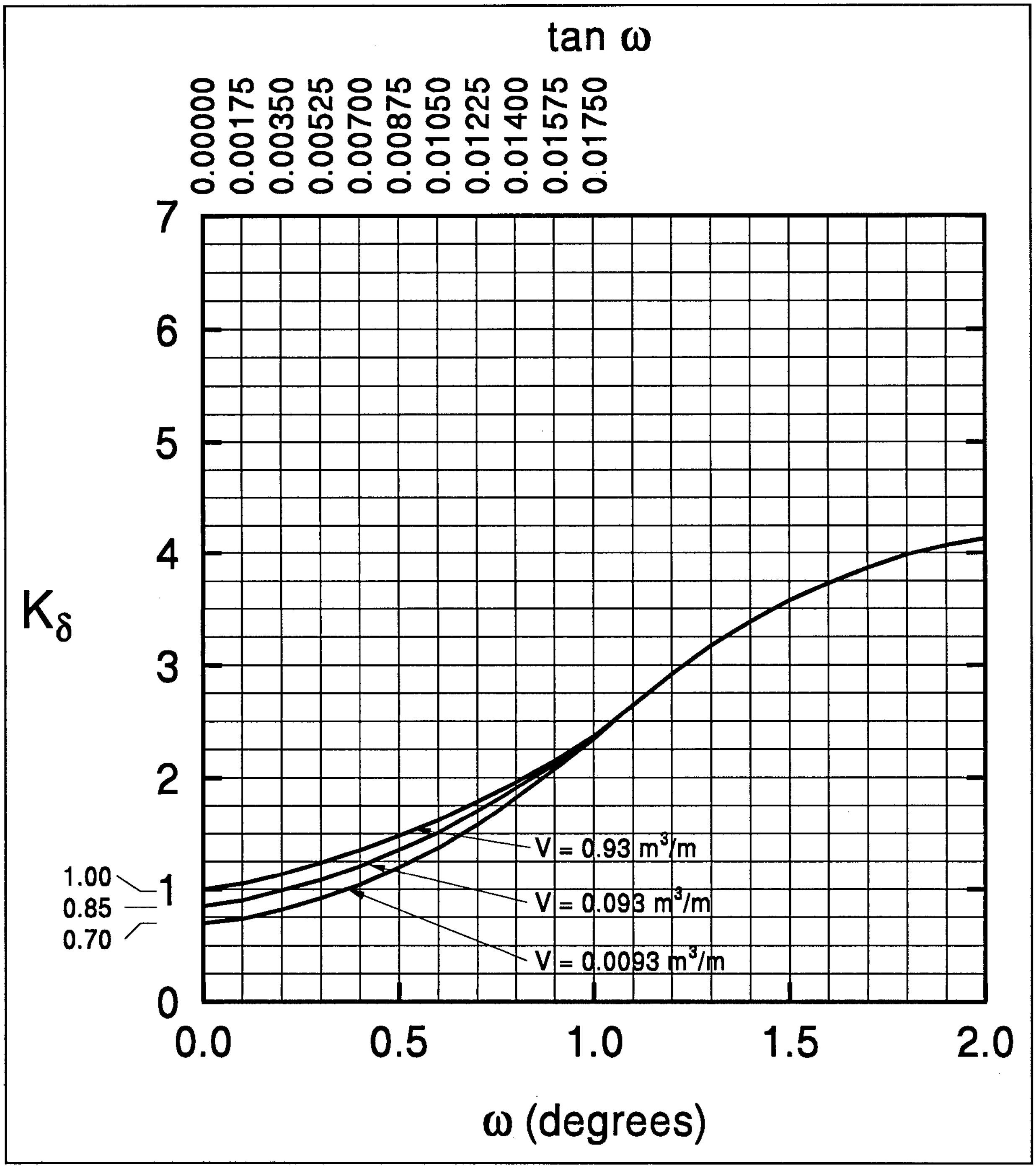


Figure 7-5. Design curves for evaluating K_δ for piles when $\phi = 25°$ (after Norlund 1979).

Table 7-6. Design curves for evaluating K_δ for piles when

$\phi = 30°$

(digitized curves from figure 7-6)

Taper ω (degrees)	K_δ values V = 0.0093	V = 0.093	V = 0.93
0.00	0.850	1.150	1.450
0.10	1.043	1.408	1.745
0.20	1.260	1.629	1.978
0.30	1.551	1.958	2.339
0.40	2.017	2.435	2.746
0.50	2.560	2.928	3.180
0.60	3.180	3.444	3.638
0.70	3.770	3.936	4.072
0.80	4.332	4.421	4.499
0.90	4.925	4.925	4.925
1.00	5.360	5.360	5.360
1.10	5.701	5.701	5.701
1.20	5.934	5.934	5.934
1.30	6.127	6.127	6.127
1.40	6.244	6.244	6.244
1.50	6.329	6.329	6.329
1.60	6.399	6.399	6.399
1.70	6.456	6.456	6.456
1.80	6.487	6.487	6.487
1.90	6.494	6.494	6.494
2.00	6.494	6.494	6.494

Note: Volume in m^3/m

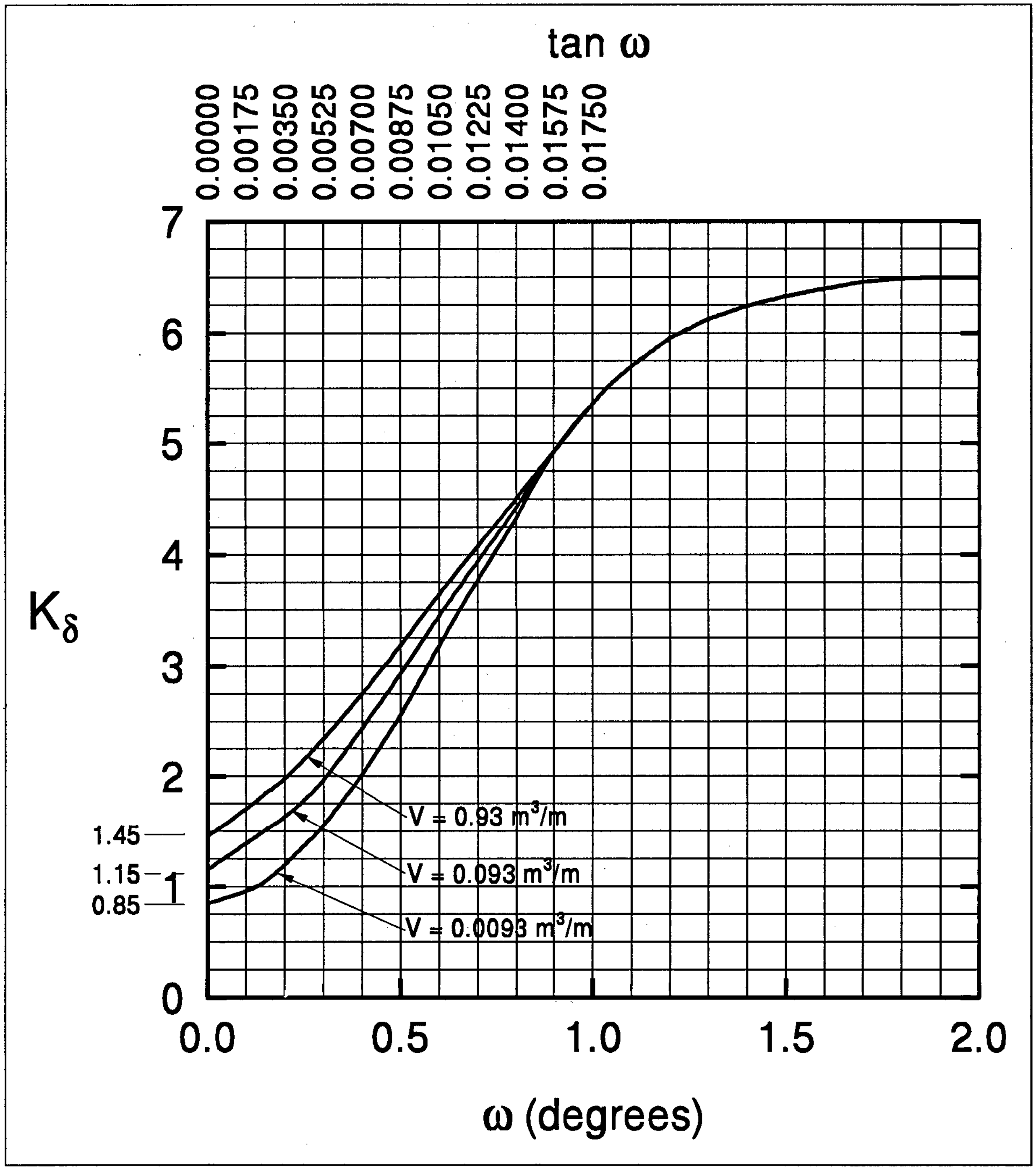


Figure 7-6. Design curves for evaluating K_δ for piles when $\phi = 30°$ (after Norlund 1979).

Table 7-7. Design curves for evaluating K_δ for piles when

$\phi = 35°$

(digitized curves from figure 7-7)

Taper ω (degrees)	K_δ values V = 0.0093	V = 0.093	V = 0.93
0.00	1.15	1.75	2.35
0.10	1.47	2.01	2.76
0.20	2.00	2.59	3.37
0.25	2.32	2.98	3.72
0.30	2.90	3.56	4.26
0.40	4.18	4.66	5.19
0.50	5.42	5.65	6.08
0.60	6.81	6.85	7.12
0.75	8.55	8.55	8.55
0.88	9.75	9.75	9.75
1.00	10.18	10.18	10.18
1.11	10.34	10.34	10.34
2.00	10.34	10.34	10.34

Notes: Volume in m^3/m

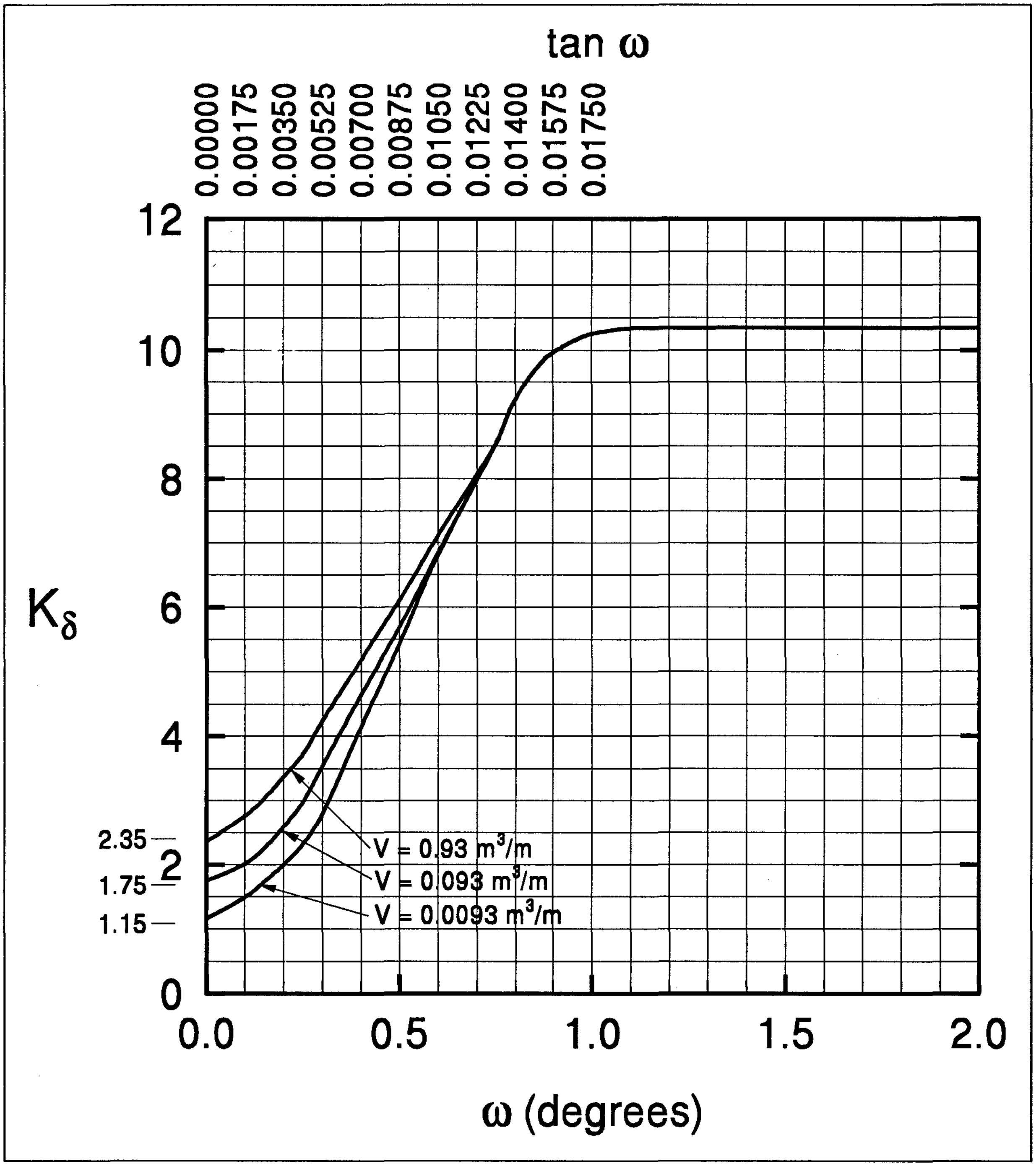


Figure 7-7. Design curves for evaluating K_δ for piles when $\phi = 35°$ (after Norlund 1979).

Table 7-8. Design curves for evaluating K_δ for piles when

$\phi = 40°$

(digitized curves from figure 7-8)

Taper ω (degrees)	K_δ values V = 0.0093	V = 0.093	V = 0.93
0.00	1.70	3.00	4.30
0.10	5.12	6.352	7.04
0.15	7.36	8.00	8.48
0.22	10.56	10.56	10.56
0.30	13.60	13.60	13.60
0.40	15.84	15.84	15.84
0.43	16.64	16.64	16.64
0.50	17.28	17.28	17.28
0.56	17.54	17.54	17.54
2.00	17.54	17.54	17.54

Notes: Volume in m^3/m

For friction angles greater than 40°, DRIVEN uses the 40° table

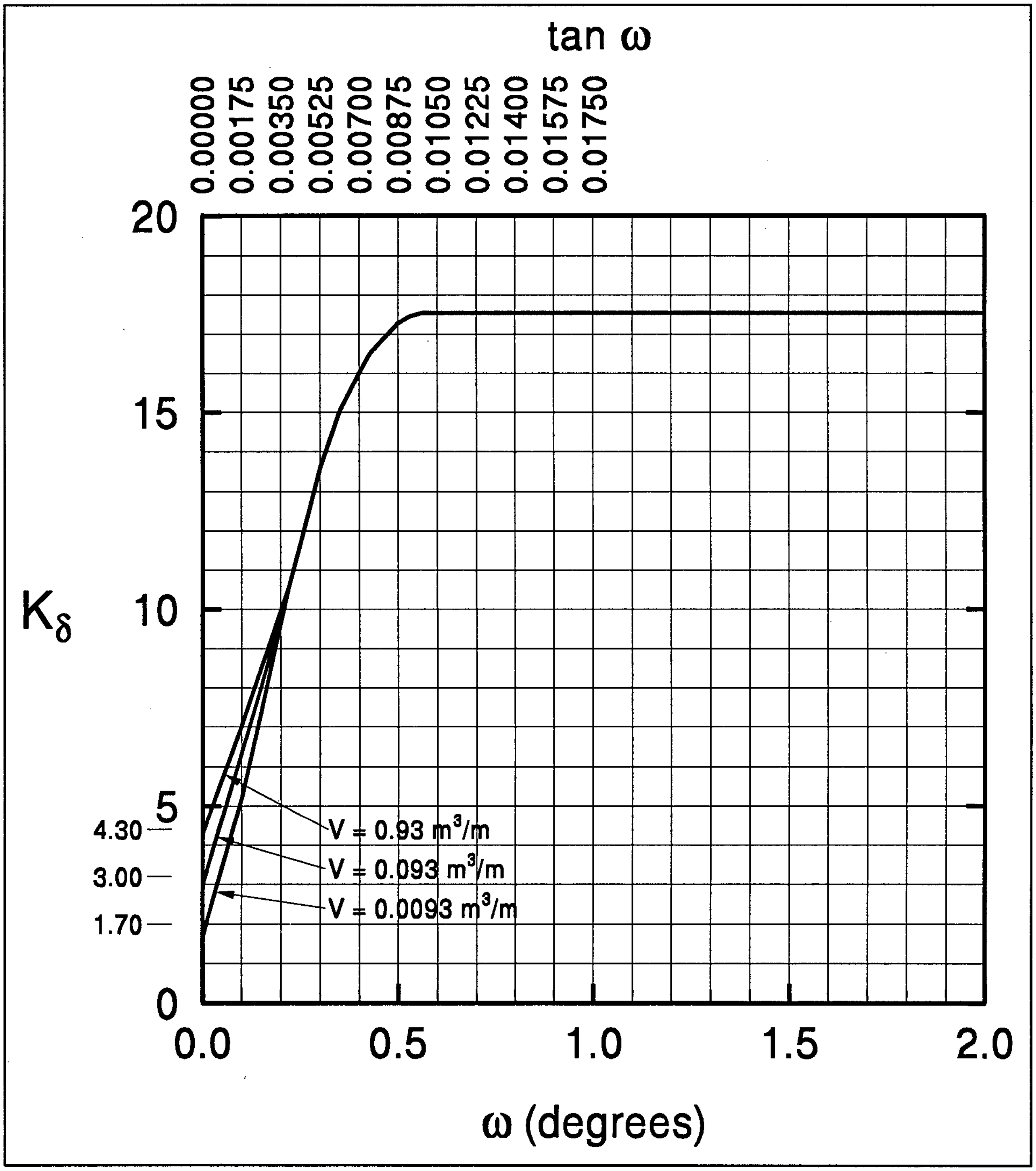


Figure 7-8. Design curves for evaluating K_δ for piles when $\phi = 40°$ (after Norlund 1979).

Table 7-9. Correction factor for K_δ when $\delta \neq \phi$

(digitized curve from figure 7-9)

Correction Factor

ϕ (degrees)	$\delta / \phi =$ 0.2	0.4	0.6	0.8	1.0	1.2	1.4
14	0.83	0.90	0.95	0.99	1.00	1.01	1.02
18	0.77	0.85	0.92	0.98	1.00	1.02	1.03
22	0.71	0.80	0.89	0.97	1.00	1.02	1.03
26	0.64	0.74	0.85	0.95	1.00	1.02	1.04
30	0.58	0.69	0.82	0.94	1.00	1.03	1.06
34	0.50	0.63	0.77	0.92	1.00	1.05	1.08
38	0.42	0.56	0.72	0.90	1.00	1.07	1.10
42	0.32	0.49	0.66	0.87	1.00	1.09	1.13
45	0.24	0.43	0.62	0.84	1.00	1.12	1.16

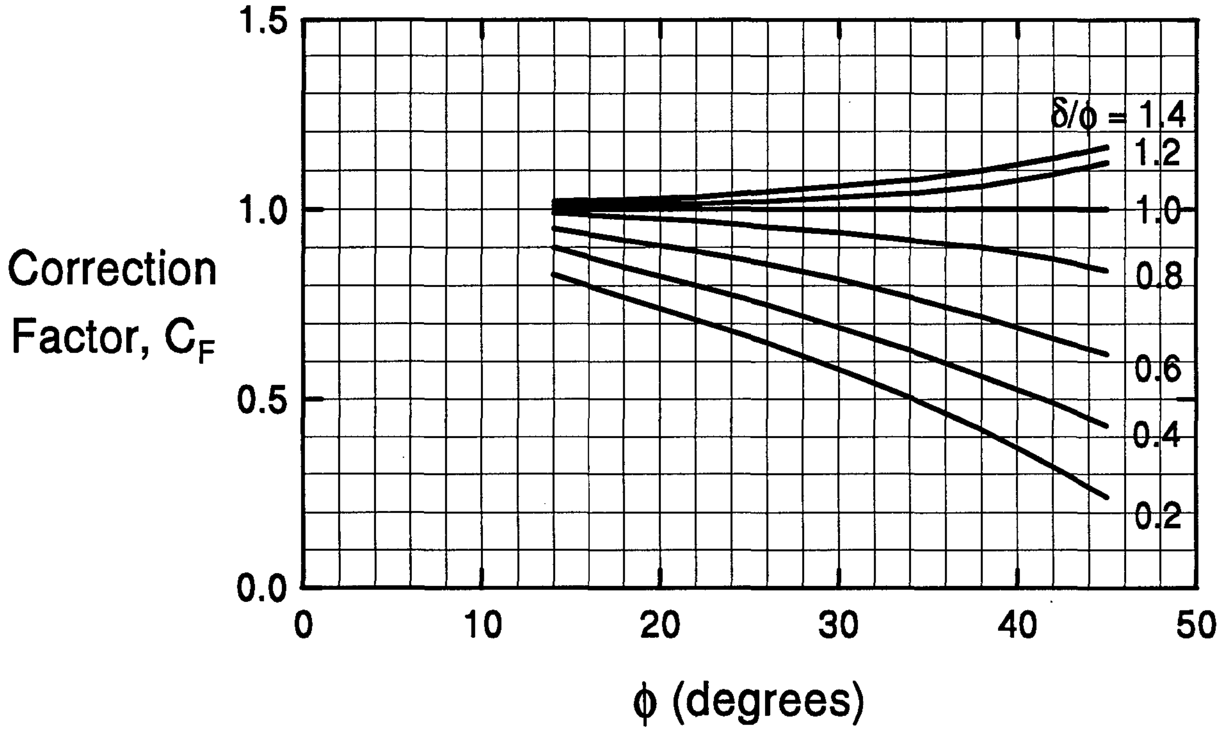


Figure 7-9. Correction factor for K_δ when $\delta \neq \phi$ (after Norlund 1979).

