TexGraf4

GRAPHICS PROGRAM FOR UTEXAS4

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Section 1 - INTRODUCTION

TexGraf4 is a companion graphics program for the UTEXAS4 slope stability analysis software. TexGraf4 displays information from a slope stability analysis graphically on the computer display screen. It also creates printed "hard-copy" output and DXF files that can subsequently be imported into suitable CAD software. TexGraf4 generates the graphics from information read from a special "Graphics Exchange" file created by UTEXAS4.

This manual assumes that you have UTEXAS4 and are familiar with how to use it. Before running TexGraf4 you must have created one or more suitable input data files and run them successfully with UTEXAS4 to create Graphics Exchange files. Additional details on using UTEXAS4 to create Graphics Exchange files are presented in the section below entitled "Creating Graphics Files with UTEXAS4."

TexGraf4 is designed to run under Microsoft's Windows 95/98 and Windows NT4 operating systems. TexGraf4 uses the standard Windows graphical user interface. Menus are used to open and read the graphics file created by UTEXAS4 and to control and format what is displayed.

Format and Style of this Manual

Sections 1 and 2 of this manual give you a general overview of how to run TexGraf4 and how the software works. More detailed information on specific features is then presented Sections 3 through 9 which follow.

References in this manual to specific menus and menu items in TexGraf4 are generally highlighted in **bold** text. Reference to specific items in a menu's list are designated in the form **File->Open**, where "**File**" is the menu name that appears in the menu bar, and "**Open**" is the specific item in the menu.

Some menus are hierarchical with sub-menus. For example, the **Settings->Line Weight** menu item has a sub-menu with specific line weights. One of the choices for line weights in the sub-menu is "hairline"; reference to this item in the sub-menu is designated in this manual as **Settings->Line Weight->Hairline**.

References to specific keys on the keyboard (**Enter**, **Shift**, **Esc**) and "buttons" in dialog boxes (**Cancel**, **OK**, etc.) are also shown in bold.

Creating Graphics Files with UTEXAS4

TexGraf4 requires as input the special Graphics Exchange file created by UTEXAS4. During a single session TexGraf4 can read multiple sets of data from a single Graphics Exchange file and read different sets of data from separate Graphics Exchange files. All of the information read is stored in memory and can be displayed at the same time. Thus, you can "overlay" graphics from separate runs or problems. Once the data have been imported and read into memory by TexGraf4 you can also selectively choose what information is displayed and/or printed from the information in memory.

To create the appropriate Graphics Exchange files the input data files for UTEXAS4 must include the necessary Command Word "GRA" (GRAphics output). The "GRA" Command Word directs UTEXAS4 to write the Graphics Exchange file for each set of data that exists when either the Command Word "COM" (COMPUTE) or the Command Word "NO" (NO COMPUTE) are issued in the UTEXAS4 input file.

UTEXAS4 can perform computations for several problems from data in a single input file. When this is done data for the various problems are all written to the same Graphics Exchange file, which can then later be imported into TexGraf4 in its entirety. Multiple problems can also be solved using data in separate input files for each problem. The choice to enter data in one input file or several different input files is entirely up to you and does not limit what you can later display in TexGraf4. Computations with either form of input can eventually all be imported into TexGraf4 and displayed simultaneously if desired. Similarly, when several sets of computation are performed with data from a single input file, results from only one of the sets of computations can be displayed alone, even though the Graphics Exchange file may contain results from several sets of computations.

For each set of data read from either a single Graphics Exchange file or multiple Graphics Exchange files TexGraf4 adds a menu item to its "Utexas" menu ("Utexas" is one of the main menu items in TexGraf4's menu bar). Ordinarily the text that is displayed in the menu for each set of computations is the text that is entered as a "Label" in the UTEXAS4 data input file. If no Label text is entered, the menu text consists of the first approximately 60 characters of the first line of the Problem Heading entered with the UTEXAS4 input data. The "Label" and "Problem Heading" data are entered as Group A data in UTEXAS4. UTEXAS4 allows you to enter several separate problem Headings for even a given set of data, e. g. one problem heading may be entered for the Profile Line data and another one may be entered with the Analysis/Computation data. When multiple Problem Headings are entered for a given problem, the Problem Heading that is displayed as text in TexGraf4 will be the last Problem Heading that was read by UTEXAS4 before the computations were performed. If neither a Label nor a Problem Heading is entered with the UTEXAS4 input data, the menu text for each data set is

shown as "Data Set Number xx (No heading or label)" where "xx" represents the number (1, 2, 3, etc.) of the data set read into TexGraf4; data sets are numbered in the order they are read by TexGraf4.

Application Preferences

Various default settings used by TexGraf4 are saved as "Application Preferences". The Application Preferences include such things as what information is automatically displayed, the colors used to display various items, the style used to display lines, information on the format of DXF files, and the default directory path for finding the Graphics Exchange files. You can save the current settings as the default Application Preferences at any time by choosing the **File->Save Preferences** menu item. Each time TexGraf4 is started the Application Preferences are read and used to determine the default values.

You can also save Application Preferences to a file of your choice and leter read the preferences to reset the current preferences to the ones that you have saved. In this way you can setup a specific configuration (set of preferences) that you want to use and retrieve them when they are needed. Saving and reading Application Preferences to either the default location or to a separate file are described in Section 3 for the File Menu items.

Graphics Configuration File

Information used to customize TexGraf4 is contained in a separate Graphics Configuration file named "TexGraf4.CFG". This file is automatically read by TexGraf4 at startup. The Graphics Configuration file contains information on the optional line weights and point sizes that are displayed in the Settings menu. It also contains the names of the "standard" line style names that will appear in the dialog box used to select line styles for the DXF file when the **Settings->DXF File Line Styles** menu item is chosen.

All documentation for items in the Graphics Configuration file is contained as comments in the file itself. The file is a text file that can be viewed and modified with any suitable text editor. Before making such changes print out a copy of the file and study it. Also, if you are going to change the Graphics Configuration file, be sure to make a secure backup copy of the file in case the changes you make produce errors or unintended results in TexGraf4.

Coordinate Systems

Two independent systems of coordinates are used and referred to in this manual. The first set of coordinates are those used to define the problem in the UTEXAS4 input data. These are referred to as "world" coordinates and are typically in units of feet or meters depending on the units (English, SI) used for the problem. The second set of coordinates are those associated with the graphics display devices (monitor screen, printer, etc.). These coordinates are usually expressed in units of "points", inches, centimeters and millimeters. These are referred to as "display" coordinates.

Running TexGraf4

TexGraf4 is started like any Windows application either by double-clicking on the TexGraf4.exe application in the Windows Explorer or by launching the TexGraf4.exe application by choosing **Start->Run** from the Windows Taskbar. When TexGraf4 is launched it first displays the startup dialog containing license and version information. The information shown, including any information that the dialog may request will vary depending on the version of TexGraf4 you are using. Once you have entered any information that the dialog requires or read any messages that are displayed, click the OK button to continue.

Once the startup dialog is displayed and dismissed TexGraf4 reads the Application Preferences and the Graphics Configuration File containing information and default values for various variables described in this manual. TexGraf4 then displays its main window with a Menu and Toolbar at the top and a Status Bar at the bottom. TexGraf4 is now ready to read information from the Graphics Exchange files created by UTEXAS4 and display the information. The next section describes briefly how to get started with reading information into TexGraf4 and displaying it.

Section 2 - OVERVIEW AND GETTING STARTED

Once you start TexGraf4 the main display window, menu, toolbar and status bar are displayed. You are now ready to open and read information from Graphics Exchange Files which you have created using UTEXAS4. To read the Graphics Exchange File go to the **File** menu and select **Open**. A standard Windows dialog box is displayed for you to select the file to read. Once you select a file and dismiss the dialog box by clicking the OK button, TexGraf4 proceeds to read <u>all</u> the data sets from the designated Graphics Exchange File.

Once data are read from a Graphics Exchange File they are displayed in the main display window. Ordinarily the items that are displayed depend on the default settings in the Application Preferences that were read at startup; however, if you have changed the default display selections using the **Display->Selections** menu item[1], the items displayed will be those that you have chosen using the **Display->Selections** menu. You may only change the <u>default</u> display selections by using the **Display->Selections** menu <u>before any data are read</u> or by reading in a new set of Application Preferences[2].

Each of the data sets that is read is identified by an entry in the **Utexas** menu in the main menu bar. The labeling of each data set in the **Utexas** menu is described in more detail in Section 3, where the menus are described.

"Current Data Set"

TexGraf4 uses what is termed a "Current Data Set". The Current Data Set is the one that you can select items for by clicking in the display window. Many of the settings that you make using various menu items are also applied to the Current Data Set.

When data are first read into TexGraf4 from Graphics Exchange Files, the first data set read becomes the Current Data Set. If more than one data set is read, you can use the **Utexas** menu to choose which data set is the Current Data Set. When you want to change the settings for a particular data set, you will normally first make that data set the Current Data Set by choosing it in the **Utexas** menu; then, you will change the settings.

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[1] The **Display->Selections** menu item is ordinarily used to set the display selections for the "Current" data set. To use the **Display->Selections** menu item to set the <u>default</u> display selections, you must do so before any data have been read.

[2] New Application Preferences are read using the **File->Read Preferences from File** menu item.

The Current Data Set only affects what you can select and set options for; it does not refer to what is displayed. Results from all data sets can be displayed at the same time if you wish.

Menus

The menus displayed by TexGraf4 at the top of the display window are used to control most of the functions of TexGraf4. The function of each menu and menu item are described in Section 3 of this manual.

Toolbar

The main Toolbar contains a collection of small icons and is displayed at the top of the display window. The Toolbar may be relocated by clicking and dragging it away from its docked location. The left hand portion of the Toolbar supports a number of "Standard" windows functions including opening a file and printing what is displayed on the screen. The right-hand side of the Toolbar contains a number of icons that are used to manipulate the display and control the display of "graphics grid[3]" points and lines for reference. The function of these special Toolbar items is described in Section 4, which covers the Toolbar in further detail.

Status Bar

The Status Bar at the bottom of the display window has four panels used to display various information. The left-most panel is used to display information about the items (icons) in the main Toolbar when the cursor is positioned over them. It is also used to display information about each menu item when the menu is active and selections are being made by scrolling down the "popped-up" menu. When an item in the display window is selected (by clicking on it) and the cursor is positioned in the display window (not in the menu or Toolbar area), the left-most panel of the status bar displays information about what is selected. For example if a point on a Profile Line is selected, the number of the Profile Line, the number of the point, and the x,y coordinates of the point are displayed at the left of the status bar.

The second two panels in the status bar, near the right hand side, are used to display the x-y "world" coordinates representing the current position of the cursor and

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[3] The "graphics grid" displayed by TexGraf for reference should be distinguished from the "search grids" that are used by UTEXAS4 to locate a critical circle. The search grids are displayed as part of the problem information by TexGraf.

scale. As the cursor is moved across the display window these coordinates are constantly updated.

The last, right-most panel in the Status Bar is used to display quantities that are being "tracked" by the cursor. Further details on what can be "tracked" and how the tracking display is controlled are given in Section 8 on Tracking.

Selecting Items

Items displayed in the main display window can be "selected" by clicking on them with the mouse. Items can be selected to display information about them in the Status Bar, as described above, or they may be selected to set information about how the item is displayed. For example to change the type and size of symbols used to display points on the Profile Lines, points are selected. Similarly, to change the scaling used to display distributed loads on the surface of the slope, the distributed load is selected.

To select an item, position the cursor over the item and click once. If more than one "selectable" item exists at the point where you clicked, a menu "pops-up" with a list of the items at that location. Use the menu to choose which item you want to "select." Once selected, the item will be highlighted and information on the item should appear in the left hand portion of the Status Bar.

In general you can only select items that belong to the Current Data Set and are displayed (visible) in the display window. The Current Data Set is chosen using the **Utexas** menu; the Current Data Set is indicated by a check mark opposite the item in the **Utexas** menu list.

Section 3 - Menus

The main menu bar for TexGraf4 has the following eight menus, which are used to control many of the functions that TexGraf4 performs:

- File
- Edit
- Display
- Settings
- Utexas
- Window
- View
- Help.

Each menu and corresponding list of items in the menu are described in the remainder of this section.

File Menu

The **File** menu includes twelve static items plus the names of the six most recently opened files. Each of the items is described below.

New…

The **New** menu item clears from memory all data that have been read to this point and displays a dialog box for you to select a new Graphics Exchange file to read. Once you select a file name from the dialog box and click OK to dismiss the dialog, the data are read and displayed. The labels for each set of data read appear in the **Utexas** menu so that you can select which set of data is the "Current Data Set". If no labels were entered in the data for UTEXAS4, the first line of the problem heading is used to identify each problem set. The items displayed initially are controlled by the default selections in the Application Preferences.

Open…

The **Open** menu is similar to the **New** menu except that any data that have been previously read into memory are saved and remain in memory. The new data are added to the existing data and the **Utexas** menu reflects the changes.

Print…

The **Print** menu is used to print the graphics displayed on the screen. When you choose this menu a standard Windows print dialog box is displayed for you to choose the printer and number of copies to be printed. You can also print by clicking on the Print icon in the Main Toolbar.

Print Preview

Print Preview is used to view what will be printed before it is printed. If you are satisfied with the display you can click the **Print** button located near the upper left of the print preview window or you can dismiss the print preview dialog box by clicking the **Close** button to print later.

Print Setup

The **Print Setup** item displays a standard Windows print setup dialog box for you to choose a printer and paper.

Default Input File Directory …

This menu item is used to set the default directory for opening Graphics Exchange Files. The first time you choose **File->New** or **File->Open**, the default directory is the one designated in the Application Preferences. The **Default Input File Directory** menu item is used to change the default directory. When you choose this menu item, a dialog box is displayed for you to choose the directory path where Graphics Exchange Files are located. Ordinarily when you change the default directory you will want to choose either the **File->Save Preferences** or **File->Save Preferences to File** menu items to save the selection.

The default input file directory only applies to the first time you open a file after starting TexGraf4. After a file has been opened, the default directory for opening files is assumed to be the last directory in which files were opened.

Create DXF File

Create DXF File creates a file of graphics information using the Autodesk®, Inc. "Drawing Exchange File" (DXF) format. This option and the file that is created are used to import UTEXAS4/TexGraf4 graphics information into a CAD program that recognizes the DXF file format. The file contains the information needed to display the items currently displayed in TexGraf4's main display window. You choose what is contained in the DXF file by choosing what is displayed in TexGraf4's display window. Use the **Display->Selections** menu to choose what will be displayed and contained in the DXF

file. Additional information regarding DXF files is given in Section 9 - DXF FILE EXPORT.

Save Preferences

This menu item is used to save the current settings as the default Application Preferences. These are the default settings that are used when the application starts up. Almost all settings are "global" for all data sets and do not depend on any particular set of data. However, the display settings that are saved as preferences do depend on whether data exist and which set of data is current. If no data exist, the display settings that are saved are the settings that are currently used as defaults by TexGraf4 when new sets of data are read. These settings are controlled by the last Application Preferences that were read and by any changes that were made using the **Display->Selections** menu when no data existed in memory. If data do exist in memory when the Application Preferences are saved, the display settings will be the ones that have been chosen for the Current Data Set. Thus, in saving Application Preferences it is important to have the appropriate data (or no data) active at the time the Application Preferences are saved.

Restore Preferences

Resets the preferences to the default Application Preferences. If data have been read from a Graphics Exchange File and exist in memory when you choose this menu item, you will be prompted to choose whether to set the current display selections to the default display selections read from the new Application Preferences or leave the display selections as they are. All other settings (colors, line styles, etc.) automatically take effect when new Application Preferences are read regardless of whether data exist or not.

Save Preferences to File…

Saves the current settings to a file rather than to the standard Application Preferences. When you choose this menu item you will be prompted for the name of the file in which the settings are to be saved. You can actually create multiple sets of preferences by saving different setting to different files. The information saved follows the same rules described above for the **Save Preferences** item. That is, the selections for what information is displayed may either be the current default settings or the settings for the Current Data Set depending on what, if any data exist in memory.

Once saved the settings can be read back in using the **File->Read Preferences from File** menu item.

Read Preferences from File…

Similar to the Restore Preferences menu item except you are prompted for the name of a file containing the preferences. When you choose the **Read Preferences from**

File menu item a standard Windows file open dialog is displayed for you to choose the Preferences file to read. Once you select the file and dismiss the dialog box by clicking the **OK** button, the new Preferences file is read and the new settings take affect. You must have already created a preferences file using the **File->Save Preferences to File** menu item to use the **Read Preferences from File** menu item.

The primary Application Preferences contain the default settings that are active at startup. If you want to use a set of preferences different from the default preferences, you can choose the desired settings in TexGraf4 and then use the **File->Save Preferences to File** menu to create an alternate Preferences file. This **File->Read Preferences from File** menu item is then used to read the preferences from the file that you created and make them the current application settings. In this way you can actually create and use several different sets of preferences.

