

CHAPTER 1. GENERAL

The documentation for Computer Program COM624P consists of three documents: Part I, Users Guide; Part II, Engineering Background; and Part III, Systems Maintenance.

PURPOSE OF THE USERS GUIDE

The purpose of Part I of COM624P is to provide detailed information to enable the user to employ the program conveniently and effectively. The project was conducted under Contract DTHF61-88-C-00101 from 1988-1989. The information is presented as follows: Chapter 1 introduces the Users Guide and provides system background; Chapter 2 summarizes the system in general; Chapter 3 provides a step-by-step operating procedure; Chapter 4 presents input information, names of variables, and data structure for the input files; and Chapter 5 presents input and output for examples that were studied.

PROJECT REFERENCES

The technology on which the program is based has been widely used for many years for the analysis of a variety of piles subjected to lateral loads. The existing program, COM624, was developed at the The University of Texas at Austin and has been used on main-frame computers for several years. The project is to upgrade COM624 and to develop a user-friendly version for running on IBM XT's, AT's, and compatible microcomputers. The first version of Program COM624P (Version 1.0) has been used and distributed by FHWA since 1990. Because of a number of inquiries by design engineers about the ultimate capacity of a pile in bending, a subroutine has been added to the current version (2.0) to compute the ultimate capacity in bending and the variation of flexural rigidity with applied moment.

The information shown in the three parts of the documentation is limited to that needed for the operation of the computer program and to a brief introduction of the method of analysis. The user is referred to two documents published by the Federal Highway Administration for a relatively complete treatment of the topic. The first one is entitled "Behavior of Piles and Pile Groups under Lateral Load" (FHWA/RD-85/106). The second one is entitled "Handbook on Design of Piles and Drilled Shafts Under Lateral Load" (FHWA-IP-84-11).

SECURITY

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No warranty, expressed or implied, is offered either by FHWA or Ensoft, Inc., as to the accuracy of results from the program. The program should not be used for design unless caution is exercised in interpreting the results, and independent calculations are available to verify the general correctness of the results. The user is assumed to be knowledgeable of the information in the documentation that accompanies the diskettes. The user is assumed to recognize that the input parameters can have a significant effect on the solution and must be chosen carefully.

CHAPTER 2. SYSTEM SUMMARY AND PROGRAM STRUCTURE

SYSTEM APPLICATION

The design of driven piles and drilled shafts under lateral loading is an important problem and one that is encountered frequently in highway design. The principal use of piles or drilled shafts in highway structures is for the support of bridges, either to span water courses or to serve in interchanges. Other applications using laterally-loaded piles on highways can be seen in bridge abutments, overhead signs, pile-supported retaining walls, and pile-stabilized slopes.

Computer program COM624P is used to analyze the behavior of piles or drilled shafts which are subjected to lateral loads. The method of analysis implemented in COM624P is the so-called p-y method. The theoretical background about the p-y method of analysis is described in Part II of this document. The digital computer allows the deflected shape (lateral deflection) of a pile to be computed rapidly and accurately by iteration even though the soil reaction against the pile is a nonlinear function of pile deflection. After the deflection is determined, the shear, bending moment, and soil resistance along the pile can be computed thereafter. With the availability of microcomputers, this program makes it possible for highway engineers to employ the rational p-y method for analysis of laterally-loaded piles and drilled shafts.

SYSTEM COMPONENTS

The package sent with COM624P, in general, contains three 5.25-inch double-sided, double-density floppy diskettes. The first diskette contains the main program of COM624P.EXE and six sample-data files: Example.IN1 through Example.IN6. The engineer may use the sample data to run COM624P and check the solutions

presented in Chapter 5. If there are significant discrepancies, the user should report to FHWA immediately.

The second diskette contains the screen-editing files. The files stored in this diskette are: C624EDIT.EXE., C624EDIT.HLP, C624EDIT.CFG, PILEDATA.LIB, and INSTVIEW.EXE. The engineer may use a preprocessor program named C624EDIT.EXE to create a new data file, retrieve, and edit an existing data file.

The third diskette contains the graphics package. The files stored in the diskette are C624VIEW.EXE., C624EDIT.CFG, INSTVIEW.EXE, and EXAM1.PLT. The main graphics program is named C624VIEW.EXE. The user may execute this program and assign the data created by COM624P for graphics display.

SYSTEM PROCESSING

The system consists of three modules as described earlier. To process the system, the user starts to load the Menu and selects the preprocessor program C624EDIT.EXE to create an input-data file. C624EDIT can also be used to retrieve an existing data file and to edit the data entry. After the data file has been created or corrected, the user should save the data file using the SAVE command.

The second step of processing the system is to call the main program COM624P. COM624P will process the data file that contains the user's input data, and will create a text-output file and a graphics-output file. The user may view the output data on the monitor or print the output file to get a hard copy. If the user prefers to have a graphics display, then the program C624VIEW should be viewed. C624VIEW will display the graphics based on the computed results, and the user can get a hard copy of graphics from the installed HP plotter or dot-matrix printer. A flow chart

depicting data flow and showing the relationships of each module is presented in Fig. 2.1.

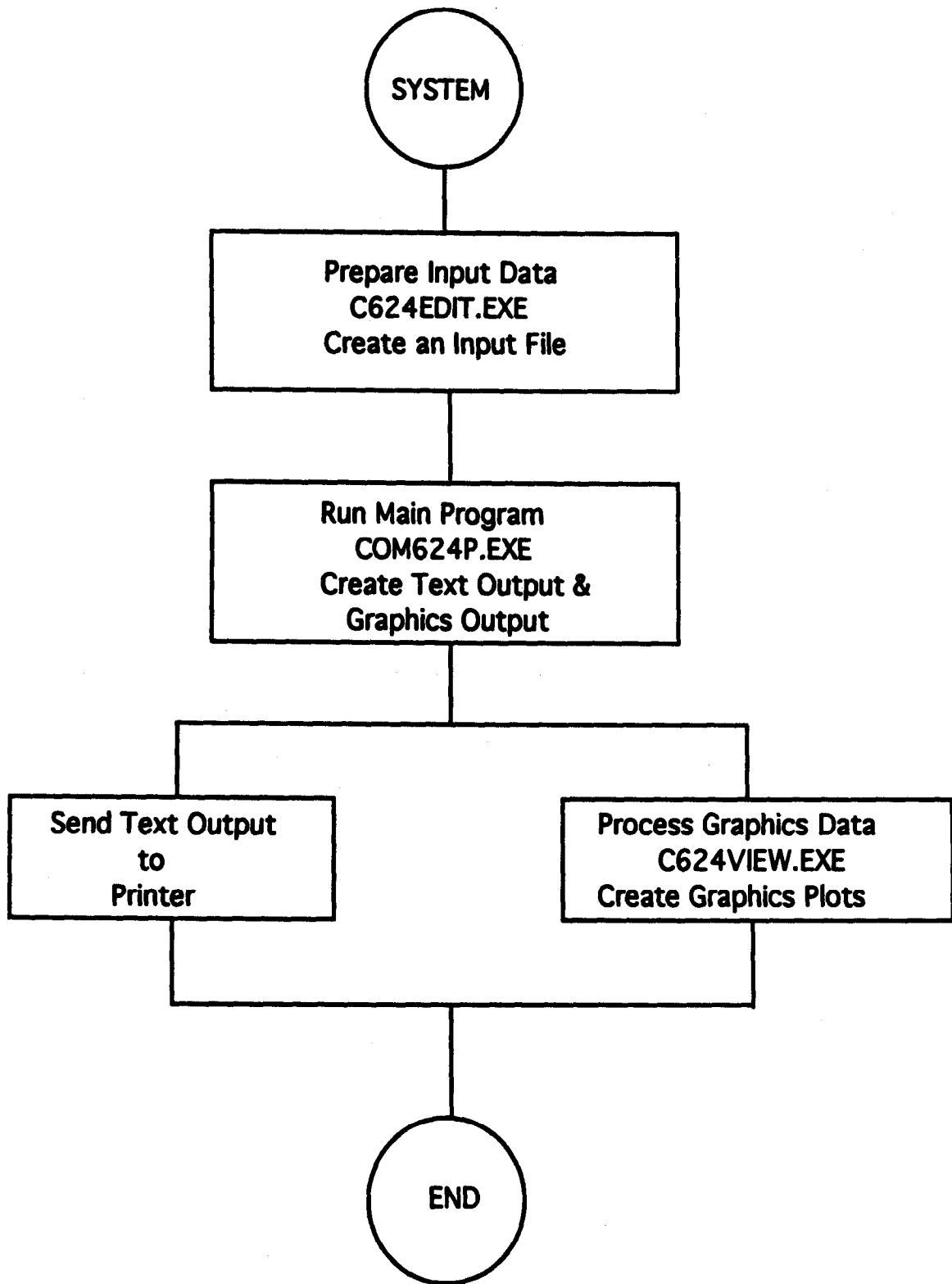
SYSTEM CONFIGURATION

Program COM624P was developed for the IBM-XT and IBM-AT or for any microcomputer that is compatible with the IBM. The program has been checked for conformance with ANSI FORTRAN77. The Fortran Compiler from Microsoft, Inc., was used to compile the source code and create the execution file.

The word length is important for convergence to a solution of the nonlinear equations employed by this program. Therefore, a double-precision real value, occupying 8 bytes of storage, was used in the Fortran Code. The precision is approximately 15 decimal digits. If a value has more digits, only the first 15 are significant.

The program requires at least 256k of RAM memory. The math coprocessor is highly recommended but is not required. If a high-speed, floating-point math coprocessor is installed, the execution time for a normal problem is less than one minute. However, it can take 3 to 7 minutes for the same problem, depending on the type of microcomputer, if the math coprocessor is absent. The operating system that is required to run the program should be MS-DOS 2.1 or a later version.

The preprocessor for input data, C624EDIT, and the post-processor for graphics display, C624VIEW, were developed in the Pascal language to utilize fully the screen-control function provided by most microcomputers. Two peripheral devices are required to run C624VIEW. One is a graphics adapter which can change the screen to the graphics mode for plotting output. Currently, the program supports the following graphics adapters:



CGA - IBM Color-Graphics Adapter Driver
EGA - IBM Enhanced-Graphics Adapter Driver
VGA - Video Graphics Array Adapter
HERC - Hercules Driver
AT&T - AT&T 400 Line Driver

The other peripheral equipment is a printer or plotter for hard copies of graphics. The program supports HP plotters; the IBM proprinter; Epson MX, FX, LX, LQ or Epson compatible printers including Okidata, Panasonic, and Star printers.

MAIN PROGRAM STRUCTURE

The structure of the main program COM624P is shown in the flow diagram Fig. 2.2. The function of each subprogram is described in the following listing.

1. Main Program

Function: the main program COM624P inputs and outputs a small amount of data, but mainly controls the flow of logic by calling appropriate subroutines.

Calls: UNITSS, NODEM INPT, OPIN, NODE, FLXRIG, DEFLEC, ESCALL, DISTR, MCALC, OPCHK, EQUIL, PYGEN, PMEIX

2. UNITSS

Function: to store table headings.

Called

From: COM624P

Calls: none

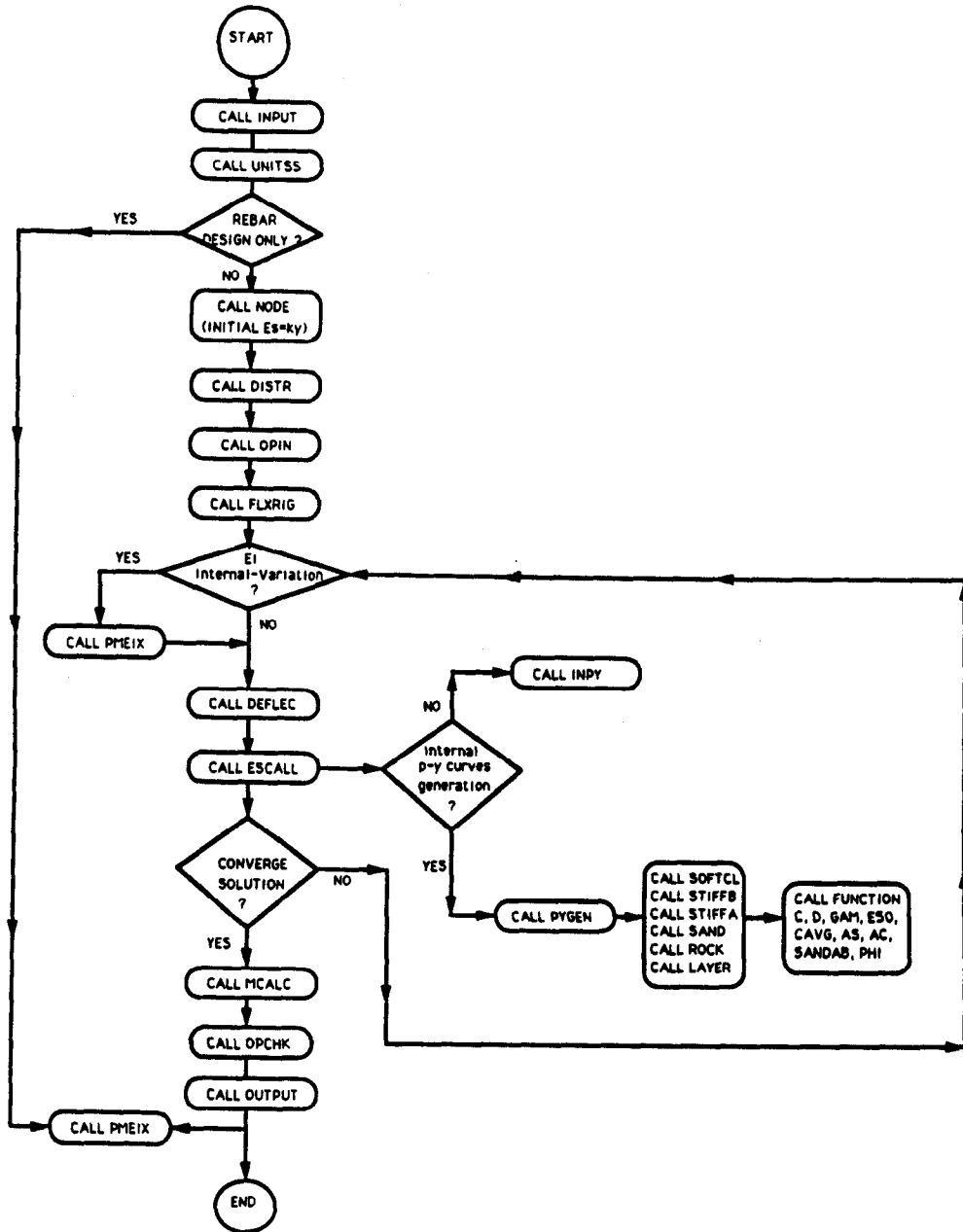


Figure 2.2. The flow chart of Main Program COM624P.

3. INPT

Function: this subroutine reads most of the technical data for the problem.

Called

From: COM624P

Calls: none

4. OPIN

Function: this subroutine outputs the data for a problem.

Called

From: COM624P

Calls: none

5. NODE

Function: this subroutine (1) calculates the coordinate for each node, (2) calculates the number of the node at the top and bottom of each layer of soil, and (3) initializes the array of soil moduli.

Called

From: COM624P

Calls: none

6. FLXRIG

Function: this subroutine calculates the flexural rigidity of the pile at each node.

Called

From: COM624P

Calls: none

7. DEFLEC

Function: subroutine DEFLEC calculates deflection at all points along the pile.

Called

By: COM624P

Calls: none

8. DISTR

Function: this subroutine calculates distributed load relevant to each node.

Called

By: COM624P

Calls: none

9. MCALC

Function: this subroutine computes the moment, soil reaction, and combined stress in the pile at each node along the pile.

Called

By: COM624P

Calls: FUNCTION D

10. OPCHK

Function: this routine calculates the imbalance in force and moment at a node.

Called

By: COM624P

Calls: none

11. OUTPT

Function: subroutine OUTPT prints the information from final solution, including a table of depth, deflection, moment, maximum combined stress in the pile, distributed load, soil modulus, and flexural rigidity.

Called

By: COM624P

Calls: none

12. EQUIL

Function: this subroutine (1) computes boundary conditions and prints them to facilitate checking and (2) computes and prints overall force and moment imbalance.

Called

By: COM624P

Calls: none

13. INPY

Function: this subroutine computes values of soil modulus from input p-y curves.

Called

By: ESCALL

Calls: none

14. FUNCTIONS C, D, GAM, E50, CAVG, AS, AC, SANDAB, PHI

Functions: these function subroutines do the following:

FUNCTION C computes the value of cohesion at any depth by linear interpolation from input data.

FUNCTION D computes the pile diameter at any depth.

FUNCTION GAM computes the average effective unit weight of soil above a point.

FUNCTION E50 computes the ϵ_{50} (strain at a stress ratio of 50 percent) by linear interpolation from input data.

FUNCTION CAVG computes the average shear strength of soil above a point.

FUNCTION AS computes the coefficient A_s for stiff clay below the water table.

FUNCTION AC computes the coefficient A_c for stiff clay below the water table.

FUNCTION SANDAB computes coefficients A and B for sand.

FUNCTION PHI computes angle of internal friction at any depth.

Called

By: these functions are called in the subroutines that generate p-y curves (SOFTCL, STIFFA, STIFFB, and SAND).

Calls: none

15. PYGEN

Function: this subroutine reads information needed to generate p-y curves, stores data for each layer, and calls ESCALL to generate p-y curves.

Called

By: COM624P

Calls: ESCALL

16. ESCALL

Function: subroutine ESCALL calls the appropriate subroutine for calculation of soil modulus or generation of p-y curves for verification purposes.

Called

By: COM624P, PYGEN

Calls: SOFTCL, STIFFB, STIFFA, SAND, INPY

17. SOFTCL

Function: this subroutine generates p-y curves for output verification and calculates secant soil modulus at all nodes in soil with KSOIL = 1 (internally-generated p-y curves in soft clay with Matlock's (1970) recommendations).

Called
By: ESCALL

Calls: Functions D, C, GAM, E50

18. STIFFB

Function: this subroutine generates p-y curves for verification of output and calculates secant soil modulus at all relevant nodes where KSOIL = 2 (stiff clay below the water table with criteria by Reese et al., 1975).

Called
By: ESCALL

Calls: Functions D, C, CAVG, GAM, E50, AS, AC

19. SAND

Function: this subroutine generates p-y curves for verification of output and calculates secant soil modulus at all relevant nodes where KSOIL = 4 (internally-generated p-y curves in sand with criteria by Reese et al., 1974).

Called
By: ESCALL

Calls: Functions D, GAM, PHI

20. STIFFA

Function: this subroutine generates p-y curves for verification of output and calculates secant soil modulus at all relevant nodes when KSOIL = 3.

Called

By: ESCALL

Calls: Functions D, C, CAVG, GAM, and E50

21. ROCK

Function: this subroutine generates p-y curves for verification of output and calculates secant soil modulus at all relevant nodes where KSOIL = 6 (internally-generated p-y curves in rock with limestone criteria by Reese and Nyman, 1978).

Called

By: ESCALL

Calls: Functions, D, C, CAVG, GAM, E50

22. LAYERS

Function: this subroutine calculates the equivalent thickness of soil layers for use in the theory for the behavior of layered soil.

Called

By: SOFTCL, STIFFB, STIFFA SAND

Calls: none.

23. PMEIX

Function: this subroutine calculates the ultimate bending capacity and variation of flexural rigidity based on given data on cross section.

Called

By: COM624P

Calls: SETUP, CSTRES, STEELP, SHELLP, SHELLM, COREP, COREM.

CHAPTER 3. GUIDE FOR EXECUTION OF COM624P ON A MICROCOMPUTER

INTRODUCTION

COM624P was written with user-friendly features such as menu input, free-field format, and screen editing. The output can be sent to printers for hard-copy or sent to plotters for display of graphics. This section describes the step-by-step procedures to operate the system.

Operation of COM624P consists of three steps. The first step is the creation of input-data files using the user friendly input menus or an ASCII input batch file using a text editor. After an input file has been created execute the program by selecting the "Run" menu or typing COM624P.EXE for batch file execution. The procedures for each step are described in the following paragraphs.

BACKING UP AND RESTORING ORIGINAL DISKETTE

The user is assumed to have basic knowledge on how to use the operating system (DOS) for selected microcomputers. Before operating, a backup copy should be made for each original diskette and the original diskettes should be stored in a safe place.

To make a backup of the entire diskette, the user can use the following steps:

1. Format a regular blank floppy diskette using the FORMAT command on the DOS operation system.
2. Insert the original diskette in Drive A, and the formatted diskette in Drive B, then enter the following:

```
A:> COPY A:*. * B: <CR>
```

(Note: <CR> represents the enter or return key)

3. If the user has a hard disk installed in the computer, use the following instructions to create a COM624P directory and save all the files onto the hard disk:

```
C:> MD COM624P <CR>
```

(Note: create a directory)

```
C:> CD COM624P <CR>
```

(Note: change main directory to COM624P directory)

```
C:\COM624P>COPY A:*. * <CR>
```

(Note: copy files from the original diskette in Drive A to the hard disk in Drive C)

GUIDE FOR INSTALLATION OF CONFIGURATION FILE

The program named INSTVIEW.EXE is used to create the configuration file used for video attributes and graphics drivers. The file produced by INSTVIEW is named C624EDIT.CFG. The configuration file must be kept on the same disk directory that contains C624EDIT.EXE and C624VIEW.EXE.

If these files are on Drive C, then enter the following:

```
C:\COM624P>INSTVIEW.EXE <CR>
```


INSTVIEW will begin and will ask the user to make selections regarding units of data, graphics hardware, Graphics Mode, and video attributes. The following sections discuss the information requested by INSTVIEW.

Control Parameters

The first input screen presented by INSTVIEW is the values for control parameters denoted by COM624P. The default values are provided as shown in the following. The user can change the preset values, if it is necessary. For example, an input value of 2 for units will cause COM624P to display SI units instead of English units. When the user is satisfied with the selection, the F8 key should be pressed to continue to the selection of the graphics driver and Graphics Mode.

```

                                C624EDIT Configuration File Editor

Units, 1 = lbs&inch, 2 = metric, 3 = other           1
p-y Curve Criteria: 0 = cyclic, 1 = static           1
Print full pile response: 0 = off, 1 = on            1
Print p-y curves: 0 = off, 1 = on .....            1
Iterations Limit for Analysis .....                100
Convergence tolerance for pile analysis ... 0.000100
Back-up data files: 0 = off, 1 = on .....           1
File Property Library Path & Name ..... B:PILEDATA.LIB

A 1:DEF:Num           1

: Move Cell — ? : Help — F2 : Edit Cell — F8 : Continue —
```

Graphics Driver and Mode

The second input screen presented by INSTVIEW is the menu from which the graphics driver is selected. The graphics drivers that are supported are:

- (1) CGA
- (2) MCGA
- (3) EGA (256K memory version)
- (4) EGA (64K memory version)
- (5) EGA driving monochrome monitors
- (6) VGA
- (7) IBM 8514
- (8) AT&T
- (9) Hercules monochrome
- (10) IBM PC3270

Graphics Drivers

- (1) Color Graphics Adapter (CGA)
 - (2) MCGA
 - (3) 16 Color Enhanced Graphics Adapter
 - (4) 4-Color Enhanced Graphics Adapter
 - (5) EGA driving Monochrome Display
 - (6) IBM-8514 Graphics Card
 - (7) Hercules Monochrome Graphics Adapter
 - (8) AT&T 400-Line Graphics Adapter
 - (9) Virtual Graphics Array (VGA)
 - (10) IBM PC3270 Graphics

 - (11) Accept this selection
- Current Selection is VGA
- Enter new selection: 11

All of the above graphics drivers, with the exception of the IBM PC3270 and Hercules monochrome, can be driven in a variety of modes. After the graphics driver has been selected, a third input

screen is presented for the selection of the Graphics Mode. The Graphics Mode controls the combination of pixel densities and colors used by COM624P.

```

                                Graphics Modes for VGA

(1) 640x200 16-Color
(2) 640x350 16-Color
(3) 640x480 16-Color

(4) Accept this selection

Current Selection is (3)

Enter new selection: 4

```

The next screen is to specify plotting-control values and the printing device in the system, as shown below. It should be noted that all the printer output will be sent to port LPT1. If the setup in the system is different, the user can use DOS MODE command to redirect the printer port.

```

                                Optional Plotting Control Values

Axis Title Character Size (IN) ..... 0.15000
Plotting Symbol Size (IN) ..... 0.15000
Plotter Pen Number for Axis Titles ..... 1
Plotter Pen Number for Axis and Borders ..... 1
Plotter Pen Number for Data Line & Symbols .. 1
Type of Printer Used for Screen Dump ..... 2
Codes for printers: 1 = Epson MX, FX
                   2 = Epson LQ
                   3 = Toshiba 24-pin
                   4 = HP LaserJet and DeskJet
                   5 = HP InkJet
                   6 = IBM Proprinter
                   7 = IBM Proprinter24

All printer output is sent to LPT1.
To redirect LPT1 to COM1 use the DOS MODE command.

A 1:DEF:Num          0.15000
----- : Move Cell --- ? : Help --- F2 : Edit Cell --- F8 : Continue ---|

```

Video Attributes

The final input screen presented by INSTVIEW is the interactive selection of the video attributes used in the screen menus. The user may use this feature to customize the colors used by Menu to suit his or her personal tastes. Five video attributes may be selected. They are the color schemes used on Menu backgrounds, the highlighted letter choices, the current Menu selections and the data-entry cells (both active and inactive). This interactive section shows an example of the current selections so that the user can appraise the selections and avoid confusing combinations of color. Users running the program on systems with monochrome monitors have a smaller range of selections, but still have a wide variety of possible selections.