Table 7-10. Relation of δ / ϕ and pile displacement, V, for various types of piles

(digitized curves from figure 7-10)

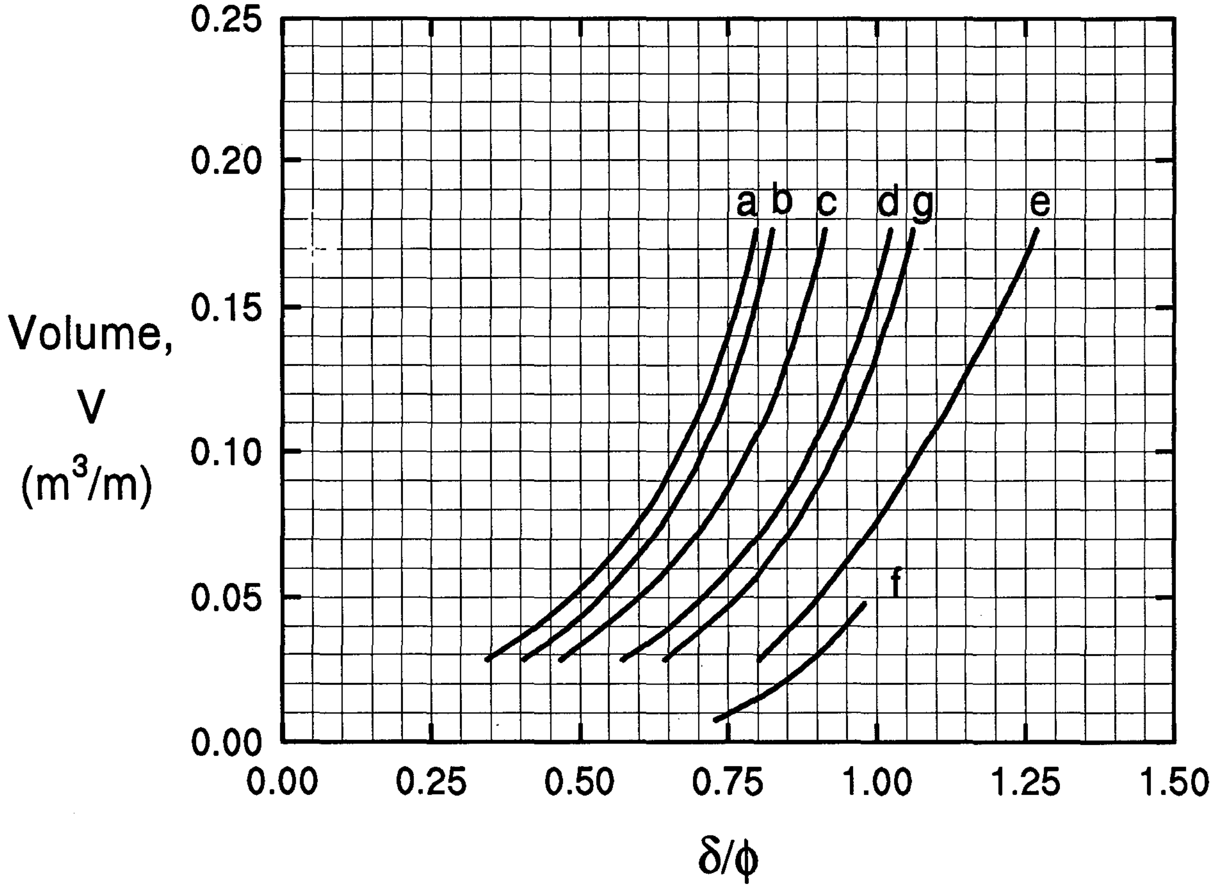
Volume	Values of δ / ϕ					
m^3/m	curve a	curve b	curve c	curve d	curve g	curve e
0.028	0.342	0.404	0.466	0.571	0.643	0.801
0.037	0.410	0.466	0.525	0.637	0.696	0.845
0.046	0.466	0.519	0.581	0.689	0.748	0.888
0.056	0.516	0.562	0.630	0.736	0.792	0.925
0.065	0.559	0.602	0.671	0.776	0.826	0.960
0.074	0.593	0.637	0.708	0.814	0.860	0.994
0.084	0.627	0.665	0.739	0.845	0.888	1.025
0.093	0.652	0.693	0.767	0.873	0.916	1.053
0.102	0.673	0.712	0.789	0.894	0.936	1.081
0.111	0.697	0.734	0.813	0.917	0.958	1.110
0.121	0.717	0.751	0.832	0.936	0.976	1.135
0.130	0.733	0.766	0.848	0.953	0.994	1.159
0.139	0.749	0.781	0.864	0.971	1.013	1.184
0.149	0.763	0.793	0.877	0.985	1.024	1.207
0.167	0.788	0.816	0.904	1.013	1.051	1.252
0.177	0.798	0.825	0.914	1.024	1.062	1.270

for curve f:

volume (m^3/m)	0.007	0.009	0.019	0.028	0.037	0.046	0.049
δ / ϕ value	0.727	0.747	0.827	0.8875	0.933	0.972	0.980

Note: If the pile volume is greater than the maximum volume contained in the table, DRIVEN uses the maximum δ / ϕ value.

Curve a - Closed end pipe and non-tapered portion of monotube
Curve b - Timber
Curve c - Pre-Cast Concrete
Curve d - Raymond Step Taper
Curve e - Raymond Uniform Taper
Curve f - Non-Displacement Steel
Curve g - Tapered portion of monotube



a. Closed end pipe and non-tapered portion of monotube piles
b. Timber piles
c. Precast concrete piles
d. Raymond step-taper piles
e. Raymond uniform taper piles
f. H-piles
g. Tapered portion of monotube piles

Figure 7-10. Relation of δ / ϕ and pile displacement, V, for various types of piles (after Norlund 1979).

Table 7-11. Chart for correction of N-values in sand for influence of effective overburden pressure
(digitized curve from figure 7-11)

Effective Overburden Pressure (kPa)	Correction Factor
0	2.000
23.94	1.470
47.88	1.200
71.82	1.080
95.76	1.000
119.7	0.940
143.64	0.875
167.58	0.800
191.52	0.770
215.46	0.740
239.4	0.700
263.34	0.660
287.28	0.620
311.22	0.600
335.16	0.580
359.1	0.560
383.04	0.5375
406.98	0.520
430.92	0.500
454.86	0.4875
478.8	0.470

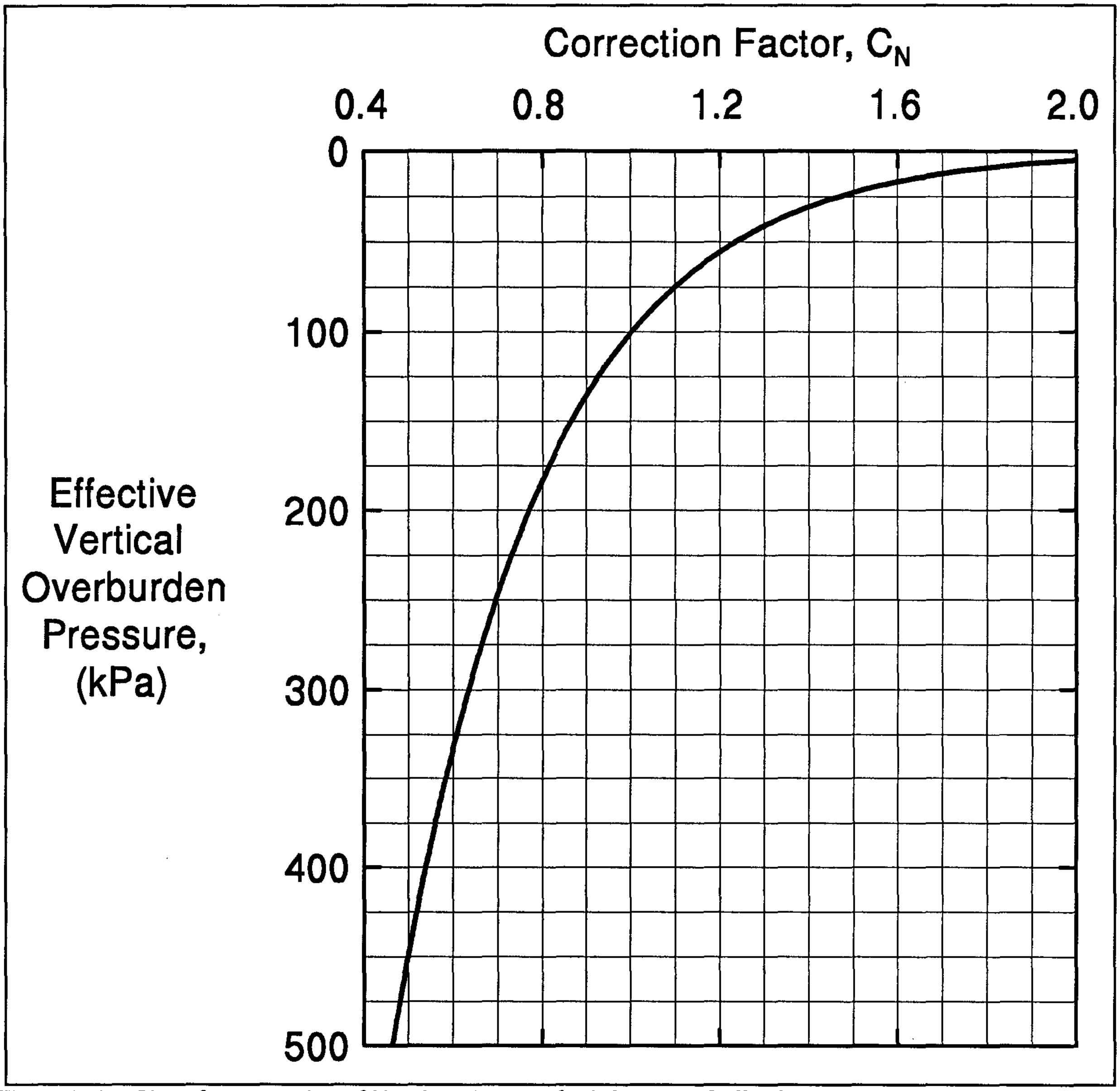


Figure 7-11. Chart for correction of N-values in sand for influence of effective overburden pressure (after Peck et. al. 1974).

Relationship between standard penetration test and ϕ (friction angle)

SPT N Value	ϕ (degrees)
5.0	28.1
10.0	30.0
15.0	31.5
20.0	33.0
25.0	34.5
30.0	36.0
35.0	37.5
40.0	38.8
45.0	40.0
50.0	41.0
55.0	42.0
60.0	43.0

Dimensions of Metric H-Pile shapes included in DRIVEN

(from FHWA Geotechnical Metrication Guidelines)

H – Pile Designation	PILE Area mm^2	Width mm	Perimeter mm	BOX Area mm^2	BOX Perimeter mm
HP 360 X 174	22 200	378.0	2153.0	136 458.0	1478.0
X 152	19 400	376.0	2140.0	133 856.0	1464.0
X 132	16 900	373.0	2122.0	130 923.0	1448.0
X 108	13 800	370.0	2106.0	128 020.0	1432.0
HP 310 X 125	15 800	312.0	1805.0	97 344.0	1248.0
X 110	14 000	310.0	1793.0	95 480.0	1236.0
X 93	11 800	308.0	1780.0	93 324.0	1222.0
X 79	9 970	306.0	1768.0	91 494.0	1210.0
HP 250 X 85	10 800	260.0	1491.0	66 040.0	1028.0
X 62	7 980	256.0	1467.0	62 976.0	1004.0
HP 200 X 53	6 810	207.0	1190.0	42 228.0	822.0

MONOTUBE PILES
Standard Monotube Weights and Volumes

TYPE	SIZE POINT DIAMETER x BUTT DIAMETER x LENGTH	Weight (N) per m				EST. CONC. VOL. m 3
		9 GA	7 GA.	5 GA.	3 GA .	
F Taper 3.6 mm per Meter	216 mm x 305 mm x 7.62 m	248	292	350	409	0.329
	203 mm x 305 mm x 9.14 m	233	292	336	394	0.420
	216 mm x 356 mm x 12.19 m	277	321	379	452	0.726
	203 mm x 406 mm x 18.29 m	292	350	409	482	1.284
	203 mm x 457 mm x 22.86 m	-	379	452	511	1.979
J Taper 6.4 mm per Meter	203 mm x 305 mm x 5.18 m	248	292	336	394	0.244
	203 mm x 356 mm x 7.62 m	263	321	379	438	0.443
	203 mm x 406 mm x 10.06 m	292	350	409	467	0.726
	203 mm x 457 mm x 12.19 m	-	379	438	511	1.047
Y Taper 10.2 mm per Meter	203 mm x 305 mm x 3.05 m	248	292	350	409	0.138
	203 mm x 356 mm x 4.57 m	277	321	379	438	0.260
	203 mm x 406 mm x 6.10 m	292	350	409	482	0.428
	203 mm x 457 mm x 7.62 m	-	379	452	511	0.657

Extensions (Overall Length 0.305 m Greater than Indicated)

TYPE	DIAMETER + LENGTH	9 GA.	7 GA.	5 GA.	3 GA.	m 3 /m
N 12	305 mm x 305 mm x 6.10 / 12.19 m	292	350	409	482	0.065
N 14	356 mm x 356 mm x 6.10 m / 12.19 m	350	423	496	598	0.088
N 16	406 mm x 406 mm x 6.10 m / 12.19 m	409	482	569	671	0.113
N 18	457 mm x 457 mm x 6.10 m / 12.19 m	-	555	642	759	0.145

Table 7-14 Monotube Piles - Standard weights, volumes, and extensions.

Example #1

0 ft ———

$\phi = 33°$ **Skin Friction**
$\phi = 38°$ **End Bearing**
$\gamma = 120$ **pcf**
10% Driving Loss

25 ft ———

$C_u = 2800$ **psf**
$\gamma = 110$ **pcf**
40% Driving Loss

50 ft ———

Water Table
Drilling = 10 ft
Restrike/Driving = 10 ft
Ultimate = 0 ft

Pile - Precast Concrete
Side = 12 in.

Other Design Considerations:
5 ft Local Scour

Example #1c

Layer	Analysis Depth	K-delta	Cf	Pd (psf) mid point	Sin delta	Cd (ft)	D (ft)	Qs Layer	Qs total	Ap (ft^2)	q-bar (psf)	alpha	Nq	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1a	0.01	1.51	0.9015	0.60	0.427531	4.00	0.01	0.00	0.00	1.0	1.2	0.722	110.4	0.10	268.60	0.10	0.10
1a	9.01	1.51	0.9015	540.60	0.427531	4.00	9.01	11.34	11.34	1.0	1081.2	0.722	110.4	86.18	268.60	86.18	97.52
1a	9.99	1.51	0.9015	599.40	0.427531	4.00	9.99	13.94	13.94	1.0	1198.8	0.722	110.4	95.55	268.60	95.55	109.49
1b	10.01	1.51	0.9015	1200.29	0.427531	4.00	0.01	0.03	14.00	1.0	1200.6	0.722	110.4	95.70	268.60	95.70	109.69
1b	19.01	1.51	0.9015	1459.49	0.427531	4.00	9.01	30.61	44.58	1.0	1719.0	0.722	110.4	137.02	268.60	137.02	181.60
1b	24.99	1.51	0.9015	1631.71	0.427531	4.00	14.99	56.94	70.91	1.0	2063.4	0.722	110.4	164.47	268.60	164.47	235.38
			Cu	alpha	Ca (psf)	Cd (ft)	D (ft)				Su	Nc					
2	25.01		2800	1.0000	2800.00	4.00	0.01	0.11	71.07	1.0	2800	9.0		25.2		25.2	96.27
2	34.01		2800	1.0000	2800.00	4.00	9.01	100.91	171.87	1.0	2800	9.0		25.2		25.2	197.07
2	43.01		2800	0.8187	2292.39	4.00	18.01	165.14	236.10	1.0	2800	9.0		25.2		25.2	261.30
2	49.99		2800	0.6914	1935.89	4.00	24.99	193.51	264.47	1.0	2800	9.0		25.2		25.2	289.67

Restrike

Example #1c

Layer	Analysis Depth	K-delta	Cf	Pd (psf) mid point	Sin delta	Cd (ft)	D (ft)	Driving Loss	Qs Layer	Qs total	Ap (ft^2)	q-bar (psf)	alpha	Nq	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1a	0.01	1.51	0.9015	0.60	0.4275314	4.00	0.01	10%	0.00	0.00	1.0	1.2	0.722	110.4	0.10	268.60	0.10	0.10
1a	9.01	1.51	0.9015	540.60	0.4275314	4.00	9.01	10%	10.20	10.20	1.0	1081.2	0.722	110.4	86.18	268.60	86.18	96.39
1a	9.99	1.51	0.9015	599.40	0.4275314	4.00	9.99	10%	12.55	12.55	1.0	1198.8	0.722	110.4	95.55	268.60	95.55	108.10
1a	10.01	1.51	0.9015	1200.29	0.4275314	4.00	0.01	10%	0.03	12.60	1.0	1200.6	0.722	110.4	95.70	268.60	95.70	108.29
1b	19.01	1.51	0.9015	1459.49	0.4275314	4.00	9.01	10%	27.55	40.12	1.0	1719.0	0.722	110.4	137.02	268.60	137.02	177.14
1b	24.99	1.51	0.9015	1631.71	0.4275314	4.00	14.99	10%	51.25	63.82	1.0	2063.4	0.722	110.4	164.47	268.60	164.47	228.29
			Cu	alpha	Ca (psf)	Cd (ft)	D (ft)					Su	Nc					
2	25.01		2800	1.0000	2800.00	4.00	0.01	40%	0.07	63.91	1.0	2800	9.0		25.2		25.2	89.11
2	34.01		2800	1.0000	2800.00	4.00	9.01	40%	60.55	124.39	1.0	2800	9.0		25.2		25.2	149.59
2	43.01		2800	0.8187	2292.39	4.00	18.01	40%	99.09	162.92	1.0	2800	9.0		25.2		25.2	188.12
2	49.99		2800	0.6914	1935.89	4.00	24.99	40%	116.11	179.95	1.0	2800	9.0		25.2		25.2	205.15