Most Recent Files

Immediately following the **Read Preferences from File** menu item in the **File** menu is a list of the six most recently opened files. You can choose any of the six most recently opened files from this list to open them.

Exit

Use **Exit** to quit TexGraf4 when you are finished.

Edit Menu

The **Edit** menu has just one item. Normally, when nothing is selected the item is labeled "Move" and is dimmed. If you select either an item associated with the material property table (interior lines, border lines or text) or the text representing the factor of safety, the text for the item in the **Edit** menu changes. Depending on which of these items is selected the text will then read either "**Move Material Property Table**" or "**Move Factor of Safety Text**". This menu is used to move these items on the display screen using the mouse or other pointing device. Refer to Section 7 for further details on moving items.

Display Menu

The Display menu is used to select what is displayed. The menu has six (6) items which are each described below.

Selections…

The Selections item is used to choose what is displayed for the "current" data set. When you choose this item a tabbed dialog box is displayed for you to make your selections. The display selections are grouped into four categories (four tabs): (1) Stage 1 Input, (2) Stage 2 Input, (3) Results, and (4) Miscellaneous. Each of these categories is briefly described below and the contents are summarized in Tables 3.1 through 3.4. More detailed information on specific items displayed is presented in Section 5 - GRAPHICAL DISPLAY OF ITEMS.

Stage 1 Input

Stage 1 Input includes data that are input to UTEXAS4 for conventional, single-stage computations and for the first stage of multi-stage computations. The Stage 1 Input items that can be selected for display are listed in Table 3.1. The "page" (tab) of the Display Selections dialog box containing the Stage 1 Input selections is shown in Figure 3.1; this page contains two buttons: **Select All** and **Clear All**. Use the buttons to select all of the Stage 1 Input items for display or to clear ("de-select") all Stage 1 Input items from the display list.

Stage 2 Input

Stage 2 Input selections consist of the input data used for the second and third stages of multi-stage computations. These data only exist when multi-stage computations are performed. Stage 2 Input items that can be displayed are listed in Table 3.2. The "page" (tab) of the Display Selections dialog box containing the Stage 2 Input selections is shown in Figure 3.2. This dialog page contains Select All and Clear All buttons that can be used to select or clear ("de-select") all Stage 2 input items from the display list.

Table 3.1

Stage 1 Input Data Items that Can be Displayed Graphically

Item	Description
Profile Lines	Lines are drawn representing the Profile Lines
Profile points	Symbols are plotted at each point where a coordinate was specified for the Profile Line.
Profile line numbers	The number of each Profile Line is displayed as text superimposed on the Profile Line. The text is located at the midpoint of the longest visible segment of each Profile Line.
Fill profile/material regions	The area beneath each Profile Line is filled with a pattern.
Material numbers	The numbers of materials are displayed in the area beneath each Profile Line.
Material property table	A table of material properties is displayed. The table contains the material number, material description, unit weight, shear strength parameters and pore water pressure information.
Piezometric lines	Lines are drawn representing each piezometric line.
Piezometric line points	Symbols are plotted at each point where coordinates were specified to define the piezometric line.
Piezometric line numbers	The number of each piezometric line is displayed as text on the line. The numbers are displayed on the longest visible segment of each piezometric line.
Interpolation points for pore pressures	Symbols are displayed at the location of each point that was entered for interpolating values of pore water pressure.
Interpolation points with r-sub-u values.	Symbols are displayed at the location of each point where values of the pore pressure coefficient, r_u, were specified for interpolating pore water pressures.
Interpolation points for shear strengths.	Symbols are displayed at the location of each point where values of shear strengths are specified for interpolation.
Slope line.	The line representing the surface profile of the slope is displayed.
Slope points.	Symbols are plotted at the location of each point on the slope entered as input data (or generated by UTEXAS4 from the Profile Lines).
Distributed loads - Normal (perpendicular)	The normal (perpendicular) component of the distributed load is displayed as a series of vectors acting on the surface of the slope.
Distributed loads - Shear (tangential)	The shear component of the distributed load is displayed.
Distributed load points.	Symbols are displayed at each point where the distributed load was specified in the input data.
Line loads.	Scaled vectors representing each line load are displayed.
Reinforcement lines.	Each reinforcement line is drawn.
Reinforcement points.	Symbols are plotted at each location where a coordinate and forces were specified for reinforcement lines.

Table 3.1 - continued

Stage 1 Input Data Items that Can be Displayed Graphically

Item	Description
Longitudinal reinforcement force distribution.	The distribution of longitudinal forces in the reinforcement is displayed immediately adjacent to the reinforcement line.
Transverse reinforcement force distribution.	The distribution of transverse (shear) forces in the reinforcement is displayed immediately adjacent to each reinforcement line.
Initial circle center points.	A cross (+) representing the center point of the initial trial circle is displayed and lines are drawn from the center of the circle to the two end points of the circle. If an individual circle was analyzed, rather than a search, the individual circle is displayed. Not applicable to noncircular shear surfaces.
Initial (or individual) shear surface lines.	A line representing either the initial circular arc or the initial trial noncircular shear surface is displayed. If an individual shear surface is analyzed, rather than a search, the individual shear surface is displayed.
Initial (or individual) shear surface points.	Symbols are displayed at each location where a coordinate was specified to define the initial trial noncircular shear surface, or, if an individual shear surface was analyzed, at each point used to define the individual shear surface. Not applicable to circular shear surfaces.
Specified search grid.	The grid used to search for a critical center with circles is displayed. See Section 5 for more information on what is displayed.
Crack information.	Information pertaining to any "tension" crack is displayed; a broken line is displayed at the base of the "cracked" zone and the cracked zone is filled with vertical hatching. (The original default color for this hatching is red to distinguish this from the hatching for the water - see below.)
Crack water (or other fluid) information.	Water in the tension crack is displayed by vertical hatching. (The original default color for this hatching is blue to distinguish this from the hatching for the crack itself - see above.)
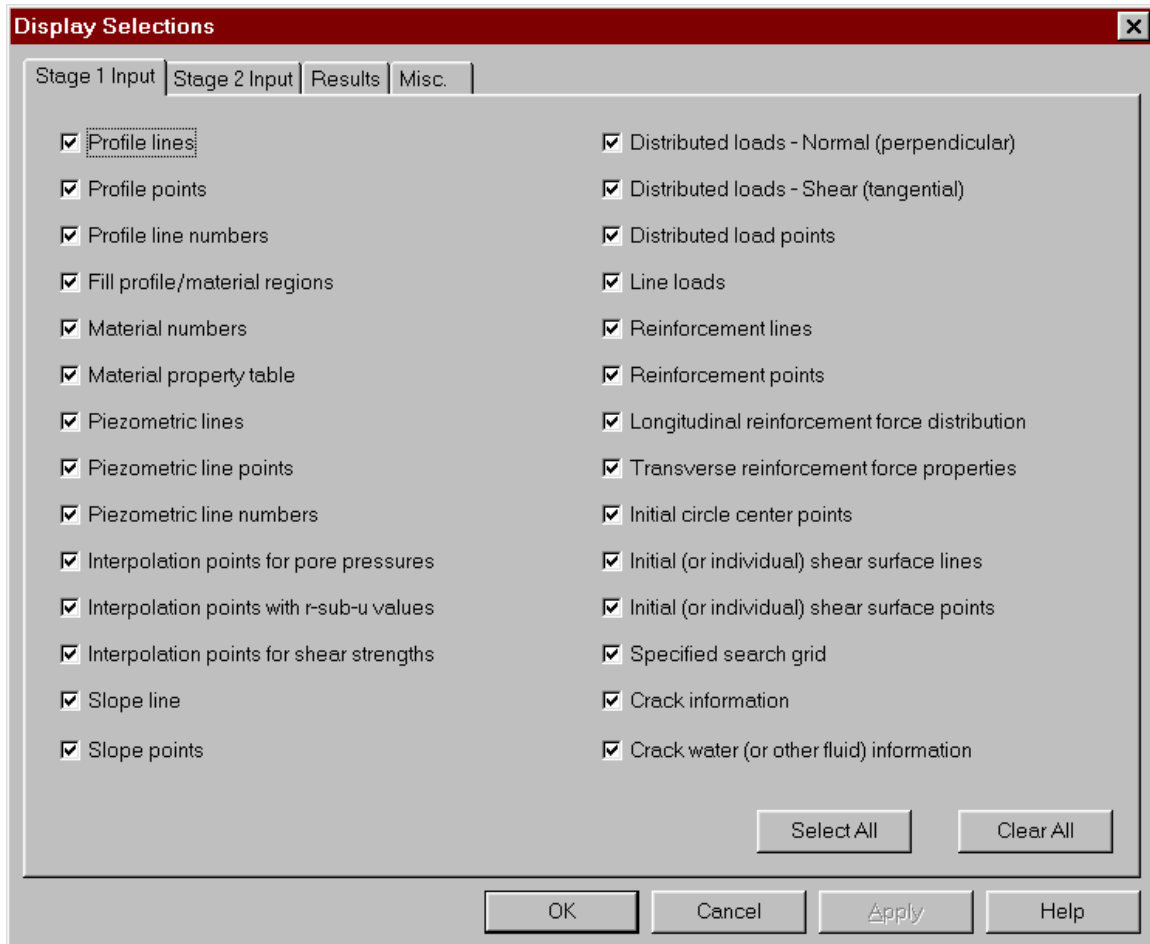
Figure 3.1 - Dialog Box "Page" (Tab) Used to Select Stage 1 Input Data for Display

Table 3.2

Stage 2 Input Data Items that Can be Displayed Graphically

Item	Description
Material property table	A table of material properties for the second and third stage of multi-stage computations is displayed. The table is identical to the one displayed with the material properties for the first stage except for the actual values in the table.
Piezometric lines	Lines are drawn representing each piezometric line defined for the second- and third- stage computations.
Piezometric line points	Symbols are plotted at each point where coordinates were specified to define the piezometric line for the second- and third- stage computations.
Piezometric line numbers	The number of each piezometric line is displayed as text on the line. The numbers are displayed on the longest visible segment of each piezometric line for the second- and third- stage computations.
Interpolation points for pore pressures	Symbols are displayed at the location of each point for interpolating values of pore water pressure for the second- and third- stage computations.
Interpolation points with r-sub-u values.	Symbols are displayed at each point where values of the pore pressure coefficient, r_u, were specified for interpolation for the second- and third- stage computations.
Interpolation points for shear strengths.	Symbols are displayed at the location of each point where values of shear strength were specified for interpolation for the second- and third- stage computations.
Distributed loads - Normal (perpendicular)	The normal component of the distributed load for the second- and third- stage computations is displayed as a series of vectors acting on the surface of the slope.
Distributed loads - Shear (tangential)	The shear component of the distributed load for the second- and third- stage computations is displayed.
Distributed load points.	Symbols are displayed at each location where a value of distributed load was specified in the input data for the second- and third- stage computations.
Line loads.	Scaled vectors representing each line load for the second- and third- stage computations are displayed.
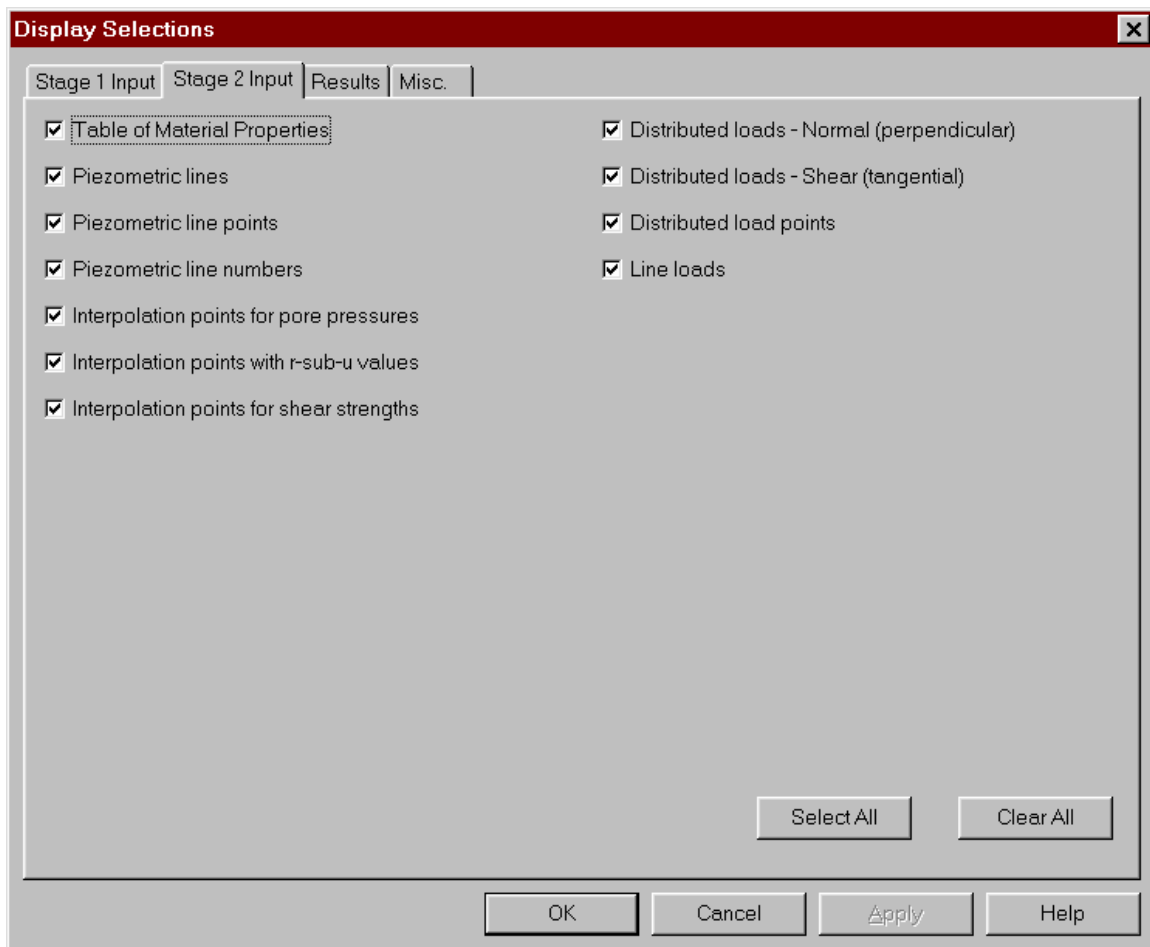
Figure 3.2 - Dialog Box "Page" (Tab) Used to Select Stage 2 Input Data for Display

<u>Results</u>

The Results items consist of information created as part of the slope stability computations. These items are only available for display when slope stability computations are successful. In contrast the Stage 1 and Stage 2 Input items described above are available even when no computations are requested[4] or when computations are not successful in UTEXAS4. The Results items that can be displayed are listed in Table 3.3.

The "page" (tab) of the Display Selections dialog box containing the Results selections is shown in Figure 3.3; this page contains two buttons: **Select All** and **Clear All**. Use the buttons to select all of the Results items for display or to clear ("de-select") all Results items from the display list.

<u>Miscellaneous</u>

Miscellaneous items include the triangles created for the interpolation of pore water pressures or shear strength, and the x-y coordinate axes. The Miscellaneous items are listed in Table 3.4. The "page" (tab) of the Display Selections dialog box containing the Miscellaneoues selections is shown in Figure 3.4.

The last three items listed in Table 3.4 are "special" items. The "special" items are used to display setting information (available patterns, line styles, and symbols) for TexGraf4 and have nothing to do with displaying a particular set of data from UTEXAS4. The "special" items are displayed as an aid to setting up TexGraf4 and setting information on how items are to be displayed. When any of the special items is selected for display, none of the other items in Table 3.4 or Tables 3.1 through 3.3 are displayed..

Clear Display for Selection

This menu item is used to to suppress display of an item that is currently selected in the main display window. Choosing this item has the same effect as choosing the **Display->Selections** menu item and unchecking the corresponding check box in the tabbed Display Selections dialog box. **Clear Display for Selection** only applies to the current data set and the type of item that you have selected. To re-display any item that you have chosen not to display, you must choose the **Display->Selections** menu item and again check the appropriate item in the dialog box that is displayed.

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[4] UTEXAS4 may be requested to read data, but perform no computations. This is done by entering the "NO compute" Command Word in the UTEXAS4 input data.