Selections for the video attributes are made by moving the box to the desired combination of letter color and background color, then by pressing the appropriate Function Key (Keys F1 through F5). The user may change any of the selections as desired. The user then presses the Escape Key when satisfied with the current selections for the video attributes.

Acceptance of Changes

The last step of the installation process is for the user to indicate acceptance of the current configuration for COM624P. If the user is satisfied, 'Y' or 'y' should be entered for yes. If a 'yes' response is given, COM624P will write the new version of C624EDIT to the current directory and indicate that it has been changed. If the user enters an answer other than 'yes', the program exits without saving a new configuration file.

MENU STRUCTURE

COM624P, Version 2.0, uses the window feature and pull-down-menu interface for easy learning and operation. Figure 3.1 shows the complete structure of COM624P's Main Menu and its successive pull-down menus.

The main function of the File Menu is for assigning files for input, output, and graphical data. The "Input" Menu will call up Module C624EDIT which consists of four sub-menus. The sub-menu named "Analysis" in C624EDIT is for entering data that are needed for computation of a pile under lateral loading. The sub-menu named "Mult" is for entering data that are needed for computing the ultimate bending moment and EI-values for the selected-pile section. Because Module C624EDIT also can be used as a stand-alone program, the "File" sub-menu is provided for reading and saving of the data files. The "Option" sub-menu mainly provides the user an easy way for changing parameters on configuration.

The "Run" Menu will call up Module COM624P for execution, using the specified files for input and output. The "Graphics" Menu will call up Module C624VIEW, which consists of four sub-menus. The sub-menu "File" under the Graphics Menu is needed only if the Module C624VIEW is used as a stand-alone program. If a file name for graphical data has been given earlier, the program will automatically use that file for producing graphical results. The sub-menu named "View" is for generating graphics on the screen for preview. The sub-menu named "Plot" is for generating HP-GL plotting files for high-quality pen plotters. The sub-menu "Option" is provided for changing the parameters on configuration. The detailed discussion of each menu will be presented later in this chapter.

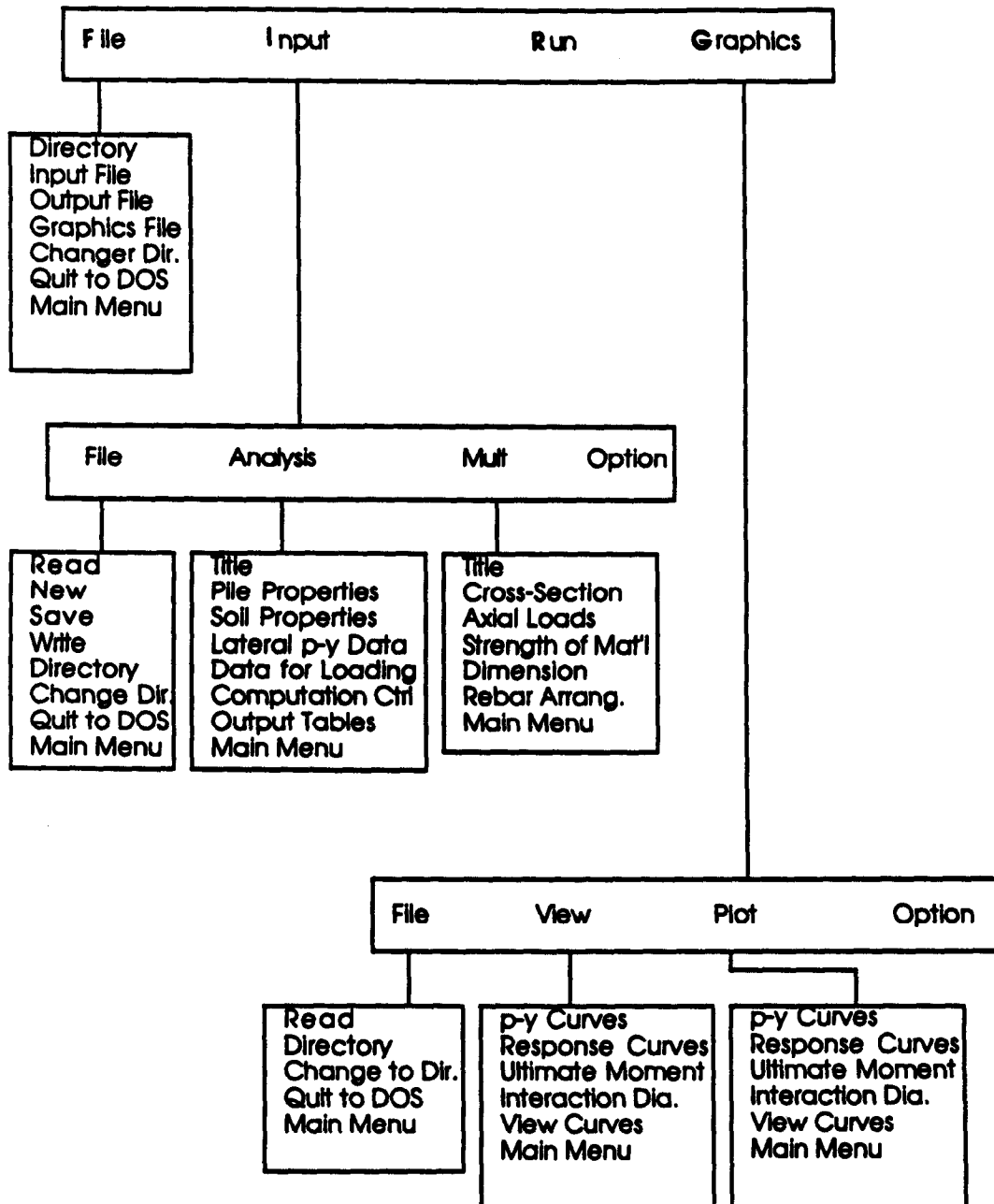


Figure 3.1. Main menu structure of COM624P.

GUIDE FOR USING MAINMENU

The MAINMENU.BAT file is a special batch file that will integrate all the modules needed for operation of COM624P in the DOS environment. The shell process was used so that the computer will automatically transfer control to the appropriate module, based on the given command.

To initiate the program, the user enters

```
C:\COM624P>MAINMENU <CR>
```

The program will quickly bring up the Main Menu on the screen. The Main Menu has four choices: File, Input, Run, and Graphics.

File Input Run Graphics

This program is developed especially for Design and analysis of piles under lateral loading. The current version is 2.0

The selection of the FILE menu allows the user to access a pull-down menu for file operations such as assigning input file, output file, and graphics file, reading in an existing file, creating a new data file, checking files in the directory, and similar operations.

The selection of INPUT menu allows the user to access Program C624EDIT to create a data file or to edit an existing data file.

The selection of the RUN menu allows the user to execute the program with the specified input and output files.

The selection of the GRAPHICS menu allows the user to view the soil and pile response curves directly on the screen. The system must have graphics adapters such as CGA, EGA, VGA, or monographics adapter in order to view the graphics.

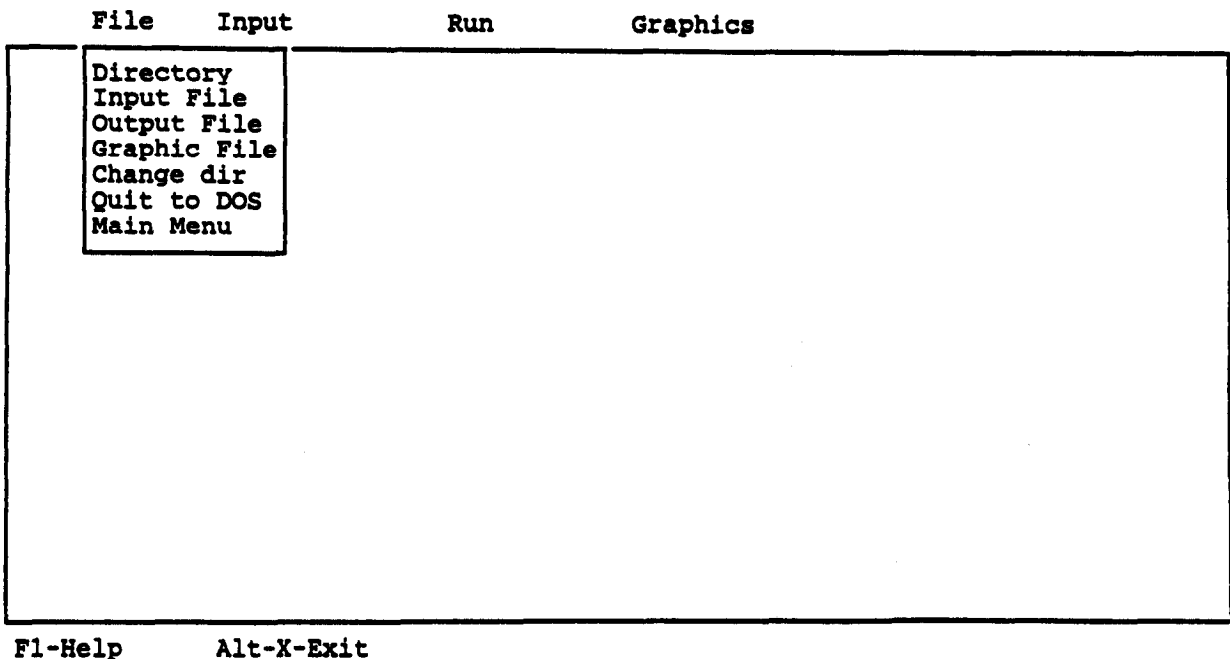
F1-Help Alt-X-Exit

Once the Main Menu has been called, an item can be selected by pressing the key corresponding to the first letter in the name of the menu. The arrow keys can also be used to move the highlight bar and Enter can be pressed when the bar is at the appropriate command.

The selection of the File Menu allows the user to access a pull-down menu for file operations such as assigning an input file, output file, and graphics file, reading an existing file, creating a new data file, checking files in the directory, and similar operations.

The selection of the Input Menu changes the screen from the Main Menu to the Input Menu as shown in Figure 3.1. The selection of the Run Menu allows the user to execute the program with the specified files for input and output. The selection of the Graphics Menu changes the screen from the Main Menu to the Graphics Menu as shown in Fig. 3.1.

The first step is to select the File Menu. Once the File Menu has been pulled down, the hot keys for the Up arrow and the Down arrow can be used to highlight the desired command.



The user needs to specify a Input, Output, and Graphics file before selecting the Input, Run or Graphics Menu.

File	Input	Run	Graphics
Directory	Read File Name _____		
EXAMPLE.IN1			
Change dir			
Quit to DOS			
Main Menu			

F1-Help Alt-X-Exit

GUIDE FOR USING INPUT MENU

Input Menu Options

Once you select the "INPUT" from the Main Menu, the Input Menu will be shown on the screen as in the following.

File	Analysis	Mult	Option
C624EDIT 2.0, Edit Variables:			
This program is a preprocessor developed especially for users for preparation of input for the computer program COM624P. The main menu for this program is displayed as a bar at the top row of the screen. The main menu has four choices: FILE, ANALYSIS, MULT, and OPTION.			
The selection of the FILE menu allows the user to access a pull-down menu for file operations such as reading in an existing file, creating a new data file, checking files in the directory, and similar operations. The selection of the ANALYSIS menu allows the user to enter required data for computing the response of the pile and soil, such as distributions of deflection, bending moment, shear, and soil resistance as a function of length along the pile. The selection of the MULT menu allows the user to enter data of a selected pile size for computing the ultimate bending moment and other design-related information. The OPTION menu is used for screen setting and it may not be needed for most computer systems.			

F1-Help Alt-X-Exit

The Input Menu has four submenus: File, Analysis, MULT, and Option. The four menus allow the user to access file operations, data editing, control of variables in the analysis, and program options. If help is needed for data entry, the FI key is pressed to access the help files.

The user can move from one choice to another by using either the arrow keys or by typing the highlighted letter of the choice. Thus, if the File selection is currently highlighted (and the File pull-down menu is not shown), one may move to the Analysis selection by either typing the right-arrow key twice or by typing 'A' or 'a' for Analysis.

File Submenu

The File Submenu presented under the "Input" menu provides additional access to the commands for the control of input files. This menu controls reading of input files, creation of new input files, saving of files, examining the contents of any subdirectory, changing of directories, and exiting the program at the conclusion of use.

If the user has already specified the file name for the input data under the Main Menu, they need not give the file name here; however, if the input file was not specified previously, the selection of "File" will allow you to enter the file name again. To access the file menu, you need to move the highlighted bar to the "File" and press <Enter>. The options under the File submenu will be shown on the screen as the following.

The File pull-down menu commands are:

Read -	to read data files,
New -	to create a new data file,
Save -	to save the current data as a disk file,

Directory - to display disk directories,
Change Dir - to switch subdirectories,
Exit to Dos - to leave the program, and
Main - to return to the Main Menu.

File	Analysis	Mult	Option
Read New Save Directory Change dir Quit to DOS Main Menu			

F1-Help Alt-X-Exit

For example, to retrieve an existing input file named EXAMPLE.IN6, you can move the cursor to highlight "Read" on the submenu and press <Enter>. The screen will have a window for the user to enter the file name as shown below.

File	Analysis	Mult	Option
Read New			
New File Name			
EXAMPLE.IN6			
Change dir Quit to DOS Main Menu			

F1-Help Alt-X-Exit

Once the input file is found, the program will read line by line from the file and the data will be echoed on the screen.

File	Analysis	Mult	Option		
Reading EXAMPLE.IN6					
Line #10:	30.0000	30.0000	14906.0000	707.0000	
Line #10:	160.0000	30.0000	47813.0000	707.0000	
Line #11:	1 4	0.0000	360.0000	90.0000	
Line #12:	0.0000	0.06900			
Line #12:	360.0000	0.06900			
Line #13:	0.0000	0.0000	38.0000	0.00000	
Line #13:	360.0000	0.0000	38.0000	0.00000	
Line #17:	4				
Line #18:	20.0000				
Line #18:	60.0000				
Line #18:	100.0000				
Line #18:	150.0000				
Line #19:	1				
Line #20:	1 60000.0000	0.0000	50000.0000		
Line #21:	2 1				
Line #22:	50000.00				
Line #23:	3500.00	60000.00	0.00	29000000.00	
Line #24:	0.00	30.00	0.00	0.00	0.00
Line #25:	8 12	0	3.0000		
Press any key to continue					

F1-Help Alt-X-Exit

If there is an error in retrieving data, a message will be given on the screen. The user should note the cause of the error and press the <Enter> key to continue. Most of the errors have to do with the format of input data. The user should check the line number and make the correction later on the Edit screen.

After the editing of the input data is completed, the user needs to save the new data by moving the cursor to "Save" and pressing <Enter> after the "Save" was highlighted. A window will allow the user to give a file name for the new data as shown in the following.

The user can press "M" and then <Enter> to return to the initial Input Menu.

File	Analysis	Mult	Option
Read New Save	Save File Name		
EXAMPLE.IN7			
Main Menu			

F1-Help Alt-X-Exit

Analysis Submenu

The Analysis Submenu opens access to edit the various data groups defining the problem. Variables that may be edited through this submenu are title for the problem, pile properties, soil properties, load-transfer data, data for loading, computation control and output format.

File	Analysis	Mult	Option
	Title File Properties Soil Properties Lateral p-y Data Data for Loading Computation Control Output Tables Main Menu		

F1-Help Alt-X-Exit

The Analysis pull-down menu commands are:

- Title* - to edit the program title,
- Pile Properties* - to edit the pile properties (length, diameter, cross-sectional area, and EI),
- Soil Properties* - to edit the soil properties (layers, strength parameters, unit weights, etc.),
- Load-Transfer* - to edit the user-specified p-y curves,
- Data for Loading* - to edit loads at the top of the pile and the distributed load,
- Computation Control* - to select the tolerance and iteration numbers for computation,
- Output Tables* - to select options for printing output data, and
- Main* - to return to Main Menu.

The user can select any one of the items shown in the Analysis submenu to review, create, or change the data. Some of the variables for input may use an abbreviated name because of the limited space available on the editing window. However, all variables will have a full, detailed explanation in the help file. It should also be noted that all the x-coordinates described by the program are based on the origin which is set at the top of the pile. If help is needed for data entry, the user can press the "F1" key to access the help file, and press the "F8" to return to the edit screen.

The screens that are used to create data for EXAMPLE.IN6 are presented in the following to illustrate the usage of the Analysis submenu.

File Analysis Mult Option

C624EDIT 2.0, Edit Variables:

This program is a preprocessor developed especially for users for preparation of input for the computer program COM624P. The main menu for this program is displayed as a bar at the top row of the screen. The main menu has four choices: FILE, ANALYSIS, MULT, and OPTION.

The selection of the FILE menu allows the user to access a pull-down menu for file operations such as reading in an existing file, creating a new data file, checking files in the directory, and similar operations. The selection of the ANALYSIS menu allows the user to enter required data for computing the response of the pile and soil, such as distributions of deflection, bending moment, shear, and soil resistance as a function of length along the pile. The selection of the MULT menu allows the user to enter data of a selected pile size for computing the ultimate bending moment and other design-related information. The OPTION menu is used for screen setting and it may not be needed for most computer systems.

F1-Help Alt-X-Exit

File Analysis Mult Option

Title ←
File Properties
Soil Properties
Lateral p-y Data
Data for Loading
Computation Control
Output Tables
Main Menu

F1-Help Alt-X-Exit

Move the cursor to "Title", then press <Enter> key; the following screen will appear.

Enter title for this data file (up to 72 characters long)

EXAMPLE 6 ANALYSES RELATED TO DESIGN OF CONCRETE PILES

A 1:DEF:Lab EXAMPLE 6 ANALYSES RELATED TO DESIGN OF CONCRETE PILES

— : Move Cell — ? : Help — / : Edit Screen — F8 : Continue —
F1-Help Alt-X-Exit

Press Command Key: [F8].

Title
Pile Properties ←
Soil Properties
Lateral p-y Data
Data for Loading
Computation Control
Output Tables
Main Menu

F1-Help Alt-X-Exit

Move the cursor to "Pile Properties", then press <Enter> key;
the following screen will appear.

Editing File Dimensions

Number of increments (<= 300)	100
Distance from top of pile to ground surface - inches	0.0
Length of pile	360.00
Pile modulus	3200000
Slope of ground surface (degrees)	0.0000

A 1:DEF:Num 100

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Press Command Key: [F8].

Editing File Section Properties

Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00	30.000	47813.0000	707.0000
2	30.00	30.000	14906.0000	707.0000
3	160.00	30.000	47813.0000	707.0000
4				
5				
6				
7				
8				
9				
10				

To access pile property library leave pile diameter blank.

A 1:DEF:Num 0.00000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Press Command Key [F1] or "?" for help, the screen on next page will appear.

Help Topics	
Mult MENU	Edit - Computation Control
Mult - Shape and Axial Loads	Edit - Output Tables
Mult - Rebar & Concrete Strength	FILE MENU
Mult - Section Dimension	File - Read
Mult - Rebar Arrangement	File - New
EDIT MENU	File - Save
Edit - Title	File - Write
Edit - Pile Properties ←	File - Directory
Edit - Soil Properties	File - Change Directory
Edit - Soil - p-y Criteria	File - Exit to DOS
Edit - Soil - k for Clays	MAIN MENU
Edit - Soil - k for Sands	Main - Pull-down Menus
Edit - Soil - E50	Main - Hot Keys
Edit - Soil - p-y Multipliers	OPTIONS MENU
Edit - Soil - Unit Weights	Options - Units
Edit - Lat. Load Trans.	Options - Pile Property Library
Edit - Data for Loading	Options - Save Config. File
	Options - Auto-backup

F1-Help Alt-X-Exit

Move the cursor to "Pile Properties" and press <Enter>; the following screen will appear.

<p>The maximum number of increments allowed into which the pile is divided is 300. Typically the user will have selected the number of increments to be equal to some multiple of the overall pile length, so that the output values are calculated uniformly with depth.</p> <p>Piles can have several different segments but each one is treated as a uniform cross section. For taper piles, the program allows the user to use up to 10 uniform segments to model the properties. "Top Depth" shown in Editing Pile Section Properties is the x-coord. (depth below the top of pile) of the top of a segment of pile with uniform cross section.</p> <p>For frequent designers if the pile diameter is set equal to zero, the user gains access to a library file defining pile properties. The pile property library is created separately by the user for his own use. If the units of the data in the pile property library are different from those set inside C624EDIT, a units conversion is performed</p>
--

_____ F1 : Help Index _____ PageUp PageDown _____ F8 : Return _____
 F1-Help Alt-X-Exit

Press Command Key [F8] to return to the Edit Menu.

Editing File Section Properties

Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00	30.000	47813.0000	707.0000
2	30.00	30.000	14906.0000	707.0000
3	160.00	30.000	47813.0000	707.0000
4				
5				
6				
7				
8				
9				
10				

To access pile property library leave pile diameter blank.

A 1:DEF:Num 0.00000

___ : Move Cell ___ ? : Help ___ / : Edit Screen ___ F8 : Continue ___
 F1-Help Alt-X-Exit

Press Command Key: [F8].

Title File Properties Soil Properties ← Lateral p-y Data Data for Loading Computation Control Output Tables Main Menu
--

F1-Help Alt-X-Exit

Move the cursor to "Soil Properties", then press <Enter>; the following screen will appear.

Editing Soil Layer Information

Layer #	Criteria #	X-top inches	X-bot inches	k lb/in ³
1	4	0.00	360.00	90.00
2	3	360.00	540.00	500.00
3				
4				
5				
6				
7				
8				
9				
10				

p-y Curve Criteria

- #1 = Soft Clay Criteria
- #2 = Stiff Clay Below Watertable
- #3 = Stiff Clay Above Watertable
- #4 = Sand
- #5 = Interp. Between Input Curves
- #6 = Vuggy Limestone

D 2:DEF:Num 500.00000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Press Command Key [F8] to continue.

Editing Effective Unit Weight Information

Point #	Depth inches	Unit Weight lb/in ³
1	0.00	0.069
2	360.00	0.069
3	360.00	0.034
4	540.00	0.034
5		
6		
7		
8		
9		
10		

A 4:DEF:Num 540.00000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Press Command Key [F8] to continue.

Editing Shear Strength Information

Layer #	Depth inches	c psi	φ deg.	E50 @ 50% of c
1	0.00	0.000	38.00	0.0000
2	360.00	0.000	38.00	0.0000
3	360.00	10.000	0.00	0.0050
4	540.00	10.000	0.00	0.0050
5				
6				
7				
8				
9				
10				

A 4:DEF:Num 540.00000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit
 Press Command Key [F8].

File	Analysis	Mult	Option
	Title Pile Properties Soil Properties Lateral p-y Data Data for Loading ← Computation Control Output Tables Main Menu		

F1-Help Alt-X-Exit

Move the cursor to "Data for Loading", then press <Enter>; the following screen will appear.

Editing Loading Information

```
Distributed lateral loading (y/n) ? ..... n
Is loading cyclic (y/n) ? ..... n
Boundary condition code (KBC) ..... 1
```

```
KBC = 1 for shear and moment (free head)
KBC = 2 for shear and slope (fixed head)
KBC = 3 for shear and rotational restraint (partially fixed)
KBC = 4 for deflection and moment
```

A 1:DEF:Lab n

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Press Command Key [F8] to continue.

Editing File-head Loading

KOP	Shear pounds	Moment in-lbs	Axial Load pounds
1	20000.00	0.000	50000.00
1	40000.00	0.000	50000.00

```
KOP=0 if only a summary output for this load to be printed
=1 if complete output is desired for this load
```

A 1:DEF:Num 1

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Press Command Key [F8].

File Analysis Mult Option

	<p>Title File Properties Soil Properties Lateral p-y Data Data for Loading Computation Control ← Output Tables Main Menu</p>	
--	--	--

F1-Help Alt-X-Exit

Move the cursor to "Computation Control", then press <Enter>; the following screen will appear.

File Analysis Mult Option EXAMPLE.IN6

<p>1. Maximum number of iterations allowed for analysis : 100 2. Tolerance on solution convergence, inches : 0.000010 3. Value of deflection considered to be excessive, inches : 147.0000 4. Computation using internally-generated cracked EI (Y/N : N Note: If the above answer is Y, remeber to enter the same axial load and other parameters such as arrangement of rebar, concrete and rebar strength in the "MULT" menu later.</p>	
<p>A 1:DEF:Num 100</p>	
<p>_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____</p>	

F1-Help Alt-X-Exit

Press Command Key [F8] (if needed, press the [F-1] key to access the Help File for an explanation of cracked/uncracked EI).

File Analysis Mult Option

Title
File Properties
Soil Properties
Lateral p-y Data
Data for Loading
Computation Control
Output Tables ←
Main Menu

F1-Help Alt-X-Exit

Move the cursor to "Output Tables," then press <Enter>; the following screen will appear.

File Analysis Mult Option EXAMPLE.IN6

Output Printing Options

*** Lateral Load Analysis ***

Printing Increment (1 for every node, 2 for every other node, etc) 1
Print deflection, moment, shear over full length of pile (y/n) Y
Print p-y curves for verification Y

A 1:DEF:Num 1

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
F1-Help Alt-X-Exit

Press Command Key: [F8].

MULT Submenu

The MULT Submenu opens access to the editing commands for ultimate-bending moment computation. Variables edited through this menu are the title for computation, cross-sectional shape, axial loads, strength of materials, dimensions of cross section, and rebar measurement. The user can pull down the MULT submenu by moving the highlighted bar to "MULT" and press <Enter> after the initial Input Menu is returned to the screen as shown below.