Example #1c

gwt = 0 ft

Layer	Analysis Depth	K-delta	Cf	Pd (psf) mid point	Sin delta	Cd (ft)	D (ft)	Qs Layer	Qs total	Ap (ft^2)	q-bar (psf)	alpha	Nq	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1a	0.01	1.51	0.9015	0.29	0.427531	4.00	0.01	0.00	0.00	1.0	0.6	0.722	110.4	0.00	268.60	0.00	0.00
1a	4.99	1.51	0.9015	143.71	0.427531	4.00	4.99	1.67	0.00	1.0	287.4	0.722	110.4	0.00	268.60	0.00	0.00
1a	5.00	1.51	0.9015	144.00	0.427531	4.00	5.00	1.68	0.00	1.0	288.0	0.722	110.4	22.96	268.60	22.96	22.96
1a	9.01	1.51	0.9015	403.49	0.427531	4.00	4.01	3.77	3.77	1.0	519.0	0.722	110.4	41.37	268.60	41.37	45.13
1a	9.99	1.51	0.9015	431.71	0.427531	4.00	4.99	5.01	5.01	1.0	575.4	0.722	110.4	45.87	268.60	45.87	50.88
1b	10.01	1.51	0.9015	576.29	0.427531	4.00	0.01	0.01	5.04	1.0	576.6	0.722	110.4	45.96	268.60	45.96	51.00
1b	19.01	1.51	0.9015	835.49	0.427531	4.00	9.01	17.52	22.55	1.0	1095.0	0.722	110.4	87.28	268.60	87.28	109.83
1b	24.99	1.51	0.9015	1007.71	0.427531	4.00	14.99	35.16	40.19	1.0	1439.4	0.722	110.4	114.73	268.60	114.73	154.93
			Cu	alpha	Ca (psf)	Cd (ft)	D (ft)				Su	Nc					
2	25.01		2800	1.0000	2800.00	4.00	0.01	0.11	40.34	1.0	2800	9.0		25.2		25.2	65.54
2	34.01		2800	1.0000	2800.00	4.00	9.01	100.91	141.14	1.0	2800	9.0		25.2		25.2	166.34
2	43.01		2800	0.8187	2292.39	4.00	18.01	165.1[illegible]	205.37	1.0	2800	9.0		25.2		25.2	230.57
2	49.99		2800	0.6914	1935.89	4.00	24.99	193.51	233.74	1.0	2800	9.0		25.2		25.2	258.94

ultimate

Example #2

0 m

$\phi = 30°$ Skin Friction
$\phi = 30°$ End Bearing
$\gamma = 18\ kN/m^3$
20% Driving Loss

5 m

$\phi = 35°$ Skin Friction
$\phi = 35°$ End Bearing
$\gamma = 20\ kN/m^3$
10% Driving Loss

10 m

Water Table
Drilling = 0 m
Restrike/Driving = 3 m
Ultimate = 1 m

Pile - Closed End Pipe
diameter = 508 mm

Other Design Considerations:
2 m Long Term Scour

Example #2m

Layer	Analysis Depth (m)	Analysis Depth (ft)	Midpoint of layer (ft)	K-delta	Cf	Pd (psf) mid point	Pd (Kpa) mid point	Sin delta	Cd (ft)	D (ft)	Qs (k) Layer	Qs (k) total	Qs (kN) total	Ap (ft^2)	q-bar (psf)	q-bar (kPa)	alpha	Nq	Qcalc (k)	Qcalc (kN)	Qp lim (k)	Qp lim (kN)	Qp (kn)	Qt (kN)
1a	0.01	0.033	0.016	1.2516	0.9388	1.880	0.09	0.4057798	5.2360	0.03	0.00	0.00	0.00	2.18	3.76	0.18	0.58	30	0.14	0.63	29.06	129.26	0.63	0.64
1a	0.99	3.248	1.624	1.2516	0.9388	186.098	8.91	0.4057798	5.2360	3.25	1.51	1.51	6.71	2.18	372.20	17.82	0.58	30	14.13	62.85	29.06	129.26	62.85	69.56
1a	1.00	3.281	1.640	1.2516	0.9388	187.978	9.00	0.4057798	5.2360	3.28	1.54	1.54	6.85	2.18	375.96	18.00	0.58	30	14.27	63.48	29.06	129.26	63.48	70.33
1a	1.01	3.314	3.297	1.2516	0.9388	377.835	18.09	0.4057798	5.2360	0.03	0.03	1.57	6.99	2.18	379.72	18.18	0.58	30	14.41	64.11	29.06	129.26	64.11	71.10
1a	2.99	9.810	6.545	1.2516	0.9388	750.032	35.91	0.4057798	5.2360	6.53	12.23	13.76	61.23	2.18	1124.11	53.82	0.58	30	42.67	189.81	29.06	129.26	129.26	190.48
1a	3.00	9.843	6.562	1.2516	0.9388	751.911	36.00	0.4057798	5.2360	6.56	12.32	13.86	61.64	2.18	1127.87	54.00	0.58	30	42.81	190.44	29.06	129.26	129.26	190.89
1a	3.01	9.875	9.859	1.2516	0.9388	1128.723	54.04	0.4057798	5.2360	0.03	0.09	13.95	62.05	2.18	1129.58	54.08	0.58	30	42.88	190.73	29.06	129.26	129.26	191.31
1a	4.99	16.371	13.107	1.2516	0.9388	1298.242	62.16	0.4057798	5.2360	6.53	21.16	35.02	155.76	2.18	1468.62	70.32	0.58	30	55.75	247.98	29.06	129.26	129.26	285.02
1a	5.00	16.404	13.123	1.2516	0.9388	1299.098	62.20	0.4057798	5.2360	6.56	21.28	35.14	156.30	2.18	1470.33	70.40	0.58	30	55.82	248.27	29.06	129.26	129.26	285.55
2	5.01	16.437	16.421	1.9533	0.9134	1471.395	70.45	0.4683925	5.2360	0.03	0.21	35.35	157.24	2.18	1472.46	70.50	0.68	64	139.80	621.85	234.75	1044.15	621.85	779.08
2	8.01	26.280	21.342	1.9533	0.9134	1790.901	85.75	0.4683925	5.2360	9.88	77.39	112.53	500.51	2.18	2111.47	101.10	0.68	64	200.48	891.72	234.75	1044.15	891.72	1392.23
2	9.99	32.776	24.590	1.9533	0.9134	2001.775	95.84	0.4683925	5.2360	16.37	143.40	178.54	794.13	2.18	2533.22	121.29	0.68	64	240.52	1069.83	234.75	1044.15	1044.15	1838.29

Restrike

Example #2m

Layer	Analysis Depth (m)	Analysis Depth (ft)	Midpoint of layer (ft)	K-delta	Cf	Pd (psf) mid point	Pd (Kpa) mid point	Sin delta	Cd (ft)	D (ft)	Driving Loss	Qs (k) Layer	Qs (k) total	Qs (kN) total	Ap (ft^2)	q-bar (psf)	q-bar (kPa)	alpha	Nq	Qcalc (k)	Qcalc (kN)	Qp lim (k)	Qp lim (kN)	Qp (kn)	Qt (kN)
1a	0.01	0.033	0.016	1.2516	0.9388	1.880	0.09	0.4057798	5.2360	0.03	20%	0.00	0.00	0.00	2.18	3.76	0.18	0.58	30	0.14	0.63	29.06	129.26	0.63	0.64
1a	0.99	3.248	1.624	1.2516	0.9388	186.098	8.91	0.4057798	5.2360	3.25	20%	1.21	1.21	5.37	2.18	372.20	17.82	0.58	30	14.13	62.85	29.06	129.26	62.85	68.22
1a	1.00	3.281	1.640	1.2516	0.9388	187.978	9.00	0.4057798	5.2360	3.28	20%	1.23	1.23	5.48	2.18	375.96	18.00	0.58	30	14.27	63.48	29.06	129.26	63.48	68.96
1a	1.01	3.314	3.297	1.2516	0.9388	377.835	18.09	0.4057798	5.2360	0.03	20%	0.02	1.26	5.59	2.18	379.72	18.18	0.58	30	14.41	64.11	29.06	129.26	64.11	69.70
1a	2.99	9.810	6.545	1.2516	0.9388	750.032	35.91	0.4057798	5.2360	6.53	20%	9.78	11.01	48.98	2.18	1124.11	53.82	0.58	30	42.67	189.81	29.06	129.26	129.26	178.24
1a	3.00	9.843	6.562	1.2516	0.9388	751.911	36.00	0.4057798	5.2360	6.56	20%	9.85	11.09	49.31	2.18	1127.87	54.00	0.58	30	42.81	190.44	29.06	129.26	129.26	178.57
1a	3.01	9.875	9.859	1.2516	0.9388	1128.723	54.04	0.4057798	5.2360	0.03	20%	0.07	11.16	49.64	2.18	1129.58	54.08	0.58	30	42.88	190.73	29.06	129.26	129.26	178.90
1a	4.99	16.371	13.107	1.2516	0.9388	1298.242	62.16	0.4057798	5.2360	6.53	20%	16.93	28.01	124.61	2.18	1468.62	70.32	0.58	30	55.75	247.98	29.06	129.26	129.26	253.87
1a	5.00	16.404	16.388	1.2516	0.9388	1469.473	70.36	0.4057798	5.2360	0.03	10%	0.11	28.12	125.09	2.18	1470.33	70.40	0.58	30	55.82	248.27	29.06	129.26	129.26	254.35
2	5.01	16.437	16.421	1.9533	0.9134	1471.395	70.45	0.4683925	5.2360	0.03	10%	0.19	28.31	125.94	2.18	1472.46	70.50	0.68	64	139.80	621.85	234.75	1044.15	621.85	747.78
2	8.01	26.280	21.342	1.9533	0.9134	1790.901	85.75	0.4683925	5.2360	9.88	10%	69.65	97.77	434.89	2.18	2111.47	101.10	0.68	64	200.48	891.72	234.75	1044.15	891.72	1326.60
2	9.99	32.776	24.590	1.9533	0.9134	2001.775	95.84	0.4683925	5.2360	16.37	10%	129.06	157.18	699.14	2.18	2533.22	121.29	0.68	64	240.52	1069.83	234.75	1044.15	1044.15	1743.30

Example #2m

Layer	Analysis Depth (m)	Analysis Depth (ft)	Midpoint of layer (ft)	K-delta	Cf	Pd (psf) mid point	Pd (Kpa) mid point	Sin delta	Cd (ft)	D (ft)	Qs (k) Layer	Qs (k) total	Qs (kN) total	Ap (ft^2)	q-bar (psf)	q-bar (kPa)	alpha	Nq	Qcalc (k)	Qcalc (kN)	Qp lim (k)	Qp lim (kN)	Qp (kn)	Qt (kN)
1a	0.01	0.033	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1a	0.99	3.248	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1a	1.00	3.281	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1a	1.01	3.314	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1a	1.99	6.529	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1a	2.00	6.562	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1a	2.99	9.810	1.624	1.2516	0.9388	84.759	4.06	0.4057798	5.2360	3.25	0.69	0.69	3.06	2.18	169.52	8.12	0.58	30	6.44	28.62	29.06	129.26	28.62	31.68
1a	3.00	9.843	1.640	1.2516	0.9388	85.616	4.10	0.4057798	5.2360	3.28	0.70	0.70	3.12	2.18	171.23	8.20	0.58	30	6.50	28.91	29.06	129.26	28.91	32.03
1a	3.01	9.875	3.297	1.2516	0.9388	172.087	8.24	0.4057798	5.2360	0.03	0.01	0.72	3.18	2.18	172.94	8.28	0.58	30	6.57	29.20	29.06	129.26	29.20	32.38
1a	4.99	16.371	6.545	1.2516	0.9388	341.606	16.36	0.4057798	5.2360	6.53	5.57	6.27	27.89	2.18	511.98	24.51	0.58	30	19.44	86.45	29.06	129.26	86.45	114.33
1a	5.00	16.404	9.826	1.2516	0.9388	512.838	24.55	0.4057798	5.2360	0.03	0.04	6.31	28.07	2.18	513.69	24.60	0.58	30	19.50	86.74	29.06	129.26	86.74	114.81
2	5.01	16.437	9.859	1.9533	0.9134	514.759	24.65	0.4683925	5.2360	0.03	0.07	6.39	28.40	2.18	515.82	24.70	0.68	64	48.98	217.84	234.75	1044.15	217.84	246.24
2	8.01	26.280	14.780	1.9533	0.9134	834.265	39.94	0.4683925	5.2360	9.88	36.05	42.36	188.42	2.18	1154.84	55.29	0.68	64	109.65	487.71	234.75	1044.15	487.71	676.13
2	9.99	32.776	18.028	1.9533	0.9134	1045.139	50.04	0.4683925	5.2360	16.37	74.87	81.18	361.09	2.18	1576.58	75.49	0.68	64	149.69	665.82	234.75	1044.15	665.82	1026.91

Example #3

0 ft
2 ft

C_u = 900 psf
γ = 110 pcf
40% Driving Loss

15 ft

depth	'N'
20	22
25	14
30	18
35	23

γ = 118 pcf
10% Driving Loss

45 ft —— 26

Water Table
Drilling = 5 ft
Restrike/Driving = 10 ft
Ultimate = 1-ft

Pile - H-Pile
HP 12X63
top of pile = 2 ft

Other Design Considerations:
8 ft Soft Soil - downdrag condition

Example 3																		
Layer	Analysis Depth	Mid point of layer				Ca (psf)	Cd (ft)	D (ft)	Qs-layer (k)	Qs-total (k)	Ap(ft^2)	Cu (psf)	Nc		Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01									0.00								0.00
1	1.99									0.00								0.00
1	2.00					732.50	5.95	0.00	0.00	0.00	0.13	900	9.00				1.04	1.04
1	9.01					732.50	5.95	7.01	30.53	30.53	0.13	900	9.00				1.04	31.57
1	14.99					746.07	5.95	12.99	57.62	57.62	0.13	900	9.00				1.04	58.66
			K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)			Ap(ft^2)	q-bar	alpha	N'q				
	15.01	0.005	1.099174	0.90	1338.28	0.43	5.95	0.01	0.03	57.71	0.13	1338.56	0.6502832	49.49	5.50	7.08	5.50	63.21
2	24.01	4.505	1.099174	0.90	1588.48	0.43	5.95	9.01	36.42	94.09	0.13	1838.96	0.6408003	49.49	7.45	7.08	7.08	101.17
2	33.01	9.005	1.099174	0.90	1838.68	0.43	5.95	18.01	84.27	141.94	0.13	2339.36	0.6212085	49.49	9.19	7.08	7.08	149.02
2	42.01	13.505	1.099174	0.90	2088.88	0.43	5.95	27.01	143.57	201.25	0.13	2839.76	0.6082939	49.49	10.92	7.08	7.08	208.33
2	44.99	14.995	1.099174	0.90	2171.72	0.43	5.95	29.99	165.74	223.41	0.13	3005.44	0.6040178	49.49	11.48	7.08	7.08	230.49

Example 3																			
Layer	Analysis Depth	Mid point of layer				Ca (psf)	Cd (ft)	D (ft)	Driving Loss	Qs-layer (k)	Qs-total (k)	Ap(ft^2)	Cu (psf)	Nc		Qcalc (k)	Qp lim	Qp (k)	Qt (k)
1	0.01										0.00								0.00
1	1.99										0.00								0.00
1	2.00					732.5	5.95	0.00	40%	0.00	0.00	0.13	900	9.00				1.04	1.04
1	9.01					732.5	5.95	7.01	40%	18.32	18.32	0.13	900	9.00				1.04	19.35
1	14.99					746.1	5.95	12.99	40%	34.57	34.57	0.13	900	9.00				1.04	35.61
			K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)				Ap(ft^2)	q-bar	alpha	N'q				
	15.01	0.005	1.099174	0.90	1338.278	0.43	5.95	0.01	10%	0.03	34.64	0.13	1338.56	0.6502832	49.49	5.50	7.08	5.50	40.15
2	24.01	4.505	1.099174	0.90	1588.478	0.43	5.95	9.01	10%	32.78	67.39	0.13	1838.96	0.6408003	49.49	7.45	7.08	7.08	74.47
2	33.01	9.005	1.099174	0.90	1838.678	0.43	5.95	18.01	10%	75.84	110.45	0.13	2339.36	0.6212085	49.49	9.19	7.08	7.08	117.53
2	42.01	13.505	1.099174	0.90	2088.878	0.43	5.95	27.01	10%	129.22	163.83	0.13	2839.76	0.6082939	49.49	10.92	7.08	7.08	170.91
2	44.99	14.995	1.099174	0.90	2171.722	0.43	5.95	29.99	10%	149.16	183.78	0.13	3005.44	0.6040178	49.49	11.48	7.08	7.08	190.86

Example 3																		
Layer	Analysis Depth	Mid point of layer				Ca (psf)	Cd (ft)	D (ft)	Qs-layer (k)	Qs-total (k)	Ap(ft^2	Cu (psf)	Nc		Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01									0.00								0.00
1	1.99									0.00								0.00
1	2.00					732.50	5.95	0.00	0.00	0.00	0.13	900	9.00				1.04	1.04
1	7.99					732.50	5.95	5.99	26.09	-26.09	0.13	900	9.00				1.04	-25.05
1	8.00					732.50	5.95	6.00	26.13	-26.13	0.13	900	9.00				1.04	-25.10
1	9.01					732.50	5.95	1.01	4.40	-21.73	0.13	900	9.00				1.04	-20.70
1	14.99					746.07	5.95	6.99	31.01	4.88	0.13	900	9.00				1.04	5.91
			K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)			Ap(ft^2	q-bar	alpha	N'q				
	15.01	0.005	1.099174	0.90	776.678	0.43	5.95	0.01	0.02	4.94	0.13	776.96	0.65028	49.49	3.19	7.08	3.19	8.14
2	24.01	4.505	1.099174	0.90	1026.878	0.43	5.95	9.01	23.54	28.47	0.13	1277.36	0.64080	49.49	5.18	7.08	5.18	33.64
2	33.01	9.005	1.099174	0.90	1277.078	0.43	5.95	18.01	58.53	63.45	0.13	1777.76	0.62121	49.49	6.98	7.08	6.98	70.43
2	42.01	13.505	1.099174	0.90	1527.278	0.43	5.95	27.01	104.97	109.90	0.13	2278.16	0.60829	49.49	8.76	7.08	7.08	116.98
2	44.99	14.995	1.099174	0.90	1610.122	0.43	5.95	29.99	122.88	127.80	0.13	2443.84	0.60402	49.49	9.33	7.08	7.08	134.88

Example #4

0 m

C_u = 50 kPa
γ = 14 kN/m^3
40% Driving Loss

25 m

ϕ = 33° Skin Friction
ϕ = 33° End Bearing
γ = 18 kN/m^3
10% Driving Loss

40 m

Water Table
Drilling = 0 m
Restrike/Driving = 3 m
Ultimate = 0 m

Pile - Square Concrete
Side = 610 mm

Other Design Considerations:
a) 4 m Soft Soil
b) 4 m negative skin friction

Example 4																								
	Skin Friction														End Bearing									
Layer				Ca (psf)																				
	D (m)	D (ft)	L/b	inter	Ca (kPa)	Cd (m)	Cd (ft)					Qs (kip)	Qs (kN)	Qs-total (k	Ap(ft^2)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	0.0164	976.57	46.76	2.44	8.0052					0.25648	1.14	1.14	4.00525	1044.28	50.00	9.0				37.64	167.44	168.58
1	3.01	9.88	4.9344	976.57	46.76	2.44	8.0052					77.2019	343.39	343.39	4.00525	1044.28	50.00	9.0				37.64	167.44	510.83
1	6.01	19.72	9.8525	976.57	46.76	2.44	8.0052					154.147	685.65	685.65	4.00525	1044.28	50.00	9.0				37.64	167.44	853.09
1	9.01	29.56	14.7705	1001.8	47.97	2.44	8.0052					237.07	1054.49	1054.49	4.00525	1044.28	50.00	9.0				37.64	167.44	1221.93
1	12.01	39.40	19.6885	1027.9	49.21	2.44	8.0052					324.221	1442.13	1442.13	4.00525	1044.28	50.00	9.0				37.64	167.44	1609.57
1	15.01	49.25	24.6066	1053.9	50.46	2.44	8.0052					415.475	1848.03	1848.03	4.00525	1044.28	50.00	9.0				37.64	167.44	2015.47
1	18.01	59.09	29.5246	1080	51.71	2.44	8.0052					510.832	2272.18	2272.18	4.00525	1044.28	50.00	9.0				37.64	167.44	2439.62
1	21.01	68.93	34.4426	1106	52.96	2.44	8.0052					610.294	2714.59	2714.59	4.00525	1044.28	50.00	9.0				37.64	167.44	2882.02
1	24.01	78.77	39.3607	1132	54.20	2.44	8.0052					713.859	3175.25	3175.25	4.00525	1044.28	50.00	9.0				37.64	167.44	3342.68
1	24.99	81.99	40.9672	1135.4	54.36	2.44	8.0052					745.218	3314.73	3314.73	4.00525	1044.28	50.00	9.0				37.64	167.44	3482.17
			midpoint (	midpoint	σ'_v (psf)	σ'_v (kN)	K_s	C_f	Sin δ	C_d	D	Q_s (kips)	Q_s (kN)	Q_s (kN)	Ap(ft^2)	q-bar (psf	q-bar (kp	α	N_q	Qp calc (k	Qp calc (kn	Qp lim (k	Qp (kN)	Qt (kN)
2	25.01	82.05	25.005	82.037	########	134.41	1.7993	0.96775	0.5024	8.00525	0.0328	0.64502	2.87	3318.93	4.00525	2808.02	134.45	0.6007	47.2	318.88	1418.37	890.77	890.77	4209.69
2	28.01	91.90	26.505	86.959	3064.015	146.71	1.7993	0.96775	0.5024	8.00525	9.8753	211.917	942.60	4258.66	4.00525	3321.72	159.04	0.5944	47.2	373.26	1660.27	890.77	890.77	5149.43
2	31.01	101.74	28.005	91.88	3320.862	159.00	1.7993	0.96775	0.5024	8.00525	19.718	458.599	2039.85	5355.90	4.00525	3835.41	183.64	0.5944	47.2	430.99	1917.02	890.77	890.77	6246.67
2	34.01	111.58	29.505	96.801	3577.709	171.30	1.7993	0.96775	0.5024	8.00525	29.56	740.691	3294.60	6610.65	4.00525	4349.11	208.24	0.5944	47.2	488.71	2173.78	890.77	890.77	7501.42
2	37.01	121.42	31.005	101.72	3834.556	183.60	1.7993	0.96775	0.5024	8.00525	39.403	1058.19	4706.85	8022.91	4.00525	4862.80	232.83	0.5944	47.2	546.43	2430.53	890.77	890.77	8913.67
2	39.99	131.20	32.495	106.61	4089.691	195.81	1.7993	0.96775	0.5024	8.00525	49.18	1408.64	6265.62	9581.68	4.00525	5373.07	257.26	0.5944	47.2	603.77	2685.58	890.77	890.77	10472.45