Table 3.3

Results of Stability Computations that Can be Displayed Graphically

Item	Description
Computed factor of safety	Text is displayed showing the computed factor of safety and, if Spencer's procedure is used, the computed side force inclination.
Critical (or individual) shear surface line segments.	The line representing the most critical shear surface (lowest factor of safety) found by the automatic search is displayed. If an individual shear surface is analyzed, rather than a search, the individual shear surface is displayed.
Critical (or individual) shear surface points.	The points along the most critical shear surface (lowest factor of safety) found by the automatic search are displayed. If an individual shear surface is analyzed, rather than a search, points on the individual shear surface are displayed. The points correspond to the locations of the vertical boundaries between slices.
Critical (or individual) circle center point.	A cross (+) is displayed at the center of the critical circle, or if an individual circle was analyzed the center of the individual circle. Straight lines are also drawn from the center point to the two ends of the circle. Not applicable to noncircular shear surfaces.
Factor of safety contours (circles - fixed grid only)	Displays contours of factor of safety based on various trial center points for circles. This is available only when a search has been conducted using circles and the Type 2, "fixed-grid" search option.
"N-most" critical shear surfaces	Draws lines representing the n-most shear surfaces with the lowest factors of safety located during an automatic search. The input data to UTEXAS4 designates the number (n) of shear surfaces that are to be saved for this display.
Slices	Draws vertical lines representing the boundaries between slices
Force vector for water in crack.	Displays a horizontal vector representing the force due to water in the vertical "tension" crack. The force is displayed for the most critical shear surface found in an automatic search or for the individual shear surface if an individual surface is analyzed.
Total normal stress on shear surface	Displays the distribution of total normal stresses along the shear surface. The shear surface for this distribution and the following two distributions is the most critical shear surface or, in the case of no search, the individual shear surface that is specified.
Effective normal stresses on shear surface	The distribution of effective stresses along the shear surface is displayed - only meaningful for effective stress analyses where pore water pressures are specified.
Pore pressures on shear surface	The distribution of pore water pressures along the shear surface is displayed.
Line of thrust	A line through the point of action of the resultant side forces between slices ("line of thrust") is displayed; only applicable to Spencer's procedure of analysis.

Display Selections   ✕

| Stage 1 Input | Stage 2 Input | Results | Misc. |

☑ Computed factor of safety

☑ Critical (or individual) shear surface line segments

☑ Critical (or individual) shear surface points

☑ Critical (or individual) circle center point

☑ Factor of safety contours (circles - fixed grid only)

☑ "N-most" critical shear surfaces

☑ Slices

☑ Force vector for water in crack

☑ Total normal stress on shear surface

☑ Effective normal stresses on shear surface

☑ Pore pressures on shear surface

☑ Line of thrust

[Select All]   [Clear All]

[OK]   [Cancel]   [Apply]   [Help]

Figure 3.3 - Dialog Box "Page" (Tab) Used to Select Results for Display

Table 3.4

Miscellaneous Items that Can be Displayed Graphically

Item	Description
XY Axes	Displays the x-y coordinate axes for the slope geometry.
Triangulation of pore pressure interpolation points - Stage 1	Displays triangles created for the interpolation data points. Triangles are for the first-stage (conventional) data where pressure values were specified for pore water pressures.
Triangulation of r-sub-u interpolation points - Stage 1	Same as above except data for r_u values.
Triangulation of shear strength interpolation points - Stage 1	Same as above except for data for interpolating shear strengths.
Triangulation of pore pressure interpolation points - Stage 2	Same as above except for pressure values, Stage 2 input.
Triangulation of r-sub-u interpolation points - Stage 2	Same as above except for r_u values, Stage 2 input.
Triangulation of shear strength interpolation points - Stage 2	Same as above except for values used to interpolate shear strengths, Stage 2 input
Print area rectangle	Displays a rectangle representing the actual size of the area where the geometry will be displayed on the printed page (Subject to limitations described in Section 5 - GRAPHICAL DISPLAY OF ITEMS)
Available patterns	Displays the available patterns that can be selected for filling the areas beneath Profile Lines.
Available line styles	Displays the available line styles that can be assigned for drawing lines (e. g. Profile Lines, Piezometric Lines, etc.)
Available symbols	Displays the various symbols that can be used to display points.
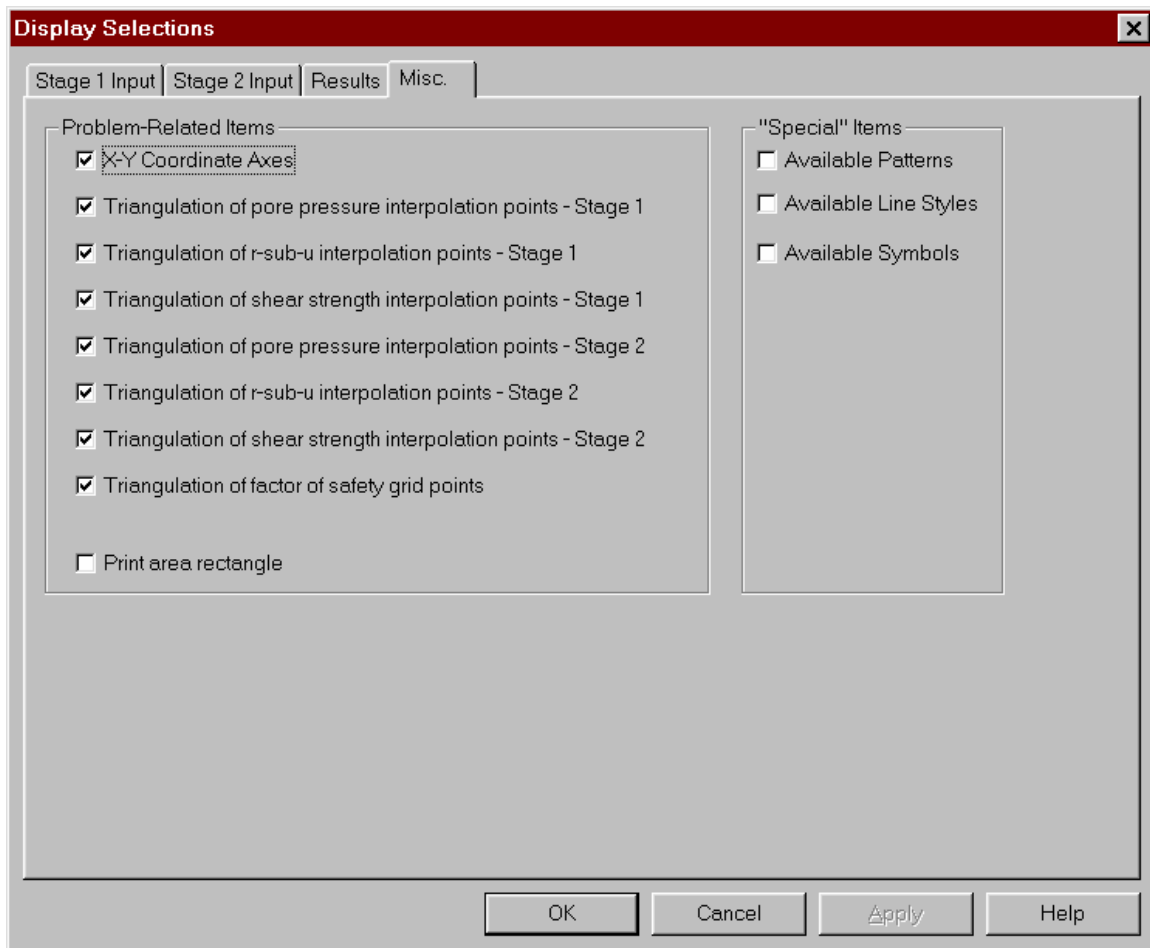
Figure 3.4 - Dialog Box "Page" (Tab) Used to Select Miscellaneous Items for Display

Set All for Current Data Set

This sets all items for the Current Data Set so that they will be displayed. Choosing this menu item is equivalent to choosing the **Display->Selections** menu item and checking all the items in the tabbed dialog box that is displayed.

Clear All for Current Data Set

This changes the settings so that nothing is displayed for the Current Data Set. It is equivalent to choosing the **Display->Selections** menu item and clearing all the check boxes in the tabbed dialog box that is displayed. If only a few items are to be displayed, it may be easiest to first clear all items for display by choosing this menu item (**Clear All for Active Data Set**) and then using the **Display->Selections** menu item to select the few items that are to be displayed.

Set All for All Data Sets

Similar to **Set All for Current Data Set** described above except applies to all the data sets that have been read into TexGraf4. The maximum amount of information is displayed by choosing this item.

Clear All for All Data Sets

Similar to **Clear All for Current Data Set** described above except clears display of information for all the data sets that have been read into TexGraf4.

Settings Menu

The **Settings** menu is used to control how information is displayed. Many of the **Settings** menu items apply to what is currently selected in the main display window and require that an appropriate item be selected before choosing the **Settings** menu item. For example the **Settings->Line Weight** item is used to set line weights. To set the line weight used to display Profile Lines you should first select a segment on one of the Profile Lines and then choose an appropriate line weight from the **Settings->Line Weight** menu. Each of the **Settings** menu items is described below.

Line Weight

The **Line Weight** menu item is used to set the weight of lines drawn in the display. To set the line weight for a particular item, first select the item by clicking on it in the display window and then choose a line weight using the Line Weight menu. Line weights are assigned based on the type of object, rather than on a specific instance of the object. For example, all Profile Lines have the same line weight; when you change the line weight for one Profile Line, the line weight is changed for all Profile Lines. The items for which you can change   line weight are listed in Table 3.5. Table 3.5 also gives further details on the items that must be selected to change the corresponding line weight. For further details on selecting items see Section 6 - SELECTING ITEMS and Table 6.1.

The Line Weight menu has a sub-menu listing the available line weights. The first 8 items in the sub-menu are TexGraf4's "standard" line weights; the standard line weights are always available. The last item in the Line Weight sub-menu allows you to select "Custom" line weights. Depending on the settings in the Graphics Configuration File there may be additional "supplemental" line weights available listed after the first 8 standard line weights and before the custom line weight option. The line weights are described in additional detail below.

Standard Line Weights.

The standard line weights are "Hairline" and 1, 2, 3, 4, 5, 7 and 10 "points". One "point" is approximately 1/72-inch. "Hairline" is the finest line weight that the output device can produce. Normally this will differ depending on the output device; printers and graphics monitors typically have different line widths.

Table 3.5

Items that May Have Their Line Weights Changed

Item	Selection/Explanation
Material property table	Select a "grid" line in the table of material properties to set the line weight. Separate line weights may be set for the border (exterior lines) and for interior lines in the table. Select an appropriate interior or border line to set the corresponding line weight.
Profile lines	Select a Profile Line segment to set the line weight for drawing Profile Lines.
Profile line point	Select a point on the Profile Line to set the line weight for drawing symbols at the Profile Line coordinate points.
Piezometric lines	Select a piezometric line to set the line weight for drawing piezometric lines.
Piezometric line points	Select a point on the piezometric line to set the line weight for drawing symbols at the piezometric line coordinate points.
Pressure, r_u or shear strength interpolation point	Select one of the interpolation data points to set the line weight for drawing symbols at the points.
Pressure, r_u or shear strength interpolation triangle	Select one of the triangles in the triangulation of interpolation data points to set the line weight for drawing the triangles.
Slope line	Select a segment of the slope line.
Slope points	Select a slope point to set the line weight for drawing the symbols at slope coordinate points.
"Crack" line.	Select a point or segment of the line representing the bottom of the crack.
"Crack" water line.	Select a segment of the line representing the water surface for the crack.
Distributed load point	Select a distributed load point t set the line weight for drawing symbols at the points where values of the distributed load are specified.
Distributed load distribution	Select the outline of the distributed load to set the line weight for drawing the vectors and outline of the distributed load.
Line load vector	Select either a line load point or vector to set the line weight for drawing the line load vectors.
Reinforcement point	Select a reinforcement line point to set the line weight for drawing symbols at points where the reinforcement line and forces are specified.
Reinforcement line segment	Select a reinforcement line segment to set the line weight for drawing reinforcement lines.
Reinforcement force distribution.	Select the longitudinal or transverse reinforcement force distribution to set the line weight for drawing the force distribution (outline and vectors).

Table 3.5 - continued

Items that May Have Their Line Weights Changed

Item	Selection/Explanation
Initial trial shear surface point.	Select a point on the initial trial shear surface to set the line weight used to draw symbols. (Applicable to noncircular shear surfaces only).
Initial trial shear surface line.	Select either the arc or line segment representing the initial trial shear surface to set the line weight for drawing the surface.
Initial trial circle center.	Select the center point for the initial trial circle to set the line weight for drawing the center point and radii extending from the center point to each end of the initial trial circle. (Applicable to circular shear surfaces only).
Search grid.	Select the grid used for searching to set the line weight used to draw the grid. (Applicable to circular shear surfaces only).
Critical shear surface point.	Select one of the points along the critical shear surface to set the line weight for drawing symbols; symbols (points) coincide with the boundaries between slices.
Critical trial shear surface line.	Select a segment of the critical shear surface; "segments" correspond to the base of slices.
Critical circle center.	Select the center point for the critical circle to set the line weight used to draw the center and radii extending from the center point to each end of the critical circle. (Applicable to circular shear surfaces only).
N-Most Critical Shear Surfaces	Select one of the "n-most" critical shear surfaces to set the line weight for drawing the n-most critical shear surfaces. All "n" surfaces have the same line weight.
Total normal stress, effective normal stress and pore water pressure distribution.	Select the appropriate stress distribution to set the line weight for drawing the respective distribution of stress along the shear surface.
Vertical slice boundaries	Select either a slice or one of the vertical lines between slices to set the line weight for drawing the vertical boundaries between slices.
Crack water force vector	Select the vector representing the force due to water in the "tension" crack to set the line weight for drawing the force vector.
Line of thrust	Select the line of thrust to set the line weight for drawing it.
Factor of safety contours	Select the factor of safety contours to set the line weight for drawing the contours.
X-Y coordinate axes	Select either the horizontal (x) or vertical (y) axis to set the line weight for drawing the axes and tick marks. The same line weight is used to draw both axes

<u>Supplemental Line Weights.</u>

Supplemental line weights listed in the Line Weight sub-menu depend on information in the Graphics Configuration File. The information in the Graphics Configuration File designates what supplemental line weights are available and how they are defined: Supplemental line weights may be defined in units of points, inches or millimeters or a mix of these three units.

<u>Custom…</u>

The Custom line weight menu item allows you to designate the line weight in either points, inches or millimeters. When you choose Custom line weights a dialog box is displayed for you to enter the line weight.

Line Style

The line Style menu item is used to set the style (solid, dashed, broken, etc.) for drawing lines for various items. TexGraf4 provides for solid lines and twelve (12) styles of broken and dashed lines. The available line styles are shown in Figure 3.5.
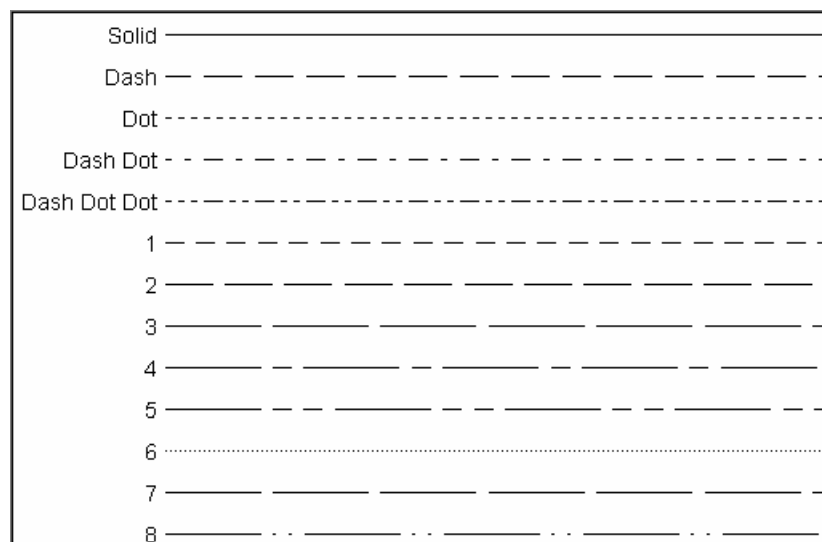
Figure 3.5 - Available styles for drawing lines.

You can also display available line styles on the screen. To do so choose the **Display->Selections** menu item and then check "Available Line Styles" in the dialog box for display selections (Available Line Styles is under the Miscellaneous tab in the Display Selections dialog box). The Available Line Styles item is one of the "special" Miscellaneous Display items; when chosen for display only line styles and other selected "special" items (available patterns, colors and symbols) are displayed.

Line styles are applied to items in the same way that line weights are set: An item is first selected in the main display window and the appropriate line style is then chosen from the **Settings->Line Style** menu. The items for which line styles can be set are listed in Table 3.6.

Point Size

The point size menu is used to set the size of symbols drawn to represent various points, including points on the Profile Lines, points used to interpolate pore water pressures, center points for the initial trial circle, etc. TexGraf4 provides 5 standard point sizes plus a number of optional point sizes depending on the information in the Graphics Configuration File. The standard point sizes are in "points" (1 point = 1/72 inch). Optional point sizes may be designated in points, inches or millimeters and are set by information in the Graphics Configuration File.