File	Analysis	Mult	Option	EXAMPLE.IN6
		Title Cross Section Shape Axial Loads Strength of Materials Dimension of Cross Section Rebar Arrangement Main Menu		

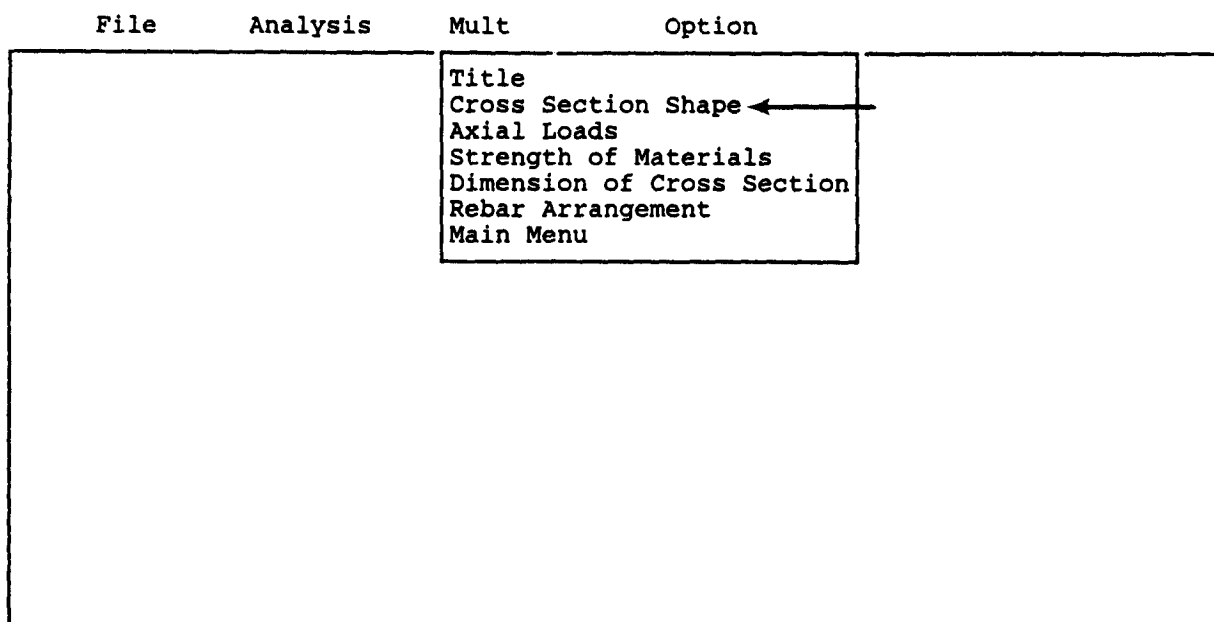
F1-Help Alt-X-Exit

The MULT pull-down menu commands are:

- Title* - to edit the program title,
- Cross-section Shape* - to select the shape of the cross section,
- Axial Loads* - to enter the values of axial loads that are considered,
- Strength of Materials* - to enter the yield strength and the elastic modulus,
- Dimension of Cross Section* - to enter the dimensions for specified cross section,
- Rebar Arrangement* - to enter the rebar size, rebar number and arrangement, and
- Main* - to return to Main Menu.

If the user would like to compute the ultimate bending moment of the pile or ask the program to generate cracked/uncracked bending stiffness used for deflection computation, input data should be provided for each item under the MULT submenu. If cracked EI is chosen for the computation, the axial load entered in the "Data for Loading" submenu of the "Analysis" menu should be consistent with the axial load used in the "Mult" submenu for each case. If help is needed for data entry, the user can press "F1" key to access the help file and then press the "F8" key to return to the previous screen.

The screens that are needed to create data for EXAMPLE.IN6 are presented in the following screens to illustrate the usage of the MULT menu.



F1-Help Alt-X-Exit
Press Command Key: [C].

Identification number of the shape of cross section
of the pile:

- 1: Rectangular or square;
- 2: Circular (without shell or core);
- 3: Circular (with shell but without core);
- 4: Circular (with shell and core);
- 5: Circular steel pipe;

Enter the number: 2

A 1:DEF:Num 2

_____ : Move Cell — ? : Help — / : Edit Screen — F8 : Continue — |
F1-Help Alt-X-Exit

Press Command Key: [F8]

Title
Cross Section Shape
Axial Loads ←
Strength of Materials
Dimension of Cross Section
Rebar Arrangement
Main Menu

F1-Help Alt-X-Exit

Press Command Key: [A]

Enter axial loads for cross section design:

Point	Loads pounds
1	50000.00
2	
3	
4	
5	
6	
7	
8	
9	
10	

If the cracked EI will be used in computation of the pile deflection, the field will show the same axial load given in the "Analysis" menu.

A 1:DEF:Num 50000.00000

— : Move Cell — ? : Help — / : Edit Screen — F8 : Continue —
F1-Help Alt-X-Exit

Press Command Key: [F8]

- Title
- Cross Section Shape
- Axial Loads
- Strength of Materials ←
- Dimension of Cross Section
- Rebar Arrangement
- Main Menu

F1-Help Alt-X-Exit

press Command Key: [S]

Enter strength parameters of materials

Cylinder strength of concrete	psi	3500.00000
Yield strength of reinforcement	psi	60000.00000
Yield strength of shell or core	psi	0.00000
Modulus of elasticity of steel	psi	29000000.00000

A 1:DEF:Num 3500.00000000

_____ : Move Cell — ? : Help — / : Edit Screen — F8 : Continue — |
F1-Help Alt-X-Exit

Press Command Key: [F8]

Title
Cross Section Shape
Axial Loads
Strength of Materials
Dimension of Cross Section ←
Rebar Arrangement
Main Menu

F1-Help Alt-X-Exit

Press Command Key: [D]

Enter cross-section dimension

Width of section (rectangular section only) inches	0.00000
Depth of section (rectangular section only) inches	0.00000
Outer diameter (circular section only) inches	30.00000
Outer diameter of core (circular section only) inches	0.00000
Thickness of shell (circular section only) inches	0.00000
Thickness of core (circular section only) inches	0.00000

A 1:DEF:Num 0.00000000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
F1-Help Alt-X-Exit

Press Command Key: [F8]

Title
Cross Section Shape
Axial Loads
Strength of Materials
Dimension of Cross Section
Rebar Arrangement ←
Main Menu

F1-Help Alt-X-Exit

Press Command Key: [R]

Rebar Arrangement

Size of the rebar (enter the bar number, 3, 5, 8, 9...)	8
Number of reinforcing bars	12
Number of rows of reinforcing bars (rectangular section only)	0
Cover of rebar (from center of rebar to outer edge of concrete) inches	3.0000

A 1:DEF:Num 8

_____ : Move Cell — ? : Help — / : Edit Screen — F8 : Continue — |
 F1-Help Alt-X-Exit

Press Command Key: [F8]

Title	
Cross Section Shape	
Axial Loads	
Strength of Materials	
Dimension of Cross Section	
Rebar Arrangement	
Main Menu ←	

F1-Help Alt-X-Exit

Press Command Key: [M]

File Analysis Mult Option

C624EDIT 2.0, Edit Variables:

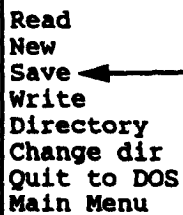
This program is a preprocessor developed especially for users for preparation of input for the computer program COM624P. The main menu for this program is displayed as a bar at the top row of the screen. The main menu has four choices: FILE, ANALYSIS, MULT, and OPTION.

The selection of the FILE menu allows the user to access a pull-down menu for file operations such as reading in an existing file, creating a new data file, checking files in the directory, and similar operations. The selection of the ANALYSIS menu allows the user to enter required data for computing the response of the pile and soil, such as distributions of deflection, bending moment, shear, and soil resistance as a function of length along the pile. The selection of the MULT menu allows the user to enter data of a selected pile size for computing the ultimate bending moment and other design-related information. The OPTION menu is used for screen setting and it may not be needed for most computer systems.

F1-Help Alt-X-Exit

Press Command Key: [F]

File Analysis Mult Option



Read
New
Save
Write
Directory
Change dir
Quit to DOS
Main Menu

F1-Help Alt-X-Exit

Press Command Key: [S]

Options Submenu

The Options Submenu provides a path for the user to the commands that control where C624EDIT looks for a library file, for pile properties, and to save the current Analysis variables in the configuration file. The procedure for accessing the Options pull-down menu is no different than for the other menus. The user can move the cursor to "Options" and press <Enter>. The following information will be shown on your screen.

File	Analysis	Mult	Option
			Units pounds & inches Library Directory Save Configuration file Auto Backup On Main Menu

F1-Help

Alt-X-Exit

The Options pull-down menu commands are:

- Units* - to select units for computation,
- Library Directory* - to change the name of the subdirectory containing the pile-properties library,
- Save Configuration File* - to save the current values of the Analysis and Options variables to the configuration file,
- Auto Backup* - a toggle switch to enable the automatic backing up of any file read by C624EDIT.EXE, so that the file may be saved under its original name. The backup-file name will be the original file name with a file extension of "BAK," and
- Main* - to return to the Main Menu.

COM624P can perform calculations in pounds and inches (Option 1), kilonewtons and meters (Option 2), or any consistent set on units (Option 3) for force and length. The user should take care that all input values are entered in consistent units. The following screen will illustrate how to select the units that the user requires.

File	Analysis	Mult	Option
			Units force & length
			Library D
			Save Conf 1 for pounds & inches
			Auto Back 2 for kN & meters
			Main Menu 3 for force & length
			Units = 1

F1-Help Alt-X-Exit

Pile-Library File

In many cases, a user may want to try several different sizes of piles, which can be a standard steel section or a non-standard reinforced concrete section, for the preliminary studies. The pile-library file is a data-base file in which the user can store data for most commonly-used pile sections. This file will be automatically loaded into the computer memory each time the user calls the Input Menu.

The pile-library file is associated with the section for editing pile properties in Module C624EDIT. The pile-library data will be presented on the screen for selection if the user leaves

blank the entry fields for pile diameter, moment of inertia, and area during the editing process.

The name of the file under which C624EDIT looks for the pile property library can have up to 42 characters. The user should be sure to enter the full name of the pile property library file, including the disk drive letter and path. The following screens will illustrate how to select the new pile property library.

File Analysis Mult Option

Editing File Section Properties

Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00			
2	240.00			
3				
4				
5				
6				
7				
8				
9				
10				

To access pile property library leave pile diameter blank.

A 2:DEF:Num 240.00000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
F1-Help Alt-X-Exit

Leave blank for all fields except for "Top Depth", then press [F8] key.

File Analysis Mult Option

File Section 1 - Top Depth = 0.00 inches

Select Appropriate File Type

HP 14x117, Axis X-X
HP 14x117 Axis Y-Y
HP 14x102, Axis X-X ←
HP 14x102, Axis Y-Y
HP 14x89, Axis X-X
HP 14x89, Axis Y-Y
HP 14x73, Axis X-X
HP 14x73, Axis Y-Y
HP 12x74, Axis X-X
HP 12x74, Axis Y-Y

FX = A FY = 3 Page = 0 Library entry 3

F1-Help Alt-X-Exit

Move the cursor to the selection for the first pile segment, then press <Enter>.

File Analysis Mult Option

File Section 2 - Top Depth = 240.00 inches

Select Appropriate File Type

HP 14x117, Axis X-X
HP 14x117 Axis Y-Y
HP 14x102, Axis X-X
HP 14x102, Axis Y-Y
HP 14x89, Axis X-X
HP 14x89, Axis Y-Y
HP 14x73, Axis X-X ←
HP 14x73, Axis Y-Y
HP 12x74, Axis X-X
HP 12x74, Axis Y-Y

FX = A FY = 7 Page = 0 Library entry 7

F1-Help Alt-X-Exit

Move the cursor to the selection for the second segment, then press <Enter>.

File Analysis Mult Option

Editing File Section Properties

Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00	14.030	1050.0000	30.0000
2	240.00	13.640	734.0000	21.5000
3				
4				
5				
6				
7				
8				
9				
10				

To access pile property library leave pile diameter blank.

A 1:DEF:Num 0.00000

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
F1-Help Alt-X-Exit

The selection from the pile-library is shown on the above screen.

The format for pile-library data is quite straightforward. There are two lines of input reserved for each size of pile. The first line is used for the description of the pile section such as "HP 14 x 73, Y-Y Axis". The second line consists of five entry fields. The first entry is the I.D. for units. For English Units "1" is entered, and "2" is entered for S.I. units. The second entry on Line 2 is the diameter or width of the section perpendicular to the direction of loading. The third entry on Line 2 is the value of the moment of inertia. The fourth entry on Line 2 is the cross-sectional area. The last entry is the modulus of elasticity for the section. The free-field format is used for the entry. The user can use any text editor to add or delete the data in the pile-library file.

Guide to Data-Entry

When a selection is made from the Analysis or Mult Submenus, a data-entry-worksheet display appears on the screen. The data that have been entered are shown in a spreadsheet-type arrangement.

The data-entry worksheet screen, as shown in Fig. 3.2, contains three main sections:

1. The top line of the screen display is the Main Menu with 'Edit' highlighted.
2. The data-entry worksheet section consists of two boxes, a large box about 18 lines high followed by a small box about two lines high.
3. The bottom two lines of the display contain a guide to some of the 'key assignments' for commands to use with the data-entry worksheet.

File Analysis Mult Option EXAMPLE.IN6 ← Top Line

Editing Shear Strength Information

Layer #	Depth inches	c psi	φ deg.	E50 @ 50% of c
1	0.00	0.000	38.00	0.0000
2	360.00	0.000	38.00	0.0000
3				
4				
5				
6				
7				
8				
9				
10				

A 1:DEF:Num 0.00000

← Small box for data entry

← Key Assignment

: Move Cell — ? : Help — / : Edit Screen — F8 : Continue — |
F1-Help Alt-X-Exit

← Large box for data entry

Figure 3.2. Data-entry worksheet.

The data-entry worksheet, Section 2, is the most important part of the display, and the section where all of the data-entry operations will take place.

The upper, and largest, box of the worksheet section of the screen display contains the data that have been entered. These data are in a spreadsheet-type arrangement; that is, in columns, designated alphabetically from left to right, and in rows, designated numerically from top to bottom. A location, designated by a column letter and a row number, is called a cell and each item of data is stored in one of these cells. By using the cursor-movement commands, a highlight can be moved in any direction from the upper left cell to the lower right cell. The highlighted cell is called the 'working cell'. A cell must be highlighted - the working cell - for data to be entered or edited. The data in an existing file, shown on the worksheet, can be manipulated to some extent by using the Worksheet Edit commands that will be described later.

The lower box of the worksheet section of the display is where data are entered into the working cell, or the existing data is edited. This box has two lines. The upper line shows the following information for the working cell:

Location - column letter and row number,
Status - UND means the cell is not defined as a part of
the data and DEF means the cell has been
defined to contain data, and
Data - the data type [Num for numeric and Lab(label)
for alphanumeric] followed by the existing
data in the cell.

The bottom line of the lower box is the 'Entry Line' where data entry or data editing are done. A blinking cursor is shown on this line. Data are typed by moving the cursor to the right. Only the Backspace key, however, may be used for corrections to

the typed data; the Backspace key is used to move the cursor back (without canceling the typed symbols) to where a correction is to be made, and then the correct data are overtyped. The Enter (Return) key is used to accept edited data as the data in the working cell.

If the information in the working cell requires editing, two methods may be used. The simplest way is merely to reenter the data. The other way is to enter the Cell Edit Mode by pressing the F2 key. Editing in this mode will be explained later. The key assignments in the bottom two lines of the display, Section 3, change to show Cell Edit commands. These commands are used to make the desired modifications to the data in a cell. Pressing Enter (Return) will exit the Edit Mode and also replace the existing data in the working cell with the edited data.

Worksheet Commands

There are three sets of commands to be used with a data-entry worksheet. These are the Basic Worksheet Commands, the Cell Edit Commands, and the Worksheet Edit Commands. The Basic Worksheet Commands are in effect when a data-entry worksheet is entered. The other two sets of commands are invoked from the Basic Worksheet Commands. A key assignment in the form of '^ (key)' may be found in the command sets. To obtain this key assignment, the 'Cntl' and the second key are pressed at the same time. For example, ^A is obtained by pressing <Cntl> and <A> at the same time. The key assignments for the various sets of commands are given in the following paragraphs.

Basic Worksheet Commands

These commands are in effect when a display of a data-entry worksheet is on the screen, except when either of the other two

command sets has been invoked and is in use. The key assignments for some, but not all, of these commands are shown in the bottom two lines, Section 3, of the screen display. The key assignments for the commands in this set are as follows:

<u>Key Assignment</u>	<u>Action</u>
Left Arrow	Move highlight one cell to the left
Right Arrow	Move highlight one cell to the right
Up Arrow	Move highlight up one cell
Down Arrow	Move highlight down one cell
Page Up	Move up one page (if more than one page)
Page Down	Move down one page (if more than one page)
F2	Enter Cell-Edit Mode
Return (Enter)	Accept data entered or edited, exit Cell-Edit Mode
/	Enter Worksheet-Edit Mode
F8	Return to Edit Menu or move to next worksheet for current menu item
End	Return to Main Menu
? or F1	Enter Help Mode

The preceding commands are all self-explanatory except for "F2" - Enter Cell - Edit Mode and "/" - Enter Worksheet - Edit Mode, which will be described in detail in the next two sections.

The following screens illustrate the procedures for calling the help file during data entry. It should be noted that the help file is a simple text file to which the user can add his/her own comments or notes at desirable locations. The user can open the help file named C624EDID.HLP by using any available text editor. The help file, however, always needs to stay in the same file directory with C624EDIT.EXE.

File	Analysis	Mult	Option	EXAMPLE.IN6
Editing Shear Strength Information				
Layer #	Depth inches	c psi	ϕ deg.	E50 @ 50% of c
1	0.00	0.000	38.00	0.0000
2	360.00	0.000	38.00	0.0000
3				
4				
5				
6				
7				
8				
9				
10				
A 1:DEF:Num 0.00000				
_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____ F1-Help Alt-X-Exit				

The help topics will be shown on the screen once the "F1" or "?" keys have been pressed. You can move the cursor to the desired topics and press <Enter> to bring the help instruction on to the screen.

File Analysis Mult Option

Help Topics

Mult MENU	Edit - Computation Control
Mult - Shape and Axial Loads	Edit - Output Tables
Mult - Rebar & Concrete Strength	FILE MENU
Mult - Section Dimension	File - Read
Mult - Rebar Arrangement	File - New
EDIT MENU	File - Save
Edit - Title	File - Write
Edit - File Properties	File - Directory
Edit - Soil Properties	File - Change Directory
Edit - Soil - p-y Criteria	File - Exit to DOS
Edit - Soil - k for Clays	MAIN MENU
Edit - Soil - k for Sands	Main - Pull-down Menus
Edit - Soil - E50 ←	Main - Hot Keys
Edit - Soil - p-y Multipliers	OPTIONS MENU
Edit - Soil - Unit Weights	Options - Units
Edit - Lat. Load Trans.	Options - File Property Library
Edit - Data for Loading	Options - Save Config. File
	Options - Auto-backup

F1-Help Alt-X-Exit

Move the cursor to the "E50", then press <Enter>.

File Analysis Mult Option EXAMPLE.IN6

Soil Strain Parameter E50

Soft Clay,	c = 1.74 to 3.47 psi	E50 = 0.02
	250 to 500 psf	
	12 to 24 KPa	
Medium Clay,	c = 3.47 to 6.94 psi	E50 = 0.01
	500 to 1000 psf	
	24 to 48 KPa	
Stiff Clay,	c = 6.94 to 13.9 psi	E50 = 0.007
	1000 to 2000 psf	
	48 to 96 KPa	
Very Stiff Clay,	c = 13.9 to 27.8 psi	E50 = 0.005
	2000 to 4000 psf	
	96 to 192 KPa	

F1 : Help Index PageUp PageDown F8 : Return

F1-Help Alt-X-Exit

Press Command Key [F8] to return.

Cell-Edit Commands

The Cell-Edit Mode is used to make changes and additions to the data in the working cell, and is entered by typing the F2 key. When this key is pressed, a highlighted bar will appear on the line between the two worksheet boxes as shown in the following.

```
File      Analysis  Mult      Option      EXAMPLE.IN6

Enter title for this data file (up to 72 characters long)
EXAMPLE 6  ANALYSES RELATED TO DESIGN OF CONCRETE PILES

----- Edit Mode ----- Overwrite -----
A 1:DEF:Lab EXAMPLE 6  ANALYSES RELATED TO DESIGN OF CONCRETE PILES
EXAMPLE 6  ANALYSES RELATED TO DESIGN OF CONCRETE PILES
----- ^A ^F : Move Cursor ----- Insert/Delete/^G -----
F1-Help   Alt-X-Exit
```

The highlighted bar contains 'Edit Mode' and an indication that the data entry is in the 'Insert' or the 'Overwrite' condition. Two general types of commands are available, cursor-movement commands and data-change commands. The key assignments for the Cell-Edit Mode are displayed in the bottom two lines, Section 3, of the screen.

Key Assignment

Action

Left Arrow

Move cursor on the entry line to the left

Right Arrow	Move cursor on the entry line to the right
^A	Move cursor to beginning of the entry line
^F	Move cursor to end of the entry line
Insert	Toggles between 'Insert' and 'Overtyping' for data entry
Del	Deletes character to the left of the cursor
^G	Deletes character at the cursor
Return (Enter)	Accepts data on the entry line and exits Cell-Edit Mode

The following screens illustrate how to use the above commands for changing the data.

File	Analysis	Mult	Option	EXAMPLE.IN6
Enter title for this data file (up to 72 characters long)				
EXAMPLE 6 ANALYSES RELATED TO DESIGN OF CONCRETE PILES				
Edit Mode		Insert On		
A 1:DEF:Lab EXAMPLE 6 ANALYSES RELATED TO DESIGN OF CONCRETE PILES				
EXAMPLE 6 ANALYSES RELATED TO DESIGN OF REINFORCED CONCRETE PILES				
^A ^F : Move Cursor		Insert/Delete/^G		
F1-Help	Alt-X-Exit			

Press the "Ins" key to change to insert mode for the edited cell, then add the word "Reinforced" before the word "Concrete" as shown in the next screen.

Enter title for this data file (up to 72 characters long)
 EXAMPLE 6 ANALYSES RELATED TO DESIGN OF REINFORCED CONCRETE PILES

A 1:DEF:Lab EXAMPLE 6 ANALYSES RELATED TO DESIGN OF REINFORCED CONCRETE PILES

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

Worksheet-Edit Commands

The Worksheet-Edit Mode is used to manipulate entire lines of data in the worksheet. It is invoked by typing '/' from the Basic-Worksheet-Command list. When the '/' is typed, a highlighted bar appears on the line between the two worksheet boxes, and a list of possible operations appears in the highlighted bar as shown in the following.

Editing File Section Properties

Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00	30.000	47813.0000	707.0000
2	30.00	30.000	14906.0000	707.0000
3	160.00	30.000	47813.0000	707.0000
5				
6				
7				
8				
9				
10				

To access pile property library leave pile diameter blank.

Blank Copy Delete Exchange Insert Move

A 1:DEF:Num 0.00000
 /

_____ : Move Cell _____ ? : Help _____ / : Edit Screen _____ F8 : Continue _____
 F1-Help Alt-X-Exit

A '/' also appears on the entry line of the lower box. To complete the command, the first letter of the choice from the list of possible operations is typed on the entry line; in addition, some answers to prompts on the entry line may have to be typed. After the selected operation is complete, the program returns to the Basic-Worksheet-Command Mode. The following operations are available:

<u>Key</u> <u>Assignment</u>	<u>Action</u>
/B(lank)	Erase current row and set all cells on the row to UND (undefined) status
/C(opy)	Copies contents of first row specified to second row specified
/D(elete)	Deletes current row and moves up following rows
/E(xchange)	Exchanges contents between first row specified and second row specified
/I(nsert)	Inserts blank row where specified and moves following rows down
/M(ove)	Moves contents of first row specified to second row specified and adjusts contents of intermediate rows so no data are lost
ESC(ape)	Exits Worksheet-Edit Mode without performing any operation

The following screens are presented to illustrate the procedures for copying and deleting one row of data. For copying data, type "C" in the lower box of the edit screen, then tell the program to copy data from Row 2 to Row 4 as shown below.


```

                                Editing File Section Properties

Section  Top Depth  Diameter  Mom. of Inert.  Area
#        inches    inches    inches**4       inches2
1         0.00     30.000   47813.0000     707.0000
2         30.00     30.000   14906.0000     707.0000
3        160.00     30.000   47813.0000     707.0000
4
5
6
7
8
9
10

To access pile property library leave pile diameter blank.

_____ Blank Copy Delete Exchange Insert Move _____
A 1:DEF:Num 0.00000
Copy from row 2 to row 4 ←
_____ : Move Cell _____ ? : Help _____ / : Edit Screen_____ F8 : Continue _____
F1-Help            Alt-X-Exit
    
```

Press <Enter> after the command is given, you will see the data from Row 2 are also presented in Row 4.

```

                                Editing File Section Properties

Section  Top Depth  Diameter  Mom. of Inert.  Area
#        inches    inches    inches**4       inches2
1         0.00     30.000   47813.0000     707.0000
2         30.00     30.000   14906.0000     707.0000
3        160.00     30.000   47813.0000     707.0000
4         30.00     30.000   14906.0000     707.0000
5
6
7
8
9
10

To access pile property library leave pile diameter blank.

_____ : Move Cell _____ ? : Help _____ / : Edit Screen_____ F8 : Continue _____
F1-Help            Alt-X-Exit
    
```

If the user decides to erase Row 4, the user need to press the "/" key first, then type "D" in the lower box of the edit screen. The screen will ask the user to specify a row number as shown below.