Example 4																									
	Skin Friction															End Bearing									
Layer				Ca (psf)																					
	D (m)	D (ft)	L/b	inter	Ca (kPa	Cd (m)	Cd (ft)						Qs (kip)	Qs (kN)	Qs-total (kN)	Ap(ft^2)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	0.0164	976.566	46.76	2.44	8.0052					40%	0.153891	0.68	0.68	4.00525	1044.28	50.00	9.0				37.64	167.44	168.12
1	3.01	9.88	4.9344	976.566	46.76	2.44	8.0052					40%	46.32116	206.04	206.04	4.00525	1044.28	50.00	9.0				37.64	167.44	373.47
1	6.01	19.72	9.8525	976.566	46.76	2.44	8.0052					40%	92.48843	411.39	411.39	4.00525	1044.28	50.00	9.0				37.64	167.44	578.83
1	9.01	29.56	14.7705	1001.83	47.97	2.44	8.0052					40%	142.2423	632.69	632.69	4.00525	1044.28	50.00	9.0				37.64	167.44	800.13
1	12.01	39.40	19.6885	1027.87	49.21	2.44	8.0052					40%	194.5324	865.28	865.28	4.00525	1044.28	50.00	9.0				37.64	167.44	1032.72
1	15.01	49.25	24.6066	1053.91	50.46	2.44	8.0052					40%	249.2847	1108.82	1108.82	4.00525	1044.28	50.00	9.0				37.64	167.44	1276.26
1	18.01	59.09	29.5246	1079.95	51.71	2.44	8.0052					40%	306.4994	1363.31	1363.31	4.00525	1044.28	50.00	9.0				37.64	167.44	1530.75
1	21.01	68.93	34.4426	1105.99	52.96	2.44	8.0052					40%	366.1763	1628.75	1628.75	4.00525	1044.28	50.00	9.0				37.64	167.44	1796.19
1	24.01	78.77	39.3607	1132.04	54.20	2.44	8.0052					40%	428.3154	1905.15	1905.15	4.00525	1044.28	50.00	9.0				37.64	167.44	2072.58
1	24.99	81.99	40.9672	1135.42	54.36	2.44	8.0052					40%	447.1309	1988.84	1988.84	4.00525	1044.28	50.00	9.0				37.64	167.44	2156.28
			midpoint (	midpoint	σ'_v(psf)	σ'_v(kN)	K_δ	C_f	Sin δ	C_d	D		Q_s (kips)	Q_s (kN)	Q_s (kN)	Ap(ft^2)	q-bar (psf	q-bar (kpa	α	N_q	Qp calc (k)	Qp calc (k	Qp lim (k	Qp (kN)	Qt (kN)
2	25.01	82.05	25.005	82.0374	2807.17	134.41	1.7993	0.96775	0.5024	8.005249	0.03281	10%	0.580522	2.58	1992.61	4.00525	2808.02	134.45	0.601	47.2	318.88	1418.37	890.77	890.77	2883.38
2	28.01	91.90	26.505	86.9587	3064.02	146.71	1.7993	0.96775	0.5024	8.005249	9.87533	10%	190.7249	848.34	2838.38	4.00525	3321.72	159.04	0.594	47.2	373.26	1660.27	890.77	890.77	3729.14
2	31.01	101.74	28.005	91.8799	3320.86	159.00	1.7993	0.96775	0.5024	8.005249	19.7178	10%	412.7388	1835.86	3825.89	4.00525	3835.41	183.64	0.594	47.2	430.99	1917.02	890.77	890.77	4716.66
2	34.01	111.58	29.505	96.8012	3577.71	171.30	1.7993	0.96775	0.5024	8.005249	29.5604	10%	666.6223	2965.14	4955.17	4.00525	4349.11	208.24	0.594	47.2	488.71	2173.78	890.77	890.77	5845.94
2	37.01	121.42	31.005	101.722	3834.56	183.60	1.7993	0.96775	0.5024	8.005249	39.4029	10%	952.3753	4236.17	6226.20	4.00525	4862.80	232.83	0.594	47.2	546.43	2430.53	890.77	890.77	7116.96
2	39.99	131.20	32.495	106.611	4089.69	195.81	1.7993	0.96775	0.5024	8.005249	49.1798	10%	1267.775	5639.06	7629.09	4.00525	5373.07	257.26	0.594	47.2	603.77	2685.58	890.77	890.77	8519.86

Example 4																								
	Skin Friction														End Bearing									
Layer				Ca (psf)																				
	D (m)	D (ft)	L/b	inter	Ca (kPa	Cd (m)	Cd (ft)	D				Qs (kip)	Qs (kN)	Qs-total (k	Ap(ft²)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	0.0164	976.5664	46.76	2.44	8.0052	0.01	0.0328			0.25648	1.14	0.00	4.00525	1044.28	50.00	9.0				37.64	0.00	0.00
1	3.01	9.88	4.9344	976.5664	46.76	2.44	8.0052	3.01	9.8753			77.2019	343.39	0.00	4.00525	1044.28	50.00	9.0				37.64	0.00	0.00
1	3.99	13.09	6.5410	976.5664	46.76	2.44	8.0052	3.99	13.091			102.337	455.20	0.00	4.00525	1044.28	50.00	9.0				37.64	0.00	0.00
1a	4.00	13.12	6.5574	976.5664	46.76	2.44	8.0052	4.00	13.123			102.594	456.34	0.00	4.00525	1044.28	50.00	9.0				37.64	167.44	167.44
1a	6.01	19.72	9.8525	976.5664	46.76	2.44	8.0052	2.01	6.5945			51.5535	229.31	229.31	4.00525	1044.28	50.00	9.0				37.64	167.44	396.75
1a	9.01	29.56	14.7705	1001.8270	47.97	2.44	8.0052	5.01	16.437			131.823	586.35	586.35	4.00525	1044.28	50.00	9.0				37.64	167.44	753.79
1a	12.01	39.40	19.6885	1027.8689	49.21	2.44	8.0052	8.01	26.28			216.237	961.82	961.82	4.00525	1044.28	50.00	9.0				37.64	167.44	1129.26
1a	15.01	49.25	24.6066	1053.9108	50.46	2.44	8.0052	11.01	36.122			304.755	1355.55	1355.55	4.00525	1044.28	50.00	9.0				37.64	167.44	1522.99
1a	18.01	59.09	29.5246	1079.9527	51.71	2.44	8.0052	14.01	45.965			397.377	1767.53	1767.53	4.00525	1044.28	50.00	9.0				37.64	167.44	1934.97
1a	21.01	68.93	34.4426	1105.9946	52.96	2.44	8.0052	17.01	55.807			494.103	2197.77	2197.77	4.00525	1044.28	50.00	9.0				37.64	167.44	2365.21
1a	24.01	78.77	39.3607	1132.0364	54.20	2.44	8.0052	20.01	65.65			594.932	2646.26	2646.26	4.00525	1044.28	50.00	9.0				37.64	167.44	2813.70
1a	24.99	81.99	40.9672	1135.4219	54.36	2.44	8.0052	20.99	68.865			625.936	2784.16	2784.16	4.00525	1044.28	50.00	9.0				37.64	167.44	2951.60
			midpoint (m	midpoint (ft)	σ'$_v$ (psf)	σ'$_v$ (kN)	K_δ	C_f	Sin δ	C_d	D	Q_s (kips)	Q_s (kN)	Q_s (kN)	Ap(ft²)	q-bar (psf	q-bar (kp	α	N_q	Qp calc (k	Qp calc (kn	Qp lim (k	Qp (kN)	Qt (kN)
2	25.01	82.05	25.005	82.037402	2193	105.00	1.7993	0.9678	0.5024	8.00525	0.0328	0.5039	2.24	2787.73	4.00525	2808.02	134.45	0.601	47.2	318.88	1418.37	890.77	890.77	3678.50
2	28.01	91.90	26.505	86.958661	2449.8	117.30	1.7993	0.9678	0.5024	8.00525	9.8753	169.438	753.66	3539.15	4.00525	3321.72	159.04	0.5944	47.2	373.26	1660.27	890.77	890.77	4429.92
2	31.01	101.74	28.005	91.879921	2706.7	129.60	1.7993	0.9678	0.5024	8.00525	19.718	373.784	1662.59	4448.08	4.00525	3835.41	183.64	0.5944	47.2	430.99	1917.02	890.77	890.77	5338.85
2	34.01	111.58	29.505	96.801181	2963.5	141.89	1.7993	0.9678	0.5024	8.00525	29.56	613.539	2729.02	5514.51	4.00525	4349.11	208.24	0.5944	47.2	488.71	2173.78	890.77	890.77	6405.28
2	37.01	121.42	31.005	101.72244	3220.4	154.19	1.7993	0.9678	0.5024	8.00525	39.403	888.706	3952.96	6738.45	4.00525	4862.80	232.83	0.5944	47.2	546.43	2430.53	890.77	890.77	7629.22
2	39.99	131.20	32.495	106.61089	3475.5	166.41	1.7993	0.9678	0.5024	8.00525	49.18	1197.09	5324.68	8110.17	4.00525	5373.07	257.26	0.5944	47.2	603.77	2685.58	890.77	890.77	9000.93

Example 4																								
	Skin Friction														End Bearing									
Layer				Ca (psf)																				
	D (m)	D (ft)	L/b	inter	Ca (kPa	Cd (m)	Cd (ft)	D				Qs (kip)	Qs (kN)	Qs-total (k	Ap(ft^2)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	0.0164	976.5664	46.76	2.44	8.0052	0.01	0.0328			0.25648	1.14	-1.14	4.00525	1044.28	50.00	9.0				37.64	0.00	-1.14
1	3.01	9.88	4.9344	976.5664	46.76	2.44	8.0052	3.01	9.8753			77.2019	343.39	-343.39	4.00525	1044.28	50.00	9.0				37.64	0.00	-343.39
1	3.99	13.09	6.5410	976.5664	46.76	2.44	8.0052	3.99	13.091			102.337	455.20	-455.20	4.00525	1044.28	50.00	9.0				37.64	0.00	-455.20
1a	4.00	13.12	6.5574	976.5664	46.76	2.44	8.0052	4.00	13.123			102.594	456.34	-456.34	4.00525	1044.28	50.00	9.0				37.64	167.44	-288.90
1a	6.01	19.72	9.8525	976.5664	46.76	2.44	8.0052	2.01	6.5945			51.5535	229.31	-227.03	4.00525	1044.28	50.00	9.0				37.64	167.44	-59.59
1a	9.01	29.56	14.7705	1001.8270	47.97	2.44	8.0052	5.01	16.437			131.823	586.35	130.01	4.00525	1044.28	50.00	9.0				37.64	167.44	297.45
1a	12.01	39.40	19.6885	1027.8689	49.21	2.44	8.0052	8.01	26.28			216.237	961.82	505.48	4.00525	1044.28	50.00	9.0				37.64	167.44	672.92
1a	15.01	49.25	24.6066	1053.9108	50.46	2.44	8.0052	11.01	36.122			304.755	1355.55	899.21	4.00525	1044.28	50.00	9.0				37.64	167.44	1066.65
1a	18.01	59.09	29.5246	1079.9527	51.71	2.44	8.0052	14.01	45.965			397.377	1767.53	1311.20	4.00525	1044.28	50.00	9.0				37.64	167.44	1478.63
1a	21.01	68.93	34.4426	1105.9946	52.96	2.44	8.0052	17.01	55.807			494.103	2197.77	1741.43	4.00525	1044.28	50.00	9.0				37.64	167.44	1908.87
1a	24.01	78.77	39.3607	1132.0364	54.20	2.44	8.0052	20.01	65.65			594.932	2646.26	2189.92	4.00525	1044.28	50.00	9.0				37.64	167.44	2357.36
1a	24.99	81.99	40.9672	1135.4219	54.36	2.44	8.0052	20.99	68.865			625.936	2784.16	2327.82	4.00525	1044.28	50.00	9.0				37.64	167.44	2495.26
			midpoint (m	midpoint (ft)	σ'_v(psf)	σ'_v(kN)	K_s	C_f	Sin δ	C_d	D	Q_s (kips)	Q_s (kN)	Q_s (kN)	Ap(ft^2)	q-bar (psf	q-bar (kp	α	N_q	Qp calc (k	Qp calc (kn	Qp lim (k	Qp (kN)	Qt (kN)
2	25.01	82.05	25.005	82.037402	2193	105.00	1.7993	0.9678	0.5024	8.00525	0.0328	0.5039	2.24	2331.39	4.00525	2808.02	134.45	0.601	47.2	318.88	1418.37	890.77	890.77	3222.16
2	28.01	91.90	26.505	86.958661	2449.8	117.30	1.7993	0.9678	0.5024	8.00525	9.8753	169.438	753.66	3082.81	4.00525	3321.72	159.04	0.5944	47.2	373.26	1660.27	890.77	890.77	3973.58
2	31.01	101.74	28.005	91.879921	2706.7	129.60	1.7993	0.9678	0.5024	8.00525	19.718	373.784	1662.59	3991.74	4.00525	3835.41	183.64	0.5944	47.2	430.99	1917.02	890.77	890.77	4882.51
2	34.01	111.58	29.505	96.801181	2963.5	141.89	1.7993	0.9678	0.5024	8.00525	29.56	613.539	2729.02	5058.17	4.00525	4349.11	208.24	0.5944	47.2	488.71	2173.78	890.77	890.77	5948.94
2	37.01	121.42	31.005	101.72244	3220.4	154.19	1.7993	0.9678	0.5024	8.00525	39.403	888.706	3952.96	6282.11	4.00525	4862.80	232.83	0.5944	47.2	546.43	2430.53	890.77	890.77	7172.88
2	39.99	131.20	32.495	106.61089	3475.5	166.41	1.7993	0.9678	0.5024	8.00525	49.18	1197.09	5324.68	7653.83	4.00525	5373.07	257.26	0.5944	47.2	603.77	2685.58	890.77	890.77	8544.60

Example #5

0 m
1 m

C_u = 100 kPa
γ = 18 kN/m^3
17% Driving Loss

10 m

ϕ = 32° Skin Friction
ϕ = 32° End Bearing
γ = 18.5 kN/m^3
8% Driving Loss

17 m

ϕ = 36° Skin Friction
ϕ = 36° End Bearing
γ = 18.5 kN/m^3
8% Driving Loss

24 m

ϕ = 38° Skin Friction
ϕ = 38° End Bearing
γ = 19 kN/m^3
5% Driving Loss

31 m

Water Table
Drilling = 2 m
Restrike/Driving = 2 m
Ultimate = 0 m

Pile - Opened End Pipe
Diameter = 508 mm
Shell Thickness = 6.35 mm

Other Design Considerations:
1.5 m Soft Soil

Example 5																							
	Skin Friction													End Bearing									
Layer	Analysis Depth (m)	Analysis Depth (ft)	L/b	Ca (psf) inter	Ca (kPa)	Cd (m)	Cd (ft)	D (ft)			Qs (kip)	Qs (kN)	Qs-total (kN)	Ap(ft²)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	0.0000	1138.43358	0.00	1.59593	5.23599	0			0	0.00	0.00	0.00000	2088.55	100.00	9.0				0.00	0.00	0.00
1	0.99	3.25	0.0000	1138.43358	0.00	1.59593	5.23599	0			0	0.00	0.00	0.00000	2088.55	100.00	9.0				0.00	0.00	0.00
1	1.00	3.28	0.0000	1138.43358	54.51	1.59593	5.23599	0			0	0.00	0.00	2.18166	2088.55	100.00	9.0				41.01	182.41	182.41
1	3.01	9.88	3.9567	1138.43358	54.51	1.59593	5.23599	6.59			39.3086	174.84	174.84	2.18166	2088.55	100.00	9.0				41.01	182.41	357.25
1	6.01	19.72	9.8622	1138.43358	54.51	1.59593	5.23599	16.44			97.9781	435.81	435.81	2.18166	2088.55	100.00	9.0				41.01	182.41	618.21
1	9.01	29.56	15.7677	1217.64131	58.30	1.59593	5.23599	26.28			167.547	745.25	745.25	2.18166	2088.55	100.00	9.0				41.01	182.41	927.65
1	9.99	32.78	17.6969	1244.13400	59.57	1.59593	5.23599	29.49			192.137	854.62	854.62	2.18166	2088.55	100.00	9.0				41.01	182.41	1037.03
			midpoint (ft	σ'$_v$ (psf)	σ'$_v$ (kPa)	K_δ	C_f	Sin δ	C_d	D	Q_s (kips)	Q_s (kN)	Q_s (kN)	Ap(ft²)	q-bar (psf	q-bar (kpa	α	N_q	Qp calc (k)	Qp lim (k)	Qp (kip)	Qp (kN)	Qt (kN)
2	10.01	32.84	32.8248	2122.67	101.63	0.98356	0.89839	0.41	5.24	0.03281	0.132	0.59	856.35	2.18166	2123.58	101.68	0.6256	40.40	117.09	71.994832	71.99	320.23	1176.58
2	13.01	42.68	37.7461	2395.18	114.68	0.98356	0.89839	0.41	5.24	9.87533	44.689	198.77	1054.54	2.18166	2668.60	127.77	0.6045	40.40	142.18	71.994832	71.99	320.23	1374.77
2	15.23	49.97	41.3878	2596.84	124.34	0.98356	0.89839	0.41	5.24	17.15879	84.186	374.46	1230.22	2.18166	3071.92	147.08	0.5881	40.40	159.22	71.994832	71.99	320.23	1550.45
2b	15.25	50.03	50.0164	3074.64	147.21	1.53229	0.92865	0.43	5.24	0.03281	0.324	1.44	1232.51	2.18166	3075.55	147.26	0.58796	40.40	159.38	71.994832	71.99	320.23	1552.74
2b	16.99	55.74	52.8707	3232.70	154.78	1.53229	0.92865	0.43	5.24	5.74147	59.612	265.16	1496.22	2.18166	3391.67	162.39	0.5817	40.40	173.88	71.994832	71.99	320.23	1816.46
3	17.01	55.81	55.7907	3394.39	162.52	2.2507	0.90835	0.48	5.24	0.03281	0.573	2.55	1500.36	2.18166	3395.30	162.57	0.6892	77.60	396.18	330.74	330.74	1471.13	2971.49
3	20.01	65.65	60.7119	3666.90	175.57	2.2507	0.90835	0.48	5.24	9.87533	186.317	828.74	2326.55	2.18166	3940.32	188.66	0.6879	77.60	458.90	330.74	330.74	1471.13	3797.68
3	23.01	75.49	65.6332	3939.41	188.62	2.2507	0.90835	0.48	5.24	19.71785	399.661	1777.69	3275.51	2.18166	4485.35	214.76	0.6867	77.60	521.42	330.74	330.74	1471.13	4746.64
3	23.99	78.71	67.2408	4028.44	192.88	2.2507	0.90835	0.48	5.24	22.93307	475.335	2114.29	3612.10	2.18166	4663.39	223.28	0.6867	77.60	542.12	330.74	330.74	1471.13	5083.23
4	24.01	78.77	78.7566	4666.16	223.42	2.84556	0.89820	0.50	5.24	0.032808	1.034	4.60	3620.20	2.18166	4667.13	223.46	0.722	110.40	811.60	585.99	585.99	2606.50	6226.71
4	27.01	88.62	83.6778	4954.34	237.21	2.84556	0.89820	0.50	5.24	9.875328	330.578	1470.41	5086.01	2.18166	5243.48	251.06	0.722	110.40	911.83	585.99	585.99	2606.50	7692.51
4	30.01	98.46	88.5991	5242.52	251.01	2.84556	0.89820	0.50	5.24	19.7178	698.450	3106.71	6722.31	2.18166	5819.83	278.65	0.722	110.40	1012.05	585.99	585.99	2606.50	9328.81
4	30.99	101.67	90.2067	5336.66	255.52	2.84556	0.89820	0.50	5.24	22.9331	826.927	3678.17	7293.78	2.18166	6008.11	287.67	0.722	110.40	1044.80	585.99	585.99	2606.50	9900.28