The **Settings->Point Size** menu item has a sub-menu for selecting the specific point size to be used. To set the size of a given type of point (e. g. Profile Line points), first select the point and then choose the desired point size from the **Settings->Point Size** sub-menu. The items for which point sizes can be set are listed in Table 3.7. The required selections for setting point sizes are also described in Table 3.7.

Point (Symbol) Type

The Point Type menu is used to set the type of symbol drawn to represent various points, e. g. points on the Profile Lines, points used to interpolate pore water pressures, etc.. TexGraf4 provides the 21 different symbols shown in Figure 3.6.
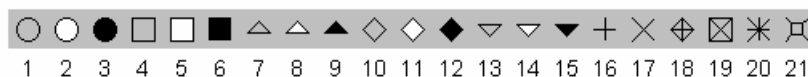
Figure 3.6 - Symbols Available for Displaying Points in TexGraf4

You can display the list of available symbols on the screen. To do so choose the **Display->Selections** menu item and then check "Available Symbols" in the dialog box for display selections (Available Symbols is under the Miscellaneous tab in the Display Selections dialog box). The Available Symbols item is one of the "special" Miscellaneous Display items; when chosen for display only symbols and other selected "special" items (available line styles and patterns) are displayed.

Table 3.6

Items that May Have The Line Style Changed

Item	Selection/Explanation
Profile lines	Select either a point or a segment of a Profile Line to set the line style for drawing Profile Lines. (Profile Line <u>points</u> are always drawn using the solid line style for drawing the symbol.)
Piezometric lines segments	Select either a point or a segment of a piezometric line to set the line style for drawing piezometric lines. (Piezometric line <u>points</u> are always drawn using the solid line style for drawing the symbol.)
Pressure, r_u or shear strength interpolation triangle	Select one of the data points or one of the triangles in the triangulation of interpolation data points to set the line style for drawing the triangles. Note: You can select points as well as triangles to set the triangle line style; the line style for drawing the points (symbols) is always solid.
Slope line	Select either a point or a segment of the slope line to set the line style for drawing the slope surface profile. Slope points (symbols) are always drawn using the solid line style.
"Crack" line.	Select a point or segment of the line representing the bottom of the crack to set the line style for drawing the crack bottom.
"Crack" water surface line segment	Select a segment of the line representing the water surface in the crack to set the line style for drawing the water surface.
Reinforcement lines	Select one of the following to set the line style for drawing reinforcement lines: (1) a reinforcement line point, (2) a reinforcement line segment, (3) a longitudinal reinforcement force distribution, or (4) transverse reinforcement force distribution. Note: Reinforcement points (symbols) and the outline of the force distributions are always drawn using a solid line style.
Initial trial shear surface.	Select either a point or segment of the initial trial circular or noncircular shear surface to set the line style for drawing the shear surface.
Critical shear surface.	Select either a point or segment of the critical circular or noncircular shear surface to set the line style for drawing the shear surface.
Slice boundaries	Select either a slice or a vertical slice boundary between slices to set the line style for drawing the vertical slice boundaries.
Line of thrust	Select the line of thrust to set the line style for drawing it.

Table 3.7

Items that May Have The Point Sizes Changed

Item	Selection/Explanation
Profile line points	Select either a point on a Profile Line or a segment of the Profile Line to set the symbol size.
Piezometric line points	Select either a point on a piezometric line or a segment of the piezometric line to set the symbol size. Symbol sizes for each loading stage (1 & 2) are set independently; therefore, you should select a point for the stage for which you want to set the point size.
Pressure, r_u or shear strength interpolation point	Select one of the interpolation data points (symbols) to set the size. Pressure, r_u and shear strength values each have different symbol sizes that are set independently. Select the appropriate type of interpolation data point (e. g. r_u values) to set the corresponding symbol size. Symbol size for each loading stage (1 & 2) are also set independently; therefore, you should select a point for the stage for which you want to set the point size.
Slope points	Select either a point on the slope line or a segment of the line defining the slope profile to set the symbol size.
Distributed load point	Select either a distributed load point or the outline of one of the load distributions (normal stress, shear stress) to set the size of the symbols drawn at points where the distributed load is specified. Point size for each loading stage (1 & 2) are set independently; select a point for the stage where the point size is to be set.
Reinforcement point	Select either a point on the reinforcement line or the outline of the distribution of longitudinal or transverse force in the reinforcement to set the symbol size for reinforcement points.
Initial trial circle center	Select the center point of the initial trial circle to set the size of the symbol drawn at the center point. (Applicable to circular shear surfaces only.)
Initial shear surface coordinate points.	Select either a point or line segment on the initial trial shear surface to set the size of symbols drawn at the locations where coordinates are specified for the initial trial shear surface. (Applicable to noncircular shear surfaces only.)
Critical shear surface coordinates points	Select either a point or line segment on the critical shear surface to set the symbol size. Symbols are drawn at points corresponding to the vertical boundaries between slices.

The appearance of symbols on the screen depends on the line weight that is chosen. Line weights for symbols are generally set by first selecting a point and then using the **Settings->Line Weight** menu item to choose the line weight. All of the symbols that are shown in Figure 3.6 and are displayed on the screen when you choose to display the list of available symbols are drawn using a line weight of 1 point.

The items for which symbol types can be set are presented in Table 3.8. To set the symbol for a particular type of data first select a point and then choose the desired symbol in the **Settings->Point (Symbol) Type** menu item. This menu item has a sub-menu with the various symbols displayed for you to choose from. The required selections for setting symbols are described in Table 3.8.

Default symbols for the various items listed in Table 3.8 are stored with the Application Preferences. If you want to use different symbols from the default ones, you can change the symbols using the **Settings->Point (Symbol) Type** menu item and save the new settings as preferences.

Font

The Font menu is used to set the font for displaying the items listed in Table 3.9. To set the font for a particular item first select the item and then choose the **Settings->Font** menu. A standard font dialog box is then displayed for you to set the appropriate font information. The selections that must be made for setting font information are described in Table 3.9. Default font selections are stored in the Application Preferences.

Color

Use the Color menu to set the color for drawing the items listed in Table 3.10. To set the color for a particular item first select the item and then choose the **Settings->Color** menu. A standard color dialog box is then displayed for you to set the appropriate color. The selections that must be made for setting colors are described in Table 3.10.

Patterns

The Patterns menu is used to set patterns for filling the various regions listed in Table 3.11. To set the pattern for filling a particular item first select the item and then choose the **Settings->Patterns** menu. The **Patterns** menu item has a sub-menu listing the patterns that can be set. The specific patterns that are shown in the menu are determined by information in the Graphics Configuration File. TexGraf4 has a total of 38 different patterns that can be used. Some or all of the available patterns may be shown in

Table 3.8

Items that May Have the Type of Symbol (Point) Changed

Item	Selection/Explanation
Profile line points	Select either a point on a Profile Line or a segment of the line to set the symbol type.
Piezometric line points	Select either a point on a piezometric line or a segment of the line to set the symbol type. Symbol types are set independently for each loading stage (1 & 2); therefore, you should select a point for the appropriate stage to be changed.
Pressure, r_u or shear strength interpolation points	Select either one of the interpolation data points (symbols) or a triangle in the triangulation of points to set the symbol type. Pressure, r_u and shear strength values each have different symbols that are set independently. Symbol types are also set independently for each loading stage (1 & 2); therefore, you should select a point for the appropriate stage to be changed.
Slope points	Select either a point on the slope line or a segment of the slope line to set the symbol type for slope points.
Distributed load points	Select either a distributed load point or the outline of one of the load distributions (normal stress, shear stress) to set the symbols drawn at points where the distributed load is specified. Point size for each loading stage (1 & 2) are set independently; select a point for the stage where the point size is to be set.
Reinforcement points	Select either a point on the reinforcement line or the outline of the distribution of either longitudinal or transverse force in the reinforcement to set the symbol type.
Initial shear surface coordinate points	Select either a point or line segment on the initial trial shear surface to set the symbol type. (Applicable to noncircular shear surfaces only; no points are drawn for initial trail circles.)
Critical shear surface coordinates points	Select either a point or segment of the critical shear surface to set the symbol type used to draw points.

Table 3.9

Items with Font Information

Item	Selection/Explanation
Profile line numbers	Select either a point, line segment or line number for one of the Profile Lines to set the font for Profile Line numbers.
Material numbers	Select the material number or region of material beneath any Profile Line to set the font for displaying material numbers.
Piezometric line numbers	Select either a point, line segment or line number of one of the piezometric lines to set the font for drawing piezometric line numbers.
Material property table	Select either the text or an interior or exterior border line in the table of material properties to set the font for drawing the table.
Factor of safety	Select the text for the factor of safety (and side force inclination if Spencer's procedure was used) to set the font.
Factor of safety contours	Select the factor of safety contours to set the font for labeling contours (drawing contour values).
Coordinate axis labels	Select either the horizontal or vertical coordinate axis to set the font for labeling the axes. The same font is used for both axes; setting the font for one axis affects both.

Table 3.10

Items Whose Color Can be Set

Item	Selection/Explanation
Coordinate axis and text	Select either the horizontal or vertical axis to set the color for the text and lines. The text and lines on both axes use the same color.
Crack "water" force.	Select the force vector representing the water in the crack to set the color for the vector.
"Crack" line.	Select either a segment of the line defining the crack bottom line or a point on the crack bottom line to set the color.
Critical circle center.	Select the center of the critical circle to set the color for the center point and radii extending from the center to each end of the shear surface.
Critical shear surface point.	Select a point on the critical (circular or noncircular) shear surface to set the point color.
Critical trial shear surface line.	Select a line segment on the critical (circular or noncircular) shear surface to set the line color.
Distributed load point	Select a distributed load point to set the color of the points. (Separate color assignments are made for Stage 1 and 2.)
Distributed load normal distribution	Select a portion of the distributed normal stress to set the color of the outline and fill of the normal stress distribution. (Separate color assignments are made for Stage 1 and 2.)
Distributed load shear distribution	Select a portion of the distributed shear stress to set the color of the outline and fill of the shear stress distribution. (Separate color assignments are made for Stage 1 and 2.)
Factor of safety	Select the text representing the computed factor of safety (and side force inclination, if applicable) to set the text color.
Factor of safety contours	Select the factor of safety contours to set the color of the contour lines and text. Contour lines and text are the same color.
Factor of safety triangles.	Select one of the triangles in the triangulation of grid points to set the color for drawing the triangles. These are the triangles used to contour factors of safety
Grid for search	Select the search grid to set the grid color.
Initial trial/individual circle center.	Select the center of the individual or initial trial circle to set the color for the center point and radii extending from the center to each end of the shear surface.
Initial trial shear surface point.	Select a point on the initial trial noncircular shear surface to set the color of the points.
Initial trial shear surface line.	Select the individual or initial trial circular or noncircular shear surface line to set the line color.
Line load.	Select either the tip or tail point of the line load vector to set its color. (Separate color assignments are made for Stage 1 and 2.)
Line of thrust	Select the line of thrust to set its color.
Material number.	Select one of the material numbers in the area beneath the Profile Lines to set the text color.

Table 3.10 - continued

Items Whose Color Can be Set

Item	Selection/Explanation
Material property table grid lines	Select any grid line in the material property table to set the color for all grid lines.
Material property table text	Select the material property text area (not grid lines) to set the text color.
Material region (fill).	Select the area beneath a Profile Line to set the color of the fill for the material beneath that particular Profile Line.
"N-most" critical shear surfaces	Select one of the "n-most" critical shear surfaces to set the color for these surfaces. (Note: All n-most critical shear surfaces have the same color except the most critical shear surface which has a separate color.)
Piezometric line points	Select any point on a piezometric line to set the color for points. (Separate color assignments are made for Stage 1 and 2.)
Piezometric line segments	Select any segment of a piezometric line to set the line color. (Separate color assignments are made for Stage 1 and 2.)
Piezometric line number	Select any piezometric line number to set the text color. (Separate color assignments are made for Stage 1 and 2.)
Profile line number	Select any Profile Line number to set the text color.
Profile line points	Select any Profile Line point to set the color for points.
Profile line segment	Select any Profile Line segment to set the color for lines.
Pressure interpolation point	Select one of the points where pressures were specified to set the color for pore pressure interpolation points. Separate colors are used for pressure values, r_u values, and shear strength values as well as for both Stages 1 and 2.
Pressure interpolation triangle	Select one of the triangles in the triangulation of data where pore pressure values were specified to set the triangle color. Separate colors are used for pressure values, r_u values, and shear strength values as well as for both Stages 1 and 2.
Reinforcement point	Select any point on a reinforcement line to set the point color.
Reinforcement line segment	Select a segment of any reinforcement line to set the line color.
Reinforcement longitudinal force distribution.	Select a portion of the outline of the distribution of longitudinal forces to set the longitudinal force distribution color.
Reinforcement transverse force distribution.	Select a portion of the outline of the distribution of transverse forces to set the transverse force distribution color.

Table 3.10 - continued

Items Whose Color Can be Set

Item	Selection/Explanation
r_u interpolation point	Select one of the points where pore pressure coefficients (r_u)were specified to set the color for r_u interpolation points. Separate colors assignments are made for pressure values, r_u values, and shear strength values as well as for both Stages 1 and 2.
r_u interpolation triangle	Select one of the triangles in the triangulation of data where pore pressure coefficient (r_u) values were specified to set the triangle color. Separate colors assignments are made for pressure values, r_u values, and shear strength values as well as for both Stages 1 and 2.
Shear surface effective stress distribution.	Select a point on the outline of effective normal stress distribution on the shear surface to set the color for the distribution outline and fill.
Shear surface pore water pressure distribution.	Select a point on the outline of pore water pressure distribution on the shear surface to set the color for the distribution outline and fill.
Shear surface total stress distribution.	Select a point on the outline of total normal stress distribution on the shear surface to set the color for the distribution outline and fill.
Slice boundaries	Select either a slice or a boundary line between slices to set the color for drawing the vertical slice boundaries.
Slope point	Select any point on the slope to set the color for slope points.
Slope line	Select any segment of the slope line to set the slope line color.
Strength interpolation point	Select one of the points where shear strength values were specified to set the color for shear strength interpolation points. Separate color assignments are made for pressure values, r_u values, and shear strength values as well as for both Stages 1 and 2.
Strength interpolation triangle	Select one of the triangles in the triangulation of data where shear strength values were specified to set the triangle color. Separate color assignments are made for pressure values, r_u values, and shear strength values as well as for both Stages 1 and 2.

Table 3.11

Items with Fill Patterns that Can be Set

Item	Selection/Explanation
Material zones beneath Profile Lines	To set the pattern used to fill a particular material, select the region where the pattern is to be set by clicking in the region immediately beneath the Profile Line. Once a region is selected, use the Patterns menu to set the pattern.
Distributed normal load.	Select the distributed normal load to set the pattern for filling the distribution of normal stresses. Then, set the pattern with the Pattern menu.
Distributed shear load.	Select the distributed shear load to set the pattern for filling the distribution of shear stresses.
Effective normal stress distribution on shear surface.	Select a point on the outline of the effective normal stress distribution on the shear surface to set the pattern for filling the stress distribution.
Longitudinal force distribution in reinforcement.	Select a portion of the outline of the distribution of longitudinal reinforcement forces to set the pattern for filling the load distribution diagram.
Pore water pressure distribution on shear surface.	Select a point on the outline of pore water pressure distribution on the shear surface to set the pattern for filling the pressure distribution.
Total normal stress distribution on shear surface.	Select a point on the outline of total normal stress distribution on the shear surface to set the pattern for filling the distribution.
Transverse force distribution in reinforcement.	Select a portion of the outline of the distribution of transverse reinforcement forces to set the pattern for filling the load distribution diagram.

the Patterns menu depending on the Graphics Configuration File. The default configuration for TexGraf4 has twenty (20) patterns, including "None".

You can display the list of available patterns on the screen. To do so choose the **Display->Selections** menu item and then check "Available Patterns" in the dialog box for display selections (Available Patterns is under the Miscellaneous tab in the Display Selections dialog box). The Available Patterns item is one of the "special" Miscellaneous Display items; when chosen for display only patterns and other selected "special" items (available line styles and symbols) are displayed.

Scaling

The Scaling menu item is used to set the scaling information (scale factors) for the items listed in Table 3.12. To set the scaling for a particular item first select the item and then choose the **Settings->Scaling** menu. An appropriate dialog box is then displayed for you to set the scale information. Further details on setting scales are described for various items below.

X-Y Coordinate (Axes)

When the coordinate axes are displayed the scaling can be set by first selecting either the horizontal or the vertical axis by clicking on one of the two axes and then choosing the **Settings->Scaling** menu item. The dialog box shown in Figure 3.7 is then displayed for you to select the scaling.