File	Analysis	Mult	Option	EXAMPLE.IN6
Editing File Section Properties				
Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00	30.000	47813.0000	707.0000
2	30.00	30.000	14906.0000	707.0000
3	160.00	30.000	47813.0000	707.0000
4	30.00	30.000	14906.0000	707.0000
5				
6				
7				
8				
9				
10				
To access pile property library leave pile diameter blank.				
Blank Copy Delete Exchange Insert Move				
A 1:DEF:Num 0.00000				
Delete row: 4 ←				
: Move Cell — ? : Help — / : Edit Screen — F8 : Continue —				
F1-Help Alt-X-Exit				

Press the <Enter> key, the user will find data on Row 4 are removed as presented in the following screen.

File	Analysis	Mult	Option	EXAMPLE.IN6
Editing File Section Properties				
Section #	Top Depth inches	Diameter inches	Mom. of Inert. inches**4	Area inches ²
1	0.00	30.000	47813.0000	707.0000
2	30.00	30.000	14906.0000	707.0000
3	160.00	30.000	47813.0000	707.0000
4				
5				
6				
7				
8				
9				
10				
To access pile property library leave pile diameter blank.				
A 1:DEF:Num 0.00000				
: Move Cell — ? : Help — / : Edit Screen — F8 : Continue —				
F1-Help Alt-X-Exit				

GUIDE FOR RUNNING MAIN PROGRAM (COM624P)

After an input file has been created and saved on the same directory, press the <ALT> and <X> keys simultaneously to exit the Input screen and return to the original Main Menu as shown below. To execute the program, the user should move the cursor to "Run" as shown on the top of the screen and press <Enter>. A normal run will end in less than one minute if a math-coprocessor is installed. The text output and graphics data will be created and saved to the previously specified files, respectively. If an unexpected result is encountered, the program will stop running and an error message will be shown on the screen. Then, the user should check the input data carefully. If Module COM624P is used as a stand-alone program, make sure to erase the file named "COMFILE.DAT" if it exists in the same directory. This file is a temporary file to be used for the shell process.

File Input Run ← Graphics

This program is developed especially for Design and analysis of piles under lateral loading. The current version is 2.0

The selection of the FILE menu allows the user to access a pull-down menu for file operations such as assigning input file, output file, and graphics file, reading in an existing file, creating a new data file, checking files in the directory, and similar operations.

The selection of INPUT menu allows the user to access Program C624EDIT to create a data file or to edit an existing data file.

The selection of the RUN menu allows the user to execute the program with the specified input and output files.

The selection of the GRAPHICS menu allows the user to view the soil and pile response curves directly on the screen. The system must have graphics adapters such as CGA, EGA, VGA, or monographics adapter in order to view the graphics.

F1-Help

Alt-X-Exit

GUIDE FOR OPERATING GRAPHICS POSTPROCESSOR (C624VIEW)

After a successful run, the graphics data will be saved to the specified file. The user can move the cursor to "Graphics" shown on the top of the Main Menu and press <Enter> to open the graphics window.

File Input Run Graphics ←

This program is developed especially for Design and analysis of piles under lateral loading. The current version is 2.0

The selection of the FILE menu allows the user to access a pull-down menu for file operations such as assigning input file, output file, and graphics file, reading in an existing file, creating a new data file, checking files in the directory, and similar operations.

The selection of INPUT menu allows the user to access Program C624EDIT to create a data file or to edit an existing data file.

The selection of the RUN menu allows the user to execute the program with the specified input and output files.

The selection of the GRAPHICS menu allows the user to view the soil and pile response curves directly on the screen. The system must have graphics adapters such as CGA, EGA, VGA, or monographics adapter in order to view the graphics.

F1-Help Alt-X-Exit

The graphics window with pull-down menu is designed for C624VIEW. The configuration file, C624EDIT.CFG, must be on the same disk directory that contains C624VIEW.EXE. If there is no plot shown on the screen after the graphics data have been read in, the user may need to again run the installation program INSTVIEW.EXE, described in a previous section, to specify the correct screen driver for the program. The detailed procedures for using C624VIEW to obtain graphics will be presented in the following section.

The driver supports the IBM color-graphics adapter (CGA), IBM enhanced color-graphics adapter (EGA), Hercules graphics boards and video-graphics array (VGA). The graphics adapters and

printers supported by this graphics package are listed in Table 3.1. The distributor will not be responsible for modifying the software for use on any graphics adapter or printer not listed or not compatible to those listed in Table 3.1. The graphics program is easy to use and the procedures will be illustrated in this section.

TABLE 3.1. DRIVER INFORMATION FOR GRAPHICS ADAPTERS AND PRINTERS

GRAPHICS ADAPTERS
IBM Color-Graphics Adapter (CGA) IBM Enhanced-Graphics Adapter (EGA) IBM PC3270 Hercules Monochrome AT&T Indigenous Graphics Board IBM Video-Graphics Array (VGA)
PRINTERS
Epson MX, FX, LX-80, 100, Okidata, Panasonic, and Star Gemini Epson LQ IBM Proprinter Hewlett Packard Laser Jet and Desk Jet Hewlett Packard Pen Plotter

Graphics Menu

The Graphics Menu is displayed on the top line of the screen. This menu has four submenus: File, Select, View, and Options. Any of these selections may be chosen by highlighting the selection using the cursor keys or by typing the first letter of the selection ("V" for View, etc.)

When the Graphics Menu is active, a status report is displayed on the screen below the Main Menu. This report shows the number and size of any data sets stored currently in the microcomputer's memory and indicates what data sets are currently selected for viewing.

File View Plot Options

C624VIEW Version 2.0, Graphics Data:

Number of p-y curves:	NumPYcurve = 4
Number of load-response curves:	NumCurves = 2
Number of point on load-response curves:	Npts = 99

Units are Pounds & Inches
p-y Curves selected for viewing

Response Curves selected for viewing

277520 bytes available
Largest block contains 277520 bytes

The graphics data file is PLOTDATA

Alt-X Exit

File Menu

The File Menu is used to read files of graphics data, show the current subdirectory, change the logged subdirectory, or quit the program and return to the disk-operating system. The selections in the File Menu are:

Read - to enter the name of the file to be read. If the file does not exist or is empty, a diagnostic message is displayed,

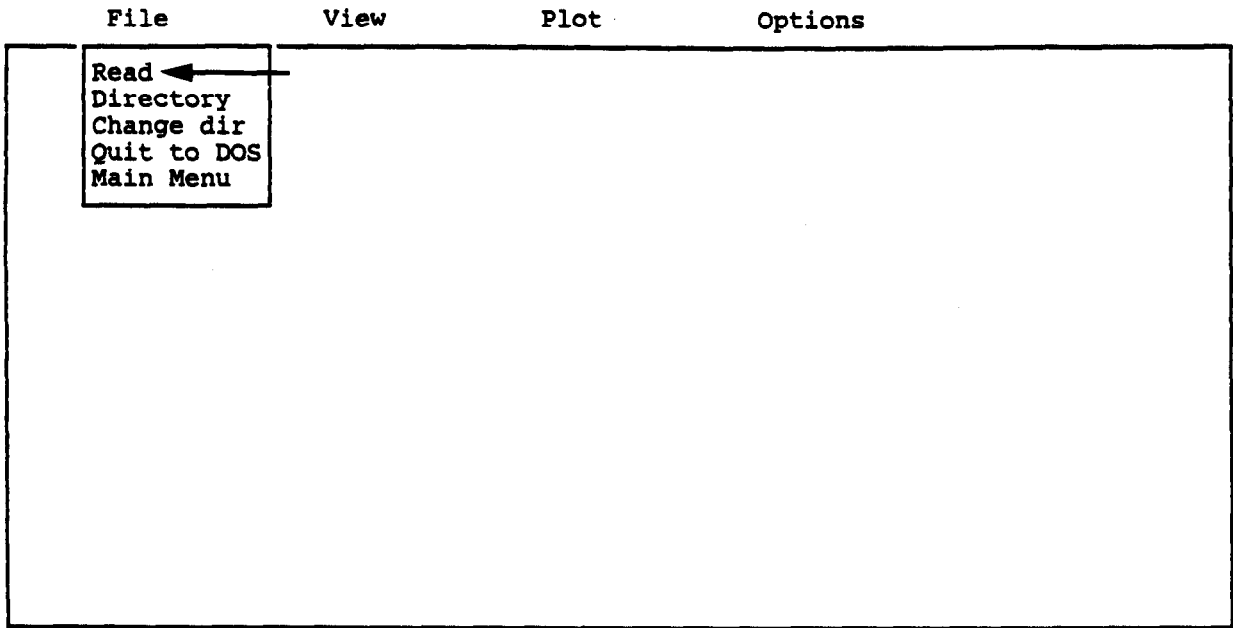
Directory - to display the directory of the current subdirectory,

Change Dir - to change the logged subdirectory,

Quit - to quit UPVIEW and return to DOS, and

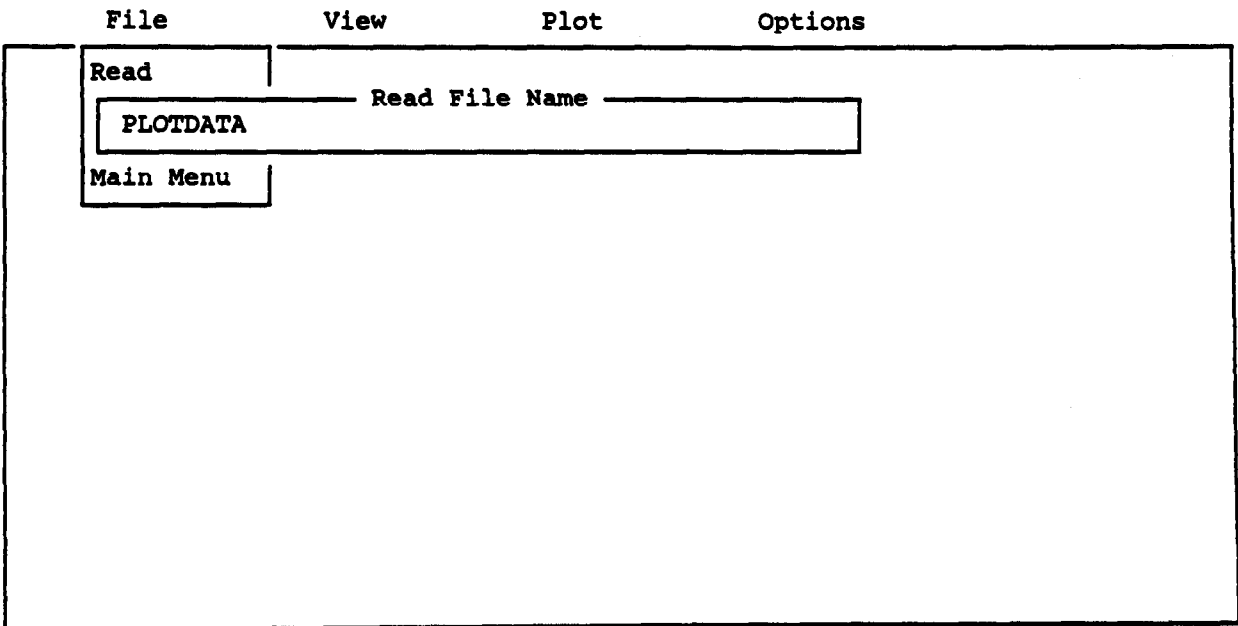
Main Menu - to return to the Main Menu.

If the user has already specified in the Main Menu the file name for the graphics data, the program will automatically read and display it on the screen. However, if the user would like to view the graphics under other file names, then the user can move the cursor to "Read" and type the new file name as shown below.



Alt-X Exit

Move the cursor to the "Read", then press <Enter>.



Alt-X Exit

View Menu

The View Menu is used to select the data sets to view under the View option. The selections on the View Menu are:

p-y Curves - to select individual p-y curves for viewing. To select a p-y curve, the user tabs down to the desired curve using the cursor keys, then presses the space bar. An asterisk will mark any p-y curve to be displayed. Pressing the space bar a second time will turn off the selection. Finally, F8 is pressed to return to the Select Menu.

Response Curves - to select individual curves for viewing that show the response of the pile. Pile-response curves are selected in the same manner as p-y curves,

Ultimate-Moment Curves - to select curves of moment versus curvature or curves of flexural rigidity (EI) versus moment for different axial-loading cases.

Interaction Diagram - to select the interaction diagram (ultimate moment vs. axial load). In order to view the diagram, the user must have selected at least three different axial loads for computation.

View Curves - to display the selected curves and to dump the graphics on the screen, and

Main Menu - to return to the Main Menu.

The user can type "V" or move the cursor to "View," then press the <Enter> key to pull down the View Menu.

The p-y curves are displayed first (if selected), followed by the pile-response curves for deflection, moment, shear, and soil reaction, and followed by the moment-curvature curve, the EI-moment curve, and the interaction diagram. The user clears the display by pressing the <Enter> key.

File	View	Plot	Options
	p-y Curves Response Curves Ultimate Moment Interaction Diagram View Curves Main Menu		

Alt-X Exit

A dump of the graphics from the screen is possible to any Epson dot-matrix, IBM or HP laser jet, or any compatible printing device. The dump is triggered by pressing the Control and "P" keys simultaneously. The user can specify the type of printer during installation or specify the printer in the Options submenu. If no printer is connected or is turned off, the program will lock until the printer is made available.

The following screens will illustrate the procedures to view each graphic. Be sure to follow the instructional commands which are printed directly below each screen for practice.

File

View

Plot

Options

p-y Curves ←
Response Curves
Ultimate Moment
Interactive Diagram
View Curves
Main Menu

Alt-X Exit

Press Command Key: [P].

File

View

Plot

Options

Selection of p-y Curves for Viewing

	Number	Depth
ON	1	20.00
ON	2	60.00
ON	3	100.00
ON	4	150.00

Toggle Viewing of Curves ON/off Using Space Bar ←

F8 : Continue

Alt-X Exit

Press Command Key: [F8].

File	View	Plot	Options
	<p>p-y Curves Response Curves ← Ultimate Moment Interactive Diagram View Curves Main Menu</p>		

Alt-X Exit
 Press Command Key: [R].

File	View	Plot	Options	
Selection of Response Curves for Viewing				
Number	Deflection	Moment	Shear	Soil Reaction
1	ON	ON	off	off
Toggle Viewing of Curves ON/off Using Space Bar ←				
F8 : Continue				

Alt-X Exit
 Press Command Key: [F8].

File	View	Plot	Options
	<p>p-y Curves Response Curves Ultimate Moment ← Interactive Diagram View Curves Main Menu</p>		

Alt-X Exit
 Press Command Key: [U].

File	View	Plot	Options
Selection of Moment, Curvature and EI Curves for Viewing			
Number	Moment vs Curvature	EI vs Moment	
1	ON	ON	
2	off	off	
3	off	off	
Toggle Viewing of Curves ON/off Using Space Bar			
F8 : Continue			

Alt-X Exit
 Press Command Key: [F8].

File

View

Plot

Options

p-y Curves
Response Curves
Ultimate Moment
Interactive Diagram
View Curves
Main Menu

Alt-X Exit

Press Command Key: [I].

File

View

Plot

Options

Selection of Curves Under Various Axial Loads for Viewing

	Number	Axial Load
ON	1	0.00
ON	2	100.00
ON	3	1000.00

Toggle Viewing of Curves ON/off Using Space Bar

F8 : Continue

Alt-X Exit

Press Command key: [F8].

File

View

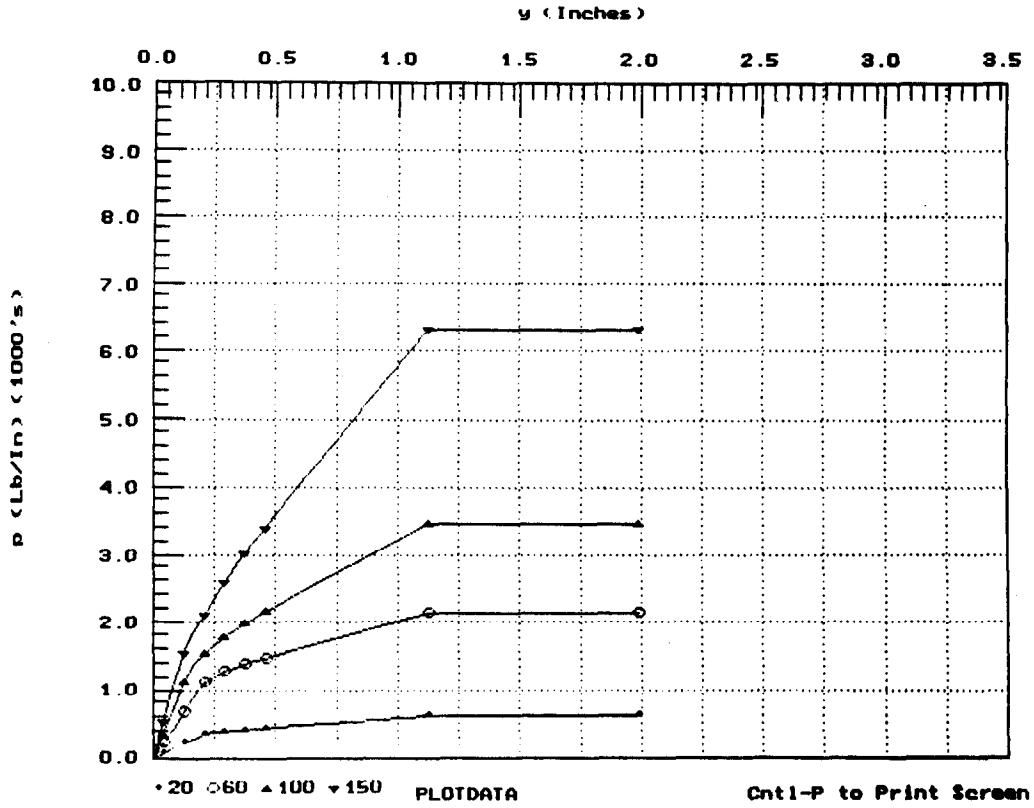
Plot

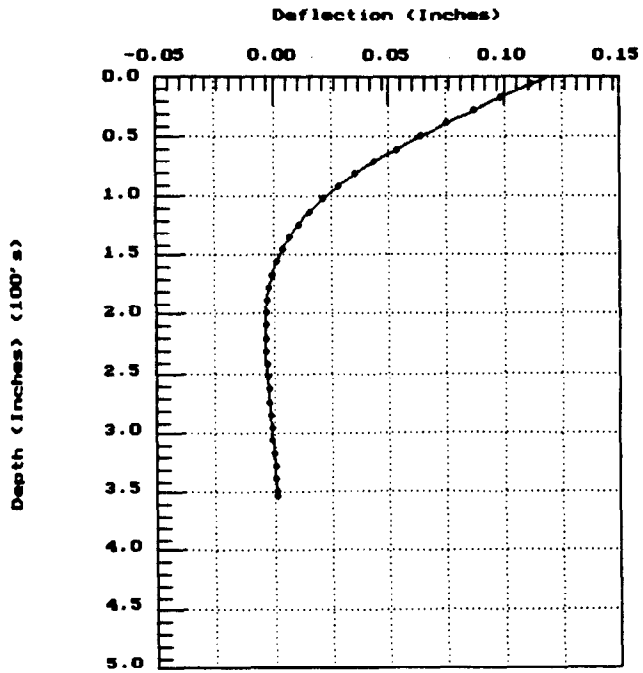
Options

p-y Curves
Response Curves
Ultimate Moment
Interactive Diagram
View Curves ←
Main Menu

Alt-X Exit

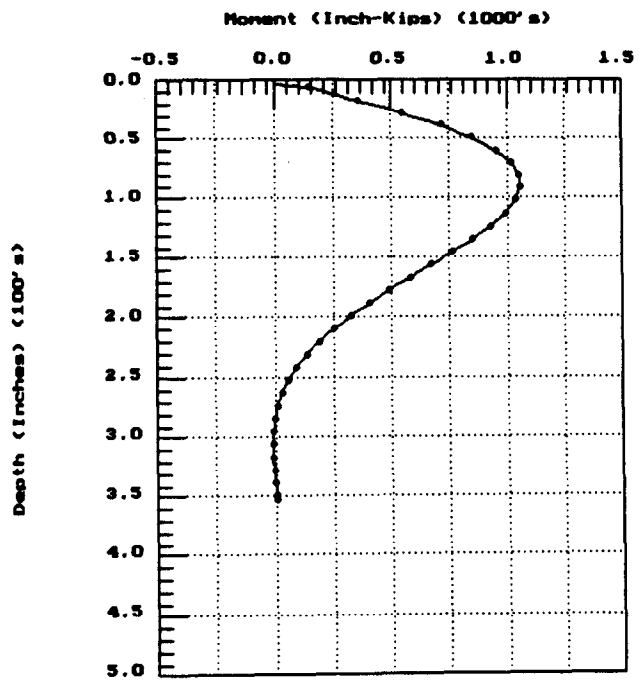
Press Command Key: [V].





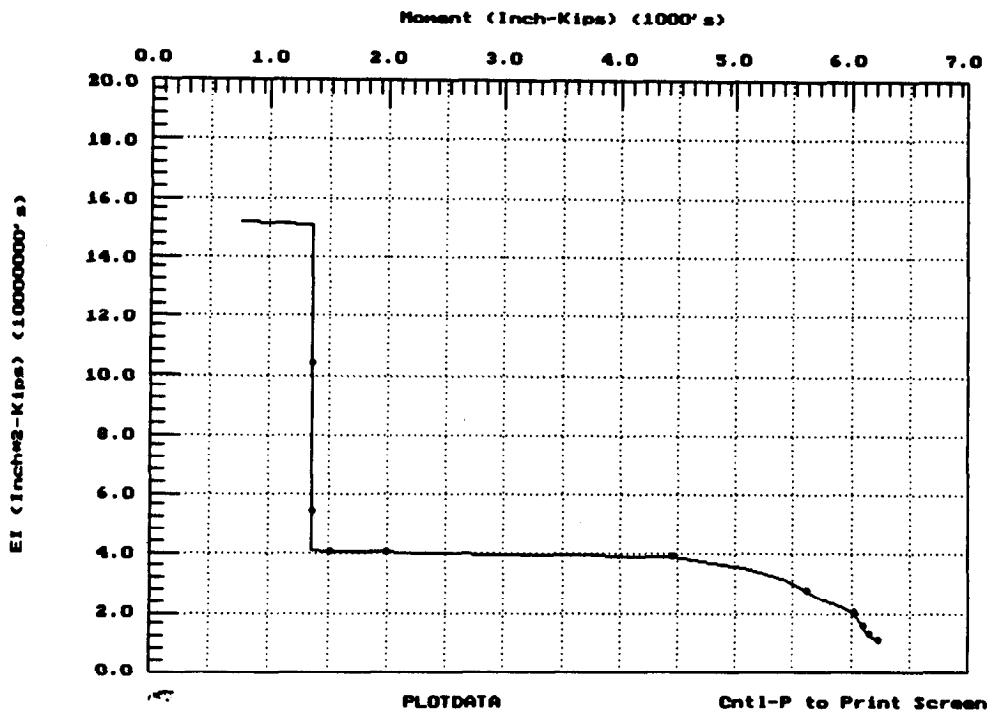
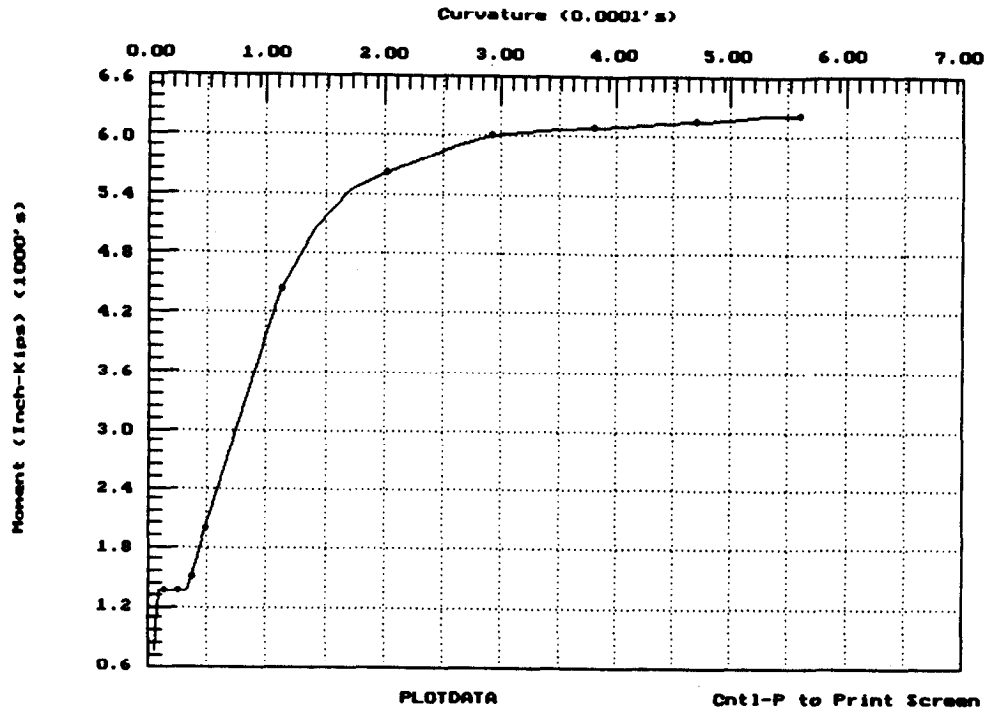
PLOTDATA

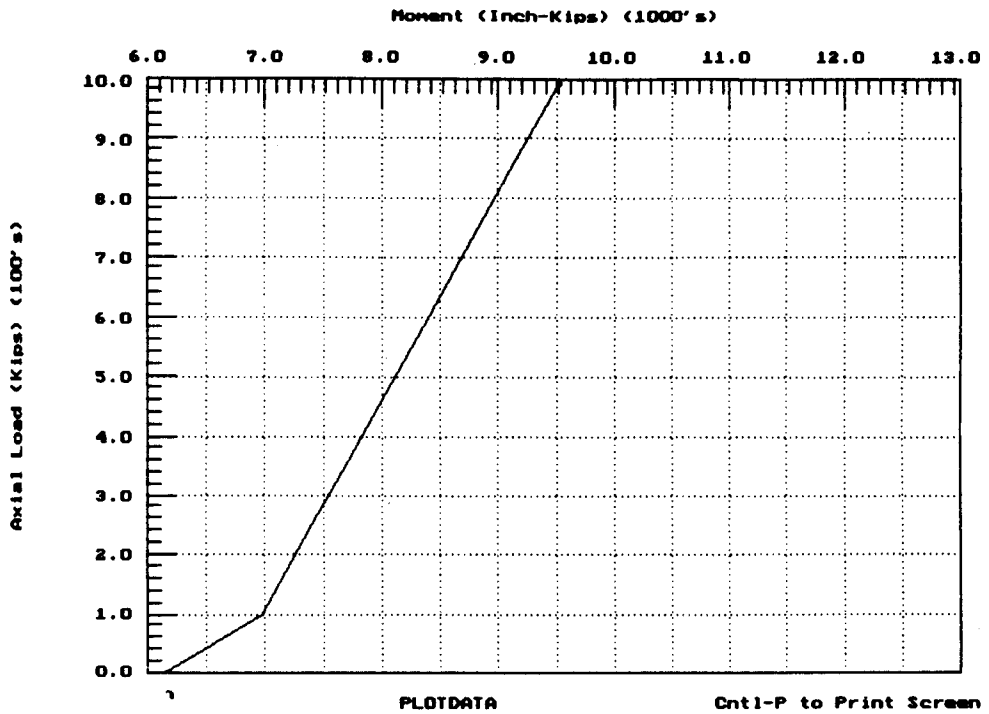
Cntl-P to Print Screen



PLOTDATA

Cntl-P to Print Screen





Plot Submenu

The Plot Submenu is used to select the sets of data and to prepare the files on graphics for HP-plotters or plotter emulators. The selections in the Plot Menu are:

p-y Curves - to select individual p-y curves for viewing. To select a p-y curve, the user tabs down to the desired curve using the cursor keys, then presses the space bar. An asterisk will mark any p-y curve to be displayed. If the space bar is pressed a second time, the selection will be eliminated. Returning to the Select Menu is accomplished by pressing F8.