Restrike

Example 5																								
	Skin Friction															End Bearing								
Layer	Analysis Depth (m)	Analysis Depth (ft)	L/b	Ca (psf) inter	Ca (kPa)	Cd (m)	Cd (ft)	D (ft)			Driving Loss (%)	Qs (kip)	Qs (kN)	Qs-total (	Ap(ft^2)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	40.0000	1550.42189	0.00	1.59593	5.23599	0			17%	0	0.00	0.00	0.00000	0.00	100.00	9.0				0.00	0.00	0.00
1	0.99	3.25	40.0000	1550.42189	0.00	1.59593	5.23599	0			17%	0	0.00	0.00	0.00000	0.00	100.00	9.0				0.00	0.00	0.00
1	1.00	3.28	40.0000	1550.42189	54.51	1.59593	5.23599	0			17%	0	0.00	0.00	2.18166	0.00	100.00	9.0				0.00	0.00	0.00
1	3.01	9.88	40.0000	1550.42189	74.23	1.59593	5.23599	6.59			17%	44.4332111	197.64	197.64	2.18166	0.00	100.00	9.0				0.00	0.00	197.64
1	6.01	19.72	40.0000	1550.42189	74.23	1.59593	5.23599	16.44			17%	110.751437	492.62	492.62	2.18166	0.00	100.00	9.0				0.00	0.00	492.62
1	9.01	29.56	40.0000	1550.42189	74.23	1.59593	5.23599	26.28			17%	177.069662	787.61	787.61	2.18166	0.00	100.00	9.0				0.00	0.00	787.61
1	9.99	32.78	40.0000	1550.42189	74.23	1.59593	5.23599	29.49			17%	198.733616	883.97	883.97	2.18166	0.00	100.00	9.0				0.00	0.00	883.97
			midpoint (ft	σ'_v(psf)	σ'_v(kPa)	K_s	C_f	Sin δ	C_d	D		Q_s (kips)	Q_s (kN)	Q_s (kN)	Ap(ft^2)	q-bar (psf	q-bar (kp	α	N_q	Qp calc (k)	Qp lim (k)	Qp (kip)	Qp (kN)	Qt (kN)
2	10.01	32.84	32.8248	2122.67	101.63	0.98356	0.89839	0.41	5.24	0.03281	8%	0.121	0.54	885.60	2.18166	2123.58	101.68	0.0000	40.40	0.00	71.99483	0.00	0.00	885.60
2	13.01	42.68	37.7461	2395.18	114.68	0.98356	0.89839	0.41	5.24	9.87533	8%	41.114	182.87	1067.93	2.18166	2668.60	127.77	0.0000	40.40	0.00	71.99483	0.00	0.00	1067.93
2	15.23	49.97	41.3878	2596.84	124.34	0.98356	0.89839	0.41	5.24	17.15879	8%	77.451	344.50	1229.56	2.18166	3071.92	147.08	0.0000	40.40	0.00	71.99483	0.00	0.00	1229.56
2b	15.25	50.03	50.0164	3074.64	147.21	1.53229	0.92865	0.43	5.24	0.03281	8%	0.298	1.33	1231.66	2.18166	3075.55	147.26	0.58796	40.40	159.38	71.99483	71.99	320.23	1551.90
2b	16.99	55.74	52.8707	3232.70	154.78	1.53229	0.92865	0.43	5.24	5.74147	8%	54.843	243.94	1474.28	2.18166	3391.67	162.39	0.5817	40.40	173.88	71.99483	71.99	320.23	1794.51
3	17.01	55.81	55.7907	3394.39	162.52	2.2507	0.90835	0.48	5.24	0.03281	8%	0.527	2.34	1478.09	2.18166	3395.30	162.57	0.6892	77.60	396.18	330.74	330.74	1471.13	2949.22
3	20.01	65.65	60.7119	3666.90	175.57	2.2507	0.90835	0.48	5.24	9.87533	8%	171.411	762.44	2238.18	2.18166	3940.32	188.66	0.6879	77.60	458.90	330.74	330.74	1471.13	3709.31
3	23.01	75.49	65.6332	3939.41	188.62	2.2507	0.90835	0.48	5.24	19.71785	8%	367.688	1635.48	3111.22	2.18166	4485.35	214.76	0.6867	77.60	521.42	330.74	330.74	1471.13	4582.35
3	23.99	78.71	67.2408	4028.44	192.88	2.2507	0.90835	0.48	5.24	22.93307	8%	437.308	1945.15	3420.89	2.18166	4663.39	223.28	0.6867	77.60	542.12	330.74	330.74	1471.13	4892.02
4	24.01	78.77	78.7566	4666.16	223.42	2.84556	0.89820	0.50	5.24	0.032808	5%	0.983	4.37	3428.59	2.18166	4667.13	223.46	0.722	110.40	811.60	585.99	585.99	2606.50	6035.09
4	27.01	88.62	83.6778	4954.34	237.21	2.84556	0.89820	0.50	5.24	9.875328	5%	314.049	1396.89	4821.11	2.18166	5243.48	251.06	0.722	110.40	911.83	585.99	585.99	2606.50	7427.61
4	30.01	98.46	88.5991	5242.52	251.01	2.84556	0.89820	0.50	5.24	19.717848	5%	663.528	2951.37	6375.59	2.18166	5819.83	278.65	0.722	110.40	1012.05	585.99	585.99	2606.50	8982.09
4	30.99	101.67	90.2067	5336.66	255.52	2.84556	0.89820	0.50	5.24	22.933071	5%	785.581	3494.26	6918.48	2.18166	6008.11	287.67	0.722	110.40	1044.80	585.99	585.99	2606.50	9524.98

Example 5																							
	Skin Friction													End Bearing									
Layer	Analysis	Analysis		Ca (psf)																			
	Depth (m)	Depth (ft)	L/b	inter	Ca (kPa)	Cd (m)	Cd (ft)	D (ft)			Qs (kip)	Qs (kN)	Qs-total (kN)	Ap(ft²)	Cu (psf)	Cu (kPa)	Nc				Qp (kip)	Qp (kN)	Qt (kN)
1	0.01	0.03	0.0000	1138.43358	0.00	1.59593	5.23599	0			0	0.00	0.00	0.00000	2088.55	100.00	9.0				0.00	0.00	0.00
1	0.99	3.25	0.0000	1138.43358	0.00	1.59593	5.23599	0			0	0.00	0.00	0.00000	2088.55	100.00	9.0				0.00	0.00	0.00
1	1.00	3.28	0.0000	1138.43358	54.51	1.59593	5.23599	0			0	0.00	0.00	0.00000	2088.55	100.00	9.0				0.00	0.00	0.00
	1.49	4.89	0.9646	1138.43358	54.51	1.59593	5.23599	0			0	0.00	0.00	0.00000	2088.55	100.00	9.0				0.00	0.00	0.00
	1.50	4.92	0.9843	1138.43358	54.51	1.59593	5.23599	0			0	0.00	0.00	2.18166	2088.55	100.00	9.0				41.01	182.41	182.41
1	3.01	9.88	3.9567	1138.43358	54.51	1.59593	5.23599	4.95			29.5303	131.35	131.35	2.18166	2088.55	100.00	9.0				41.01	182.41	313.76
1	6.01	19.72	9.8622	1138.43358	54.51	1.59593	5.23599	14.80			88.1999	392.31	392.31	2.18166	2088.55	100.00	9.0				41.01	182.41	574.72
1	9.01	29.56	15.7677	1217.64131	58.30	1.59593	5.23599	24.64			157.088	698.73	698.73	2.18166	2088.55	100.00	9.0				41.01	182.41	881.13
1	9.99	32.78	17.6969	1244.13400	59.57	1.59593	5.23599	27.85			181.451	807.09	807.09	2.18166	2088.55	100.00	9.0				41.01	182.41	989.50
			midpoint (ft	σ'v (psf)	σ'v (kPa)	Kδ	Cf	Sin δ	Cd	D	Qs (kips)	Qs (kN)	Qs (kN)	Ap(ft²)	q-bar (psf	q-bar (kpa	α	Nq	Qp calc (k)	Qp lim (k)	Qp (kip)	Qp (kN)	Qt (kN)
2	10.01	32.84	32.8248	1713.22	82.03	0.98356	0.89839	0.41	5.24	0.03281	0.106	0.47	808.69	2.18166	1714.13	82.07	0.6256	40.40	94.52	71.994832	71.99	320.23	1128.92
2	13.01	42.68	37.7461	1985.73	95.08	0.98356	0.89839	0.41	5.24	9.87533	37.049	164.80	973.01	2.18166	2259.15	108.17	0.6045	40.40	120.37	71.994832	71.99	320.23	1293.25
2	15.23	49.97	41.3878	2187.39	104.73	0.98356	0.89839	0.41	5.24	17.15879	70.912	315.42	1123.64	2.18166	2662.47	127.48	0.5881	40.40	138.00	71.994832	71.99	320.23	1443.87
2b	15.25	50.03	50.0164	2665.20	127.61	1.53229	0.92865	0.43	5.24	0.03281	0.281	1.25	1125.62	2.18166	2666.10	127.65	0.58796	40.40	138.16	71.994832	71.99	320.23	1445.85
2b	16.99	55.74	52.8707	2823.25	135.18	1.53229	0.92865	0.43	5.24	5.74147	52.062	231.57	1355.94	2.18166	2982.22	142.79	0.5817	40.40	152.89	71.994832	71.99	320.23	1676.17
3	17.01	55.81	55.7907	2984.94	142.92	2.2507	0.90835	0.48	5.24	0.03281	0.504	2.24	1359.58	2.18166	2985.85	142.96	0.6892	77.60	348.40	330.74	330.74	1471.13	2830.71
3	20.01	65.65	60.7119	3257.45	155.97	2.2507	0.90835	0.48	5.24	9.87533	165.512	736.20	2093.54	2.18166	3530.87	169.06	0.6879	77.60	411.21	330.74	330.74	1471.13	3564.67
3	23.01	75.49	65.6332	3529.97	169.01	2.2507	0.90835	0.48	5.24	19.71785	358.122	1592.93	2950.27	2.18166	4075.90	195.15	0.6867	77.60	473.83	330.74	330.74	1471.13	4421.40
3	23.99	78.71	67.2408	3618.99	173.28	2.2507	0.90835	0.48	5.24	22.93307	427.022	1899.39	3256.73	2.18166	4253.94	203.68	0.6867	77.60	494.52	330.74	330.74	1471.13	4727.86
4	24.01	78.77	78.7566	4256.72	203.81	2.84556	0.89820	0.50	5.24	0.032808	0.944	4.20	3264.12	2.18166	4257.68	203.86	0.722	110.40	740.40	585.99	585.99	2606.50	5870.63
4	27.01	88.62	83.6778	4544.89	217.61	2.84556	0.89820	0.50	5.24	9.875328	303.257	1348.89	4608.82	2.18166	4834.03	231.45	0.722	110.40	840.63	585.99	585.99	2606.50	7215.32
4	30.01	98.46	88.5991	4833.07	231.41	2.84556	0.89820	0.50	5.24	19.7178	643.900	2864.07	6124.00	2.18166	5410.38	259.05	0.722	110.40	940.85	585.99	585.99	2606.50	8730.50
4	30.99	101.67	90.2067	4927.21	235.91	2.84556	0.89820	0.50	5.24	22.9331	763.482	3395.97	6655.90	2.18166	5598.66	268.06	0.722	110.40	973.59	585.99	585.99	2606.50	9262.40

Example #6

0 ft

depth	'N'
5	12
10	17
15	14
20	21
25	27
30	23
35	31

2 ft

0 ft – 15 ft:
$\gamma = 120$ pcf
15% Driving Loss

15 ft – 35 ft:
$\gamma = 120$ pcf
10% Driving Loss

35 ft – 70 ft:
$C_u = 2500$ psf
$\gamma = 120$ pcf
40% Driving Loss

70 ft

Water Table
Drilling = 6 ft
Restrike/Driving = 3 ft
Ultimate = 1-ft

Pile - Open Ended Pipe
diameter = 36 in.
wall thickness = 0.5 in.

Other Design Considerations:

1-ft local scour
3 ft long term scour

Example 6																		
Layer	Analysis	Mid point																
	Depth	of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs (k)		Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k	Qp (k)	Qt (k)
1	0.01																	
1	0.99																	
1	1.01																	
1	1.99																	
1	2.00	1.500			0.00						7.07	240.00	0.63437	42.4	45.63	271.326	45.63	45.63
1	2.99	2.495	1.25360	0.974	299.40	0.500	9.42	0.99	1.71	1.71	7.07	358.80	0.63437	42.4	68.22	271.326	68.22	69.92
1	3.01	3.005	1.25360	0.974	360.29	0.500	9.42	0.01	0.02	1.75	7.07	360.58	0.63437	42.4	68.55	271.326	68.55	70.30
1	12.01	7.505	1.25360	0.974	619.49	0.500	9.42	9.01	32.14	33.86	7.07	878.98	0.63437	42.4	167.12	271.326	167.12	200.98
1	14.99	8.995	1.25360	0.974	705.31	0.500	9.42	11.99	48.69	50.42	7.07	1050.62	0.63437	42.4	199.75	271.326	199.75	250.17
	15.01	15.005	1.47415	0.9696	1051.49	0.532	9.42	0.01	0.08	50.55	7.07	1051.78	0.67483	61.47	308.42	688.16	308.42	358.97
2	24.01	19.505	1.47415	0.9696	1310.69	0.532	9.42	9.01	84.71	135.19	7.07	1570.18	0.67483	61.47	460.44	688.16	460.44	595.62
2	33.01	24.005	1.47415	0.9696	1569.89	0.532	9.42	18.01	202.81	253.29	7.07	2088.58	0.67483	61.47	612.45	688.16	612.45	865.74
2	34.99	24.995	1.47415	0.9696	1626.91	0.532	9.42	19.99	233.28	283.76	7.07	2202.62	0.67483	61.47	645.90	688.16	645.90	929.66
				Cu (psf)	alpha	Ca (psf)	Cd (ft)	D (ft)			Ap	Su	Nc					
3	35.01			2500.00	1.00	2500.00	9.42	0.01	0.24	284.16	7.07	2500.00	9.00				159.043	443.20
3	44.01			2500.00	1.00	2500.00	9.42	9.01	212.29	496.21	7.07	2500.00	9.00				159.043	655.26
3	53.01			2500.00	1.00	2500.00	9.42	18.01	424.35	708.27	7.07	2500.00	9.00				159.043	867.31
4	62.01			2500.00	1.00	2500.00	9.42	27.01	636.41	920.33	7.07	2500.00	9.00				159.043	1079.37
5	69.99			2500.00	0.97	2431.86	9.42	34.99	801.96	1085.88	7.07	2500.00	9.00				159.043	1244.92

Example 6																			
Layer	Analysis Depth	Mid point of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Driving Loss (%)	Qs (k)		Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01																		
1	0.99																		
1	1.01																		
1	1.99																		
1	2.00	1.500			180.00							0.00	240.00	0.63437	42.4	0.00	271.326	0.00	0.00
1	2.99	2.495	1.25360	0.974	299.40	0.500	9.42	0.99	15%	1.45	1.45	0.00	358.80	0.63437	42.4	0.00	271.326	0.00	1.45
1	3.01	3.005	1.25360	0.974	360.29	0.500	9.42	0.01	15%	0.02	1.49	0.00	360.58	0.63437	42.4	0.00	271.326	0.00	1.49
1	12.01	7.505	1.25360	0.974	619.49	0.500	9.42	9.01	15%	27.32	28.78	0.00	878.98	0.63437	42.4	0.00	271.326	0.00	28.78
1	14.99	8.995	1.25360	0.974	705.31	0.500	9.42	11.99	15%	41.39	42.85	0.00	1050.62	0.63437	42.4	0.00	271.326	0.00	42.85
	15.01	15.005	1.47415	0.9696	1051.49	0.532	9.42	0.01	10%	0.07	42.98	0.00	1051.78	0.67483	61.47	0.00	688.16	0.00	42.98
2	24.01	19.505	1.47415	0.9696	1310.69	0.532	9.42	9.01	10%	76.24	119.15	0.00	1570.18	0.67483	61.47	0.00	688.16	0.00	119.15
2	33.01	24.005	1.47415	0.9696	1569.89	0.532	9.42	18.01	10%	182.53	225.44	0.00	2088.58	0.67483	61.47	0.00	688.16	0.00	225.44
2	34.99	24.995	1.47415	0.9696	1626.91	0.532	9.42	19.99	10%	209.96	252.86	0.00	2202.62	0.67483	61.47	0.00	688.16	0.00	252.86
				Cu (psf)	alpha	Ca (psf)	Cd (ft)	D (ft)				Ap	Su	Nc					
3	35.01			2500.00	0.53	1325.52	9.42	0.01	22%	0.097	253.09	0.00	2500.00	9.00				0	253.09
3	44.01			2500.00	0.53	1325.52	9.42	9.01	22%	87.797	340.78	0.00	2500.00	9.00				0	340.78
3	53.01			2500.00	0.53	1325.52	9.42	18.01	22%	175.496	428.48	0.00	2500.00	9.00				0	428.48
4	62.01			2500.00	0.53	1325.52	9.42	27.01	22%	263.195	516.18	0.00	2500.00	9.00				0	516.18
5	69.99			2500.00	0.53	1325.52	9.42	34.99	22%	340.955	593.94	0.00	2500.00	9.00				0	593.94

Example 6																		
Layer	Analysis	Mid point																
	Depth	of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs (k)		Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k	Qp (k)	Qt (k)
1	0.01																	
1	0.99																	
1	1.01																	
1	1.99																	
1	2.00																	
1	2.99																	
1	3.00																	
1	3.01																	
1	3.99																	
1	4.00	0.000									7.07	57.60	0.63437	42.4	10.95	271.326	10.95	10.95
1	12.01	4.005	1.25360	0.974	288.29	0.500	9.42	8.01	13.30	13.30	7.07	518.98	0.63437	42.4	98.67	271.326	98.67	111.97
1	14.99	5.495	1.25360	0.974	374.11	0.500	9.42	10.99	23.67	23.67	7.07	690.62	0.63437	42.4	131.31	271.326	131.31	154.98
	15.01	15.005	1.47415	0.9696	691.49	0.532	9.42	0.01	0.05	23.76	7.07	691.78	0.67483	61.47	202.86	688.16	202.86	226.62
2	24.01	19.505	1.47415	0.9696	950.69	0.532	9.42	9.01	61.44	85.15	7.07	1210.18	0.67483	61.47	354.87	688.16	354.87	440.03
2	33.01	24.005	1.47415	0.9696	1209.89	0.532	9.42	18.01	156.30	180.02	7.07	1728.58	0.67483	61.47	506.89	688.16	506.89	686.90
2	34.99	24.995	1.47415	0.9696	1266.91	0.532	9.42	19.99	181.66	205.38	7.07	1842.62	0.67483	61.47	540.33	688.16	540.33	745.71
				Cu (psf)	alpha	Ca (psf)	Cd (ft)	D (ft)			Ap	Su	Nc					
3	35.01			2500.00	1.00	2500.00	9.42	0.01	0.24	205.74	7.07	2500.00	9.00				159.043	364.79
3	44.01			2500.00	1.00	2500.00	9.42	9.01	212.29	417.80	7.07	2500.00	9.00				159.043	576.84
3	53.01			2500.00	1.00	2500.00	9.42	18.01	424.35	629.86	7.07	2500.00	9.00				159.043	788.90
4	62.01			2500.00	1.00	2500.00	9.42	27.01	636.41	841.92	7.07	2500.00	9.00				159.043	1000.96
5	69.99			2500.00	0.97	2431.86	9.42	34.99	801.96	1007.47	7.07	2500.00	9.00				159.043	1166.51