Initially all items are set automatically and the "Auto" check box for each item is checked. If you change the value for an item by typing a new value in the corresponding text box, e. g. the starting x value, the Auto check box is cleared and the value that you entered is used. If you later change your mind and decide that you want to have the value set automatically, you can do so by clicking on the Auto check box again. The scaling parameters for the coordinate axes and their meaning are described further below:

Starting X value, Starting Y value
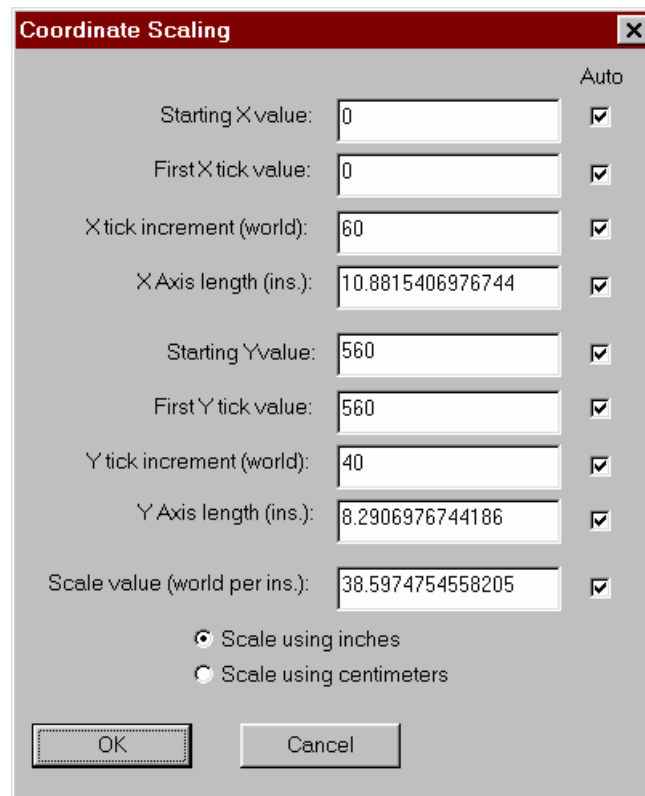
These are the starting world coordinate values for the x and y axes. When these values are specified (rather than set automatically) the axes will start with these values.

First X tick value, First Y tick value

The first tick values designate the first value where tick marks and text representing the coordinate values begin. If the values specified are less that the starting x value, the tick marks will begin at the first point where tick marks become visible if they started at the designated value and proceeded accordingly. This depends on the tick

Table 3.12

Items that Have Scaling Information

| Item	Selection/Explanation
Coordinate axes	Select one of the two (x, y) coordinate axes to set the scaling for displaying the slope geometry and related items.
Crack "water" force	Select the horizontal vector representing the force in the crack to set the scaling for this force..
Distributed loads	Select either a distributed load point or the outline of the stress distribution to set the scaling.
Line loads	Select either the tip or tail of the line load vector to set the scaling for the line loads.
Reinforcement forces	Select either (a) a point on a reinforcement line, (b) a segment of a reinforcement line, or (c) the outline of the distribution of longitudinal or transverse force in the reinforcement to set the scaling for the reinforcement force distributions.
Stresses and pressures on the shear surface	To set the scaling for distributions of stress along the shear surface select one of the following: (a) a point on the critical shear surface, (b) a segment of the critical shear surface/base of slice, (c) the outline of either the total normal stress, effective normal stress, or pore water pressure distribution on the shear surface.

Figure 3.7 – Coordinate Scaling Dialog Box

increment as well. If the first tick value exceeds the largest value on the axis, no tick marks or coordinate values are displayed.

X tick increment, Y tick increment

The tick increments are the intervals in world coordinate units (e. g. feet, meters, etc.) between adjacent tick marks. Axes will always be scaled so that there is at least one tick increment along each axis. Because of this, if a tick increment is specified that is much larger than the total range of coordinate values for a problem, the scaling may be such that the display is very small.

X axis length, Y axis length

The axes lengths represent the physical length of the axis line drawn on the display or printer, independently of the world coordinates used for the problem. The axis lengths may be specified in either inches or centimeters (see "Units") below.

Scale value

The scale value is specified in terms of the world coordinate units (feet, meters, etc.) per display coordinate units. The display coordinate units may be in either inches or centimeters; display coordinate units are chosen using the two radio buttons immediately below the scale value at the bottom of the dialog box shown in Fig. 3.7.

Crack "Water" Force

The force produced by water (or another fluid) in the tension crack is represented as a horizontal vector. To set the scaling for this vector select the force and choose the **Settings->Scaling** menu item. The dialog box shown in Fig. 3.8 is then displayed. You can choose from five different options for scaling. These options are described in Table 3.13. Depending on the option selected, you will need to enter an appropriate scale "factor".

Distributed Loads

Distributed loads are represented as vectors and an outline of the distribution of stress. The same scaling is used to display the normal and shear stresses. To set the scaling select either a point where the distributed load was specified or the outline of the distributed load and choose the **Setting->Scaling** menu item. The dialog box shown in Fig. 3.9 is then displayed for setting the scaling for the distributed loads. The scale options are the same as those described in Table 3.13, except that stress (force/area) is used rather than force in setting the scaling. For example, "load per world coordinate" units will be expressed by a scale factor expressed as stress per world coordinate unit.
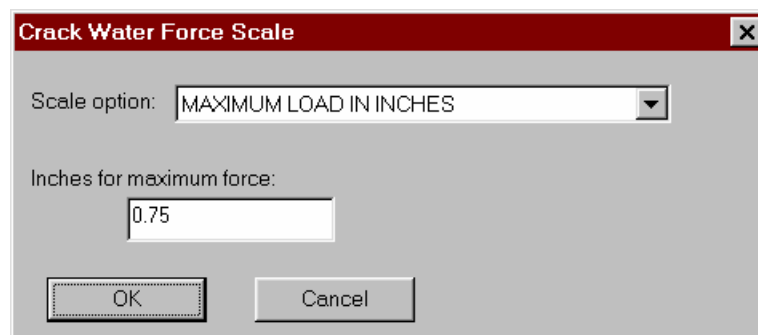
Figure 3.8 –Dialog Box for Setting Scaling of the Water Force in a "Tension" Crack
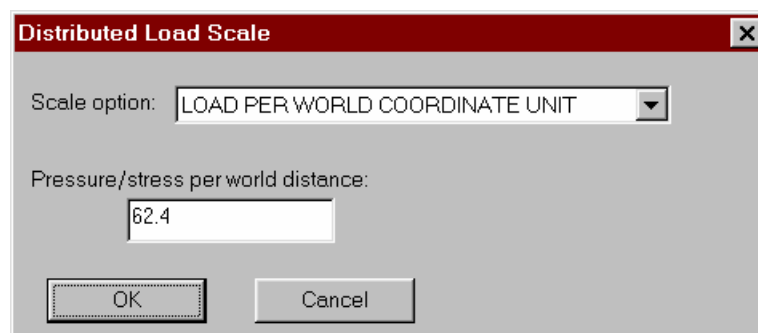
Figure 3.9 –Dialog Box for Setting Scaling for the Distributed Loads on the Surface of the Slope

Table 3.13

Force Scaling Options Available When the Settings->Scaling Menu Item is Chosen

Scaling Option	Explanation
Load per World Coordinate Unit	The scale factor is expressed as the load per unit "distance" where "distance" is in the same units as the coordinates. For example, if load is in pounds and coordinates are in feet, you will enter the scale factor in pounds per foot. The scaled distances for load distributions on the display will then depend on the scale factor for load as well as the scale factor for coordinate distances. Depending on the amount you "zoom" in or out, the actual length of vectors on the display will change because the scaling for coordinates changes.
Load per Inch	The scale factor is expressed as the load per inch of display distance. For example, if the loads are in pounds, you will enter the scale factor in units of pounds per inch. The length of a vector representing a given magnitude of load will then be independent of the coordinate scaling, e. g. the amount of "zooming" in or out.
Load per Centimeter	Similar to "Load per Inch" except display distances are expressed using centimeters rather than inches.
Maximum Load in Inches	The scale is set so that the vector representing the largest load has a specified, fixed length in inches, regardless of the magnitude of the load or the amount of zooming in or out. You enter the length for the largest load in inches. If, for example, you enter a value of 1 inch, the largest load vector will have a length of 1 inch and all smaller loads will have proportionately shorter lengths.
Maximum Load in Centimeters	Similar to "Maximum Load in Inches" except the length for the maximum load vector is specified in centimeters, rather than inches.

<u>Line Loads</u>

Each line load is represented as a vector. To set the scaling select either the tip or tail of the line load vector and choose the **Settings->Scaling** menu item. A dialog box like the one shown in Fig. 3.10 is then displayed. The scale options are the same as those described in Table 3.13.

<u>Reinforcement Forces</u>

Longitudinal and transverse forces in reinforcement are represented by an outline of the distribution of force displayed immediately adjacent to each reinforcement line. The same scaling is used for the longitudinal and transverse forces. To set the scaling select a point or segment of the reinforcing line or the outline of the distributed longitudinal or transverse force in the reinforcement and choose the **Settings->Scaling** menu item. A dialog box like the one shown in Fig. 3.11 is then displayed for you to set the scaling information. The scale options are the same as those described in Table 3.13.

<u>Stresses and Pressures on the Shear Surface</u>

The distribution of total and effective normal stress and pore water pressure along the shear surface are represented by an outline of the stress distribution on the base of each slice. The same scaling is used for all three distributions (total stress, effective stress, pore water pressure). To set the scaling for these distributions, select a segment of the outline of any one of the distributions and choose the **Settings->Scaling** menu item. The dialog box that is displayed is identical to the one displayed for setting the scaling for the ("crack" water) force in the vertical crack. The scale options are the same as those described in Table 3.13, except that 'load" is represented by stress (force/area) rather than by force in setting the scaling.

Units and Scaling

Different scaling is used with each different type of units (English, SI, "Other"). When you set scaling values using the Scaling menu item, the scaling that you set is applied to the current type of units (See the **Settings->Unit** menu item for a description of the current type of units). If you change the units, different scaling may apply; you will need to set scaling factors for each type of units separately. When you save the Application Preferences, the scaling for all three types of units is saved.

Factor of Safety Contours

This menu item is used to set how the contours of factor of safety will be chosen and drawn. When you choose this menu item the dialog box shown in Fig. 3.12 is
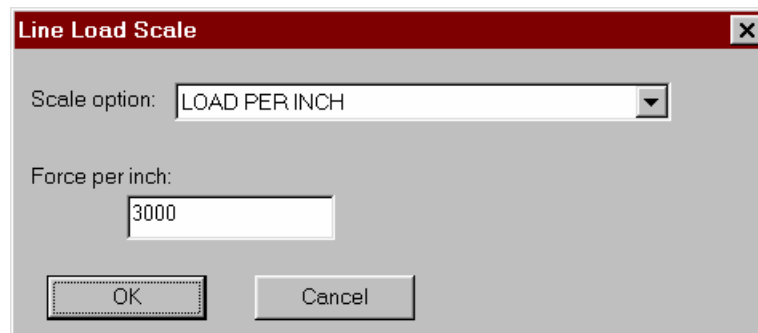
Figure 3.10 - Dialog Box for Setting Line Load Scaling
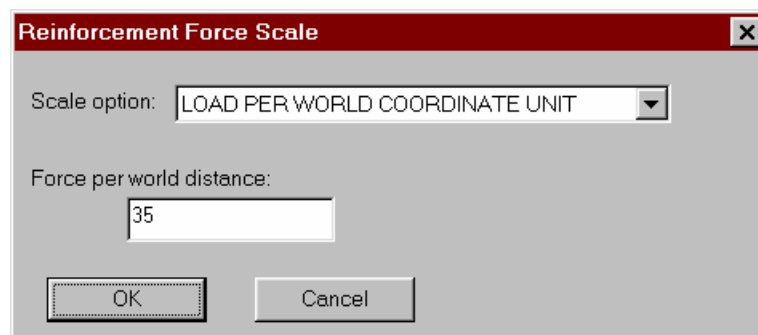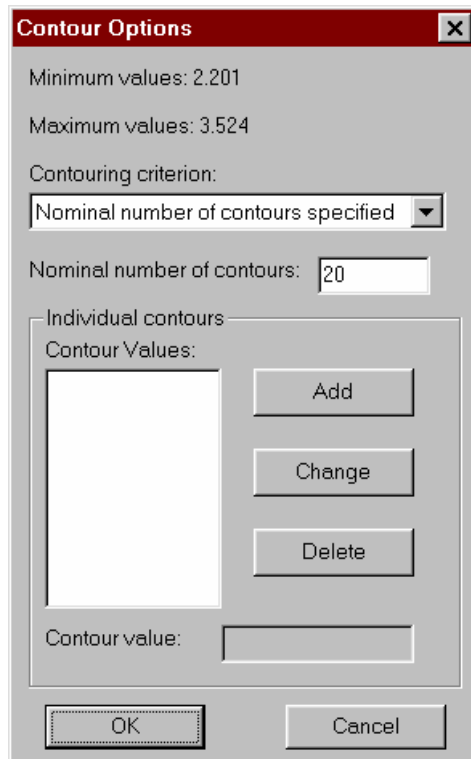
Figure 3.11 - Dialog Box for Setting Scaling for Reinforcement Forces

Contour Options

Minimum values: 2.201

Maximum values: 3.524

Contouring criterion:

Nominal number of contours specified ▼

Nominal number of contours: 20

Individual contours

Contour Values:

Add

Change

Delete

Contour value:

OK   Cancel

Figure 3.12 - Factor of Safety Contour Settings Dialog Box

displayed. The dialog box displays the minimum and maximum values of the factor of safety for the Current Data Set along with the current contour settings. A drop-down list allows you to select a "Contouring Criterion": You can select to draw contours using either (1) a nominal number of contours or (2) you can enter the specific values of factor of safety for which you want to draw contour lines. If you choose the nominal number of contours, you will need to enter a number in the text box immediately below where you choose the contouring criterion. The actual number of contours that will be drawn may differ from the number that you enter in order to ensure that a "nice", even contour interval is used.

If you choose to enter the specific contour values, the text box for entering contour values (near the bottom of the dialog box) will become active and you can type in specific contour values. To enter a specific contour value, type the value in the text box and click on the **Add** button. If you want to change a value once you have entered it, click on the value in the list box where the values are displayed (just below the label "Contour Values") and re-type the new value in the lower text box. When you are satisfied with the change, click on the **Change** button and the new value will replace the old value in the list. To delete a value which you have entered, first click on the value in the list to select it and then click on the **Delete** button. Once you have completed entry of information for drawing the contours, click on the **OK** button to dismiss the dialog and the new settings then go into effect.

Units

The **Units** menu item is used to set the current set of "units." The current units determine which group of settings is to be used to scale loads (forces, stresses) and determine the numbers of decimals for displaying text[5]. TexGraf4 maintains and stores as Application Preferences three groups of settings for scaling and defining the numbers of decimals used to display text. These are associated with "English", "SI" and "Other" units. Depending on which of these three "units" is selected, the corresponding default values are used. If you change the units, the default values for scaling and the numbers of decimals used to display text are changed. This may alter the display. Be sure when you change the units that you have set appropriate values for the scaling and numbers of decimals for display.

The **Units** menu has a sub-menu for you to select either **English**, **SI** or **Other** units. A check mark will appear opposite the current set of units. The default selection for "units" is stored in the Application Preferences.

---

[5] The scaling for loads is set using the **Settings->Scaling** menu item; the numbers of decimals are set using the **Settings->Decimal Points** menu item.

Decimal Points …

  This menu item is used to set the numbers of decimal points that are used when numerical values are displayed as text. When you choose this menu item the dialog Box shown in Fig. 3.13 is displayed. Decimal points are set for each type of quantity (length, stress, force, etc.). In addition for each quantity, you can designate whether the number of decimals is to be fixed, or the number is a maximum. If you designate that the number is a maximum, any trailing zeros are eliminated and only the number of decimals required to display the non-zero digits are displayed.

  The numbers of decimals can be set for three different types of "units". "Units" are actually just a convenient name for a particular configuration of decimal point settings and have no other formal meaning. The first two types of units are labeled "English" and "SI". The third type of units is labeled "Other" and can be used to set the number of decimals for any system of units that you want. Too set the current "units" for teh display use the **Settings->Units** menu and select an appropriate set of units from teh units sub-smenu as described above.