Response Curves - to select individual curves for viewing on the response of the pile. The curves are selected in the same manner as the p-y curves,

Ultimate-Moment Curves - to select curves of moment vs curvature or flexural rigidity (EI) vs moment for different axial-loading cases.

Interaction Diagram - to select the interaction diagram (ultimate moment vs axial load). To view the interaction diagram, at least three different axial loads must have been used in the computations.

Generate Plots - to prepare the HD-LG-plot files and to select the pen speed, and

Main Menu - to return to the Main Menu.

The pull-down menu shown below can be opened by pressing "P" or moving the highlighted cursor to "Plot" followed by the <Enter> key. The following screen will be presented to illustrate the procedures to create a HP-GL-PLOT file to send to the pen plotter.

File View Plot Options

p-y Curves
Response Curves ←
Ultimate Moment
Interaction Diagram
Generate Plots
Main Menu

Alt-X Exit

Press Command Key: [R].

File View Plot Options

Selection of Response Curves for Plotting

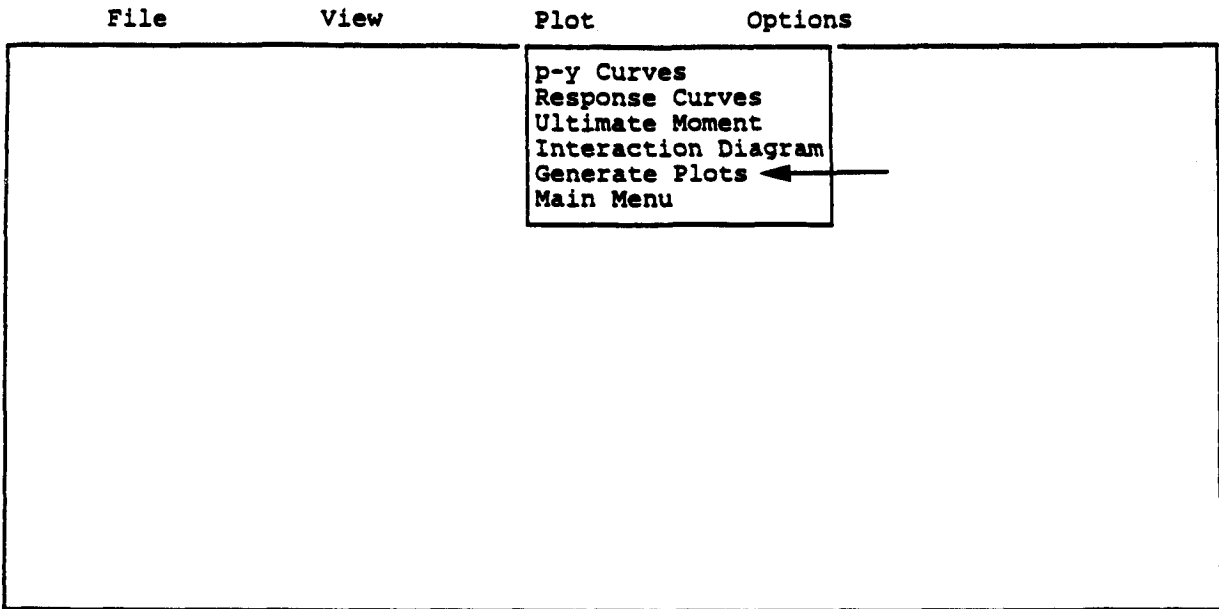
Number	Deflection	Moment	Shear	Soil Reaction
1	ON	ON	off	off

Toggle Plotting of Curves ON/off Using Space Bar ←

F8 : Continue

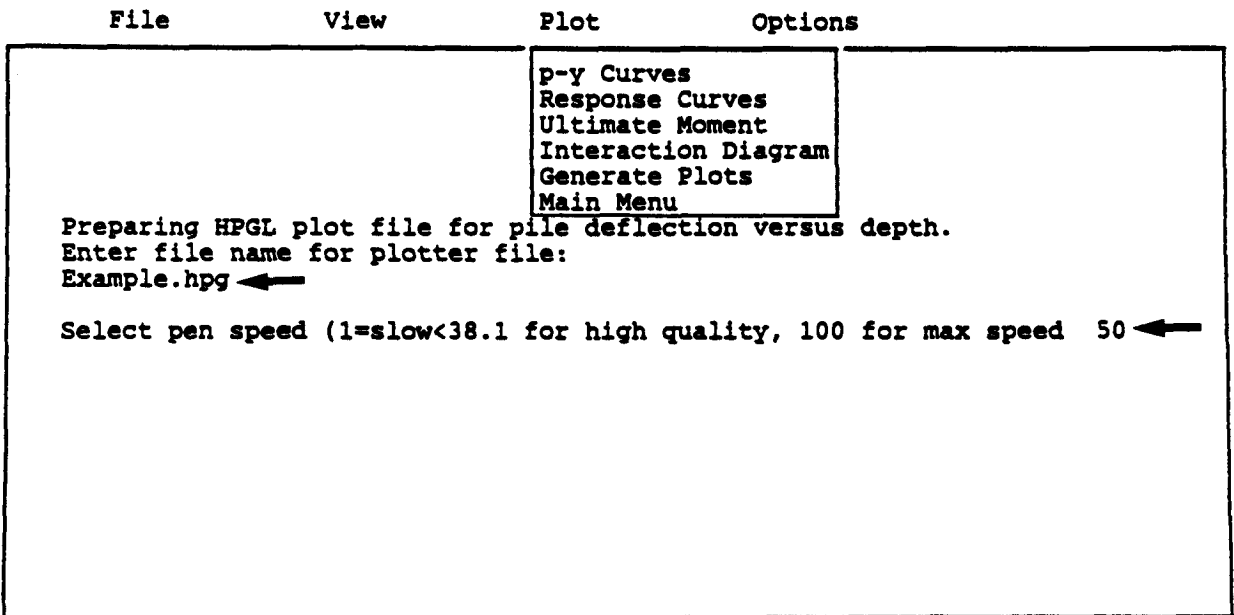
Alt-X Exit

Press Command Key: [F8].



Alt-X Exit

Press Command Key: [G].



Alt-X Exit

Press Command Key: [Enter].

File View Plot Options

C624VIEW Version 2.0, Graphics Data:

Number of p-y curves: NumPYcurve = 0

Number of load-response curves: NumCurves = 0

Number of point on load-response curves: Npts = 0

Units are Pounds & Inches

p-y Curves selected for viewing

Response Curves selected for viewing

212416 bytes available

Largest block contains 212416 bytes

The graphics data file is D:PLOTDATA

Alt-X Exit

Press Command Key: [ALT] [X].

After the HP-GL-plot files have been created, the user can exit (Alt-x) to DOS and use the following DOS commands to get hard copies from the HP-plotter.

```
C:> MODE COM1:9600,N,7,1,P <CR>
      (For DOS 4.01 or higher, using the following
      MODE COM1:9600,N,7,1,B <CR>)
```

```
C:> Print (HP-GL File-Name) <CR>
```

Some parameters used in the Mode command may vary with the set-up of the hardware. The user should refer to the DOS Manual for proper changes.

Options

The Options selection of the Main Menu is used for several options relating to the display of data on the screen. The user can move the cursor to "Options" followed by the <Enter> key to open the first window as shown below.

File	View	Plot	Options ←
------	------	------	-----------

Optional Plotting Control Values - Screen 1 of 2

Symbol plotting increment.....	3
Upper y-value for p-y curves (in).....	2.000
Limiting depth for response curve plots (in).	600.000
Plotter X-coordinate for origin (in).....	1.750
Plotter Y-coordinate for origin (in).....	1.500
Plotter X-axis length (in).....	8.000
Plotter Y-axis length (in).....	5.000

Symbol plotting increment is 0 for no symbols, 1 for every symbol, 2 for every 2nd point, 3 for every 3rd point, and so on.

A 3:DEF:Num 6.0000000000E+02

: Move Cell — ? : Help — F2 : Edit Cell — F8 : Continue —

Alt-X Exit

The first optional value is the increment used to mark individual data sets with unique symbols. Any value of increment may be used, including zero for no symbols at all. A legend defining the symbols used by UPVIEW is displayed on each graph.

The second optional value is the value of depth below which no response of the pile is displayed. The program will normally allow the user to view the curves showing the response of the pile over the full length of the pile. By setting the length to something less than the full length of the pile, the user may zoom in on the area where the response is most often critical.

The third optional value is the y-value above which no p-y data are displayed. This allows the user to zoom in on the p-y values near the origin to examine the initial stiffness of the p-y curves. The other options are for the format used by the pen plotter. The most important option shown on the second window is the selection of a printing device. The printer may already be specified in the configuration file; however, the user may make a change here. The code for printers must be set before the command for "screen dump" can be sent.

File View Plot Options

File	View	Plot	Options
Optional Plotting Control Values - Screen 2 of 2			
Axis Title Character Size (in)			0.15000
Plotting Symbol Size (in)			0.15000
Plotter Pen Number for Axis Titles			1
Plotter Pen Number for Axis and Borders			1
Plotter Pen Number for Data Line & Symbols ..			1
Type of Printer Used for Screen Dump			2
Codes for printers: 1 = Epson MX, FX			
2 = Epson LQ			
3 = Toshiba 24-pin			
4 = HP LaserJet and DeskJet			
5 = HP InkJet			
6 = IBM Proprinter			
7 = IBM Proprinter24.			
All printer output is sent to LPT1.			
To redirect LPT1 to COM1 use the DOS MODE command.			
A 1:DEF:Num 1.5000000000E-01			

_____ : Move Cell — ? : Help — F2 : Edit Cell — F8 : Continue — |

Alt-X Exit

CHAPTER 4. INPUT INFORMATION AND DATA STRUCTURE

INTRODUCTION

A user-friendly, menu-input, preprocessor C624EDIT was developed to create and edit input data for the computer program COM624P. C624EDIT is a full-screen editor and has an option to save and retrieve data files.

The user can also prepare an input file by following the line-by-line input guide with any available text editor. The structure of input data is presented in this chapter. It should be noted that all the data entry is free-field format with a maximum of 80 characters per line. Therefore, numerical data may be entered in fixed, floating-point, or exponential format as desired. A blank space is needed to separate two variables in the same line. The sequence of the line-by-line input format is presented in Appendix A.

GENERAL REMARKS

Data input is based on a coordinate system in which the pile head (top of pile) is the origin and the positive x-direction is downward (Fig. 4.1). The ground surface need not be at the elevation of the pile head. Sign conventions are shown in Fig. 4.2.

Any convenient and consistent units of force and length can be used. The program is set up to label the output in one of three ways.

1. The user can designate that English units of inches and pounds will be used, and output will be labeled accordingly.

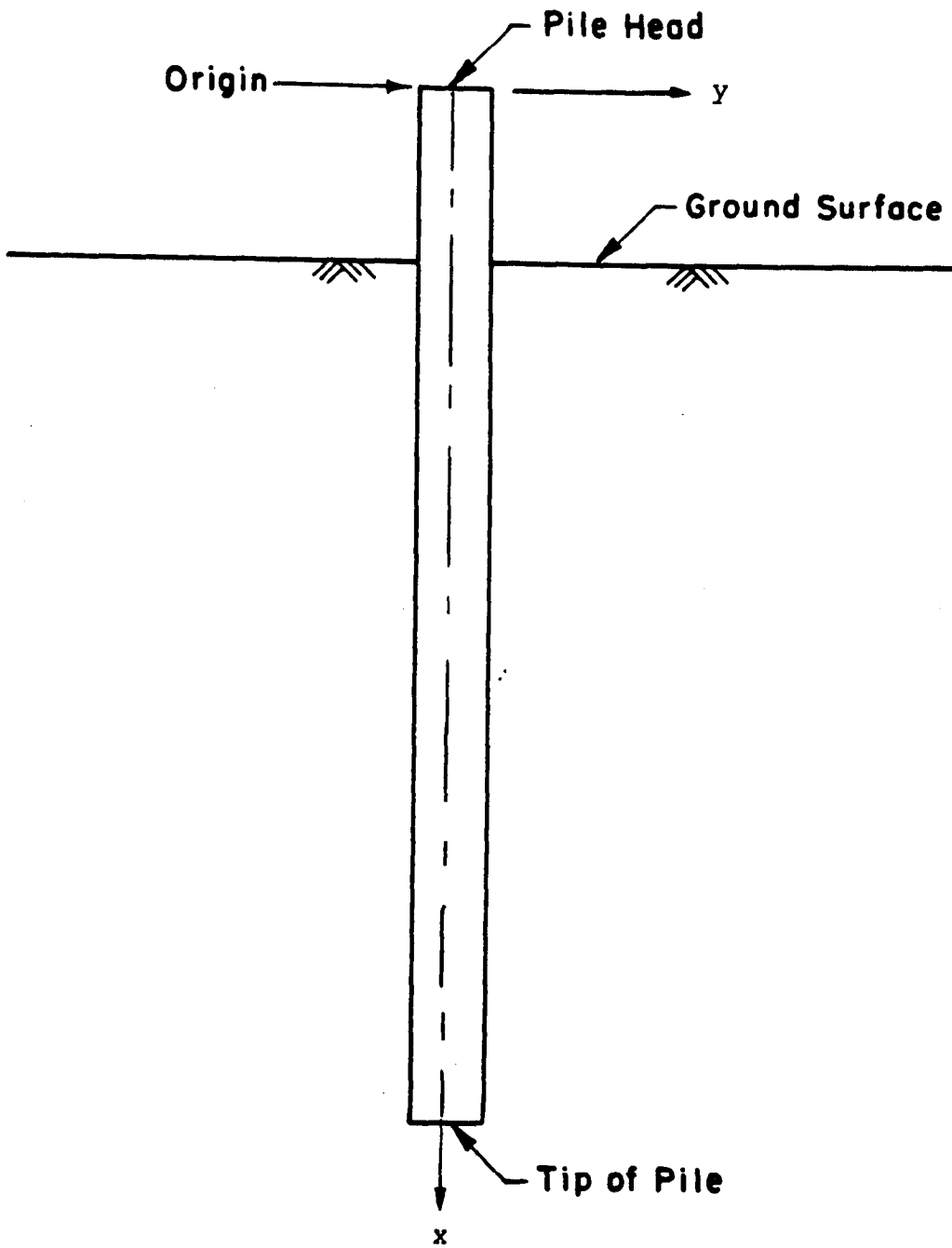


Figure 4.1. Coordinate system.

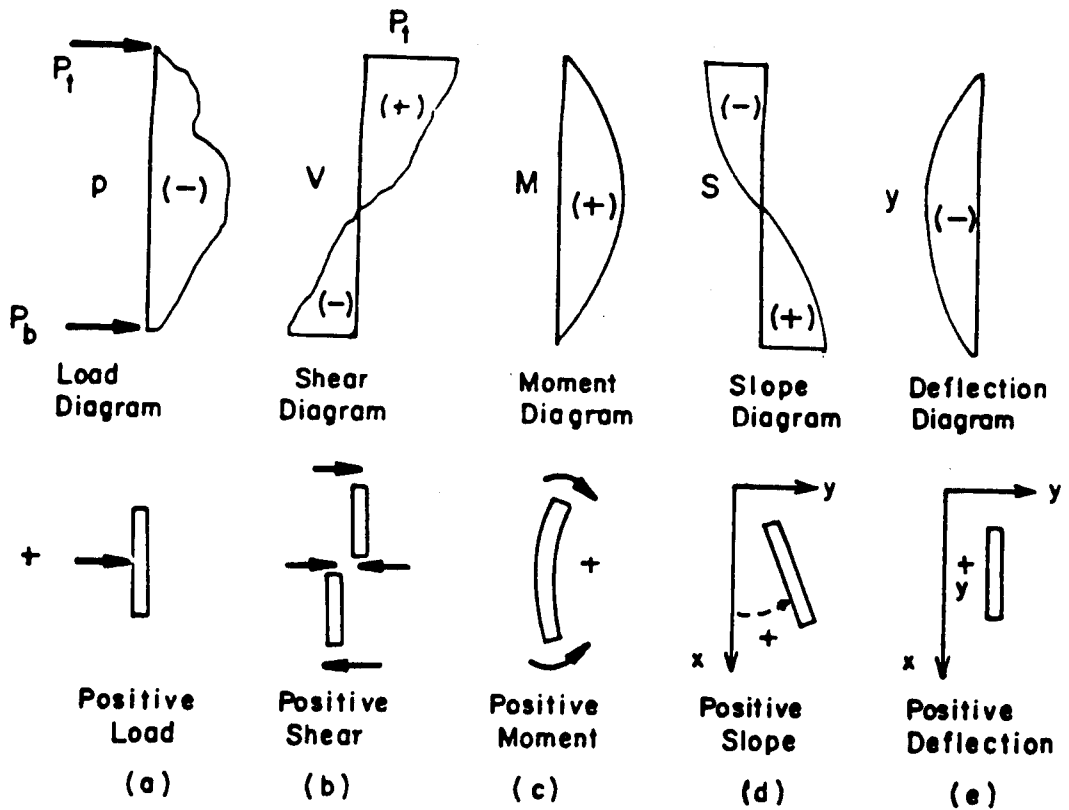


Figure 4.2. Sign conventions.

2. The user can specify that SI units of kilonewtons and meters will be used, and output will be labeled accordingly.

3. The user can use any other consistent units (the computer does not need to know which ones) of force and length, and output will be labeled in terms of forces and lengths (F and L).

Several default values may be used in data input. Where the user desires to use a default value, the input should be left blank for the relevant variable.

(In this section, the symbol "O" denotes a capital letter O; the symbol "Ø" denotes the number zero.)

The following steps are recommended for preparation of input of data.

1. Decide which units will be used for force and length.

2. Decide into how many increments the pile is to be divided. Up to 300 increments are allowed. Be sure to satisfy yourself that an adequate number of increments have been used to obtain a satisfactory solution. Some trials will be helpful as discussed in Part II on verification of results.

3. Decide whether p-y curves will be input or whether they will be generated internally. If they are to be input, pick the depth for each curve, pick the number of points to be input for each depth, and tabulate the data. Up to 30 p-y curves are allowed.

4. If p-y curves are to be generated internally, divide the soil profile into from one to nine layers; decide which of the following p-y criteria will be used for each layer:

- Matlock's (1970) criteria for soft clay;
- Reese et al.'s (1975) criteria for stiff clay below the water table;
- Welch and Reese's (1972) criteria for stiff clay above the water table;
- Reese et al.'s (1974) criteria for sand; and/or
- Reese and Nyman's (1978) criteria for limestone.

Estimate undrained shear strength c and strain at 50 percent stress level ϵ_{50} for clay layers; estimate the angle of internal friction ϕ for sand; and estimate the slope k of a plot of maximum soil modulus E_s versus depth x for all strata. Be sure to read the background on any criteria that are used so that their basis and limitations are thoroughly understood.

5. Select the length of the pile, the modulus of elasticity of the pile material, and the x-coordinate of the ground surface (x is equal to zero at the top of the pile).

6. Divide the pile into from one to 10 segments with uniform cross-section. For each segment, tabulate the x-coordinate of the top of the segment, the diameter of the segment, the moment of inertia, and the pile cross-section area.

7. If there are any distributed lateral loads on the pile, tabulate up to 10 points on a plot of distributed load versus depth below top of pile.

8. Tabulate up to 10 points on a plot of effective unit weight of soil versus depth. This step is not necessary if no p-y curves are generated internally.

9. Tabulate up to 10 points on plots of c , ϕ , and ϵ_{50} versus x . Skip this step if no p-y curves will be generated internally.

10. If p-y curves are generated internally in the program, tabulate any depths for which p-y curves are to be printed. Ordinarily, a few curves are printed for the purpose of verification.

11. Determine the loads to be applied to the top of the pile:

- A. lateral load at pile head or lateral deflection at pile head;
- B. second boundary condition at pile head, which can be either,
 - i. moment (M_t),
 - ii. slope (S_t),
 - iii. rotational restraint (M_t/S_t); and
- C. axial load (assumed to be uniform over full length of pile).

Up to 20 loading combinations can be input for each problem, e.g., to generate a load-deflection curve.

SELECTION OF BOUNDARY CONDITIONS AT PILE HEAD

Four types of boundary conditions for the pile-head connection are implemented in Program COM624P. These are designated as Cases 1 through 4. The detailed information for modeling these boundary conditions is described in Chapter 2 of Part II of this manual.

Case 1. Pile Head is Free to Rotate (KBC=1)

The lateral load (P_t), the bending moment (M_t), and the axial load (P_x) at the top of the pile are known. No rotational restraint will be provided by the superstructure, and the rotation at the top of the pile will depend only on the flexural rigidity of the pile itself. If the above conditions are met, the user can select this boundary condition for analysis. A typical example is a pile that is used to support an overhead sign.

Case 2. Pile Head is Fixed Against Rotation (KBC=2)

Frequently, the pile head is embedded into a monolithic reinforced-concrete cap. Conceptually, if the flexural rigidity of the pile cap is much stronger than that of a connected pile, the rotation angle between the pile head and the monolithic cap is unchanged with or without lateral bending. For such a case, the pile-head connection is defined as completely fixed and the rotation of the pile head within the monolithic concrete cap is assumed to be zero, in which case the slope (S_t) is set to zero. However, if a small rotation at the pile-head connection is allowed, the user can specify the slope (in radians) for the computation. To apply the boundary condition in Case 2, the lateral load (P_t), the slope or rotation (S_t) at the pile head, and the axial load (P_x) should be given.

Case 3. Pile Head is Restrained Against Rotation (KBC=3)

The connection between the pile and the superstructure, such as a steel frame, may not be always a perfectly rigid joint. If the magnitude of the restraint between the pile and superstructure can be estimated, and can be further expressed with a function of M_t/S_t (M_t and S_t are the bending moment and the slope angle at the pile head, respectively), the elastically-restrained boundary condition can be selected for use in Program COM624P. The elastic restraint M_t/S_t is largely affected by the stiffness of superstructures. The superstructures are different in many ways; therefore, the elastic restraint at each joint needs to be studied by using a sound structural theory. If there is a nonlinear relationship between M_t and S_t , iteration may be required to achieve compatibility. To apply this boundary condition, the lateral load (P_t), the elastic restraint (M_t/S_t), and the axial load (P_x), at the top of the pile must be known.

Case 4. Pile Head Deflection is Restrained Against Lateral Movement (KBC=4)

If the pile-head deflection (y_t), the bending moment (M_t), and the axial load (P_x) at the top of the pile are given, then the user can use the boundary conditions in Case 4 for computation. The deflection of the pile head can be restrained in either direction. The reaction force at the pile head (restrained point) will be one of the outputs of the program. This boundary condition can be applied to piles which support a bridge abutment that has zero or a very small allowable movement.