Example #7

0 ft

$C_u = 1580$ psf
$\gamma = 110$ pcf
20% Driving Loss

10 ft

$\phi = 27°$ Skin Friction
$\phi = 33°$ End Bearing
$\gamma = 120$ pcf
10% Driving Loss

20 ft

$\phi = 38°$ Skin Friction
$\phi = 38°$ End Bearing
$\gamma = 120$ pcf
2% Driving Loss

30 ft

Water Table
Drilling = 0 ft
Restrike/Driving = 5 ft
Ultimate = 0 ft

Pile - Timber
diameter at top = 12 in.
diameter at bottom = 8 in.
length of taper = 30 ft

Other Design Considerations:

3 ft Soft Soil

Example 7																			
Layer	Analysis		Mid point																
	Depth		of layer				Ca (psf)	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2	Su	Nc		Qcalc (k)	Qp lim (k	Qp (k)	Qt (k)
1	0.01		0.005				1280.000	2.095	0.01	0.03	0.03	0.35	1580.00	9.000000		4.96		4.96	4.99
1	9.01		4.505				1302.969	2.252	9.01	26.43	26.43	0.35	1580.00	9.000000		4.96		4.96	31.40
1	9.99		4.995				1314.245	2.269	9.99	29.79	29.79	0.35	1580.00	9.000000		4.96		4.96	34.75
							Ca (psf)	Cd (ft)	D (ft)										
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)			Ap(ft^2	q-bar	alpha	N'q				
1	10.01	0-10	5.000	--	--	--	1314.340	2.269	10.00	29.83									
2	10.01	10-10.01	0.005	1.3629018	0.7473127	788.29	0.20875	2.095	0.01	0.00	29.83	0.35	788.58	0.645600	47.2000	8.39	17.4533	8.39	38.22
1	19.01	0-10	5.000	--	--	--	1299.301	2.583	10.00	33.57									
2	19.01	10-19.01	4.505	1.3793281	0.7665019	1047.49	0.22410	2.252	9.01	5.03	38.60	0.35	1306.98	0.622099	47.2000	13.40	17.4533	13.40	52.00
1	19.99	0-10	5.000	--	--	--	1297.88	2.618	10.00	33.97									
2	19.99	10-19.99	4.995	1.3810471	0.76838	1075.71	0.22560	2.269	9.99	5.84	39.81	0.35	1363.42	0.618041	47.2000	13.88	17.4533	13.88	53.69
							Ca (psf)	Cd (ft)	D (ft)										
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)										
1	20.01	0-10	5.000				1297.852	2.61834	10	33.98									
2	20.01	10-20	5.000	1.3810995	0.7684346	1076	0.225642	2.26928	10	5.85									
3	20.01	20.-20.01	0.005	9.7959605	0.5875655	1364.29	0.248254	2.09457	0.01	0.04	39.87	0.35	1364.58	0.722000	110.4000	37.97	93.7591	37.97	77.84
	29.01	0-10	5.000				1286.37	2.9325	10	37.72									
	29.01	10-20	5.000	1.4105515	0.8036173	1076	0.253635	2.58344	10	7.99									
	29.01	20-29.01	4.505	9.8117149	0.6142635	1623.49	0.310612	2.25165	9.01	61.66	107.37	0.35	1882.98	0.722000	110.4000	52.39	93.7591	52.39	159.76
	29.99	0-10	5.000				1285.266	2.96671	10	38.13									
	29.99	10-20.00	5.000	1.4135395	0.807118	1076	0.25641	2.61764	10	8.24									
	29.99	20-29.99	4.995	9.8133636	0.6168723	1651.71	0.312667	2.26875	9.99	70.86	117.23	0.35	1939.42	0.722000	110.4000	53.96	93.7591	53.96	171.19

Example 7																					
Laye	Analysis		Mid point								Driving	Driving									
	Depth		of layer				Ca (psf)	Cd (ft)	D (ft)	Qs layer	Loss	Qs lay	Qs total	Ap(ft^2)	Su	Nc		Qcalc (k)	Qp lim (	Qp (k)	Qt (k)
1	0.01		0.005				1280.000	2.095	0.01	0.03	20%	0.02	0.02	0.35	1580.00	9.000000		4.96		4.96	4.99
1	9.01		4.505				1302.969	2.252	9.01	26.43	20%	21.15	21.15	0.35	1580.00	9.000000		4.96		4.96	26.11
1	9.99		4.995				1314.245	2.269	9.99	**29.79**	20%	23.83	23.83	0.35	1580.00	9.000000		4.96		4.96	28.79
							Ca (psf)	Cd (ft)	D (ft)												
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)					Ap(ft^2)	q-bar	alpha	N'q				
1	10.01	0-9.99	4.995	--	--	--	1314.245	2.269	9.99	**29.79**	20%	23.83									
1	10.01	9.99-10		--	--	--	1324.566	2.269	0.01	0.03	10%	0.03									
2	10.01	10-10.01	0.005	1.363	0.7473	788.29	0.20875	2.095	0.01	0.00	10%	0.00	23.86	0.35	788.58	0.645600	47.2000	8.39	17.453	8.39	32.25
1	19.01	0-9.99	4.995	--	--	--	1299.185	2.584	9.99	**33.53**	20%	26.83									
1	19.01	9.99-10	9.995	--	--	--	1307.163	2.409	0.01	0.031	10%	0.03									
2	19.01	10-19.01	4.505	1.379	0.7665	1047.49	0.22410	2.252	9.01	5.035	10%	4.53	31.39	0.35	1306.98	0.622099	47.2000	13.40	17.453	13.40	44.78
1	19.01	0-9.99	4.995	--	--	--	1297.767	2.618	9.99	**33.94**	20%	27.15									
1	19.01	9.99-10	9.995	--	--	--	1305.532	2.443	0.01	0.03	10%	0.03									
2	19.99	10-19.99	4.995	1.381	0.76838	1075.71	0.22560	2.269	9.99	**5.84**	10%	5.25	32.43	0.35	1363.42	0.618041	47.2000	13.88	17.453	13.88	46.32
							Ca (psf)	Cd (ft)	D (ft)												
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)												
1	20.01	0-9.99					1297.738	2.61852	9.99	**33.95**	20%	27.16									
1	20.01	9.99-10					1305.499	2.44398	0.01	0.03	10%	0.03									
2	20.01	10-19.99		1.381	0.7685	1075.712	0.225658	2.26945	9.99	**5.84**	10%	5.26									
2	20.01	19.99-20		1.363	0.7474	1939.712	0.208778	2.09492	0.01	0.01	2%	0.01									
3	20.01	20.-20.01		9.796	0.5876	1364.29	0.248254	2.09457	0.01	0.04	2%	0.04	32.49	0.35	1364.58	0.722000	110.4000	37.97	93.759	37.97	70.46
1	29.01	0-9.99					1286.268	2.93268	9.99	**37.68**	20%	30.15									
1	29.01	9.99-10					1292.419	2.75814	0.01	0.04	10%	0.03									
2	29.01	10-19.99		1.411	0.8036	1075.712	0.253649	2.58361	9.99	**7.98**	10%	7.18									
2	29.01	19.99-20		1.395	0.7843	1363.712	0.238287	2.40908	0.01	0.01	2%	0.01									
3	29.01	20-29.01		9.812	0.6143	1623.49	0.310612	2.25165	9.01	61.66	2%	60.43	97.80	0.35	1882.98	0.722000	110.4000	52.39	93.759	52.39	150.19
	29.99	0-9.99					1285.166	2.96689	9.99	**38.09**	20%	30.47									
	29.99	9.99-10					1291.173	2.79235	0.01	0.04	10%	0.03									
	29.99	10-19.99		1.398	0.7883	1075.712	0.24149	2.44329	9.99	**6.99**	10%	6.29									
	29.99	19.99-20		1.414	0.8071	1363.712	0.256424	2.61782	0.1	0.10	2%	0.10									
	29.99	20-29.99		9.813	0.6169	1651.71	0.312667	2.26875	9.99	70.86	2%	69.44	106.34	0.35	1939.42	0.722000	110.4000	53.96	93.759	53.96	160.30

Example 7																			
Layer	Analysis		Mid point																
	Depth		of layer				Ca (psf)	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2	Su	Nc		Qcalc (k)	Qp lim (k	Qp (k)	Qt (k)
1	0.01		0.005				0.000	2.095	0.01	0.00	0.00	0.35	0.00	9.00		0.00		0.00	0.00
	2.99		1.495				0.000	2.147	2.99	0.00	0.00	0.35	0.00	9.00		0.00		0.00	
	3.00		1.500				0.000	2.147	3.00	0.00	0.00	0.35	0.00	9.00		0.00		0.00	
1	9.01		4.505				1305.642	2.199	6.01	17.26	17.26	0.35	1580.00	9.00		4.96		4.96	22.22
1	9.99		4.995				1317.164	2.216	6.99	20.41	20.41	0.35	1580.00	9.00		4.96		4.96	25.37
							Ca (psf)	Cd (ft)	D (ft)										
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)			Ap(ft^2	q-bar	alpha	N'q				
1	10.01	0-10	5.000	--	--	--	1317.261	2.217	7.00	20.44									
2	10.01	10-10.01	0.005	1.3629018	0.7473127	476.29	0.20875	2.095	0.01	0.00	20.44	0.35	476.58	0.645600	47.2000	5.07	17.4533	5.07	25.51
1	19.01	0-10	5.000	--	--	--	1301.548	2.531	7.00	23.06									
2	19.01	10-19.01	4.505	1.3793281	0.7665019	735.49	0.22410	2.252	9.01	3.54	26.60	0.35	994.98	0.622099	47.2000	10.20	17.4533	10.20	36.79
1	19.99	0-10	5.000	--	--	--	1300.07	2.565	7.00	23.35									
2	19.99	10-19.99	4.995	1.3810471	0.76838	763.71	0.22560	2.269	9.99	4.14	27.49	0.35	1051.42	0.618041	47.2000	10.71	17.4533	10.71	38.20
							Ca (psf)	Cd (ft)	D (ft)										
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)										
1	20.01	0-10	5.000				1300.04	2.56598	7	23.35									
2	20.01	10-20	5.000	1.3810995	0.7684346	764	0.225642	2.26928	10	4.15									
3	20.01	20.-20.01	0.005	9.7959605	0.5875655	1052.29	0.248254	2.09457	0.01	0.03	27.53	0.35	1052.58	0.722000	110.4000	29.29	93.7591	29.29	56.82
	29.01	0-10	5.000				1288.109	2.88014	7	25.97									
	29.01	10-20	5.000	1.4105515	0.8036173	764	0.253635	2.58344	10	5.67									
	29.01	20-29.01	4.505	9.8117149	0.6142635	1311.49	0.310612	2.25165	9.01	49.81	81.45	0.35	1570.98	0.722000	110.4000	43.71	93.7591	43.71	125.16
	29.99	0-10	5.000				1286.966	2.91435	7	26.25									
	29.99	10-20.00	5.000	1.4135395	0.807118	764	0.25641	2.61764	10	5.85									
	29.99	20-29.99	4.995	9.8133636	0.6168723	1339.71	0.312667	2.26875	9.99	57.47	89.58	0.35	1627.42	0.722000	110.4000	45.28	93.7591	45.28	134.86

Example 7																			
Layer	Analysis		Mid point																
	Depth		of layer				Ca (psf)	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2	Su	Nc		Qcalc (k)	Qp lim (k	Qp (k)	Qt (k)
1	0.01		0.005				1280.000	2.096	0.01	-0.03	-0.03	0.35	0.00	9.00		0.00		0.00	-0.03
	2.99		1.495				1280.000	2.147	2.99	-8.22	-8.22	0.35	0.00	9.00		0.00		0.00	
	3.00		1.500				1280.000	2.147	3.00	-8.24	-8.24	0.35	0.00	9.00		0.00		0.00	
1	9.01	0-3					1280.000	2.357	3.00	-9.05		0.35	1580.00	9.00		4.96		4.96	4.96
1	9.01	3-9.01					1305.642	2.199	6.01	17.26	8.21								
1	9.99	0-3					1280.000	2.391	3.00	-9.18		0.35	1580.00	9.00		4.96		4.96	4.96
1	9.99	3-9.99					1317.164	2.216	6.99	20.41	11.23								
							Ca (psf)	Cd (ft)	D (ft)										
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)			Ap(ft^2	q-bar	alpha	N'q				
	10.01	0-3					1280.000	2.391	3.00	-9.18									
1	10.01	3-10		–	–	–	1317.261	2.217	7.00	20.44									
2	10.01	10-10.01	0.005	1.3629018	0.7473127	476.29	0.20875	2.095	0.01	0.00	11.26	0.35	476.58	0.645600	47.2000	5.07	17.4533	5.07	16.33
1	19.01	0-3		–	–	–	1280.000	2.706	3.00	-10.39									
	19.01	3-10		–	–	–	1301.548	2.531	7.00	23.06									
2	19.01	10-19.01	4.505	1.3793281	0.7665019	735.49	0.22410	2.252	9.01	3.54	16.21	0.35	994.98	0.622099	47.2000	10.20	17.4533	10.20	26.40
1	19.99	0-3		–	–	–	1280.00	2.740	3.00	-10.52									
1	19.99	3-10		–	–	–	1300.07	2.565	7.00	23.35									
2	19.99	10-19.99	4.995	1.3810471	0.76838	763.71	0.22560	2.269	9.99	4.14	16.97	0.35	1051.42	0.618041	47.2000	10.71	17.4533	10.71	27.67
							Ca (psf)	Cd (ft)	D (ft)										
				K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)										
1	20.01	0-3		–	–	–	1280.00	2.74052	3	-10.52									
1	20.01	3-10		–	–	–	1300.04	2.56598	7	23.35									
2	20.01	10-20	5.000	1.3810995	0.7684346	764	0.225642	2.26928	10	4.15									
3	20.01	20.-20.01	0.005	9.7959605	0.5875655	1052.29	0.248254	2.09457	0.01	0.03	17.01	0.35	1052.58	0.722000	110.4000	29.29	93.7591	29.29	46.30
1	29.01	0-3		–	–	–	1280.00	3.05468	3	-11.73									
1	29.01	3-10		–	–	–	1288.11	2.88014	7	25.97									
2	29.01	10-20	5.000	1.4105515	0.8036173	764	0.253635	2.58344	10	5.67									
3	29.01	20-29.01	4.505	9.8117149	0.6142635	1311.49	0.310612	2.25165	9.01	49.81	69.72	0.35	1570.98	0.722000	110.4000	43.71	93.7591	43.71	113.43
1	29.99	0-3		–	–	–	1280.00	3.08888	3	-11.86									
1	29.99	3-10		–	–	–	1286.97	2.91435	7	26.25									
2	29.99	10-20.00	5.000	1.4135395	0.807118	764	0.25641	2.61764	10	5.85									
3	29.99	20-29.99	4.995	9.8133636	0.6168723	1339.71	0.312667	2.26875	9.99	57.47	77.72	0.35	1627.42	0.722000	110.4000	45.28	93.7591	45.28	123.00

Example #8

0 ft 0.5 ft

$\phi = 31°$ Skin Friction
$\phi = 36°$ End Bearing
$\gamma = 114$ pcf
12% Driving Loss

20 ft

$C_u = 2000$ psf
$\gamma = 110$ pcf
20% Driving Loss

30 ft

$\phi = 35°$ Skin Friction
$\phi = 35°$ End Bearing
$\gamma = 120$ pcf
7% Driving Loss

48 ft

Water Table
Drilling = 0 ft
Restrike/Driving = 6 ft
Ultimate = 3 ft

Pile - Raymond Uniform Taper
diameter at top = 54 in.
diameter at bottom = 36 in.
length of taper = 50 ft

Other Design Considerations:
a) 2 ft Local Scour
b) 2 ft Long Term Scour
c) 1-ft Local and 1-ft Long Term Scour

ex8.xls

Example8																		
Layer	Analysis Depth	Mid point of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k	Qp (k)	Qt (k)
1	0.01	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.068583	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.49	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.068583	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.5	0.250	0	0.0000	0	0	0	0.00	0.00	0.00	7.068583	57	0.693	77.6	21.68	1071.60	21.68	21.68
	0.00-0.5	0.250	5.71023	1.0455	28.5	0.64592181	9.683	0.00	0.00									
	0.50-2.99	1.745	5.70991	1.0455	198.93	0.64592181	9.542	2.49	18.225	18.23	7.068583	340.86	0.693	77.6	129.63	1071.60	129.63	147.86
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.70991	1.0455	199.5	0.64592181	9.544	2.50	18.35									
	3.00-3.01	3.005	5.70964	1.0455	342.57	0.64592181	9.425	0.01	0.12	18.48	7.068583	343.14	0.693	77.6	130.50	1071.60	130.50	148.98
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71055	1.0455	199.5	0.64592181	9.824	2.50	18.90									
	3.00-5.99	3.005	5.70997	1.0455	512.43	0.64592181	9.566	2.99	56.51	75.41	7.068583	682.86	0.693	77.6	259.70	1071.60	259.70	335.11
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71056	1.0455	199.5	0.64592181	9.826	2.50	18.90									
	3.00-6.00	4.500	5.70997	1.0455	513	0.64592181	9.567	3.00	56.77									
	6.00-6.01	6.005	5.70964	1.0455	684.258	0.64592181	9.425	0.01	0.25	75.92	7.068583	684.52	0.693	77.6	260.33	1071.60	260.33	336.25
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71238	1.0455	199.5	0.64592181	10.67	2.50	20.54									
	3.00-6.00	4.500	5.71184	1.0455	513	0.64592181	10.42	3.00	61.83									
	6.00-15.01	6.005	5.71061	1.0455	916.458	0.64592181	9.849	9.01	313.64	396.01	7.068583	1148.92	0.693	77.6	436.94	1071.60	436.94	832.95
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71333	1.0455	199.5	0.64592181	11.14	2.50	21.44									
	3.00-6.00	4.500	5.71281	1.0455	513	0.64592181	10.88	3.00	64.63									
	6.00-19.99	10.995	5.71113	1.0455	1044.94	0.64592181	10.08	13.99	568.55	654.62	7.068583	1405.884	0.693	77.6	534.67	1071.60	534.67	1189.29
											Ap(ft^2)	Su	Nc					
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71333	1.0455	199.5	0.64592181	11.15	2.50	21.45									
	3.00-6.00	4.500	5.71281	1.0455	513	0.64592181	10.89	3.00	64.64									
	6.00-20.00	13.000	5.71113	1.0455	1045.2	0.64592181	10.09	14.00	569.18									
	20.00-20.01	20.005				2000	9.425	0.01	0.189	655.45	7.068583	2000	9		127.23		127.23	782.69
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71346	1.0455	199.5	0.64592181	11.99	2.50	23.08									
	3.00-6.00	4.500	5.71346	1.0455	513	0.64592181	11.73	3.00	69.68									
	6.00-20.00	13.000	5.71291	1.0455	1045.2	0.64592181	10.93	14.00	617.24									
	20.00-29.01	24.505				2000	9.849	9.01	177.486	887.49	7.068583	2000	9		127.23		127.23	1014.72
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71346	1.0455	199.5	0.64592181	12.09	2.50	23.26									
	3.00-6.00	4.500	5.71346	1.0455	513	0.64592181	11.83	3.00	70.23									
	6.00-20.00	13.000	5.71309	1.0455	1045.2	0.64592181	11.03	14.00	622.48									
	20.00-29.99	24.505				2000	9.896	9.99	197.713	913.68	7.068583	2000	9		127.23		127.23	1040.91
											Ap(ft^2)	q-bar	alpha	N'q				
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71346	1.0455	199.5	0.64592181	12.09	2.50	23.26									
	3.00-6.00	4.500	5.71346	1.0455	513	0.64592181	11.83	3.00	70.24									
	6.00-20.00	13.000	5.7131	1.0455	1045.2	0.64592181	11.03	14.00	622.58									
	20.00-30.00	24.505				2000	9.897	10.00	197.939									
	30.00-30.01	30.005	9.55959	1.0655	1882.69	0.7109945	9.425	0.01	1.29	915.31	7.068583	1882.98	0.68	64	579.25	760.58	579.25	1494.56
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71346	1.0455	199.5	0.64592181	12.94	2.50	24.89									
	3.00-6.00	4.500	5.71346	1.0455	513	0.64592181	12.68	3.00	75.28									
	6.00-20.00	13.000	5.71346	1.0455	1045.2	0.64592181	11.88	14.00	670.51									
	20.00-30.00	24.505				2000	10.75	10.00	214.904									
	30.00-39.01	34.505	9.55959	1.0655	2141.89	0.7109945	9.849	9.01	1376.54	2362.13	7.068583	2401.38	0.68	64	738.72	760.58	738.72	3100.85
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-3.00	1.750	5.71346	1.0455	199.5	0.64592181	13.78	2.50	26.52									
	3.00-6.00	4.500	5.71346	1.0455	513	0.64592181	13.52	3.00	80.30									
	6.00-20.00	13.000	5.71346	1.0455	1045.2	0.64592181	12.72	14.00	718.30									
	20.00-30.00	24.505				2000	11.59	10.00	231.831									
	30.00-47.99	34.505	9.55959	1.0655	2400.51	0.7109945	10.27	17.99	3212.71	4269.66	7.068583	2918.62	0.68	64	897.84	760.58	760.58	5030.24