  Normally you will use the dialog box shown in Fig. 3.13 to select the numbers of decimals for the current units. However, you can also use the dialog to set the number of decimals for all three types of units (English, SI and Other) at one time. To do so first choose the type of units that you want to set the decimals for using the drop-down list at the top of the dialog box. Then set the desired numbers of decimals, including whether or not they are to be interpreted as the "Maximums" or as a fixed number of decimals. Next click on the **Accept** button to fix the decimal point information for the current set of units. Repeat this process for the other types of units until all have been set to your satisfaction. The decimal points which you set will be stored for all three unit systems and saved as part of the Application Preferences. Thus, you can use different settings for the numbers of decimals with different units all with one set of Application Preferences.
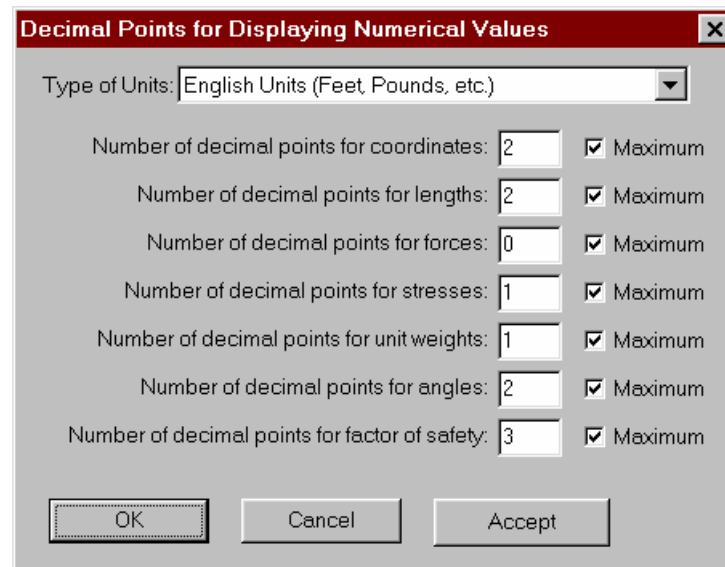
Figure 3.13 - Dialog Box for Setting Numbers of Decimals Used to Display Numerical Quantities as Text

DXF File Drawing Layers

The **DXF File Drawing Layers** menu item is used to designate what drawing "layers" will be assigned to each type of information placed in the DXF file[6]. When you choose this menu item the dialog box shown in Fig. 3.14 is displayed. Click on the appropriate item that you want to specify the drawing layer for, e. g. Profile Line. The current name assigned to the item will then appear in the edit box in the lower right-hand area of the dialog box. Type a suitable name for the layer and then click on the **Accept** button to assign it. The new layer name should then appear in the list of names in the upper portion of the dialog box.

Layer names can contain letters, digits and the special characters hyphen (-), underscore (_) and dollar sign ($); layer names must not include blank spaces. Layer names also must not exceed 31 characters.

Layer names are stored in the Application Preferences. If you want to use different sets of layer names for different problems or applications, you should create and save separate sets of preference files (See the **File->Save Preferences to File** and **File->Read Preferences from File** menu items.).

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[6] "Layer" information is only used for creating DXF files; otherwise layer information has no bearing on the screen or printed graphics.
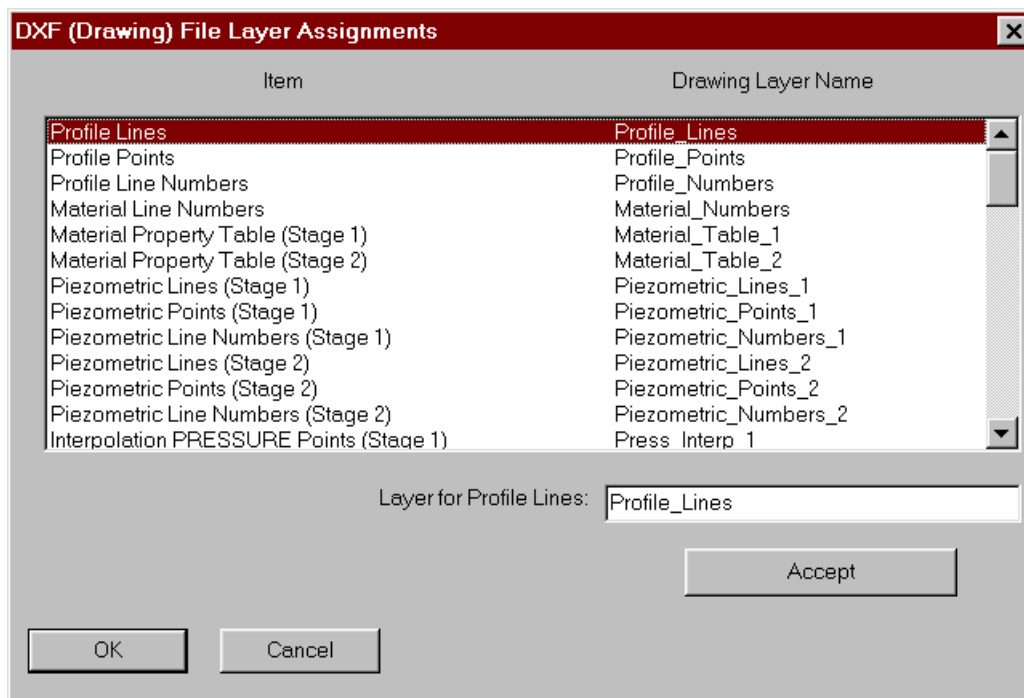
Figure 3.14 - Dialog Box for Setting Layer Names for Items in DXF Files

DXF File Line Styles

The DXF File Line Styles menu item is used to designate what line styles are used for lines in the DXF drawing file[7]. When you choose this menu item the dialog box shown in Fig. 3.15 is displayed. To set the line style, select the item that you want to set the line style for by clicking on the item name in the list box in the upper portion of the dialog box. The current line style will then appear in the edit text box near the lower left of the dialog box. You can choose a line style from the drop-down list or type the name of a line style in the edit text box. Once you have selected or typed the name of the desired line style click on the **Accept** button and the new line style will appear opposite the item name in the list box in the upper portion of the dialog box. Repeat this process to set the line styles for other items.

The names of available line styles that you can select from the drop-down list in the lower left portion of the dialog box is controlled by information in the Graphics Configuration File. The Graphics Configuration File contains the names of available line styles (other than CONTINUOUS, which is always shown) that will be displayed in the drop-down list. The Graphics Configuration File should be edited to include the line

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[7] DXF line style information is only used for creating DXF files; it has no bearing on the screen or printed graphics otherwise. Line style information for the screen and printed graphics is set separately using the **Settings->Line Style** menu item.

styles that are available in the particular CAD software you are using. You do not have to choose a line style from those in the list; you can type any line style name that is valid for your CAD software.
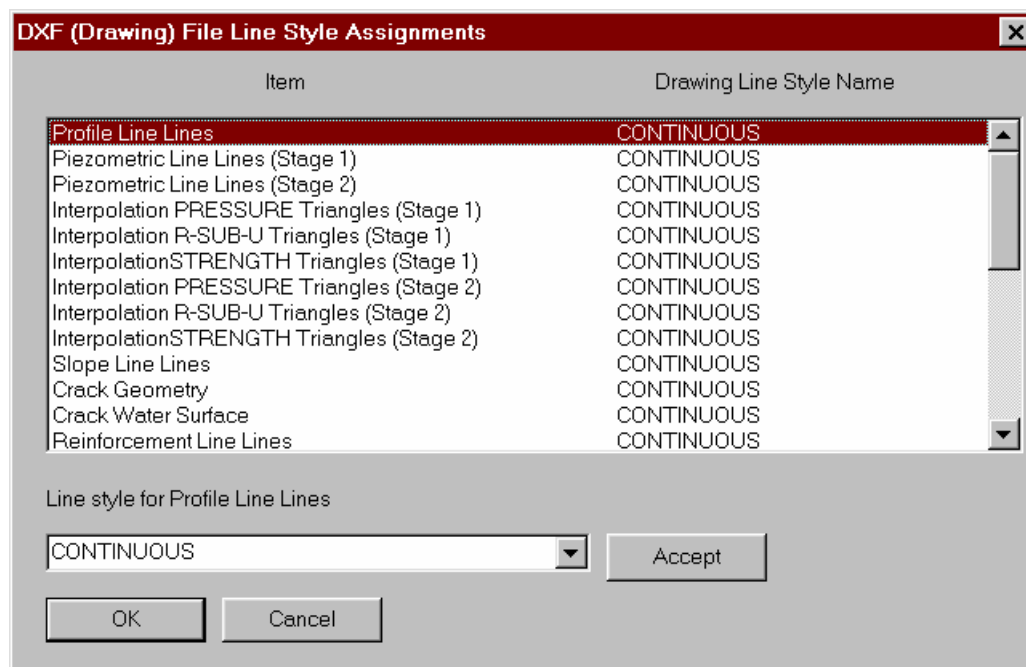
Figure 3.15 - Dialog Box for Setting Line Styles for Items in the DXF File

DXF File Item Colors

The **DXF File Item Colors** menu item is used to set the colors assigned for various items in the DXF file[8]. When you choose this menu item the dialog box shown in Fig. 3.16 is displayed. To set the color for a particular item, first click on the item in the list box in the upper portion of the dialog box. When you select an item its name also appears above the drop-list in the lower left portion of the dialog box and the current color selection is shown. If the current item color is one of the "standard" AutoCAD colors, the color name (and number in parentheses) appears in the drop-down list, and the edit box to the right of the list is made inactive (dimmed). To choose a color you can either choose one of the standard colors from the list of colors or choose "other". If you choose other as the color the edit box to the right of the list becomes active and you can type in the color number for the color than you want. Colors must conform to the AutoCAD standard number system for colors and be either one of the standard colors or an integer from 0 through 255. Other colors selections are not allowed.

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[8] DXF File color information only pertains to information in the DXF file; it has no bearing on the colors used for the display screen or printed output. Color information for the screen display and printed output is set separately using the **Settings->Color** menu item.
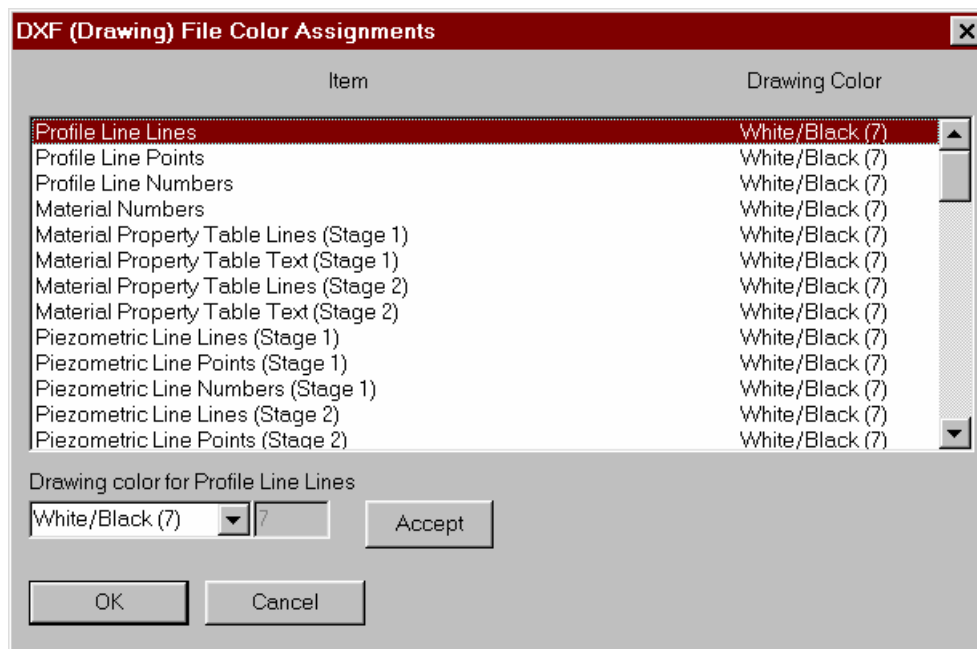
Figure 3.16 - Dialog Box for Setting Colors for Items in the DXF File

DXF File Miscellaneous

The **DXF File Miscellaneous** menu item is used to set information regarding how points are represented in DXF files; it is only used when you are creating DXF files. When you choose this menu item the dialog box shown in Fig. 3.17 is displayed. You can choose either to have points drawn as symbols like the ones drawn for the screen display and printed output, or you can have the points represented as Autodesk "Point" entities. One advantage of having points displayed as Point entities is that their size can be set such that it is a fixed fraction of the display dimensions. Thus, if you "zoom" in or out the points will remain the same size[9]. Otherwise the size of points in the DXF file will increase and decrease as you zoom in and out, respectively.

When points are displayed as Point entities their appearance (size and type of symbol) is controlled by the Autodesk system variables, PDMODE and PDSIZE. If you check the check box to have points displayed as Point entities, the edit boxes opposite PDMODE and PDSIZE become active for you to enter appropriate values for your CAD software. You will need to refer to your CAD software documentation to determine if Autodesk Point entities are supported and the meanings of the System Variables PDMODE and PDSIZE.

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[9] This may require that you "Regenerate" the drawing in AutoCAD.
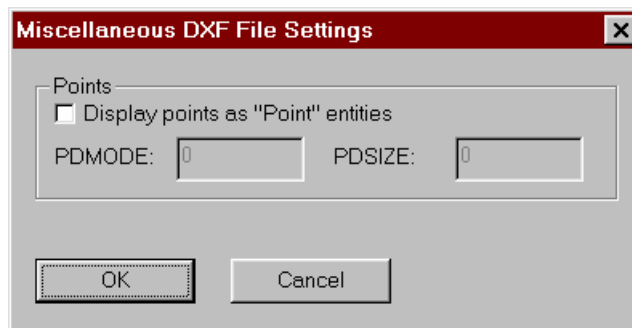
Figure 3.17 - Dialog Box for Setting "Miscellaneous" Information for the DXF File

Miscellaneous

The Miscellaneous settings menu item is used to set special display options for the Profile Lines and material properties table. When you choose this menu item the dialog box shown in Fig. 3.18 is displayed for you to make selections as described below.

<u>Profile line clipping</u>

If the original Profile Lines extend outside the region defined by the slope geometry data, you can choose to display either the original Profile Lines or have the Profile Lines "clipped" to the region within the slope. Ordinarily the entire Profile Lines are displayed. To display only the portion that is within the outline of the slope, click on the check box labeled "Clip profile lines to slope".

<u>Material property table layout</u>

Ordinarily the material property table is displayed as a single column with one line of information for each material. As an option, the material table can be laid out and displayed with the information arranged in two columns, side-by-side. Each of the two columns will contain the information for approximately one-half the materials represented. To choose how the material property data will be arranged click on either the radio button labeled "Single column" or "Two columns side-by-side". The manner in which the material property table is displayed (one column vs. two columns) is saved as part of the Application Preferences.
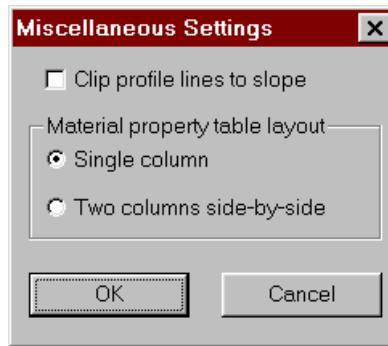
Figure 3.18 – Miscellaneous Settings Dialog Box

Utexas Menu

The Utexas menu is used to select the "Current Data Set". When you first start TexGraf4 the Utexas menu contains just one item, labeled "none." As you read data sets into memory, either by choosing the **File->Open** menu item or choosing one of the files from the list of six most recently opened files (near the bottom of the File menu), an item is added to the Utexas menu as each data set is read. The menu text for each new item is determined as follows:

1. If a "Label" is entered as part of the original Utexas4 Group A input data for the data set, the label text is used as the text for the menu item, or

2. If no label is entered, but at least one line of problem heading is entered with the original UTEXAS4 Group A input data, the first line of the problem heading is used as the text for the menu item, or

3. If neither a Label nor a Problem Heading is entered, the Utexas menu text will appear as "Data Set Number *xx* (No heading or label)", where "*xx*" represents the number of the data set (The first data set is the first set read, the second set is the second set read, etc.; set numbers are accumulated with each new set of data read.).

Window Menu

The Windows Menu is used to "refresh" (ReDraw) the display screen, to activate automatic "tracking" of values with the cursor, to set information pertaining to the "Graphics Grid" which is used for reference, and to "zoom" and "pan" the display extents. The Window Menu has fourteen (14) items which are discussed below.

Redraw

Use the Redraw menu item to refresh the display screen if the display has been corrupted. Redraw also serves a special purpose when the display is scrolled using the scroll bars and either the Profile Line numbers, piezometrc line numbers or material numbers are displayed. When you scroll the display the numbers remain at the same x-y location where they were first displayed, before scrolling was initiated. Thus, it is possibly that they will be "scrolled" off the display. If you specifically request that the display be redrawn, the location of the numbers will be recomputed to place them more optimally for viewing in the current coordinate "window".

Tracking On/Tracking Off

When "tracking" is "on" values of a variable corresponding to the current selection and position of the cursor are displayed in the right-most panel of the Status Bar at the bottom of the main display window. For example, if tracking is on and a piezometric line is selected, the value of the pore water pressure at the cursor location calculated from the piezometric line and displayed in the Status Bar. The Tracking menu item is used to toggle tracking on and off. Tracking and the types of information that can be "tracked" are described in Section 8 of this manual.