ITERATIONS OF COMPUTATIONS USING CRACKED/UNCRACKED EI GENERATED INTERNALLY BY SUBROUTINE PMEIX

A new feature of the second version of Program COM624P is that the program will use a more rigorous approach to control the

use of cracked and uncracked EI values during computation. The subroutine PMEIX will compute the ultimate bending moment for the selected section. For reinforced concrete sections, it will compute the EI values for uncracked sections and for cracked sections. The user can manually input different EI values for several sections after examining the computer curve for bending moment and finding the length over which the moment distribution to the cracked-section conditions will exist. Two or three iterations may be required to achieve satisfactory results. Program COM624P provides an option for the user to request the computer to select values of EI internally for cracked or uncracked sections for use in the iterations.

Figure 4.3 shows the variation of bending moment and associated cracked/uncracked EI values. As it may be seen, only the upper portion of the pile will be subjected to a large moment. Because the upper portion of the pile needs greater stiffness, the reinforcing steel can be enhanced only for that portion in order to reduce the pile deflection.

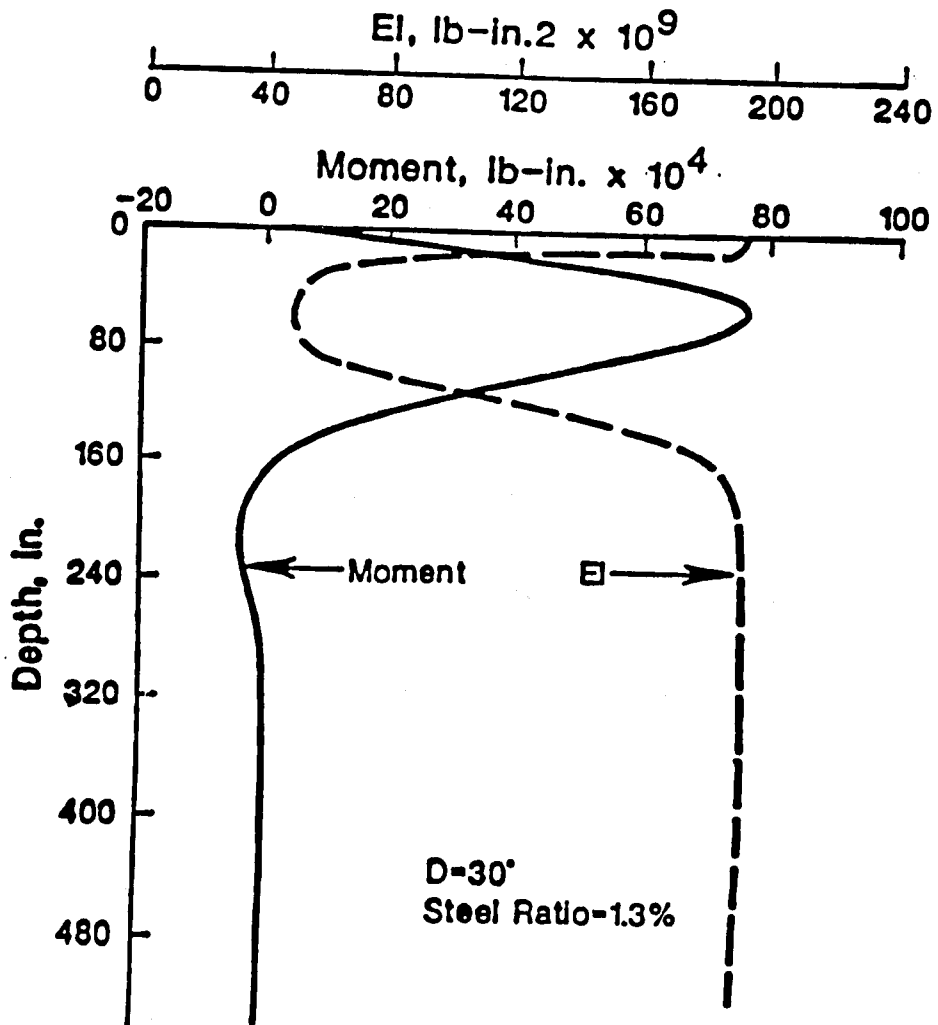


Figure 4.3. Bending moment and flexural rigidity versus depth for a laterally-loaded pile.

CHAPTER 5. EXAMPLE STUDIES

INTRODUCTION

This chapter presents six examples that were studied by use of COM624P. The first example is for a 14HP89 steel pile embedded in a single-layer deposit. The second example is for a reinforced-concrete pile embedded in a multi-layer deposit. The third example is for a pile embedded in a sloping abutment. The fourth example is to illustrate the use of p-y curves entered by the user. Examples 5 and 6 are included to illustrate the cases in which the ultimate bending moment and design of reinforcement are required.

The examples that follow are intended to demonstrate the capability of the computer program and are not intended to be a complete presentation of the design process. The publication (FHWA-IP-84-11) entitled "Handbook on Design of Piles and Drilled Shafts under Lateral Load" is highly recommended for engineers seeking guidelines for design. There are a number of factors that must be considered in design before and after the computer execution.

A general procedure on proper use of the program was developed by Christopher Dumas of FHWA during the design review and analysis of a case study for pile-supported abutment. The guidelines and procedures are presented in Appendix B.

The program gives output as follows:

- Echo-print of input data,
- Generated p-y curves,

Listing of pile deflection, bending moment, shear, soil resistance, and flexural rigidity along the length of the pile,

Summary results of pile-head deflection, maximum bending moment, and maximum shear force for various loading conditions, and

Listing of bending moment, EI, neutral axis, and concrete strain at each curvature.

From the variety of output that can be generated, the user should be able to get all the needed information on the response of a pile.

EXAMPLE 1, PILES IN A SINGLE LAYER OF SOIL

A 14HP89 H-pile is used for the foundation of a bridge abutment. The width of the steel section is 14.7 in and the length of the pile is 25 feet. The soil deposit is a uniform stiff clay above the water table. The undrained cohesive strength is 14 lb/sq in, the total unit weight is 0.069 lb/cu in, and the ϵ_{50} is 0.007. The value of soil modulus (k) is assumed for 400/lb/cu inch. The user can estimate the value of k based on Table 3.2 in Part II of this manual if k-values were not measured for soils. The axial load is 39 kips and lateral loads at the pile head are 40 kips and 20 kips respectively. The pile head is assumed to be free to rotate.

This example was used by the Design Handbook (FHWA-IP-84-11) in Section 3.5, Page 75. In regard to the aspects of design, thorough discussions have been given in the handbook. The users are encouraged to read that section. The strong axis of the pile ($I_x - 904 \text{ in}^4$) will be used to resist the lateral load. Therefore, the width (14.7 in) of the flange was used as the equivalent diameter for the input required by Program COM624P.

The input file created by C624EDIT is presented on the next page followed by a listing of the output data. The computed maximum bending moment on the pile is less than the yield moment ($5.84 \times 10^3 \text{ in-kip}$) of the section. In this example the user can increase the lateral load until the ultimate bending moment is reached. The service load can be selected by dividing the maximum lateral load, which creates the ultimate bending moment, with a load factor. The load factor can be 2 to 2.5 depending on the importance of the structure. The deflection under the service load also needs to be satisfied by the design specifications. The graphics display of p-y curves, pile-deflection curves, and bending moment curves are also presented for verification.

EXAMPLE 1 PILES IN A SINGLE LAYER OF SOIL

UNITS--ENGL

PILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE

I N P U T I N F O R M A T I O N

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH	=	300.00	IN
MODULUS OF ELASTICITY OF PILE	=	.290E+05	KIP/IN**2
1 SECTION(S)			
X	DIAMETER	MOMENT OF	AREA
IN	IN	INERTIA	IN**2
.00		IN**4	
300.00	14.700	.904E+03	.261E+02

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = .00 IN
SLOPE ANGLE AT THE GROUND SURFACE = .00 DEG.

1 LAYER(S) OF SOIL

LAYER 1
THE LAYER IS A STIFF CLAY ABOVE THE WATER TABLE
X AT THE TOP OF THE LAYER = .00 IN
X AT THE BOTTOM OF THE LAYER = 360.00 IN
VARIATION OF SOIL MODULUS, k = .400E+03 LBS/IN**3

DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
2 POINTS

X, IN	WEIGHT, LBS/IN**3
.00	.69E-01
360.00	.69E-01

DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
2 POINTS

X, IN	C, LBS/IN**2	PHI, DEGREES	E50
.00	.140E+02	.000	.700E-02
360.00	.140E+02	.000	.700E-02

FINITE DIFFERENCE PARAMETERS

NUMBER OF PILE INCREMENTS	=	120
TOLERANCE ON DETERMINATION OF DEFLECTIONS	=	.100E-04 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS	=	100
MAXIMUM ALLOWABLE DEFLECTION	=	.15E+03 IN

INPUT CODES

OUTPT	=	1
KCYCL	=	1
KBC	=	1
KPYOP	=	1
INC	=	2

EXAMPLE 1 PILES IN A SINGLE LAYER OF SOIL

UNITS--ENGL

OUTPUT INFORMATION

GENERATED P-Y CURVES

THE NUMBER OF CURVE IS	=	4
THE NUMBER OF POINTS ON EACH CURVE	=	17

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	CAVG LBS/IN**2	GAMMA LBS/IN**3	E50
20.00	14.700	.1E+02	.1E+02	.7E-01	.700E-02
		Y		P	
		IN		LBS/IN	
		.000		.000	
		.274		395.168	
		.549		469.936	
		.823		520.070	
		1.098		558.852	
		1.372		590.914	
		1.646		618.471	
		1.921		642.771	
		2.195		664.590	
		2.470		684.451	
		2.744		702.719	
		3.018		719.664	
		3.293		735.490	
		3.567		750.356	
		3.842		764.387	
		4.116		777.686	
		5.145		777.686	

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	CAVG LBS/IN**2	GAMMA LBS/IN**3	E50
60.00	14.700	.1E+02	.1E+02	.7E-01	.700E-02
		Y		P	
		IN		LBS/IN	
		.000		.000	
		.274		558.061	
		.549		663.650	
		.823		734.449	
		1.098		789.217	
		1.372		834.496	
		1.646		873.412	
		1.921		907.729	
		2.195		938.543	
		2.470		966.590	
		2.744		992.388	
		3.018		1016.318	
		3.293		1038.668	
		3.567		1059.662	
		3.842		1079.477	
		4.116		1098.258	
		5.145		1098.258	

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	CAVG LBS/IN**2	GAMMA LBS/IN**3	E50
100.00	14.700	.1E+02	.1E+02	.7E-01	.700E-02

Y IN	P LBS/IN
.000	.000
.274	720.954
.549	857.364
.823	948.829
1.098	1019.583
1.372	1078.078
1.646	1128.354
1.921	1172.687
2.195	1212.495
2.470	1248.729
2.744	1282.058
3.018	1312.973
3.293	1341.847
3.567	1368.968
3.842	1394.568
4.116	1418.830
5.145	1418.830

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	CAVG LBS/IN**2	GAMMA LBS/IN**3	E50
150.00	14.700	.1E+02	.1E+02	.7E-01	.700E-02

Y IN	P LBS/IN
.000	.000
.274	924.570
.549	1099.506
.823	1216.803
1.098	1307.540
1.372	1382.555
1.646	1447.031
1.921	1503.885
2.195	1554.936
2.470	1601.403
2.744	1644.145
3.018	1683.791
3.293	1720.819
3.567	1755.601
3.842	1788.430
4.116	1819.545
5.145	1819.545

----- *** -----

PILE LOADING CONDITION

LATERAL LOAD AT PILE HEAD = .200E+02 KIP
 APPLIED MOMENT AT PILE HEAD = .000E+00 IN-KIP
 AXIAL LOAD AT PILE HEAD = .390E+02 KIP

X	DEFLECTION		MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
	IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
0.00	.145E+00	.000E+00	.149E+04	.201E+02	.267E+03	.262E+08	
5.00	.134E+00	.971E+02	.228E+04	.186E+02	.279E+03	.262E+08	
10.00	.123E+00	.187E+03	.302E+04	.172E+02	.290E+03	.262E+08	
15.00	.112E+00	.270E+03	.369E+04	.157E+02	.299E+03	.262E+08	
20.00	.101E+00	.345E+03	.430E+04	.142E+02	.308E+03	.262E+08	
25.00	.910E-01	.413E+03	.485E+04	.127E+02	.315E+03	.262E+08	
30.00	.812E-01	.473E+03	.534E+04	.111E+02	.321E+03	.262E+08	
35.00	.718E-01	.524E+03	.576E+04	.945E+01	.326E+03	.262E+08	
40.00	.629E-01	.568E+03	.611E+04	.781E+01	.330E+03	.262E+08	
45.00	.546E-01	.603E+03	.640E+04	.615E+01	.332E+03	.262E+08	
50.00	.468E-01	.630E+03	.662E+04	.449E+01	.332E+03	.262E+08	
55.00	.396E-01	.649E+03	.677E+04	.283E+01	.332E+03	.262E+08	
60.00	.331E-01	.659E+03	.685E+04	.118E+01	.329E+03	.262E+08	
65.00	.272E-01	.661E+03	.687E+04	-.456E+00	.325E+03	.262E+08	
70.00	.219E-01	.655E+03	.682E+04	-.206E+01	.318E+03	.262E+08	
75.00	.172E-01	.641E+03	.670E+04	-.364E+01	.310E+03	.262E+08	
80.00	.132E-01	.619E+03	.652E+04	-.516E+01	.299E+03	.262E+08	
85.00	.972E-02	.589E+03	.629E+04	-.663E+01	.286E+03	.262E+08	
90.00	.682E-02	.553E+03	.599E+04	-.802E+01	.270E+03	.262E+08	
95.00	.444E-02	.509E+03	.564E+04	-.932E+01	.250E+03	.262E+08	
100.00	.255E-02	.460E+03	.523E+04	-.105E+02	.224E+03	.262E+08	
105.00	.110E-02	.405E+03	.479E+04	-.115E+02	.187E+03	.262E+08	
110.00	.367E-04	.345E+03	.430E+04	-.123E+02	.805E+02	.262E+08	
115.00	-.700E-03	.284E+03	.380E+04	-.118E+02	-.176E+03	.262E+08	
120.00	-.117E-02	.227E+03	.334E+04	-.108E+02	-.205E+03	.262E+08	
125.00	-.141E-02	.176E+03	.292E+04	-.978E+01	-.221E+03	.262E+08	
130.00	-.150E-02	.130E+03	.255E+04	-.865E+01	-.229E+03	.262E+08	
135.00	-.145E-02	.892E+02	.222E+04	-.750E+01	-.233E+03	.262E+08	
140.00	-.132E-02	.546E+02	.194E+04	-.633E+01	-.233E+03	.262E+08	
145.00	-.114E-02	.259E+02	.170E+04	-.517E+01	-.230E+03	.262E+08	
150.00	-.938E-03	.287E+01	.152E+04	-.404E+01	-.224E+03	.262E+08	
155.00	-.729E-03	-.146E+02	.161E+04	-.295E+01	-.214E+03	.262E+08	
160.00	-.533E-03	-.267E+02	.171E+04	-.192E+01	-.198E+03	.262E+08	
165.00	-.363E-03	-.339E+02	.177E+04	-.974E+00	-.180E+03	.262E+08	
170.00	-.225E-03	-.366E+02	.179E+04	-.127E+00	-.159E+03	.262E+08	
175.00	-.121E-03	-.353E+02	.178E+04	.613E+00	-.136E+03	.262E+08	
180.00	-.511E-04	-.306E+02	.174E+04	.123E+01	-.110E+03	.262E+08	
185.00	-.993E-05	-.232E+02	.168E+04	.170E+01	-.729E+02	.262E+08	

190.00	.925E-05	-.145E+02	.161E+04	.158E+01	.718E+02	.262E+08
195.00	.145E-04	-.755E+01	.156E+04	.120E+01	.803E+02	.262E+08
200.00	.124E-04	-.257E+01	.152E+04	.801E+00	.772E+02	.262E+08
205.00	.772E-05	.499E+00	.150E+04	.437E+00	.686E+02	.262E+08
210.00	.343E-05	.186E+01	.151E+04	.125E+00	.560E+02	.262E+08
215.00	.840E-06	.184E+01	.151E+04	-.113E+00	.394E+02	.262E+08
220.00	-.529E-07	.857E+00	.150E+04	-.207E+00	-.196E+02	.262E+08
225.00	-.981E-07	.101E+00	.150E+04	-.921E-01	-.230E+02	.262E+08
230.00	-.127E-07	-.967E-01	.150E+04	.136E-02	-.139E+02	.262E+08
235.00	.602E-09	-.502E-02	.149E+04	.107E-01	.654E+01	.262E+08
240.00	-.181E-13	.274E-04	.149E+04	-.494E-03	-.512E+00	.262E+08
245.00	.289E-18	-.452E-09	.149E+04	.150E-07	.157E-04	.262E+08
250.00	-.460E-23	.746E-14	.149E+04	-.239E-12	-.250E-09	.262E+08
255.00	.732E-28	-.123E-18	.149E+04	.381E-17	.396E-14	.262E+08
260.00	-.116E-32	.203E-23	.149E+04	-.606E-22	-.629E-19	.262E+08
265.00	.185E-37	-.334E-28	.149E+04	-.133E-28	.996E-24	.262E+08
270.00	-.293E-42	.550E-33	.149E+04	.219E-33	-.157E-28	.262E+08
275.00	.464E-47	-.905E-38	.149E+04	-.361E-38	.249E-33	.262E+08
280.00	-.733E-52	.149E-42	.149E+04	.593E-43	-.393E-38	.262E+08
285.00	.116E-56	-.245E-47	.149E+04	-.976E-48	.618E-43	.262E+08
290.00	-.183E-61	.403E-52	.149E+04	.161E-52	-.973E-48	.262E+08
295.00	.288E-66	-.663E-57	.149E+04	-.264E-57	.153E-52	.262E+08
300.00	-.924E-71	.000E+00	.149E+04	.000E+00	-.489E-57	.262E+08

COMPUTED LATERAL FORCE AT PILE HEAD = .20000E+02 KIP
 COMPUTED MOMENT AT PILE HEAD = .00000E+00 IN-KIP
 COMPUTED SLOPE AT PILE HEAD = -.22178E-02

 THE OVERALL MOMENT IMBALANCE = .103E-09 IN-KIP
 THE OVERALL LATERAL FORCE IMBALANCE = .612E-08 LBS

OUTPUT SUMMARY

FILE HEAD DEFLECTION = .145E+00 IN
 MAXIMUM BENDING MOMENT = .661E+03 IN-KIP
 MAXIMUM TOTAL STRESS = .687E+04 LBS/IN**2

 NO. OF ITERATIONS = 20
 MAXIMUM DEFLECTION ERROR = .949E-05 IN

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PILE LOADING CONDITION

LATERAL LOAD AT PILE HEAD = .400E+02 KIP
 APPLIED MOMENT AT PILE HEAD = .000E+00 IN-KIP
 AXIAL LOAD AT PILE HEAD = .390E+02 KIP

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
*****	*****	*****	*****	*****	*****	*****
.00	.623E+00	.000E+00	.149E+04	.403E+02	.385E+03	.262E+08
5.00	.586E+00	.197E+03	.309E+04	.380E+02	.404E+03	.262E+08
10.00	.549E+00	.383E+03	.461E+04	.360E+02	.422E+03	.262E+08
15.00	.512E+00	.559E+03	.604E+04	.338E+02	.438E+03	.262E+08
20.00	.476E+00	.724E+03	.738E+04	.316E+02	.454E+03	.262E+08
25.00	.441E+00	.878E+03	.863E+04	.293E+02	.468E+03	.262E+08
30.00	.406E+00	.102E+04	.978E+04	.269E+02	.481E+03	.262E+08
35.00	.372E+00	.115E+04	.108E+05	.245E+02	.492E+03	.262E+08
40.00	.340E+00	.127E+04	.118E+05	.220E+02	.503E+03	.262E+08
45.00	.308E+00	.137E+04	.126E+05	.195E+02	.512E+03	.262E+08
50.00	.278E+00	.146E+04	.134E+05	.169E+02	.519E+03	.262E+08
55.00	.250E+00	.154E+04	.140E+05	.143E+02	.525E+03	.262E+08
60.00	.223E+00	.161E+04	.146E+05	.116E+02	.530E+03	.262E+08
65.00	.197E+00	.166E+04	.150E+05	.897E+01	.532E+03	.262E+08
70.00	.173E+00	.170E+04	.153E+05	.630E+01	.533E+03	.262E+08
75.00	.150E+00	.173E+04	.155E+05	.364E+01	.533E+03	.262E+08
80.00	.130E+00	.174E+04	.156E+05	.978E+00	.530E+03	.262E+08
85.00	.111E+00	.174E+04	.156E+05	-.166E+01	.526E+03	.262E+08
90.00	.931E-01	.172E+04	.155E+05	-.428E+01	.519E+03	.262E+08
95.00	.772E-01	.170E+04	.153E+05	-.685E+01	.510E+03	.262E+08
100.00	.630E-01	.166E+04	.150E+05	-.937E+01	.499E+03	.262E+08
105.00	.504E-01	.160E+04	.145E+05	-.118E+02	.485E+03	.262E+08
110.00	.392E-01	.154E+04	.140E+05	-.142E+02	.468E+03	.262E+08
115.00	.296E-01	.146E+04	.134E+05	-.165E+02	.448E+03	.262E+08
120.00	.213E-01	.137E+04	.127E+05	-.187E+02	.424E+03	.262E+08
125.00	.144E-01	.128E+04	.119E+05	-.207E+02	.394E+03	.262E+08
130.00	.867E-02	.117E+04	.110E+05	-.226E+02	.355E+03	.262E+08
135.00	.405E-02	.105E+04	.100E+05	-.243E+02	.301E+03	.262E+08
140.00	.432E-03	.925E+03	.902E+04	-.255E+02	.176E+03	.262E+08
145.00	-.230E-02	.798E+03	.798E+04	-.248E+02	-.274E+03	.262E+08
150.00	-.428E-02	.678E+03	.700E+04	-.233E+02	-.327E+03	.262E+08
155.00	-.560E-02	.565E+03	.609E+04	-.216E+02	-.356E+03	.262E+08
160.00	-.639E-02	.462E+03	.525E+04	-.198E+02	-.368E+03	.262E+08
165.00	-.674E-02	.367E+03	.448E+04	-.180E+02	-.373E+03	.262E+08
170.00	-.673E-02	.282E+03	.379E+04	-.161E+02	-.373E+03	.262E+08
175.00	-.646E-02	.206E+03	.317E+04	-.142E+02	-.369E+03	.262E+08
180.00	-.599E-02	.140E+03	.263E+04	-.124E+02	-.362E+03	.262E+08
185.00	-.538E-02	.822E+02	.216E+04	-.106E+02	-.352E+03	.262E+08
190.00	-.470E-02	.334E+02	.177E+04	-.889E+01	-.340E+03	.262E+08

195.00	-.398E-02	-.682E+01	.155E+04	-.722E+01	-.327E+03	.262E+08
200.00	-.327E-02	-.389E+02	.181E+04	-.563E+01	-.311E+03	.262E+08
205.00	-.260E-02	-.632E+02	.201E+04	-.412E+01	-.294E+03	.262E+08
210.00	-.198E-02	-.802E+02	.215E+04	-.269E+01	-.274E+03	.262E+08
215.00	-.145E-02	-.904E+02	.223E+04	-.137E+01	-.254E+03	.262E+08
220.00	-.994E-03	-.942E+02	.226E+04	-.163E+00	-.231E+03	.262E+08
225.00	-.631E-03	-.922E+02	.224E+04	.930E+00	-.206E+03	.262E+08
230.00	-.356E-03	-.850E+02	.219E+04	.189E+01	-.179E+03	.262E+08
235.00	-.162E-03	-.735E+02	.209E+04	.271E+01	-.147E+03	.262E+08
240.00	-.379E-04	-.582E+02	.197E+04	.334E+01	-.102E+03	.262E+08
245.00	.311E-04	-.413E+02	.183E+04	.320E+01	.969E+02	.262E+08
250.00	.606E-04	-.266E+02	.171E+04	.266E+01	.115E+03	.262E+08
255.00	.646E-04	-.147E+02	.161E+04	.207E+01	.116E+03	.262E+08
260.00	.543E-04	-.580E+01	.154E+04	.150E+01	.111E+03	.262E+08
265.00	.384E-04	.332E+00	.150E+04	.962E+00	.102E+03	.262E+08
270.00	.226E-04	.390E+01	.153E+04	.479E+00	.895E+02	.262E+08
275.00	.104E-04	.521E+01	.154E+04	.657E-01	.737E+02	.262E+08
280.00	.310E-05	.466E+01	.153E+04	-.260E+00	.544E+02	.262E+08
285.00	.128E-06	.275E+01	.152E+04	-.459E+00	.266E+02	.262E+08
290.00	-.245E-06	.580E+00	.150E+04	-.332E+00	-.254E+02	.262E+08
295.00	-.153E-08	-.446E+00	.150E+04	.219E-01	.329E+01	.262E+08
300.00	.538E-13	.000E+00	.149E+04	.000E+00	-.517E-01	.262E+08

COMPUTED LATERAL FORCE AT PILE HEAD = .40000E+02 KIP
 COMPUTED MOMENT AT PILE HEAD = .00000E+00 IN-KIP
 COMPUTED SLOPE AT PILE HEAD = -.74502E-02