Restrike

Example 8																				
Layer	Analysis Depth	Mid point of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs layer			Qs total	Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01	0.000	0	0.0000	0	0	0	0.00	0.00			0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.49	0.000	0	0.0000	0	0	0	0.00	0.00			0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.5	0.250	0	0.0000	0	0	0	0.00	0.00			0.00	7.06858	57	0.693	77.6	21.68	1071.60	21.68	21.68
	0.00-0.5	0.250	5.7102	1.0455	28.5	0.6459218	9.683	0.00	0.00	12%	0.00									
	0.50-2.99	1.745	5.7099	1.0455	198.93	0.6459218	9.542	2.49	18.225	12%	16.04	16.04	7.06858	340.86	0.693	77.6	129.63	1071.60	129.63	145.67
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7099	1.0455	199.5	0.6459218	9.544	2.50	18.35	12%	16.15									
	3.00-3.01	3.005	5.7096	1.0455	342.57	0.6459218	9.425	0.01	0.12	12%	0.11	16.26	7.06858	343.14	0.693	77.6	130.50	1071.60	130.50	
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7106	1.0455	199.5	0.6459218	9.824	2.50	18.90	12%	16.63									
	3.00-5.99	3.005	5.71	1.0455	512.43	0.6459218	9.566	2.99	56.51	12%	49.73	66.36	7.06858	682.86	0.693	77.6	259.70	1071.60	259.70	326.06
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7106	1.0455	199.5	0.6459218	9.826	2.50	18.90	12%	16.63									
	3.00-6.00	4.500	5.71	1.0455	513	0.6459218	9.567	3.00	56.77	12%	49.96									
	6.00-6.01	6.005	5.7096	1.0455	684.26	0.6459218	9.425	0.01	0.25	12%	0.22	66.81	7.06858	684.52	0.693	77.6	260.33	1071.60	260.33	327.14
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7124	1.0455	199.5	0.6459218	10.67	2.50	20.54	12%	18.07									
	3.00-6.00	4.500	5.7118	1.0455	513	0.6459218	10.42	3.00	61.83	12%	54.41									
	6.00-15.01	6.005	5.7106	1.0455	916.46	0.6459218	9.849	9.01	313.64	12%	276.00	348.49	7.06858	1148.92	0.693	77.6	436.94	1071.60	436.94	785.43
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7133	1.0455	199.5	0.6459218	11.14	2.50	21.44	12%	18.87									
	3.00-6.00	4.500	5.7128	1.0455	513	0.6459218	10.88	3.00	64.63	12%	56.87									
	6.00-19.99	10.995	5.7111	1.0455	1044.9	0.6459218	10.08	13.99	568.55	12%	500.33	576.07	7.06858	1405.884	0.693	77.6	534.67	1071.60	534.67	1110.74
													Ap(ft^2)	Su	Nc					
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7133	1.0455	199.50	0.6459218	11.15	2.50	21.45	12%	18.87									
	3.00-6.00	4.500	5.7128	1.0455	513.00	0.6459218	10.89	3.00	64.64	12%	56.88									
	6.00-19.99	12.995	5.7111	1.0455	1044.94	0.6459218	10.08	13.99	568.61	12%	500.37									
	19.99-20.00	19.995	5.7096	1.0455	1406.14	0.6459218	9.426	0.01	0.51	12%	0.45									
	20.00-20.01	20.005				2000	9.425	0.01	0.189	20%	0.15	576.73	7.06858	2000	9		127.23		127.23	703.96
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7135	1.0455	199.5	0.6459218	11.99	2.50	23.08	12%	20.31									
	3.00-6.00	4.500	5.7135	1.0455	513	0.6459218	11.73	3.00	69.68	12%	61.32									
	6.00-19.99	12.995	5.7129	1.0455	1044.94	0.6459218	10.93	13.99	616.65	12%	542.65									
	19.99-20.00	19.995	5.7115	1.0455	1406.14	0.6459218	10.27	0.01	0.56	20%	0.45									
	20.00-29.01	24.505				2000	9.849	9.01	177.486	20%	141.99	766.72	7.06858	2000	9		127.23		127.23	127.23
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7135	1.0455	199.5	0.6459218	12.09	2.50	23.26	12%	20.47									
	3.00-6.00	4.500	5.7135	1.0455	513	0.6459218	11.83	3.00	70.23	12%	61.80									
	6.00-19.99	12.995	5.7131	1.0455	1044.9	0.6459218	11.03	13.99	621.90	12%	547.28									
	19.99-20.00	19.995	5.7117	1.0455	1406.14	0.6459218	10.37	0.01	0.56	20%	0.45									
	20.00-29.99	24.505				2000	9.896	9.99	197.713	20%	158.17	788.17	7.06858	2000	9		127.23		127.23	915.40
													Ap(ft^2)	q-bar	alpha	N'q				
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7135	1.0455	199.5	0.6459218	12.09	2.50	23.26	12%	20.47									
	3.00-6.00	4.500	5.7135	1.0455	513	0.6459218	11.83	3.00	70.24	12%	61.81									
	6.00-19.99	13.000	5.7131	1.0455	1045.2	0.6459218	11.03	13.99	622.16	12%	547.51									
	19.99-20.00	19.995	5.7117	1.0455	1406.14	0.6459218	10.37	0.01	0.56	20%	0.45									
	20.00-29.99	24.995				2000	9.897	9.99	197.751	20%	158.20									
	29.99-30.00	29.995				2000	9.426	0.01	0.189	7%	0.18									
	30.00-30.01	30.005	9.5596	1.0655	1882.7	0.7109945	9.425	0.01	1.29	7%	1.20	789.81	7.06858	1882.98	0.68	64	579.25	760.58	579.25	1369.06
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7135	1.0455	199.5	0.6459218	12.94	2.50	24.89	12%	21.91									
	3.00-6.00	4.500	5.7135	1.0455	513	0.6459218	12.68	3.00	75.28	12%	66.24									
	6.00-19.99	12.995	5.7135	1.0455	1045.2	0.6459218	11.88	13.99	670.06	12%	589.65									
	19.99-20.00	19.995	5.7135	1.0455	1406.14	0.6459218	11.22	0.01	0.61	20%	0.49									
	20.00-29.99	24.995				2000	10.28	9.99	205.302	20%	164.24									
	29.99-30.00	29.995				2000	10.27	0.01	0.205	7%	0.19									
	30.00-39.01	34.505	9.5596	1.0655	2141.9	0.7109945	9.849	9.01	1376.54	7%	1280.18	2122.91	7.06858	2401.38	0.68	64	738.72	760.58	738.72	2861.63
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00	12%	0.00									
	0.50-3.00	1.750	5.7135	1.0455	199.5	0.6459218	13.78	2.50	26.52	12%	23.34									
	3.00-6.00	4.500	5.7135	1.0455	513	0.6459218	13.52	3.00	80.30	12%	70.67									
	6.00-19.99	12.995	5.7135	1.0455	1045.2	0.6459218	12.72	13.99	717.81	12%	631.67									
	19.99-20.00	19.995	5.7135	1.0455	1406.14	0.6459218	12.06	0.01	0.65	20%	0.52									
	20.00-29.99	24.995				2000	11.59	9.99	231.608	20%	185.29									
	29.99-30.00	29.995				2000	11.12	0.01	0.222	7%	0.21									
	30.00-47.99	34.505	9.5596	1.0655	2400.5	0.7109945	10.27	17.99	3212.71	7%	2987.82	3899.52	7.06858	2918.62	0.68	64	897.84	760.58	760.58	4660.10

Example8																		
Layer	Analysis Depth	Mid point of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.49	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.5	0.250	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	0	0.0000	28.5	0.015	0	0.00	0.00									
	0.50-1.99	1.245	5.71	1.0455	198.93	0.6459218	9.589	0.00	0.000	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	0	0.0000	28.5	0.015	0	0.00	0.00									
	0.50-2.00	1.745	0	0.0000	198.93	0.6459218	0	0.00	0.000	0.00	7.06858	228	0.693	77.6	86.71	1071.60	86.71	86.71
	0.00-0.5	0.250	5.7102	1.0455	28.5	0.6459218	9.683	0.00	0.00									
	0.50-2.00	1.250	5.71	1.0455	142.5	0.6459218	9.589	0.00	0.00									
	2.00-2.99	2.495	5.7097	1.0455	284.43	0.6459218	9.471	0.99	10.28	10.28	7.06858	340.86	0.693	77.6	129.63	1071.60	129.63	139.92
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7098	1.0455	285	0.6459218	9.473	1.00	10.41									
	3.00-3.01	3.005	5.7096	1.0455	342.26	0.6459218	9.425	0.01	0.12	10.53	7.06858	342.52	0.693	77.6	130.26	1071.60	130.26	140.80
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7104	1.0455	285	0.6459218	9.754	1.00	10.72									
	3.00-5.99	4.495	5.71	1.0455	419.14	0.6459218	9.566	2.99	46.23	56.95	7.06858	496.28	0.693	77.6	188.74	1071.60	188.74	245.69
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7104	1.0455	285	0.6459218	9.756	1.00	10.72									
	3.00-6.00	4.500	5.71	1.0455	419.4	0.6459218	9.567	3.00	46.42									
	6.00-6.01	6.005	5.7096	1.0455	497.06	0.6459218	9.425	0.01	0.18	57.32	7.06858	497.32	0.693	77.6	189.13	1071.60	189.13	246.45
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7122	1.0455	285	0.6459218	10.6	1.00	11.66									
	3.00-6.00	4.500	5.7118	1.0455	419.4	0.6459218	10.42	3.00	50.55									
	6.00-15.01	10.505	5.7106	1.0455	729.26	0.6459218	9.849	9.01	249.57	311.78	7.06858	961.72	0.693	77.6	365.75	1071.60	365.75	677.53
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7132	1.0455	285	0.6459218	11.07	1.00	12.18									
	3.00-6.00	4.500	5.7128	1.0455	419.4	0.6459218	10.88	3.00	52.83									
	6.00-19.99	12.995	5.7111	1.0455	857.74	0.6459218	10.08	13.99	466.70	531.71	7.06858	1218.68	0.693	77.6	463.48	1071.60	463.48	995.18
											Ap(ft^2)	Su	Nc					
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7132	1.0455	285	0.6459218	11.08	1.00	12.18									
	3.00-6.00	4.500	5.7128	1.0455	419.4	0.6459218	10.89	3.00	52.84									
	6.00-20.00	13.000	5.7111	1.0455	858.00	0.6459218	10.09	14.00	467.24									
	20.00-20.01	20.005				2000	9.425	0.01	0.189	532.45	7.06858	2000	9		127.23		127.23	659.68
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	285	0.6459218	11.92	1.00	13.11									
	3.00-6.00	4.500	5.7135	1.0455	419.4	0.6459218	11.73	3.00	56.97									
	6.00-20.00	13.000	5.7129	1.0455	858.00	0.6459218	10.93	14.00	506.69									
	20.00-29.01	24.505				2000	9.849	9.01	177.486	754.26	7.06858	2000	9		127.23		127.23	881.49
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7152	1.0455	0	0.6459218	12.13	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	285	0.6459218	12.02	1.00	13.21									
	3.00-6.00	4.500	5.7135	1.0455	419.4	0.6459218	11.83	3.00	57.42									
	6.00-20.00	13.000	5.7131	1.0455	858.00	0.6459218	11.03	14.00	510.99									
	20.00-29.99	24.505				2000	9.896	9.99	197.713	779.33	7.06858	2000	9		127.23		127.23	906.56
											Ap(ft^2)	q-bar	alpha	N'q				
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7152	1.0455	0	0.6459218	12.14	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	285	0.6459218	12.02	1.00	13.21									
	3.00-6.00	4.500	5.7135	1.0455	419.4	0.6459218	11.83	3.00	57.43									
	6.00-20.00	13.000	5.7131	1.0455	858.00	0.6459218	11.03	14.00	511.08									
	20.00-30.00	25.000				2000	9.897	10.00	197.939									
	30.00-30.01	30.005	9.5596	1.0655	1695.5	0.7109945	9.425	0.01	1.16	780.81	7.06858	1695.78	0.68	64	521.66	760.58	521.66	1302.47
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	285	0.6459218	12.87	1.00	14.15									
	3.00-6.00	4.500	5.7135	1.0455	419.4	0.6459218	12.68	3.00	61.54									
	6.00-20.00	13.000	5.7135	1.0455	858.00	0.6459218	11.88	14.00	550.42									
	20.00-30.00	25.000				2000	10.75	10.00	214.904									
	30.00-39.01	34.505	9.5596	1.0655	1954.7	0.7109945	9.849	9.01	1256.23	2097.25	7.06858	2214.18	0.68	64	681.14	760.58	681.14	2778.38
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7181	1.0455	0	0.6459218	13.83	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	285	0.6459218	13.71	1.00	15.08									
	3.00-6.00	4.500	5.7135	1.0455	419.4	0.6459218	13.52	3.00	65.65									
	6.00-20.00	13.000	5.7135	1.0455	858.00	0.6459218	12.72	14.00	589.65									
	20.00-30.00	25.000				2000	11.59	10.00	231.831									
	30.00-47.99	38.995	9.5596	1.0655	2213.3	0.7109945	10.27	17.99	2962.17	3864.38	7.06858	2731.42	0.68	64	840.25	760.58	760.58	4624.96

Example8																		
Layer	Analysis	Mid point																
	Depth	of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.49	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.5	0.250	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	0	0.0000	0	0.015	0	0.00	0.00									
	0.50-1.99	1.245	5.71	1.0455	0	0.6459218	9.589	0.00	0.000	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	0	0.0000	0	0.015	0	0.00	0.00									
	0.50-2.00	1.745	0	0.0000	0	0.6459218	0	0.00	0.000	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	5.7102	1.0455	0	0.6459218	9.683	0.00	0.00									
	0.50-2.00	1.250	5.71	1.0455	0	0.6459218	9.589	0.00	0.00									
	2.00-2.99	2.495	5.7097	1.0455	56.43	0.6459218	9.471	0.99	2.04	2.04	7.06858	112.86	0.693	77.6	42.92	1071.60	42.92	44.96
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7098	1.0455	57	0.6459218	9.473	1.00	2.08									
	3.00-3.01	3.005	5.7096	1.0455	114.26	0.6459218	9.425	0.01	0.04	2.12	7.06858	114.52	0.693	77.6	43.55	1071.60	43.55	45.67
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7104	1.0455	57	0.6459218	9.754	1.00	2.14									
	3.00-5.99	4.495	5.71	1.0455	191.14	0.6459218	9.566	2.99	21.08	23.22	7.06858	268.28	0.693	77.6	102.03	1071.60	102.03	125.26
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7104	1.0455	57	0.6459218	9.756	1.00	2.14									
	3.00-6.00	4.500	5.71	1.0455	191.40	0.6459218	9.567	3.00	21.18									
	6.00-6.01	6.005	5.7096	1.0455	269.06	0.6459218	9.425	0.01	0.10	23.42	7.06858	269.32	0.693	77.6	102.42	1071.60	102.42	125.85
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7122	1.0455	57	0.6459218	10.6	1.00	2.33									
	3.00-6.00	4.500	5.7118	1.0455	191.40	0.6459218	10.42	3.00	23.07									
	6.00-15.01	10.505	5.7106	1.0455	501.26	0.6459218	9.849	9.01	171.55	196.95	7.06858	733.72	0.693	77.6	279.04	1071.60	279.04	475.98
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7132	1.0455	57	0.6459218	11.07	1.00	2.44									
	3.00-6.00	4.500	5.7128	1.0455	191.40	0.6459218	10.88	3.00	24.11									
	6.00-19.99	12.995	5.7111	1.0455	629.74	0.6459218	10.08	13.99	342.64	369.19	7.06858	990.68	0.693	77.6	376.77	1071.60	376.77	745.96
											Ap(ft^2)	Su	Nc					
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7132	1.0455	57	0.6459218	11.08	1.00	2.44									
	3.00-6.00	4.500	5.7128	1.0455	191.40	0.6459218	10.89	3.00	24.12									
	6.00-20.00	13.000	5.7111	1.0455	630.00	0.6459218	10.09	14.00	343.08									
	20.00-20.01	20.005				2000	9.425	0.01	0.189	369.82	7.06858	2000	9		127.23		127.23	497.05
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	57	0.6459218	11.92	1.00	2.62									
	3.00-6.00	4.500	5.7135	1.0455	191.40	0.6459218	11.73	3.00	26.00									
	6.00-20.00	13.000	5.7129	1.0455	630.00	0.6459218	10.93	14.00	372.05									
	20.00-29.01	24.505				2000	9.849	9.01	177.486	578.15	7.06858	2000	9		127.23		127.23	705.39
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7152	1.0455	0	0.6459218	12.13	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	57	0.6459218	12.02	1.00	2.64									
	3.00-6.00	4.500	5.7135	1.0455	191.40	0.6459218	11.83	3.00	26.20									
	6.00-20.00	13.000	5.7131	1.0455	630.00	0.6459218	11.03	14.00	375.20									
	20.00-29.99	24.505				2000	9.896	9.99	197.713	601.76	7.06858	2000	9		127.23		127.23	728.99
											Ap(ft^2)	q-bar	alpha	N'q				
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7152	1.0455	0	0.6459218	12.14	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	57	0.6459218	12.02	1.00	2.64									
	3.00-6.00	4.500	5.7135	1.0455	191.40	0.6459218	11.83	3.00	26.21									
	6.00-20.00	13.000	5.7131	1.0455	630.00	0.6459218	11.03	14.00	375.27									
	20.00-30.00	25.000				2000	9.897	10.00	197.939									
	30.00-30.01	30.005	9.5596	1.0655	1467.5	0.7109945	9.425	0.01	1.00	603.06	7.06858	1467.78	0.68	64	451.52	760.58	451.52	1054.58
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	57	0.6459218	12.87	1.00	2.83									
	3.00-6.00	4.500	5.7135	1.0455	191.40	0.6459218	12.68	3.00	28.09									
	6.00-20.00	13.000	5.7135	1.0455	630.00	0.6459218	11.88	14.00	404.15									
	20.00-30.00	25.000				2000	10.75	10.00	214.904									
	30.00-39.01	34.505	9.5596	1.0655	1726.7	0.7109945	9.849	9.01	1109.70	1759.67	7.06858	1986.18	0.68	64	611.00	760.58	611.00	2370.67
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7181	1.0455	0	0.6459218	13.83	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	57	0.6459218	13.71	1.00	3.02									
	3.00-6.00	4.500	5.7135	1.0455	191.40	0.6459218	13.52	3.00	29.96									
	6.00-20.00	13.000	5.7135	1.0455	630.00	0.6459218	12.72	14.00	432.96									
	20.00-30.00	25.000				2000	11.59	10.00	231.831									
	30.00-47.99	38.995	9.5596	1.0655	1985.3	0.7109945	10.27	17.99	2657.03	3354.79	7.06858	2503.42	0.68	64	770.12	760.58	760.58	4115.37