Grid Settings…

This menu item is used to setup the "Graphics Grid", which consists of a series of points arranged horizontally and vertically and a series of horizontal and verical lines. The Graphics Grid is intended for use as a reference for locating items and precise control of the cursor. When you choose the "Graphics Grid" menu item a dialog box is displayed. The dialog box allows you to enter the grid spacing (in world coordinate units) as well as to choose whether to display points, lines or both points and lines for the grid. You can also choose to have the cursor "snap" to the grid. If you choose to have the cursor snap to the grid, the coordinates displayed in the Status Bar at the bottom of the display window correspond to integer increments of the current grid spacing. The spacing between grid points and lines is designated as an integer multiple of the grid spacing. For example you might choose to have points displayed at intervals of 5 times the grid spacing and lines spaced at 10 times the grid spacing. Then if you choose a 1

foot grid spacing and the "snap" mode is active, the cursor coordinates will change in 1 foot intervals, and grid points and lines will be displayed at 5 and 25 foot intervals, respectively.

Grid Snap On/Grid Snap Off

Use this menu item to "toggle" the snap mode for the Graphics Grid on and off. The snap mode can also be toggled on and off by clicking on the Snap On/Off icon in the main Toolbar.

Display Grid Points/Hide Grid Points

This menu item is used to toggle the display of grid points on and off. The grid point display may also be changed by clicking on the Grid Points Display icon in the main Toolbar or by choosing the **Display->Grid Settings** menu item and clicking the appropriate check box in the dialog box that is displayed.

Display Grid Lines/Hide Grid Lines

This menu item is used to toggle the display of grid lines on and off. The grid line display may also be changed by clicking on the Grid Lines Display icon in the main Toolbar or by choosing the **Display->Grid Settings** menu item and clicking the appropriate check box in the dialog box that is displayed.

Increase Grid Spacing

Doubles the Graphics Grid spacing, e. g. if the current grid spacing is 1 foot, the grid spacing will be set to 2 feet. The grid spacing may also be increased by either clicking on the Increase Grid Spacing icon in the main Toolbar or choosing the **Display->Grid Settings** menu item and changing the spacing in the dialog box that is displayed.

Decrease Grid Spacing

Decreases the Graphics Grid spacing to one-half the current spacing, e. g. if the current spacing between points in the Graphics Grid is 2 feet, the spacing will be changed to 1 foot. The grid spacing may also be decreased by either clicking on the Decrease Grid Spacing icon in the main Toolbar or choosing the **Display->Grid Settings** menu item and changing the spacing in the dialog box that is displayed.

Zoom All

"Zooms" the display to the full extent, showing the entire slope geometry. The display may also be zoomed to the full extent by clicking on the Zoom All icon in the main Toolbar.

Zoom Window

Use this menu item to "zoom" in on a selected rectangular region of the display. When you choose this menu item a vertical and horizontal "crosshair" is displayed at the location of the cursor. Use this crosshair to set the location of the first corner of the rectangular region that you want to zoom in on by clicking with the mouse. Once you click to set the first corner a rectangle is displayed with one corner at the location where you clicked and the other corner at the current cursor position. Move the cursor until the rectangle encloses the region that you want to zoom in on and click to set the second, opposite corner of the rectangle. As soon as you set the second corner of the rectangle the display is updated to the new extent you have just selected.

"Zoom Window" may also be activated by clicking on the Zoom Window icon in the main Toolbar. To return the display to the original extent after zooming in choose the Zoom All item or use the Zoom Out function described below.

Zoom Out

This menu item allows you to "zoom" the current display region out by a factor of two. When you choose this menu item, the cursor changes to a magnifying glass with a minus sign (-). Each time you click the mouse at a point in the main display window the display "zooms" out with the geometry centered at the point you clicked. You can repeatedly click in the main display window to zoom out further. To terminate or cancel the "Zoom Out" mode either press the Escape (**Esc**) key or click the right mouse button, and the cursor returns to normal. The Zoom Out function may also be activated by choosing the Zoom Out icon in the main Toolbar.

Zoom In

Similar to the Zoom Out function but instead "zooms" the display in by a factor of two each time you click in the display. When you choose this menu item, the cursor changes to a magnifying glass with a plus sign (+). Each time you click the mouse at a point in the main display window the display is magnified by a factor of two, centered at the point you clicked. You can repeatedly click in the main display window to zoom in further. To terminate or cancel the "Zoom In" mode either press the Escape (**Esc**) key or

click the right mouse button and the cursor returns to normal. The Zoom In function may also be activated by choosing the Zoom In icon in the main Toolbar.

Pan

Use the Pan menu item to "pan" the geometry in the display window. "Panning" translates the area of the geometry that is displayed in the window much like scrolling with the scroll bars.

When you choose the Pan menu item a vertical and horizontal "crosshair" is displayed at the location of the cursor. Use the cursor to locate the point that you want to pan (translate) in the display window by clicking at the point. A vector (line) is then drawn between the point that you clicked and the current position of the cursor. Use the vector to set the location that you want the point moved to by clicking at the new location for the point. The display is then redrawn with the point at its new location. The Pan function may also be activated by choosing the Pan icon in the main Toolbar.

If the x-y coordinate axes are displayed when you pan, the amount of translation may not be exactly what you indicated with the "pan" vector because of the way that the axes are scaled. After panning the axes are re-scaled to accommodate the translation that you specified and at the same time provide suitable values for the origins of the x-y axes and the increment for the tick marks. Accordingly, the point that was moved may be adjusted to conform to the new scaling. In any case the point that was panned will be visible in the display and at least near where it was panned.

Fit to Print Area

This menu item changes the size of the display window to match the printable area on the output page. This can be used to view the display at the same size and scale that will be used when the display is printed. When you use this feature you will normally choose this menu item first to set the size of the display window and, then, adjust the display using the Zoom All, Zoom Window, Zoom In, Zoom Out and Pan functions to set the extent of what is displayed in the window.

Section 4 – TOOLBAR

TexGraf4 has a single toolbar containing a number of small icons. Initially the Toolbar is displayed at the top of the main display window, but it can be dragged to other locations in the main display window. The TexGraf4 Toolbar is shown below in Figure 4.1.

Figure 4.1 - TexGraf4 Main Toolbar

The Toolbar can be used to access a number of the functions that are also accessible through the TexGraf4 menus described in Section 3. Each item (icon) in the Toolbar is briefly described below. For more details on the icons refer to the description of the various TexGraf4 menus in Section 3.

New File Icon

Opens and reads a Graphics Exchange File ("*.UT4") created by UTEXAS4. Before reading data from the file all data that are currently in memory are deleted.

File Open Icon

Opens and reads a Graphics Exchange File created by UTEXAS4. The information will be added to any information already in memory. Performs the same function as the **File->Open** menu item.

Print Icon

Prints the information displayed in the main display window to the current printer.

About Icon

Displays the "About" dialog for TexGraf4.

Zoom All Icon

"Zooms" to display the full extent of the problem geometry in the main display window. See the **Window->Zoom All** menu item for more details.

Zoom Window Icon

Allows you to set the extent of the display window using a dynamically positioned "box". See the **Window->Zoom Window** menu item for more details.

Pan Icon

Allows you to "pan" the display window using a dynamic positioning vector. See the **Window->Pan** menu item for more details.

Zoom In Icon

Allows you to "zoom in" by a factor of two by clicking with the mouse. See the **Window->Zoom In** menu item for more details.

Zoom Out Icon

Allows you to "zoom out" by a factor of two by clicking with the mouse. See the **Window->Zoom Out** menu item for more details.

Grid Snap Icon

Turns the Graphics Grid "snap" mode on and off. See the **Window->Grid Snap On/Grid Snap Off** menu item for more details.

⊞ Display Grid Points Icon

"Toggles" the display of Graphics Grid points on and off. See the **Window->Display Grid Points/Hide Grid Points** menu item for more details.

⊞ Display Grid Lines Icon

"Toggles" the display of Graphics Grid lines on and off. See the **Window->Display Grid Points/Hide Grid Points** menu item for more details.

⊞ Increase Grid Spacing Icon

Doubles the spacing for Graphics Grid points. See the **Window->Increase Grid Spacing** menu item for more details.

⊟ Decrease Grid Spacing Icon

Halves the spacing for Graphics Grid points. See the **Window->Decrease Grid Spacing** menu item for more details.

Section 5 – GRAPHICAL DISPLAY OF ITEMS

This section describes the information displayed by TexGraf4. The graphical representation of the information and the settings that can be made to control how the information is displayed are also explained. The specific items that are displayed are determined by selections made using the **Display->Selections** menu item and the dialog box that is displayed for you to make selections.

The first part of this section explains the graphical representation of data that are entered as input data to UTEXAS4; the latter parts describe the graphical display of the computed results and information generated by UTEXAS4.

Input Data – Stages 1 and 2

Input data for conventional (single-stage) and the first stage of multi-stage computations are displayed independently of data used for the second and third stage computations. Data for either stage or both stages may be displayed depending on the selections made using the **Display->Selections** menu item. The dialog box for making the display selections has separate tabs for the first stage and the second stage data. Except for differences in color and style used to display lines and points, the display of information for both stages is very similar and, thus, no distinction between the data for different stages is made in the explanations below.

Profile Lines, Points and Numbers.

Profile Lines are displayed as a series of straight line segments connecting the points that define the Profile Line. Unless "Profile Line clipping" is activated (as described later below), the points that are displayed are the points that were specified in the input data for UTEXAS4. Points are displayed as symbols, e. g. solid circles, open squares, etc. Depending on your selections either the lines, the points or both lines and points can be displayed.

Set the color, style and weight for drawing the Profile Lines using the **Settings** menu. The **Settings** menu is also used to set the type of symbol, the size of the symbol and the color of the symbol used to draw points. By setting the line weight used to draw symbols you can also change the appearance of a symbol. The line weights used to draw lines and to draw points (symbols) can be set separately.

The numbers assigned to Profile Lines in the UTEXAS4 input data can also be displayed. The numbers are displayed as text superimposed on the Profile Line at the

midpoint of the longest visible segment of each Profile Line. Numbers are outlined with a rectangular or square box. The **Settings** menu is used to change the font used to draw the numbers and the color of the text.

UTEXAS4 allows you to define a soil profile that extends outside the limits of the slope geometry. In this case a separate slope line (Group F Input Data) defines the surface profile of the slope. Normally, TexGraf4 displays the full extent of the Profile Lines, including portions that extend outside the limits of the slope. However, if you wish to display only the portions of the Profile Lines that lie within the slope you can choose to activate "Profile Line Clipping" using the **Miscellaneous** item in the **Settings** menu. If you choose to have the Profile Lines "clipped" to the slope, the points that are displayed are a combination of some of the points that were entered as input data and (possibly) additional points that were computed when the Profile Lines were "clipped" to the slope.

Material "Fills"

The areas beneath Profile Lines can be filled with a patterned fill to represent the different types of materials in the soil profile. The color and pattern used for the fill can be set by first clicking in the region representing a particular material to select the region. The color and pattern are then set by choosing the desired color and pattern, respectively, from the **Settings** menu.

Material Numbers

The numbers assigned to materials in the UTEXAS4 input data can be displayed in the regions beneath the Profile Lines. The location of each number is determined by UTEXAS4 using an algorithm that attempts to locate the number in the largest, visible region of each material. Material numbers are outlined with a circle drawn in the same color as the material number. To change the font or color used to display the number, first select the number of any material and then choose either **Font** or **Color**, respectively, from the **Settings** menu.

Material Property Table

A table containing the material properties is automatically generated and displayed if you choose. For each material the table contains the material number, the description of the material, the unit weight, the shear strength, and the pore water pressures. Set the characteristics of the font used to draw the table by selecting either the text in the table or one of the interior or exterior border lines in the table and choosing the **Settings->Font** menu item.

The line weights for both the interior and exterior border lines in the material property tables can be set by selecting an appropriate line and choosing the **Settings-**

>LineWeight menu item: Choose an exterior line to set the line weight for the outer boundary of the table; choose any interior line to set the interior line weight. Only two line weights are used (interior, exterior) so it doesn't matter which particular interior or exterior border line you select for setting line weights. All lines in the table are drawn as solid lines; "styles" cannot be set for the lines in the material properties table.

Colors for both the text and border lines are set by selecting an appropriate item (text, line) and choosing the **Settings->Color** menu item.

A material property table may be relocated on the display by selecting and either dragging the table or initiating a "move" by choosing the **Edit->Move Material Property Table** item. Section 7 of this manual gives further details on relocating items on the display.

Piezometric Line, Points and Numbers

Piezometric line are displayed much like Profile Lines. Lines, points and numbers may all be displayed for the piezometric lines. The display of piezometric lines differs from the display of Profile Lines only in the particular choice of line weights, colors, styles, fonts, etc. that are used. Piezometric line numbers are also surrounded by a triangular frame rather than the square/rectangular frame that surrounds Profile Line numbers.

Interpolation Data Points for Pore Pressure, r_u and Shear Strength

The individual points entered as input data to UTEXAS4 for interpolating values of pore water pressure, pore water pressure coefficient (r_u) and shear strength are displayed as symbols drawn at the location of each point. Generally different symbols are drawn for each of the three types of interpolation data (pore water pressures; pore water pressure coefficients, r_u; undrained shear strengths). The type of symbol, color of symbol and size of symbol may be set using the **Settings** menu. The line weight for the symbols may also be set using the **Settings** menu. Different settings are used for each stage and must be set independently.

A Delauney triangulation is constructed for each set of interpolation data points; the triangulation is used by UTEXAS4 for interpolating values of the appropriate variable. The triangles making up the triangulation are displayed by TexGraf4 as a series of straight lines connecting the various interpolation points making up the boundaries of the triangles. (Note: Selection of the display of the triangles is under the "Miscellaneous" tab in the Display Selections dialog box.) The color, weight and style of lines for the triangles may be changed by selecting a triangle for a particular set of interpolation data and choosing the appropriate item (**Line Weight**, **Line Style**, **Color**) from the **Settings** menu.

Slope Line and Points

The line representing the surface profile of the slope and the points defining this line are displayed in much the same way that Profile Lines and piezometric lines are displayed. If the slope line is entered directly as part of the input data for UTEXAS4, the points displayed are the points that were entered with the input data. If instead, the slope geometry data are created by UTEXAS4 from the Profile Line data, the points are whatever points were computed by UTEXAS4. In some cases there may be extra, unnecessary points, i. e. where a series of points all lie along the same straight line. However, this has no adverse effect of the results from UTXAS4.

Distributed Loads

Distributed loads are displayed as a series of vectors and an outline representing the magnitude of the stress distribution. Symbols are also displayed at each point where the distributed load was specified in the input data for UTEXAS4. If the distributed loads were generated from the data for a piezometric line, the points will be the points that UTEXAS4 determined when it generated the data. In some cases there may be extra points, e. g. where points all lie along a straight line and the distributed loads vary linearly along the line. However, such extra points have no adverse effects on the results from UTEXAS4.

Distributed loads are scaled according to scale factors that are initially set based on Application Preferences (units and default scale factors). These may be changed by first selecting a segment of the outline of the stress distribution (the line running through the "tails" of the vectors) and then choosing the **Settings->Scaling** menu item. If you want to change the default scaling, set the scaling for the current set of units and then save the Application Preferences.

The normal stress distribution, shear stress distribution or both normal and shear stress distribution are displayed depending on what is chosen in the Display Selections dialog box. If only the normal stress distribution is displayed the vectors are plotted so that they act perpendicular to the surface of the slope. If only the shear stress distribution is displayed, teh shear stress is also displayed as a set of vectors that act perpendicular to the surface of the slope; the length of the vectors is scaled according to the scale factor and represents the magnitude of the shear stress. If both the shear and the normal stress are selected for display, the vectors represent the resultant due to the shear and normal stress component and act in the direction of the resultant force. In this case the vectors will not be perpendicular to the surface of the slope except at points where the shear stress is zero.

The line weight and color used to draw the stress distribution can be set by selecting the outline of the stress distribution and then choosing the appropriate item (**Line Weight**, **Color**) from the **Settings** menu. You can also fill the stress distribution

with a patterned fill by selecting the stress distribution and selecting a pattern from the **Settings->Patterns** menu. The size, color and symbol used to plot points where the stress distribution was specified can also be set by selecting a point and then choosing the appropriate menu item from the Settings menu. Similarly, the line weight used to draw symbols is changed by selecting a point and choosing the **Settings->Line Weight** menu item.

Line Loads

Line loads are displayed as vectors (lines with arrowheads) at the locations where the line loads act. The vectors are scaled in accordance with the scale factors which are set initially by information in the Application Preferences and can be changed using the **Settings->Scaling** menu. Different scaling information is set and stored for each of the three types of "units" (English, SI and Other). Changing the units using the **Settings->Units** menu item may change the scaling depending on the scale that information has been set for each type of units.

The line weight and color for drawing line loads can be changed using the **Settings** menu. To change the scaling, color, line weight, etc for the line loads you must first select a line load. This is done by clicking on either the tip or the end of the tail of the vector; you cannot select a line load by clicking at an intermediate point along the shaft of the line load.