THE OVERALL MOMENT IMBALANCE = -.278E-07 IN-KIP
 THE OVERALL LATERAL FORCE IMBALANCE = .563E-06 LBS

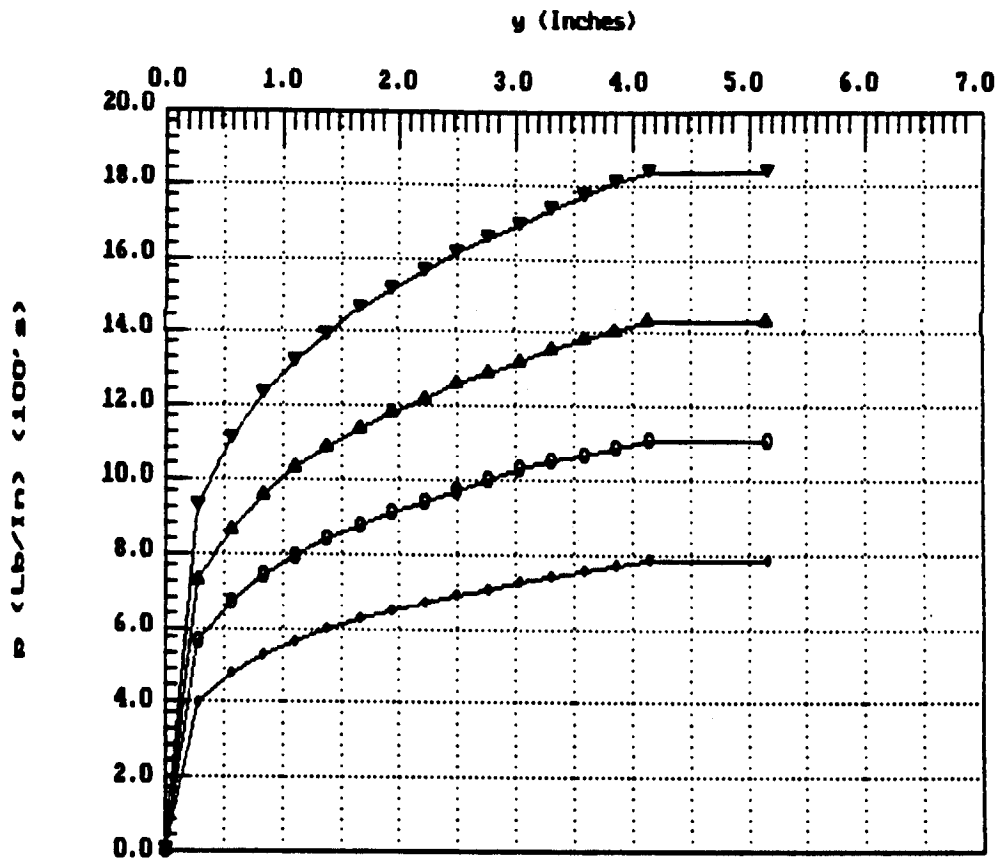
OUTPUT SUMMARY

PILE HEAD DEFLECTION = .623E+00 IN
 MAXIMUM BENDING MOMENT = .174E+04 IN-KIP
 MAXIMUM TOTAL STRESS = .156E+05 LBS/IN**2

NO. OF ITERATIONS = 27
 MAXIMUM DEFLECTION ERROR = .880E-05 IN

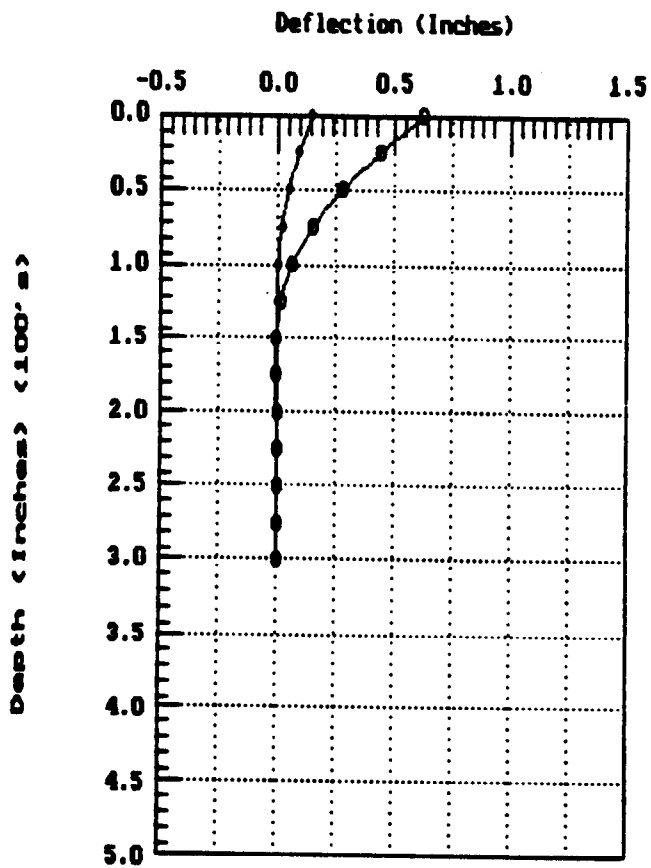
S U M M A R Y T A B L E

LATERAL LOAD (KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.200E+02	.000E+00	.390E+02	.145E+00	-.222E-02	.661E+03	.687E+04
.400E+02	.000E+00	.390E+02	.623E+00	-.745E-02	.174E+04	.156E+05



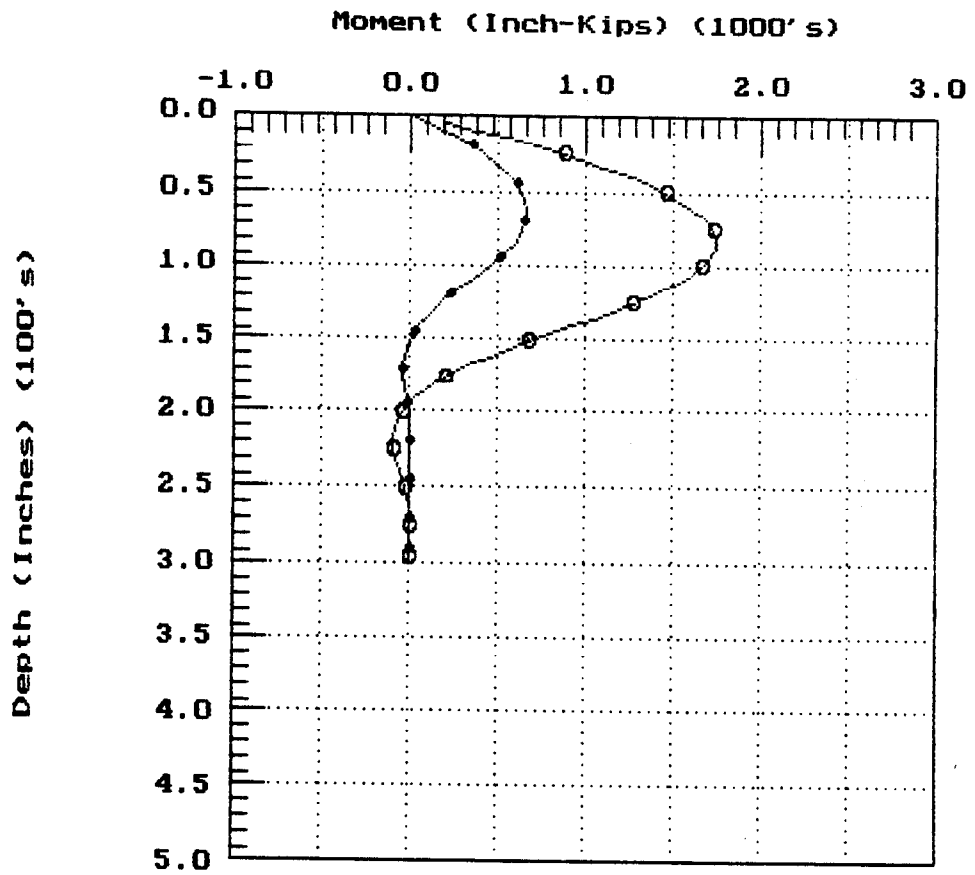
- Depth
- 20 inches
 - 60 inches
 - ▲ 100 inches
 - ▼ 150 inches

p-y Curves.

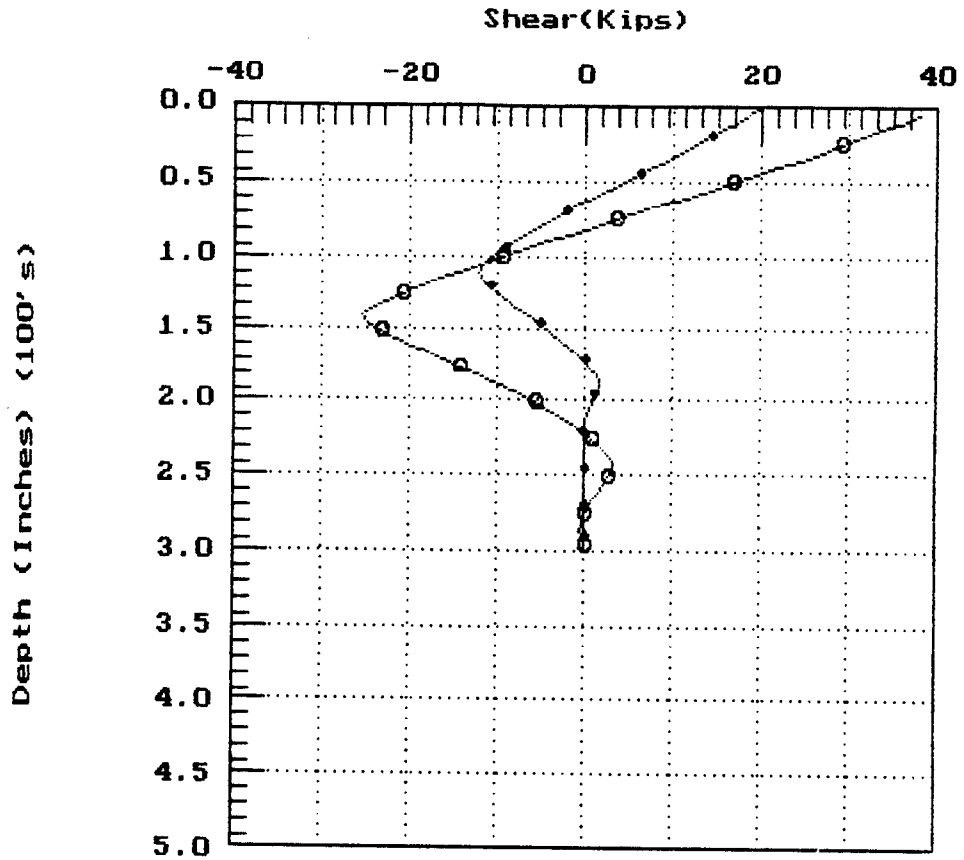


• 1
 ◻ 2

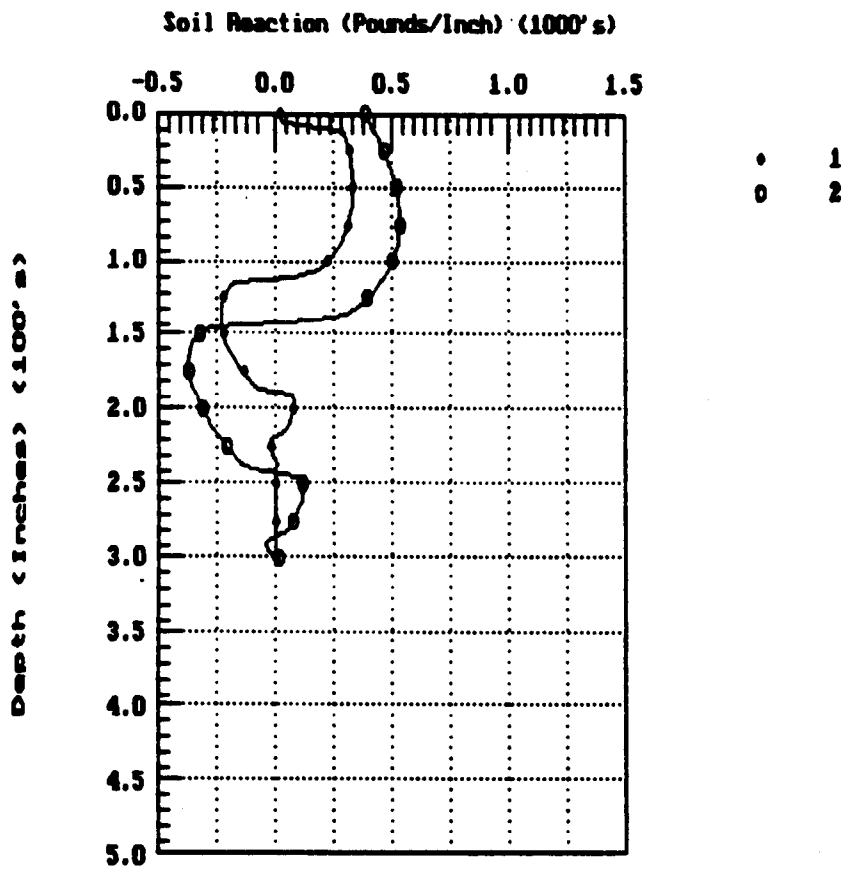
Pile Deflection vs. Depth.



Bending Moment vs. Depth.



Shearing Force vs. Depth.



Soil Reaction vs. Depth.

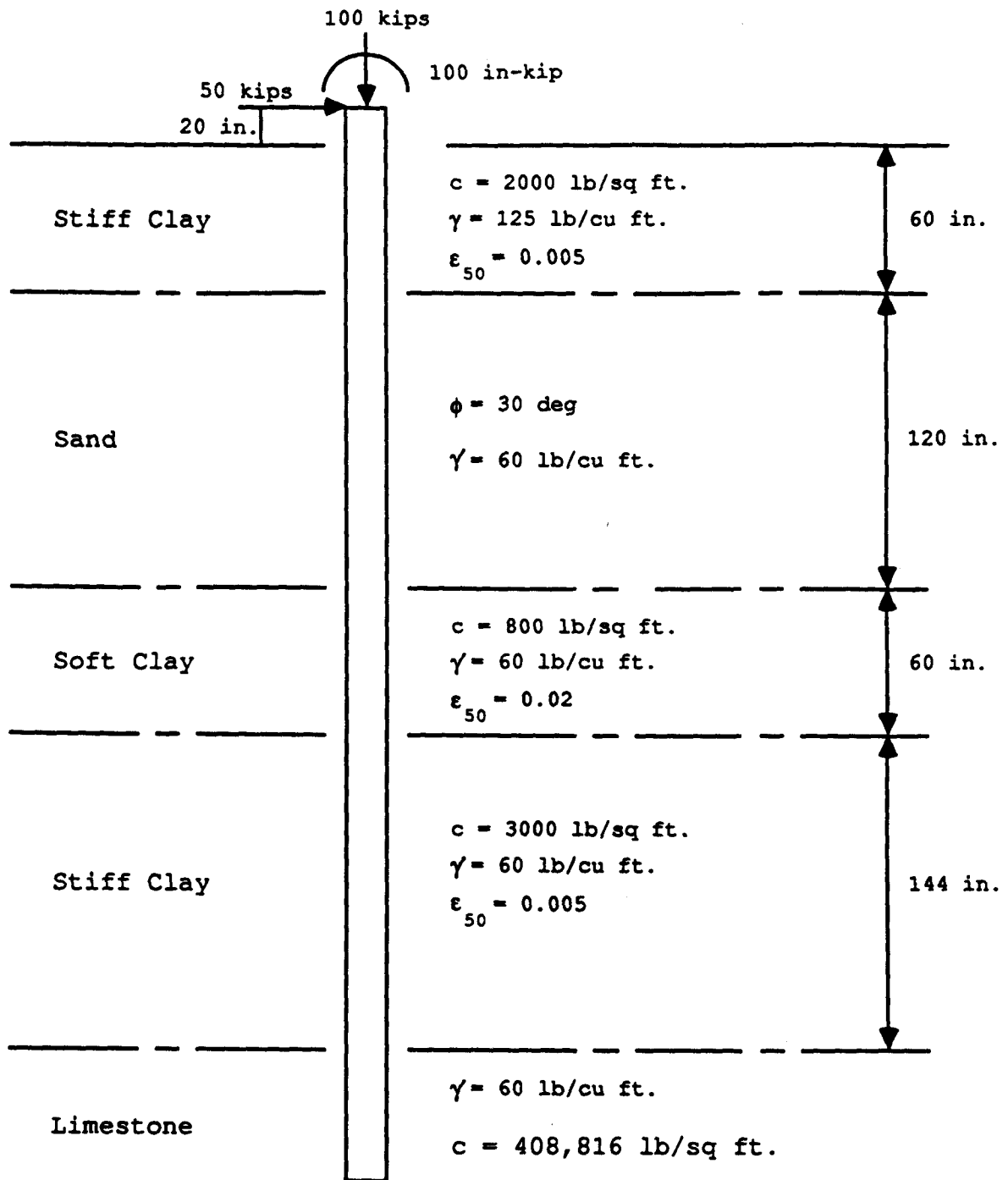
EXAMPLE 2, CONCRETE PILES IN LAYERED SOIL WITH DISTRIBUTED LOAD

This example is included to illustrate a common case in which a 36-in diameter, reinforced-concrete pile is subjected to both horizontal and vertical forces at the top of the pile. Distributed loads are also specified near the top portion of the pile. The soil deposit is not uniform and, as shown in Fig. 5.1, five different layers are encountered in this example.

The recommendations for p-y curves for layered soils are presented in Chapter 3 of Part II of this manual. The computer will calculate the equivalent thickness for each layer. If the user wants to check the p-y curves generated by the computer, the equivalent thickness should be taken into account. The p-y curves for rock at the fifth layer were generated internally by the computer. The only parameter that is needed for rock is the shear strength. The modulus k and ϵ_{50} are only used for the initial condition. It should be noted that the shear strength is half of the uniaxial compression strength reported for most rock specimens.

Layered-soil is commonly encountered in routine design. It should be noted that there may be some uncertainty regarding the theory used for conversion of layered soils. If soil layers do not change their natural properties dramatically (for example, sandy layers with differing angles of friction) then the best approach for modeling the soil response is to use a lower number of layers. However, care must be taken to characterize in detail the strength variation profile in the input data.

The input and output data are shown in the following pages.



Pile Length = 500 in.
 Pile Diameter = 36 in.
 Modulus of Elasticity = $3.1 \times 10^6 \text{ lb/sq in.}$

Figure 5.1. Data for Example 2.

EXAMPLE 2 CONCRETE PILES IN LAYERED SOIL WITH DISTRIBUTED LOADS

UNITS--ENGL

FILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE

I N P U T I N F O R M A T I O N

DISTRIBUTED LOAD CURVE 3 POINTS
 X, IN LOAD, LBS/IN
 .00 .500E+02
 10.00 .100E+03
 20.00 .200E+03

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 500.00 IN
MODULUS OF ELASTICITY OF PILE = .310E+04 KIP/IN**2
 2 SECTION(S)

X	DIAMETER	MOMENT OF INERTIA	AREA
IN	IN	IN**4	IN**2
.00	36.000	.825E+05	.108E+04
300.00	36.000	.615E+05	.108E+04
500.00			

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = 20.00 IN

SLOPE ANGLE AT THE GROUND SURFACE = .00 DEG.

5 LAYER(S) OF SOIL

LAYER 1
 THE LAYER IS A STIFF CLAY ABOVE THE WATER TABLE
 X AT THE TOP OF THE LAYER = 20.00 IN
 X AT THE BOTTOM OF THE LAYER = 80.00 IN
 VARIATION OF SOIL MODULUS, k = .100E+04 LBS/IN**3

LAYER 2
 THE LAYER IS A SAND
 X AT THE TOP OF THE LAYER = 80.00 IN
 X AT THE BOTTOM OF THE LAYER = 200.00 IN
 VARIATION OF SOIL MODULUS, k = .600E+02 LBS/IN**3

LAYER 3
 THE LAYER IS A SOFT CLAY
 X AT THE TOP OF THE LAYER = 200.00 IN
 X AT THE BOTTOM OF THE LAYER = 260.00 IN
 VARIATION OF SOIL MODULUS, k = .200E+03 LBS/IN**3

LAYER 4
 THE LAYER IS A STIFF CLAY ABOVE THE WATER TABLE
 X AT THE TOP OF THE LAYER = 260.00 IN
 X AT THE BOTTOM OF THE LAYER = 404.00 IN
 VARIATION OF SOIL MODULUS, k = .120E+04 LBS/IN**3

LAYER 5
 THE LAYER IS A ROCK
 X AT THE TOP OF THE LAYER = 404.00 IN
 X AT THE BOTTOM OF THE LAYER = 600.00 IN
 VARIATION OF SOIL MODULUS, k = .200E+04 LBS/IN**3

DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
 4 POINTS

X, IN	WEIGHT, LBS/IN**3
20.00	.72E-01
80.00	.72E-01
80.00	.35E-01
600.00	.35E-01

DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
 10 POINTS

X, IN	C, LBS/IN**2	PHI, DEGREES	E50
20.00	.139E+02	.000	.500E-02
80.00	.139E+02	.000	.500E-02
80.00	.000E+00	30.000	-----
200.00	.000E+00	30.000	-----
200.00	.556E+01	.000	.200E-01
260.00	.556E+01	.000	.200E-01

260.00	.208E+02	.000	.500E-02
404.00	.208E+02	.000	.500E-02
404.00	.284E+04	.000	.100E-02
600.00	.284E+04	.000	.100E-02

FINITE DIFFERENCE PARAMETERS

NUMBER OF PILE INCREMENTS	=	100
TOLERANCE ON DETERMINATION OF DEFLECTIONS	=	.100E-04 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS	=	100
MAXIMUM ALLOWABLE DEFLECTION	=	.36E+03 IN

INPUT CODES

OUTPT	=	1
KCYCL	=	1
KBC	=	1
KPYOP	=	1
INC	=	2

EXAMPLE 2 CONCRETE PILES IN LAYERED SOIL WITH DISTRIBUTED LOADS

UNITS--ENGL

OUTPUT INFORMATION

GENERATED P-Y CURVES

THE NUMBER OF CURVE IS	=	4
THE NUMBER OF POINTS ON EACH CURVE	=	17

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	CAVG LBS/IN**2	GAMMA LBS/IN**3	E50
40.00	36.000	.1E+02	.1E+02	.7E-01	.500E-02
		Y		P	
		IN		LBS/IN	
		.000		.000	
		.480		956.753	
		.960		1137.777	

1.440	1259.158
1.920	1353.053
2.400	1430.679
2.880	1497.399
3.360	1556.232
3.840	1609.060
4.320	1657.145
4.800	1701.374
5.280	1742.401
5.760	1780.718
6.240	1816.710
6.720	1850.682
7.200	1882.880
9.000	1882.880

DEPTH BELOW GS IN	DIAM IN	PHI	GAMMA LBS/IN**3	A	B
100.00	36.00	30.0	.6E-01	1.14	.78

Y IN	P LBS/IN
.000	.000
.050	370.940
.100	741.881
.150	1093.652
.200	1216.369
.250	1320.962
.300	1413.062
.350	1495.924
.400	1571.620
.450	1641.561
.500	1706.759
.550	1767.966
.600	1825.758
1.350	2669.421
37.350	2669.421
73.350	2669.421
109.350	2669.421

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	GAMMA LBS/IN**3	E50
220.00	36.000	.6E+01	.5E-01	.200E-01

Y, IN	P, LBS/IN
.000	.000
.014	180.144
.450	567.418
.900	714.902
1.350	818.358
1.800	900.720

2.250	970.271
2.700	1031.067
3.150	1085.432
3.600	1134.836
4.050	1180.277
4.500	1222.465
4.950	1261.926
5.400	1299.063
14.400	1801.440
27.000	1801.440
36.000	1801.440

DEPTH BELOW GS IN	DIAM IN	C LBS/IN**2	CAVG LBS/IN**2	GAMMA LBS/IN**3	E50
340.00	36.000	.2E+02	.2E+02	.4E-01	.500E-02
		Y		P	
		IN		LBS/IN	
		.000		.000	
		.480		2789.525	
		.960		3317.323	
		1.440		3671.222	
		1.920		3944.985	
		2.400		4171.313	
		2.880		4365.843	
		3.360		4537.376	
		3.840		4691.404	
		4.320		4831.600	
		4.800		4960.555	
		5.280		5080.173	
		5.760		5191.892	
		6.240		5296.831	
		6.720		5395.880	
		7.200		5489.757	
		9.000		5489.757	

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PILE LOADING CONDITION

LATERAL LOAD AT PILE HEAD = .500E+02 KIP
 APPLIED MOMENT AT PILE HEAD = .100E+03 IN-KIP
 AXIAL LOAD AT PILE HEAD = .100E+03 KIP