Example8																		
Layer	Analysis Depth	Mid point of layer	K-delta	Cf	Pd (psf)	Sin delta	Cd (ft)	D (ft)	Qs layer	Qs total	Ap(ft^2)	q-bar	alpha	N'q	Qcalc (k)	Qp lim (k)	Qp (k)	Qt (k)
1	0.01	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.49	0.000	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.5	0.250	0	0.0000	0	0	0	0.00	0.00	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	0	0.0000	0	0.015	0	0.00	0.00									
	0.50-1.99	1.245	5.71	1.0455	0	0.6459218	9.589	0.00	0.000	0.00	7.06858	0	0.693	77.6	0.00	1071.60	0.00	0.00
	0.00-0.5	0.250	0	0.0000	0	0.015	0	0.00	0.00									
	0.50-2.00	1.745	0	0.0000	0	0.6459218	0	0.00	0.000	0.00	7.06858	114	0.693	77.6	43.36	1071.60	43.36	43.36
	0.00-0.5	0.250	5.7102	1.0455	0	0.6459218	9.883	0.00	0.00									
	0.50-2.00	1.250	5.71	1.0455	0	0.6459218	9.589	0.00	0.00									
	2.00-2.99	2.495	5.7097	1.0455	170.43	0.6459218	9.471	0.99	6.16	6.16	7.06858	226.86	0.693	77.6	86.28	1071.60	86.28	92.44
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7098	1.0455	171	0.6459218	9.473	1.00	6.25									
	3.00-3.01	3.005	5.7096	1.0455	228.26	0.6459218	9.425	0.01	0.08	6.33	7.06858	228.52	0.693	77.6	86.91	1071.60	86.91	93.24
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7104	1.0455	171	0.6459218	9.754	1.00	6.43									
	3.00-5.99	4.495	5.71	1.0455	305.14	0.6459218	9.566	2.99	33.65	40.09	7.06858	382.28	0.693	77.6	145.39	1071.60	145.39	185.47
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7104	1.0455	171	0.6459218	9.756	1.00	6.43									
	3.00-6.00	4.500	5.71	1.0455	305.4	0.6459218	9.567	3.00	33.80									
	6.00-6.01	6.005	5.7096	1.0455	383.06	0.6459218	9.425	0.01	0.14	40.37	7.06858	383.32	0.693	77.6	145.78	1071.60	145.78	186.15
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7122	1.0455	171	0.6459218	10.6	1.00	6.99									
	3.00-6.00	4.500	5.7118	1.0455	305.4	0.6459218	10.42	3.00	36.81									
	6.00-15.01	10.505	5.7106	1.0455	615.26	0.6459218	9.849	9.01	210.56	254.36	7.06858	847.72	0.693	77.6	322.39	1071.60	322.39	576.76
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7132	1.0455	171	0.6459218	11.07	1.00	7.31									
	3.00-6.00	4.500	5.7128	1.0455	305.4	0.6459218	10.88	3.00	38.47									
	6.00-19.99	12.995	5.7111	1.0455	743.74	0.6459218	10.08	13.99	404.67	450.45	7.06858	1104.68	0.693	77.6	420.12	1071.60	420.12	870.57
											Ap(ft^2)	Su	Nc					
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7132	1.0455	171	0.6459218	11.08	1.00	7.31									
	3.00-6.00	4.500	5.7128	1.0455	305.4	0.6459218	10.89	3.00	38.48									
	6.00-20.00	13.000	5.7111	1.0455	744.00	0.6459218	10.09	14.00	405.16									
	20.00-20.01	20.005				2000	9.425	0.01	0.189	451.13	7.06858	2000	9		127.23		127.23	578.37
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	171	0.6459218	11.92	1.00	7.87									
	3.00-6.00	4.500	5.7135	1.0455	305.4	0.6459218	11.73	3.00	41.48									
	6.00-20.00	13.000	5.7129	1.0455	744.00	0.6459218	10.93	14.00	439.37									
	20.00-29.01	24.505				2000	9.849	9.01	177.486	666.20	7.06858	2000	9		127.23		127.23	793.44
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7152	1.0455	0	0.6459218	12.13	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	171	0.6459218	12.02	1.00	7.93									
	3.00-6.00	4.500	5.7135	1.0455	305.4	0.6459218	11.83	3.00	41.81									
	6.00-20.00	13.000	5.7131	1.0455	744.00	0.6459218	11.03	14.00	443.09									
	20.00-29.99	24.505				2000	9.896	9.99	197.713	690.54	7.06858	2000	9		127.23		127.23	817.78
											Ap(ft^2)	q-bar	alpha	N'q				
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7152	1.0455	0	0.6459218	12.14	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	171	0.6459218	12.02	1.00	7.93									
	3.00-6.00	4.500	5.7135	1.0455	305.4	0.6459218	11.83	3.00	41.82									
	6.00-20.00	13.000	5.7131	1.0455	744.00	0.6459218	11.03	14.00	443.17									
	20.00-30.00	25.000				2000	9.897	10.00	197.939									
	30.00-30.01	30.005	9.5596	1.0655	1581.5	0.7109945	9.425	0.01	1.08	691.93	7.06858	1581.78	0.68	64	486.59	760.58	486.59	1178.53
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	0	0.0000	0	0	0	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	171	0.6459218	12.87	1.00	8.49									
	3.00-6.00	4.500	5.7135	1.0455	305.4	0.6459218	12.68	3.00	44.81									
	6.00-20.00	13.000	5.7135	1.0455	744.00	0.6459218	11.88	14.00	477.29									
	20.00-30.00	25.000				2000	10.75	10.00	214.904									
	30.00-39.01	34.505	9.5596	1.0655	1840.7	0.7109945	9.849	9.01	1182.97	1928.46	7.06858	2100.18	0.68	64	646.07	760.58	646.07	2574.53
	0.00-0.50	0.250	0	0.0000	0	0	0	0.00	0.00									
	0.50-2.00	1.250	5.7181	1.0455	0	0.6459218	13.83	0.00	0.00									
	2.00-3.00	2.500	5.7135	1.0455	171	0.6459218	13.71	1.00	9.05									
	3.00-6.00	4.500	5.7135	1.0455	305.4	0.6459218	13.52	3.00	47.81									
	6.00-20.00	13.000	5.7135	1.0455	744.00	0.6459218	12.72	14.00	511.30									
	20.00-30.00	25.000				2000	11.59	10.00	231.831									
	30.00-47.99	38.995	9.5596	1.0655	2099.3	0.7109945	10.27	17.99	2809.60	3609.59	7.06858	2617.42	0.68	64	805.18	760.58	760.58	4370.17

Example #9

0 m

0.5 m

C_u = 90 kPa
γ = 15 kN/m^3
20% Driving Loss

8 m

ϕ = 32° Skin Friction
ϕ = 36° End Bearing
γ = 18 kN/m^3
8% Driving Loss

20 m

Water Table
Drilling = 2 m
Restrike/Driving = 2 m
Ultimate = 1 m

Pile - Monotube
J-taper 203 mm x 356 mm x 10.06 m
Extension 356 mm x 356 mm x 12.12 m

Other Design Considerations:
2 m Soft Soil

Example 9																							
Layer	Top of	Bottom o	Midpoint of					Ca (psf)	Cd (ft)	D (ft)													
	Layer	Layer	Layer	K-delta	Cf	Pd (psf)	Pd (kPa)	Sin delta	Cd (ft)	D (ft)	Qs-layer (k)	Qs-layer (kN)	Qs-total (k)	Ap(ft^2)	Cu (psf)		Nc		Qcalc (k)	Qp lim (k	Qp (k)	Qp (kN)	Qt (k)
1	0.01							0.00						0.35	1879.70		9.00		5.89		5.89	0.00	0.00
1	0.49							0.00						0.35	1879.70		9.00		5.89		5.89	0.00	
1	0.50							0.00						0.35	1879.70		9.00		5.89		5.89	26.21	26.21
1	0.00	0.500						0.00	0.00	0.0	0.00	0.00											
1	0.50	3.010						1175.75	2.29	8.235	22.16	98.58	98.58	0.35	1879.70		9.00		5.89		5.89	26.21	124.80
1	0	0.5						0.00	0.00	0.0	0.00	0.00											
1	0.5	6.01						1294.03	2.52	18.077	59.05	262.65	262.65	0.35	1879.70		9.00		5.89		5.89	26.21	288.86
1	0	0.5						0.00	0.00	0.0	0.00	0.00											
1	0.5	7.99						1360.73	2.68	24.573	89.59	398.51	398.51	0.35	1879.70		9.00		5.89		5.89	26.21	424.72
														Ap(ft^2)	q-bar		alpha	N'q					
1	0.00	0.50						0.00	3.31	0.0	0.00	0.00											
1	0.50	8.00						1360.87	2.68	24.606	89.80	399.43											
2	8.00	8.01	8.005	3.390501	0.84	1278.88	61.23	0.37197	2.09	0.03	0.09	0.41	399.85	0.348379	1279.74	61.27	0.6879	77.60	23.80	52.81	23.80	105.86	505.70
1	0.00	0.50						0.00	3.67	1.640	0.00	0.00											
1	0.50	0.95						1161.99	3.67	1.476	6.29	28.00											
1	0.95	8.00						1318.36	3.12	23.130	95.04	422.74											
2	8.00	11.01	9.505	3.427158	0.87	1535.73	73.53	0.39443	2.33	9.88	41.56	184.88	635.62	0.35	1793.43	85.87	0.68666667	77.60	33.29	52.81	33.29	148.08	783.71
1	0.00	0.50						0.00	3.67	1.640	0.00	0.00											
1	0.50	3.95						1161.99	3.67	11.319	48.26	214.66											
1	3.95	8.00						1299.98	3.35	13.287	57.90	257.53											
2	8.00	14.01	11.005	3.460285	0.90	1792.57	85.83	0.41779	2.56	19.72	118.11	525.35	997.54	0.35	2307.12	110.47	0.68666667	77.60	42.83	52.81	42.83	190.50	1188.04
1	0.00	0.50						0.00	3.67	1.640	0.00	0.00											
1	0.50	6.95						1247.75	3.67	21.161	96.89	430.95											
1	6.95	8.00						1284.01	3.59	3.445	15.87	70.57											
2	8.00	17.01	12.505	3.490503	0.93	2049.42	98.13	0.43889	2.80	29.56	241.53	1074.32	1575.84	0.35	2820.82	135.06	0.68666667	77.60	52.36	52.81	52.36	232.92	1808.75
1	0.00	0.50						0.00	3.67	1.640	0.00	0.00											
1	0.50	8.00						1278.91	3.67	24.606	115.47	513.61											
1	8.00	9.93	8.965	1.402583	0.84	1443.26	69.10	0.36390	3.67	6.33	14.38	63.97											
2	9.93	19.99	14.96	3.500482	0.93	2469.79	118.25	0.44523	2.88	33.01	341.98	1521.12	2098.70	0.35	3331.09	159.49	0.68666667	77.60	61.84	52.81	52.81	234.92	2333.62

Example 9																								
Layer	Top of	Bottom	Midpoint of					Ca (psf)	Cd (ft)	D (ft)	Driving													
	Layer	Layer	Layer	K-delta	Cf	Pd (psf)	Pd (kPa)	Sin delta	Cd (ft)	D (ft)	Loss	Qs-layer (k)	Qs-layer (kN)	Qs-total (k)	Ap(ft^2)	Cu (psf)		Nc		Qcalc (k)	Qp lim (k	Qp (k)	Qp (kN)	Qt (k)
1	0.01							0.00							0.35	1879.70		9.00		5.89		5.89	0.00	0.00
1	0.49							0.00							0.35	1879.70		9.00		5.89		5.89	0.00	0.00
1	0.50							0.00							0.35	1879.70		9.00		5.89		5.89	0.00	0.00
1	0.00	0.500						0.00	0.00	0.0	20%	0.00	0.00											
1	0.50	3.010						1169.69	2.29	8.235	20%	17.64	78.46	78.46	0.35	1879.70		9.00		5.89		5.89	26.21	104.67
1	0	0.5						0.00	0.00	0.0		0.00	0.00											
1	0.5	6.01						1235.92	2.52	18.077	20%	45.12	200.68	200.68	0.35	1879.70		9.00		5.89		5.89	26.21	226.90
1	0	0.5						0.00	0.00	0.0	20%	0.00	0.00											
1	0.5	7.99						1273.26	2.68	24.573	20%	67.07	298.32	298.32	0.35	1879.70		9.00		5.89		5.89	26.21	324.53
															Ap(ft^2)	q-bar		alpha	N'q					
1	0.00	0.50						0.00	3.31	0.0	20%	0.00	0.00											
1	0.50	7.99						1273.07	2.68	24.573	20%	67.14	298.62											
1	7.99	8.00						1321.13	2.09	0.033	8%	0.08	0.37											
2	8.00	8.01	8.005	3.390501	0.84	1278.88	61.23	0.37197	2.09	0.03	8%	0.09	0.38	299.37	0.348379	1279.74	61.27	0.6879	77.60	23.80	52.81	23.80	105.86	405.23
1	0.00	0.50						0.00	3.67	1.640	20%	0.00	0.00											
1	0.50	0.95						1161.99	3.67	1.476	20%	5.04	22.40											
1	0.95	7.99						1249.31	3.12	23.097	20%	71.97	320.11											
1	7.99	8.00						1281.11	2.56	0.033	8%	0.10	0.44											
2	8.00	11.01	9.505	3.427158	0.87	1535.73	73.53	0.39443	2.33	9.88	8%	38.24	170.09	513.04	0.35	1793.43	85.87	0.6866667	77.60	33.29	52.81	33.29	148.08	661.12
1	0.00	0.50						0.00	3.67	1.640	20%	0.00	0.00											
1	0.50	3.95						1161.99	3.67	11.319	20%	38.61	171.73											
1	3.95	7.99						1239.04	3.35	13.255	20%	44.05	195.93											
1	7.99	8.00						1253.49	3.04	0.033	8%	0.11	0.51											
2	8.00	14.01	11.005	3.460285	0.90	1792.57	85.83	0.41779	2.56	19.72	8%	108.66	483.32	851.49	0.35	2307.12	110.47	0.6866667	77.60	42.83	52.81	42.83	190.50	1041.99
1	0.00	0.50						0.00	3.67	1.640	20%	0.00	0.00											
1	0.50	6.95						1210.01	3.67	21.161	20%	75.16	334.33											
1	6.95	7.99						1230.12	3.59	3.412	20%	12.05	53.59											
1	7.99	8.00						1233.28	3.51	0.033	20%	0.11	0.50											
2	8.00	17.01	12.505	3.490503	0.93	2049.42	98.13	0.43889	2.80	29.56	8%	222.21	988.37	1376.79	0.35	2820.82	135.06	0.6866667	77.60	52.36	52.81	52.36	232.92	1609.71
1	0.00	0.50						0.00	3.67	1.640	20%	0.00	0.00											
1	0.50	7.99						1227.29	3.67	24.573	20%	88.53	393.78											
1	7.99	8.00						1227.45	3.67	0.033	8%	0.14	0.60											
1	8.00	9.93	8.965	1.402583	0.84	1443.26	69.10	0.36390	3.67	6.33	8%	13.23	58.85											
2	9.93	19.99	14.96	3.500482	0.93	2469.79	118.25	0.44523	2.88	33.01	8%	314.62	1399.43	1852.67	0.35	3331.09	159.49	0.6866667	77.60	61.84	52.81	52.81	234.92	2087.58

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Example 9																							
Layer	Top of	Bottom o	Midpoint of					Ca (psf)	Cd (ft)	D (ft)													
	Layer	Layer	Layer	K-delta	Cf	Pd (psf)	Pd (kPa)	Sin delta	Cd (ft)	D (ft)	Qs-layer (k)	Qs-layer (kN)	Qs-total (k)	Ap(ft^2)	Cu (psf)		Nc		Qcalc (k)	Qp lim (k	Qp (k)	Qp (kN)	Qt (k)
1	0.01							0.00						0.35	1879.70		9.00		5.89		5.89	0.00	0.00
1	0.49							0.00						0.35	1879.70		9.00		5.89		5.89	0.00	
1	0.50							0.00						0.35	1879.70		9.00		5.89		5.89	26.21	26.21
1	0.00	2.000						0.00	0.00	0.0	0.00	0.00											
1	2.00	3.010						1182.21	2.17	3.314	8.51	37.84	37.84	0.35	1879.70		9.00		5.89		5.89	26.21	64.05
1	0	2						0.00	0.00	0.0	0.00	0.00											
1	2	6.01						1305.64	2.41	13.156	41.34	183.88	183.88	0.35	1879.70		9.00		5.89		5.89	26.21	210.09
1	0	2						0.00	0.00	0.0	0.00	0.00											
1	2	7.99						1374.69	2.56	19.652	69.21	307.84	307.84	0.35	1879.70		9.00		5.89		5.89	26.21	334.06
														Ap(ft^2)	q-bar		alpha	N'q					
1	0.00	2.00						0.00	3.19	0.0	0.00	0.00											
1	2.00	8.00						1374.83	2.56	19.685	69.40	308.67											
2	8.00	8.01	8.005	3.390501	0.84	1074.16	51.43	0.37197	2.09	0.03	0.08	0.35	309.02	0.348379	1075.01	51.47	0.6879	77.60	19.99	52.81	19.99	88.92	397.94
1	0.00	0.50						0.00	3.67	1.640	0.00	0.00											
1	0.50	0.95						0.00	3.67	1.476	0.00	0.00											
1	0.95	2.00						0.00	3.67	3.445	0.00	0.00											
1	2.00	8.00						1325.47	3.03	19.685	79.17	352.17											
2	8.00	11.01	9.505	3.427158	0.87	1331.00	63.73	0.39443	2.33	9.88	36.02	160.23	512.40	0.35	1588.71	76.07	0.68666667	77.60	29.49	52.81	29.49	131.18	643.58
1	0.00	2.00						0.00	3.67	6.562	0.00	0.00											
1	2.00	3.95						1161.99	3.67	6.398	27.28	121.33											
1	3.95	8.00						1299.98	3.35	13.287	57.90	257.53											
2	8.00	14.01	11.005	3.460285	0.90	1587.85	76.03	0.41779	2.56	19.72	104.62	465.35	844.21	0.35	2102.40	100.66	0.68666667	77.60	39.03	52.81	39.03	173.60	1017.81
1	0.00	2.00						0.00	3.67	6.562	0.00	0.00											
1	2.00	6.95						1247.75	3.67	16.240	74.35	330.73											
1	6.95	8.00						1284.01	3.59	3.445	15.87	70.57											
2	8.00	17.01	12.505	3.490503	0.93	1844.70	88.32	0.43889	2.80	29.56	217.40	967.00	1368.30	0.35	2616.09	125.26	0.68666667	77.60	48.56	52.81	48.56	216.01	1584.31
1	0.00	2.00						0.00	3.67	6.562	0.00	0.00											
1	2.00	8.00						1278.91	3.67	19.685	92.38	410.89											
1	8.00	9.93	8.965	1.402583	0.84	1238.54	59.30	0.36390	3.67	6.33	12.34	54.89											
2	9.93	19.99	14.96	3.500482	0.93	2265.07	108.45	0.44523	2.88	33.01	313.63	1395.03	1860.82	0.35	3126.36	149.69	0.68666667	77.60	58.04	52.81	52.81	234.92	2095.73

REFERENCES

Bowles (1977), Foundation Analysis and Design, McGraw-Hill Book Company, New York, 2nd edition.

Cheney, R.S. and Chassie, R.G. (1982), "Soils and Foundations Workshop Manual" U.S. Department of Transportation, Federal Highway Administration.

Hannigan P.J., et. al. (1997), "Design and Construction of Driven Pile Foundations," U.S. Department of Transportation, Federal Highway Administration.

Meyerhof, G.G. (1976), "Bearing Capacity and Settlement of Pile Foundations," Journal of Geotechnical Engineering Division, ASCE, Vol. 102, No. GT3, Proc. Paper 11962, pp. 195-228.

Nordlund, R.L. (1963), "Bearing Capacity of Piles in Cohesionless Soils," ASCE, SM&F Journal SM-3.

Nordlund, R.L. (1979), Point Bearing and Shaft Friction of Piles in Sand," 5th Annual Fundamentals of Deep Foundation Design, University of Missouri-Rolla.

Peck, Hanson and Thornburn (1974) Foundation Engineering, John Wiley & Sons, New York, 2nd edition.

Stream Stabilization and scour at Highway Bridges (1995) NHI course 13046 Participants Workbook, FHWA-HI-91-011.

Thurman, A.G. (1964), "Computed Load Capacity and Movement of Friction and End-Bearing Piles Embedded in Uniform and Stratified Soil," Ph.D. Thesis, Carnegie Institute of Technology.

Tomlinson, M.J. (1980), Foundation Design and Construction, Pitman Advanced Publishing, Boston, MA, 4th edition.

Tomlinson, M.J. (1985), Foundation Design and Construction, Longman Scientific and Technical, Essex, England.

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