DISTRIBUTED LOAD CURVE 3 POINTS

X, IN	LOAD, LBS/IN
.00	.500E+02
10.00	.100E+03
20.00	.200E+03

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
.00	.251E+00	.100E+03	.114E+03	.502E+02	.000E+00	.256E+09
10.00	.230E+00	.605E+03	.225E+03	.507E+02	.000E+00	.256E+09
20.00	.209E+00	.112E+04	.337E+03	.507E+02	.620E+03	.256E+09
30.00	.189E+00	.160E+04	.442E+03	.449E+02	.643E+03	.256E+09
40.00	.170E+00	.202E+04	.534E+03	.384E+02	.663E+03	.256E+09
50.00	.151E+00	.237E+04	.611E+03	.316E+02	.680E+03	.256E+09
60.00	.133E+00	.266E+04	.673E+03	.248E+02	.695E+03	.256E+09
70.00	.117E+00	.287E+04	.719E+03	.178E+02	.706E+03	.256E+09
80.00	.101E+00	.302E+04	.751E+03	.112E+02	.507E+03	.256E+09
90.00	.865E-01	.310E+04	.770E+03	.621E+01	.486E+03	.256E+09
100.00	.733E-01	.314E+04	.778E+03	.149E+01	.456E+03	.256E+09
110.00	.613E-01	.314E+04	.777E+03	-.288E+01	.418E+03	.256E+09
120.00	.505E-01	.309E+04	.767E+03	-.684E+01	.375E+03	.256E+09
130.00	.409E-01	.300E+04	.748E+03	-.104E+02	.328E+03	.256E+09
140.00	.325E-01	.289E+04	.722E+03	-.134E+02	.281E+03	.256E+09
150.00	.253E-01	.274E+04	.690E+03	-.160E+02	.233E+03	.256E+09
160.00	.191E-01	.257E+04	.653E+03	-.181E+02	.187E+03	.256E+09
170.00	.139E-01	.238E+04	.612E+03	-.197E+02	.145E+03	.256E+09
180.00	.965E-02	.218E+04	.567E+03	-.210E+02	.106E+03	.256E+09
190.00	.624E-02	.196E+04	.520E+03	-.219E+02	.725E+02	.256E+09
200.00	.360E-02	.174E+04	.472E+03	-.226E+02	.113E+03	.256E+09
210.00	.164E-02	.151E+04	.422E+03	-.236E+02	.872E+02	.256E+09
220.00	.263E-03	.127E+04	.369E+03	-.243E+02	.475E+02	.256E+09
230.00	-.614E-03	.102E+04	.316E+03	-.241E+02	-.629E+02	.256E+09
240.00	-.109E-02	.787E+03	.264E+03	-.234E+02	-.762E+02	.256E+09
250.00	-.126E-02	.558E+03	.214E+03	-.226E+02	-.799E+02	.256E+09
260.00	-.121E-02	.336E+03	.166E+03	-.208E+02	-.482E+03	.256E+09
270.00	-.102E-02	.152E+03	.126E+03	-.160E+02	-.476E+03	.256E+09
280.00	-.781E-03	.161E+02	.961E+02	-.113E+02	-.457E+03	.256E+09
290.00	-.530E-03	-.744E+02	.109E+03	-.688E+01	-.425E+03	.256E+09
300.00	-.308E-03	-.122E+03	.119E+03	-.283E+01	-.380E+03	.223E+09
310.00	-.140E-03	-.132E+03	.131E+03	.690E+00	-.320E+03	.191E+09
320.00	-.400E-04	-.110E+03	.125E+03	.352E+01	-.239E+03	.191E+09
330.00	.261E-05	-.643E+02	.111E+03	.479E+01	.129E+03	.191E+09
340.00	.111E-04	-.235E+02	.995E+02	.321E+01	.184E+03	.191E+09
350.00	.669E-05	-.167E+00	.926E+02	.149E+01	.165E+03	.191E+09
360.00	.166E-05	.711E+01	.947E+02	.822E-01	.119E+03	.191E+09
370.00	-.132E-07	.296E+01	.935E+02	-.533E+00	-.363E+02	.191E+09

380.00	-.206E-07	-.184E+00	.926E+02	-.894E-01	-.425E+02	.191E+09
390.00	.262E-10	-.731E-03	.926E+02	.156E-01	.866E+01	.191E+09
400.00	-.704E-16	.153E-08	.926E+02	-.200E-04	-.112E-01	.191E+09
410.00	-.467E-15	.763E-09	.926E+02	-.650E-10	-.414E-08	.191E+09
420.00	-.455E-15	.249E-09	.926E+02	-.380E-10	-.405E-08	.191E+09
430.00	-.304E-15	-.110E-10	.926E+02	-.162E-10	-.271E-08	.191E+09
440.00	-.153E-15	-.984E-10	.926E+02	-.339E-11	-.137E-08	.191E+09
450.00	-.505E-16	-.971E-10	.926E+02	.219E-11	-.455E-09	.191E+09
460.00	.188E-17	-.653E-10	.926E+02	.342E-11	.138E-10	.191E+09
470.00	.200E-16	-.334E-10	.926E+02	.271E-11	.177E-09	.191E+09
480.00	.202E-16	-.122E-10	.926E+02	.153E-11	.180E-09	.191E+09
490.00	.137E-16	-.221E-11	.926E+02	.554E-12	.123E-09	.191E+09
500.00	.578E-17	.000E+00	.926E+02	.000E+00	.525E-10	.191E+09

COMPUTED LATERAL FORCE AT PILE HEAD = .50000E+02 KIP
 COMPUTED MOMENT AT PILE HEAD = .10000E+03 IN-KIP
 COMPUTED SLOPE AT PILE HEAD = -.20834E-02

THE OVERALL MOMENT IMBALANCE = .756E-09 IN-KIP
 THE OVERALL LATERAL FORCE IMBALANCE = .152E-06 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .251E+00 IN
 MAXIMUM BENDING MOMENT = .315E+04 IN-KIP
 MAXIMUM TOTAL STRESS = .779E+03 LBS/IN**2

NO. OF ITERATIONS = 14
 MAXIMUM DEFLECTION ERROR = .499E-05 IN

S U M M A R Y T A B L E

LATERAL LOAD (KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.500E+02	.100E+03	.100E+03	.251E+00	-.208E-02	.315E+04	.779E+03

EXAMPLE 3, PILES IN A SLOPING ABUTMENT

The third example is illustrated in Fig. 5.2 and is included to show the use of the program for analysis of a 36-O.D. drilled shaft in a sloping abutment. The pile length is 500 in and the diameter is 36 inches. The soil stratum is a medium-dense sand layer underlaid by a stiff clay. The slope of the abutment is 20 degree from a horizontal surface.

The input and the output are shown in the following pages. The deflection at the pile head for this case is 0.402 in, which is about 20 percent higher than that (0.335 in) if the ground were a flat plane. A parametric study, with different slope angles in each run, indicates that the deflection of piles increases with an increase in the slope angle (Fig. 5.3).

It should be noted that the slope angle cannot be greater than the internal friction angle ϕ if the soil in the slope is cohesionless material. If a slope has a factor of safety below the standard requirement, it may create a driving force instead of a resisting force on the pile. For such a situation, analyses for slope stability with piles in place should be conducted. If a driving force from the slope is possible, the user should input the driving force as a distributed load on the pile in making the design.

The input and output data are shown in the following pages.

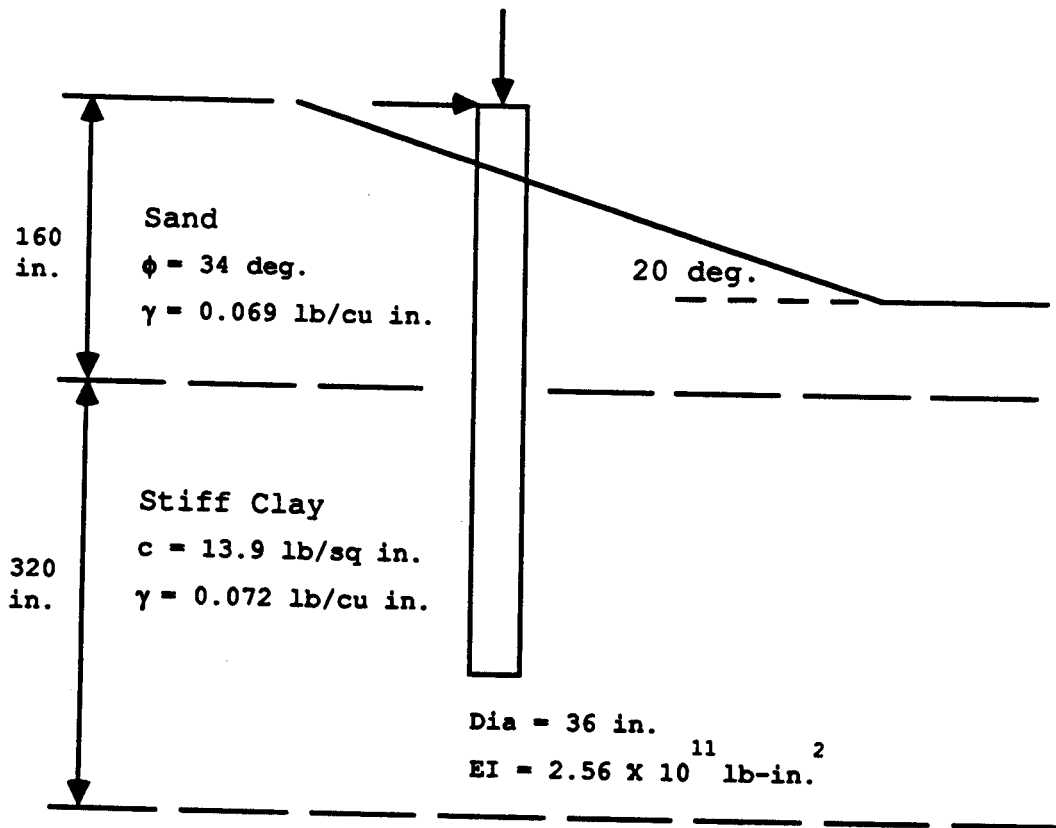


Figure 5.2. Data for Example 3.

Yt Versus Slope Angle

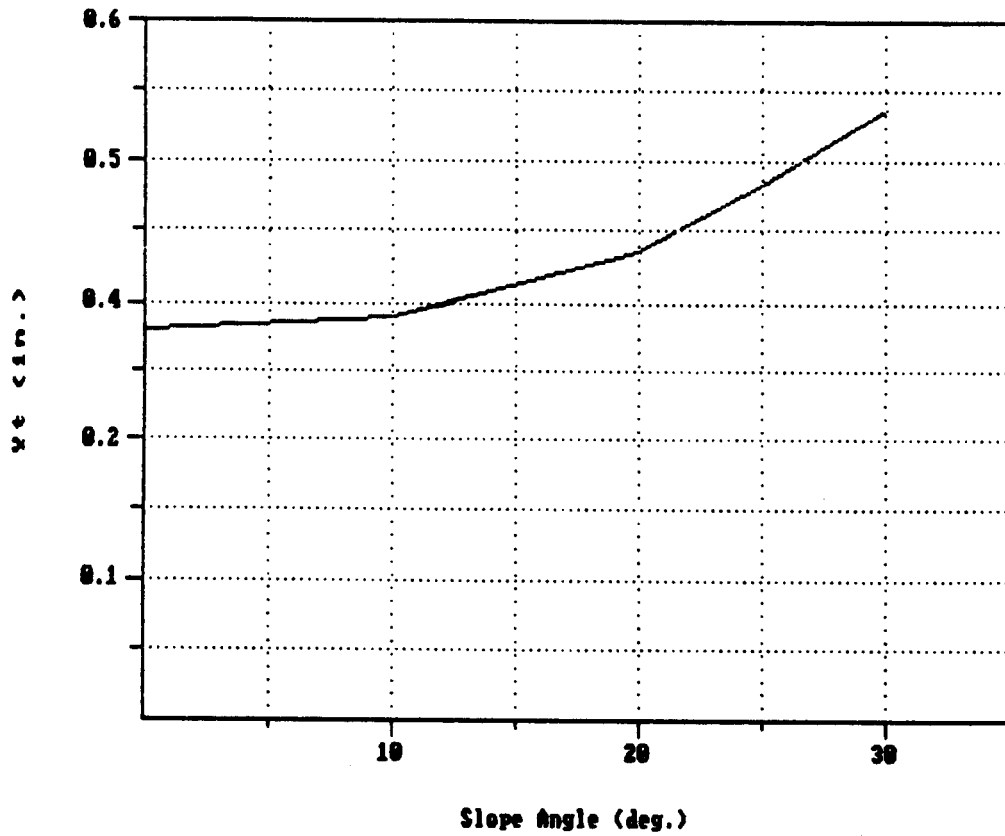


Figure 5.3. Pile-head deflection y_t versus slope angle.

EXAMPLE 3 PILES IN A SLOPING ABUTMENT

UNITS--ENGL

PILE DEFLECTION, BENDING MOMENT, SHEAR & SOIL RESISTANCE

I N P U T I N F O R M A T I O N

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 400.00 IN
MODULUS OF ELASTICITY OF PILE = .310E+04 KIP/IN**2
1 SECTION(S)

X	DIAMETER	MOMENT OF INERTIA	AREA
IN	IN	IN**4	IN**2
.00	36.000	.825E+05	.108E+04
400.00			

SOILS INFORMATION

X-COORDINATE AT THE GROUND SURFACE = 20.00 IN
SLOPE ANGLE AT THE GROUND SURFACE = 20.00 DEG.

2 LAYER(S) OF SOIL

LAYER 1
THE LAYER IS A SAND
X AT THE TOP OF THE LAYER = 20.00 IN
X AT THE BOTTOM OF THE LAYER = 180.00 IN
VARIATION OF SOIL MODULUS, k = .600E+02 LBS/IN**3

LAYER 2
 THE LAYER IS A STIFF CLAY ABOVE THE WATER TABLE
 X AT THE TOP OF THE LAYER = 180.00 IN
 X AT THE BOTTOM OF THE LAYER = 500.00 IN
 VARIATION OF SOIL MODULUS, k = .100E+04 LBS/IN**3

DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
 4 POINTS

X, IN	WEIGHT, LBS/IN**3
20.00	.69E-01
180.00	.69E-01
180.00	.72E-01
500.00	.72E-01

DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
 4 POINTS

X, IN	C, LBS/IN**2	PHI, DEGREES	E50
20.00	.000E+00	34.000	-----
180.00	.000E+00	34.000	-----
180.00	.139E+02	.000	.500E-02
500.00	.139E+02	.000	.500E-02

FINITE DIFFERENCE PARAMETERS

NUMBER OF PILE INCREMENTS	=	100
TOLERANCE ON DETERMINATION OF DEFLECTIONS	=	.100E-04 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS	=	100
MAXIMUM ALLOWABLE DEFLECTION	=	.36E+03 IN

INPUT CODES

OUTPT	=	1
KCYCL	=	1
KBC	=	1
KPYOP	=	1
INC	=	2

EXAMPLE 3 PILES IN A SLOPING ABUTMENT

UNITS--ENGL

OUTPUT INFORMATION

GENERATED P-Y CURVES

THE NUMBER OF CURVE IS = 1

THE NUMBER OF POINTS ON EACH CURVE = 17

DEPTH BELOW GS IN	DIAM IN	PHI	GAMMA LBS/IN**3	A	B
30.00	36.00	34.0	.7E-01	2.23	1.64
		Y IN		P LBS/IN	
		.000		.000	
		.050		90.000	
		.100		180.000	
		.150		228.027	
		.200		247.984	
		.250		264.660	
		.300		279.114	
		.350		291.948	
		.400		303.543	
		.450		314.151	
		.500		323.954	
		.550		333.085	
		.600		341.646	
		1.350		466.197	
		37.350		466.197	
		73.350		466.197	
		109.350		466.197	

----- *** -----

PILE LOADING CONDITION

LATERAL LOAD AT PILE HEAD = .400E+02 KIP
 APPLIED MOMENT AT PILE HEAD = .600E+03 IN-KIP
 AXIAL LOAD AT PILE HEAD = .200E+03 KIP

X	DEFLECTION	MOMENT	TOTAL STRESS	SHEAR	SOIL RESIST	FLEXURAL RIGIDITY
IN	IN	IN-KIP	LBS/IN**2	KIP	LBS/IN	KIP-IN**2
*****	*****	*****	*****	*****	*****	*****
.00	.403E+00	.600E+03	.316E+03	.406E+02	.000E+00	.256E+09
8.00	.379E+00	.925E+03	.387E+03	.400E+02	.000E+00	.256E+09
16.00	.355E+00	.125E+04	.458E+03	.400E+02	.000E+00	.256E+09
24.00	.332E+00	.157E+04	.529E+03	.399E+02	.335E+02	.256E+09
32.00	.308E+00	.190E+04	.599E+03	.394E+02	.105E+03	.256E+09
40.00	.286E+00	.221E+04	.668E+03	.383E+02	.177E+03	.256E+09
48.00	.264E+00	.252E+04	.734E+03	.365E+02	.250E+03	.256E+09
56.00	.242E+00	.280E+04	.797E+03	.343E+02	.317E+03	.256E+09
64.00	.222E+00	.307E+04	.856E+03	.315E+02	.378E+03	.256E+09
72.00	.202E+00	.332E+04	.909E+03	.283E+02	.428E+03	.256E+09
80.00	.183E+00	.353E+04	.956E+03	.247E+02	.471E+03	.256E+09
88.00	.164E+00	.372E+04	.996E+03	.208E+02	.503E+03	.256E+09
96.00	.147E+00	.387E+04	.103E+04	.166E+02	.525E+03	.256E+09
104.00	.131E+00	.399E+04	.106E+04	.124E+02	.538E+03	.256E+09
112.00	.116E+00	.407E+04	.107E+04	.807E+01	.537E+03	.256E+09
120.00	.101E+00	.412E+04	.109E+04	.383E+01	.522E+03	.256E+09
128.00	.879E-01	.414E+04	.109E+04	-.236E+00	.492E+03	.256E+09
136.00	.757E-01	.413E+04	.109E+04	-.407E+01	.465E+03	.256E+09
144.00	.645E-01	.408E+04	.108E+04	-.763E+01	.425E+03	.256E+09
152.00	.543E-01	.401E+04	.106E+04	-.108E+02	.375E+03	.256E+09
160.00	.451E-01	.391E+04	.104E+04	-.136E+02	.317E+03	.256E+09
168.00	.369E-01	.380E+04	.101E+04	-.159E+02	.277E+03	.256E+09
176.00	.297E-01	.366E+04	.984E+03	-.181E+02	.257E+03	.256E+09
184.00	.233E-01	.351E+04	.950E+03	-.212E+02	.426E+03	.256E+09
192.00	.179E-01	.333E+04	.911E+03	-.245E+02	.411E+03	.256E+09
200.00	.132E-01	.312E+04	.865E+03	-.277E+02	.392E+03	.256E+09
208.00	.937E-02	.288E+04	.814E+03	-.308E+02	.371E+03	.256E+09
216.00	.624E-02	.263E+04	.758E+03	-.337E+02	.344E+03	.256E+09
224.00	.376E-02	.235E+04	.697E+03	-.363E+02	.312E+03	.256E+09
232.00	.188E-02	.205E+04	.632E+03	-.386E+02	.269E+03	.256E+09
240.00	.502E-03	.173E+04	.563E+03	-.405E+02	.198E+03	.256E+09
248.00	-.440E-03	.141E+04	.492E+03	-.395E+02	-.399E+03	.256E+09
256.00	-.103E-02	.110E+04	.426E+03	-.359E+02	-.493E+03	.256E+09
264.00	-.134E-02	.833E+03	.367E+03	-.318E+02	-.527E+03	.256E+09
272.00	-.145E-02	.596E+03	.315E+03	-.275E+02	-.536E+03	.256E+09
280.00	-.140E-02	.393E+03	.271E+03	-.232E+02	-.532E+03	.256E+09
288.00	-.126E-02	.224E+03	.234E+03	-.190E+02	-.518E+03	.256E+09
296.00	-.106E-02	.876E+02	.204E+03	-.150E+02	-.496E+03	.256E+09
304.00	-.835E-03	-.167E+02	.189E+03	-.111E+02	-.468E+03	.256E+09
312.00	-.616E-03	-.911E+02	.205E+03	-.753E+01	-.433E+03	.256E+09
320.00	-.419E-03	-.138E+03	.215E+03	-.423E+01	-.394E+03	.256E+09
328.00	-.257E-03	-.159E+03	.220E+03	-.126E+01	-.348E+03	.256E+09
336.00	-.133E-03	-.159E+03	.220E+03	.131E+01	-.296E+03	.256E+09
344.00	-.497E-04	-.139E+03	.216E+03	.342E+01	-.231E+03	.256E+09
352.00	-.698E-06	-.105E+03	.208E+03	.478E+01	-.808E+02	.256E+09
360.00	.220E-04	-.677E+02	.200E+03	.424E+01	.126E+03	.256E+09
368.00	.277E-04	-.379E+02	.193E+03	.319E+01	.136E+03	.256E+09

376.00	.237E-04	-.168E+02	.189E+03	.211E+01	.133E+03	.256E+09
384.00	.154E-04	-.408E+01	.186E+03	.109E+01	.122E+03	.256E+09
392.00	.599E-05	.902E+00	.185E+03	.207E+00	.982E+02	.256E+09
400.00	-.332E-05	.000E+00	.185E+03	.000E+00	-.116E+03	.256E+09

COMPUTED LATERAL FORCE AT PILE HEAD	=	.40000E+02 KIP
COMPUTED MOMENT AT PILE HEAD	=	.60000E+03 IN-KIP
COMPUTED SLOPE AT PILE HEAD	=	-.30108E-02

THE OVERALL MOMENT IMBALANCE	=	.996E-07 IN-KIP
THE OVERALL LATERAL FORCE IMBALANCE	=	-.174E-05 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION	=	.403E+00 IN
MAXIMUM BENDING MOMENT	=	.414E+04 IN-KIP
MAXIMUM TOTAL STRESS	=	.109E+04 LBS/IN**2

NO. OF ITERATIONS	=	18
MAXIMUM DEFLECTION ERROR	=	.809E-05 IN

S U M M A R Y T A B L E

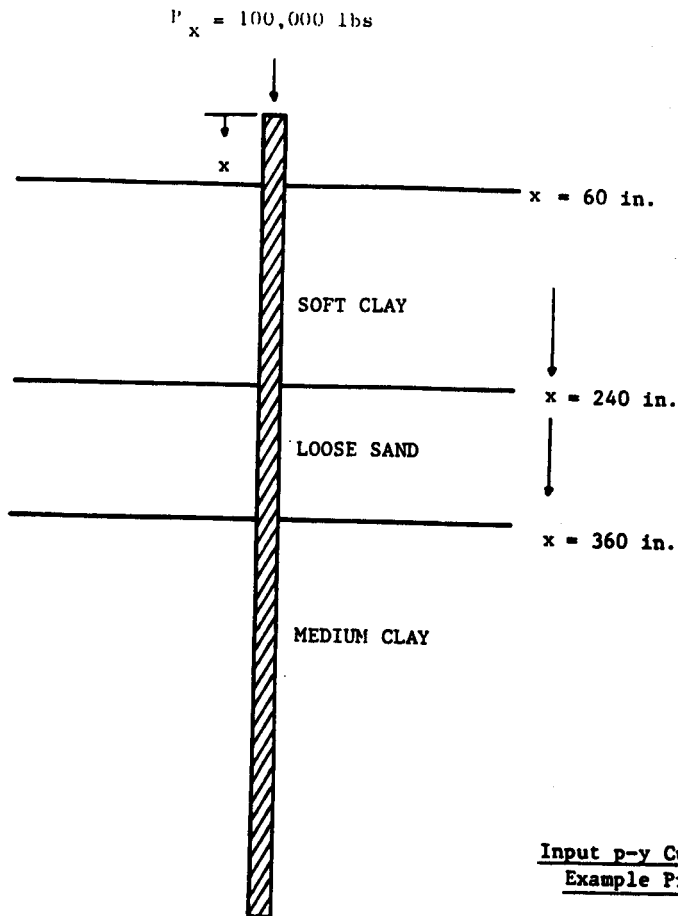
LATERAL LOAD (KIP)	BOUNDARY CONDITION BC2	AXIAL LOAD (KIP)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-KIP)	MAX. STRESS (LBS/IN**2)
.400E+02	.600E+03	.200E+03	.403E+00	-.301E-02	.414E+04	.109E+04

EXAMPLE 4, USER INPUT p-y CURVES

This example is included to illustrate a case in which the p-y curves are specified externally by the user. The head of the pile will be assumed to be unrestrained against rotation (free-head case) with no moment. A lateral load of 5 kips will be used to generate data for preparing a load-deflection curve. The p-y curves shown in Fig. 5.4 will be used. The output for every other mode is shown on the following pages.

The program interpolates linearly between points on a p-y curve and between p-y curves. In this example, the deepest p-y curve is given at 188 inches. For any nodes that extend below the depth of the deepest p-y curve, the program uses the deepest p-y curve for computation.

The input and output data are shown on the following pages.



Input p-y Curves for
Example Problem 4

File Properties:

- * 16" O.D. Pipe Pile
- * $E = 29 \times 10^6 \text{ psi}$
- * $I = 1047 \text{ in.}^4$ between $x = 0$
and $x = 180 \text{ in.}$
- * $I = 720 \text{ in.}^4$ between $x = 180$
and $x = 720 \text{ in.}$
- * Length = 720 in.

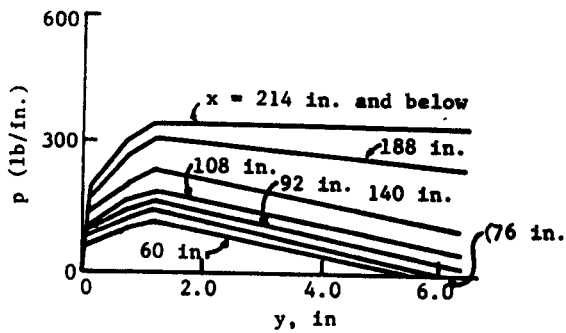


Figure 5.4. Data for Example 4.