Reinforcement Lines, Points and Force Distribution

Reinforcement lines and the points defining the reinforcement lines can both be displayed. In addition the distribution of longitudinal and transverse force in the reinforcement can be displayed. The display of reinforcement lines and points is very similar to the display of Profile Lines and piezometric lines. The line weights, colors, point sizes and symbols used to represent points can all be changed by selecting either a point or line (depending on what is to be changed) and choosing the appropriate item from the **Settings** menu.

The distributions of longitudinal and transverse forces in the reinforcement are displayed as outlines representing the magnitude of the force distribution. The forces are scaled in accordance with scaling information in the Application Preferences and can be changed using the **Settings->Scaling** menu item. Different scaling information is set and stored for each of the three types of "units" (English, SI and Other). Changing the units using the **Settings->Units** menu item may change the scaling depending on what scale information has been set for each type of units.

The distributions of longitudinal and transverse forces are displayed independently by two separate outlines of the distributions[10]. For both longitudinal and transverse forces the perpendicular distance between the reinforcement line and the outline of the force distribution is proportional to the magnitude of the respective force in the reinforcement, and depends on the current scaling.

The line weight and color used to draw the outlines of the reinforcement force distributions may be changed by selecting the distributions and then choosing the appropriate item in the Settings menu. The line weights and colors used to draw the longitudinal and transverse force distributions are independent of each other and different settings and may be used for each. The outline of the force distributions in the reinforcement can also be filled with a patterned fill. The fill pattern is set initially based on Application Preferences and can be changed using the **Settings->Patterns** menu. Again, different patterns may be used for the longitudinal and transverse force distributions. However, when both the longitudinal and transverse force distributions are filled it may be difficult to see the underlying distribution of one force component because it is covered by the other. Filling the reinforcement force distributions with patterns is not recommended when the reinforcement carries both longitudinal and transverse forces and both sets of forces are displayed.

Initial Shear Surface

The initial shear surface that is specified either as an individual shear surface to be analyzed or as the initial trial shear surface for a search is displayed as either a circular arc or a series of straight line segments depending on whether the shear surface is circular or noncircular, respectively. For noncircular shear surfaces the points that were specified to define the shear surface may also be displayed. Information pertaining to the line weight, line and point color, point size, symbol types, etc. is set in much the same way that this information is set for Profile Lines and piezometric lines.

For circular shear surfaces the center point for either the individual circle that was specified or the initial trial circle for an automatic search is also displayed. The center is displayed by a cross (+) and two lines drawn from the center point to each of the two extreme, outer ends of the circle. The color and line weight as well as the size of the symbol drawn for the center point of the circle can all be set by selecting the center point and choosing the appropriate item from the **Settings** menu. For searches performed with a fixed grid, there is no specific initial trial circle and this information is not displayed.

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[10] This differs somewhat from how distributed loads on the surface of the slope are represented. When both normal and shear components are displayed for the distributed loads on the surface of the slope, they are displayed as a single distribution representing the resultant of the two components. For reinforcement forces the two components (longitudinal and transverse) are displayed separately.

Specified Search Grid

For automatic searches performed with circles the initial grid for the search is displayed. The grid displayed will differ depending on whether a "floating' or "fixed" grid was used. For a <u>floating grid</u> the display consists of two square, 3 x 3 (9-point) grids, both with the same center point; the center point is the center of the initial trial circle. Each of the two grids is represented by a series of three horizontal and three vertical lines whose intersections represent the nine points in each grid. One grid is very large and the spacing between points corresponds to the coarse initial spacing that is used in the search. The second grid is much smaller and corresponds to the finest grid used for the search; the spacing for this grid is part of the input data for UTEXAS4. For searches performed using a <u>fixed grid</u>, the complete fixed grid is drawn. The line weight and color used to draw the search grids can be set by selecting the grid and choosing the appropriate item in the **Settings** menu.

Crack and Crack Water Information

Both the crack and any water in the crack are displayed graphically. The crack is displayed by a line representing the bottom of the crack with vertical "hatching" running from the bottom of the crack to the ground surface. Both the line weight and the line style for the line representing the bottom of the crack may be set by selecting a segment of the crack bottom and choosing the appropriate item from the **Settings** menu. The <u>vertical</u> <u>hatching</u> is always drawn using solid lines with a line weight of 1 point; this cannot be changed. The color of both the crack base line and the vertical hatching is set by selecting a point on the base line of the crack and choosing the **Settings->Color** menu item.

If there is water in the vertical tension crack, a line is drawn representing the surface of the water. Vertical hatching is also drawn running from the water surface to the bottom of the crack. The vertical hatching is drawn such that the vertical hatch marks are located approximately midway laterally between the vertical hatch marks representing the crack. Both the line weight and line style for the line representing the water surface may be set by selecting a segment of the water surface and choosing the appropriate item from the **Settings** menu. The <u>vertical</u> <u>hatching</u> representing the water is always drawn using solid lines with a line weight of 1 point; this cannot be changed. The same color is used for both the water surface and the vertical hatching and is set by selecting a point on the water surface and choosing the **Settings->Color** menu item.

Results

Results of computations are displayed when the computations with UTEXAS4 are completed successfully. If the computations are not successful only the input data are

displayed. The various information from the computed results that can be displayed is described below.

Computed Factor of Safety

The computed factor of safety for either an individually specified shear surface or a critical shear surface (in the case of an automatic search) is displayed as text. When Spencer's procedure is used the corresponding value for the side force inclination is also displayed.

The color and font used to display the computed factor of safety is changed by selecting the text and then choosing the **Settings->Color** and **Settings->Font** menu items, respectively.

You can also move the text for the computed factor of safety by selecting it and dragging it to a new location. The procedure for doing this differs somewhat depending on whether the text is located at the same area as other items (e. g. the material property table, Profile Lines, etc.) or if the text is displayed in an area away from any other objects. If the text is displayed away from the location of any other items, you can simply click on the text and while continuing to hold the mouse button down, drag the text to its new location. If instead the text lies over other items, when you click on the text a menu will pop up for you to choose the item to be selected. If you choose "Computed answer (factor of safety) text" from the pop-up menu, you can then move the text by choosing **Move Factor of Safety Text** from the **Edit** menu. The **Edit** menu only displays this option (**Move Factor of Safety Text**) when the text is selected. The **Edit** menu normally just displays a **Move** item and "Move" is grayed out unless a movable item (factor of safety text or material property table) is selected.

Critical (or Individual) Shear Surfaces.

Either the individually specified shear surface or the critical shear surface (in the case of an automatic search) is displayed as a series of symbols at points along the surface and straight line segments connecting the points. The points are displayed at the locations of the vertical boundaries of the slices. For the lines the color, line weight and line style may be set by choosing a segment of the shear surface (base of slice) and choosing the appropriate item from the **Settings** menu. Similarly for the symbols plotted at points, the color, line weight, symbol type and symbol size can be set by selecting a point on the shear surface and choosing the appropriate item from the **Settings** menu.

When an individual shear surface (not a search) has been specified, the shear surface drawn as part of the "Results" display is at the same location as the shear surface drawn as part of the "Input Data", i. e. two shear surfaces are drawn at the same location. However, the display of each of the two shear surfaces is different: For circles the "input" circle is plotted as a continuous arc without regard to where slices are located; no

points are plotted along the "input" circle. In contrast the "results" circle is plotted as a series of straight line segments representing the bottom of the slices; with points where each slice boundary exists. For noncircular shear surfaces both the "input" and "results" shear surfaces are plotted as a series of straight line segments connecting points along the surface; however, for the "input" shear surface the points are the points that were entered as input data to define the noncircular shear surface. For the "results" shear surface the points are at the boundaries between slices.

For automatic searches with circles using either a "floating grid" or "fixed grid" (Type 1 or Type2 search, respectively) the center of the "critical" circle with the lowest factor of safety can also be displayed. The center is displayed by a cross (+) with two lines drawn from the center to the two extreme ends of the circular arc. The color and line weight used to draw the center and two radii can be changed by selecting the center point and choosing the appropriate item from the **Settings** menu. For individually specified circles the center point and two radii can be drawn by displaying the center for the initial (input) shear surface as described for the input data.

Factor of Safety Contours

Contours representing constant values of factor of safety can be drawn when an automatic search has been performed using a Type 2, "Fixed Grid" search. The contour interval used to draw contours can be set by first selecting a contour line by clicking with the mouse and then choosing the **Settings->Factor of Safety Contours**. You can also change the line weight and color for the contours by selecting one of the contour lines and then choosing the appropriate item from the **Settings** menu. The font used to label the contour is changed by selecting a contour and choosing the **Settings->Font** menu item.

"N-Most" Critical Shear Surfaces

TexGraf4 displays each of the "n-most" critical shear surfaces from an automatic search if you have specified that UTEXAS4 was to save them. These "n" surfaces are displayed independently and in addition to the most critical shear surface described earlier above. Actually the most critical shear surface may be displayed twice, once because it is the most critical shear surface and again because it is a member of the "n-most" critical shear surfaces. The settings for displaying the most critical shear surface information described earlier are made entirely independently of the settings used to display the n-most critical shear surfaces. You can change the line weight and color used to display the n-most critical shear surfaces using the **Settings** menu. You cannot selectively choose which of the n-most critical shear surfaces is displayed, nor can you set separate line weights and colors for individual shear surfaces among the n-most critical ones. All of the "n-most" critical shear surfaces are displayed when any one of

the n-most critical shear surfaces is displayed. Also the same settings are used for all of the n-most critical shear surfaces when they are displayed.

Slices

Vertical lines are drawn to represent the boundaries between slices for either the individually specified or the most critical (in the case of an automatic search) shear surface. You can set the line weight, line style and color for the vertical lines using the appropriate **Settings** menu items.

Force Vector for Water in Crack

A horizontal vector is drawn to represent the force of water in the vertical "tension" crack. You can set the line weight and color used to draw the vector by clicking on the vector to select it and then using the appropriate **Settings** menu item. To set the scaling used to draw the vector, first select the vector by clicking on it and then choose the **Settings->Scaling** menu item.

Total Normal Stress, Effective Normal Stress and Pore Water
Pressure Distributions on Shear Surface

The distributions of total normal stress, effective normal stress and pore water pressure along the shear surface are displayed by drawing a quadrilateral outline representing the magnitude of the stress on the base of each slice. Positive stresses are plotted below the shear surface, negative stresses are plotted above the shear surface (inside the slide mass).

The line weight used to draw the outline of the distribution, the pattern used to fill the area inside the rectangular outline and the color may all be selected independently for the total stress, effective stress and pore water pressure distributions. To set these items first select a segment of the outline of the distribution representing the magnitude of the stress (the portion furthest from the base of the slice) and then choose the appropriate **Settings** menu item to set how the information is to be displayed. Negative stresses are displayed using different settings for the line weight, fill pattern and color from the ones used to display positive values of the stresses. To change the settings for negative values select a portion of the distribution where the stresses are negative; settings for positive values are made by selecting portions of the distribution where the stresses are positive.

The scale factors used to plot stress distributions can be changed by selecting the outline of the stress distribution as described above and then choosing the **Settings->Scaling** menu item.

Line of Thrust

The "line of thrust" is the line drawn through points where the side forces are located on the boundaries between each slice. The line of thrust is displayed as a line running from the left to the right of the shear surface. The line weight, line style and color used to display the line of thrust can be set by first selecting a segment of the line of thrust by clicking on it with the mouse and then choosing the appropriate **Settings** menu item.

Miscellaneous

"Miscellaneous" items that can be displayed include "Problem-Related" items and "Special Items". These are each discussed separately below.

Problem-Related Items

Problem-Related items consist of a set of x-y coordinate axes, triangles representing the Delauney triangulation used for interpolation of pore water pressures and shear strengths, and an outline representing the area that will be printed on the printed output page. Except for the rectangle representing the print area, all of these items will be included in the printed output if they are displayed in the main display window.

X-Y Coordinate Axes

A set of x-y coordinate axes can be drawn to show the coordinates currently being displayed. Scaling for the axes can either be done automatically or set manually using the **Settings->Scaling** menu item (See Section 3 on menus). When the axes are displayed only the portion of the geometry inside the limits of the axes is scrolled when you scroll the display; the lines representing the two axes are not moved. However, if you scroll the display and the axes are displayed, the coordinate values and tick marks along the axes are adjusted ("scrolled") to reflect the shift in coordinates.

The line weight, color and font used to draw the axes and text labels can be set by first clicking on one of the axes to select it and then choosing the appropriate item from the **Settings** menu.

Triangulations

Separate Delauney triangulations are created by TexGraf4 to interpolate values of pore water pressure and shear strength and to draw contours of factor of safety (when a Type 2, "Fixed Grid" search is performed). Triangulations are automatically created for each set of pore water pressure, pore water pressure coefficient (r_u), and shear strength

interpolation data points entered as input to UTEXAS4. Triangulations are also created for the grid points used in a Type 2, fixed grid search with circles. The triangulation of the search grid points is not used in the actual slope stability computations, but is used to draw contours in TexGraf4. Each of these triangulations is displayed by lines connecting adjacent vertices of each triangle. The primary purposes for displaying these triangles is to provide you with insight into how interpolation is done and to understand why a particular pattern of contours is drawn for the factor of safety.

The line weight, line style and color used to display the triangles can be set by first selecting a triangle of the type for which you wish to change the settings and then choosing the appropriate item in the Settings menu. All triangles for a given type of data, e. g. shear strength values for the first stage computations have the same display parameters (line weight, color, etc.), but each different type of data (pore water pressure, shear strength, etc.) and each stage have different display settings. Select the appropriate type of data to change the settings for it.

<u>Print Area Rectangle</u>

A rectangle can be superimposed on the display to show the approximate size of the printed page relative to the current scale of the display in the main display window. This may be useful for setting font sizes and scaling for forces and stresses to achieve the appropriate proportions in the final printed output. The orientation and size of the rectangle depend on the current printer selections.

Special Items

"Special items" consist of the various available line styles, symbols, etc. that can be used to display graphics. The special items are displayed primarily to help you in choosing display settings; the special items display can be printed for your reference in choosing display settings. When one or more "special" items are displayed, only the special items are displayed; none of the slope information, coordinate axes, etc. is displayed regardless of the selections made in the Display Selection dialog box.

<u>Available Patterns</u>

When the "Available Patterns" item is selected for display, a series of rectangles is displayed. Each rectangle is numbered and filled with one of thirty-eight (38) different patterns that can be used to fill areas. The use of patterns for filling areas is described in Section 3 where the **Settings->Pattern** menu item is described.

The **Settings->Patterns** sub-menu lists many, but not all of the available patterns. The specific patterns which are shown and available for assignment in the **Settings->Patterns** sub-menu are set by information in the Graphics Configuration File. TexGraf4 allows you to set in the Graphics Configuration File up to twenty (20) of the

available patterns for assignment using the **Settings->Patterns** menu; all thirty-eight patterns can never be used or assigned at the same time.

<u>Available Line Styles</u>

The Available Line Styles display selection displays the line styles that are available and can be assigned using the **Settings->Line Style** menu item. The available line styles that are shown in Figure 3.5 were actually drawn on the computer display screen using the "Available Line Styles" display option and then "captured" for insertion as a graphic into the text for this manual.

<u>Available Symbols</u>

The available symbols that can be used to draw points can be displayed by choosing the "Available Symbols" display option. These are the symbols that can be assigned using the **Settings->Point (Symbol) Type** menu item. Figure 3.6 shows the available symbols and was actually drawn on the computer display screen using the "Available Symbols" display option and then "captured" for insertion as a graphic into the text for this manual.

Section 6 – SELECTING ITEMS

TexGraf4 lets you select items that are displayed on the screen. Items are selected to get information that is then displayed in the Status Bar, and to set how information is displayed (See the **Settings** menu). In order to select an item it must be displayed and must generally be a member of the "Current Data Set"; the Current Data Set is described in the section on the **Utexas** menu. Only the x-y coordinate axes do not belong to a particular data set; the coordinate axes can be selected regardless of the Current Data Set.

Items are selected by positioning the cursor over the item and clicking the left mouse button. If multiple items exist at the point where you clicked, a menu is "popped-up" listing the items at that location. Use the menu to choose which item to select.

Items must be displayed to be selected. For example, if you display the Profile Lines, but not the points (symbols) for the Profile Lines, you will not be able to select points. The items that can be selected and the location that must be clicked to select them are listed in Table 6.1.

Table 6.1

Items that Can be Selected

Item	How to Select Item
"Crack" line	Click on a segment of the line representing the bottom of the tension crack.
"Crack" point	Click on one of the points that define the bottom profile of the crack (these points are never actually displayed).
"Crack" water force	Click on the horizontal vector that is drawn to represent the force in the vertical "tension" crack.
"Crack" water line segment	Click on a segment of the line representing the surface of the water in the tension crack.
Critical circle center	Click on the center point of the critical circle to select it. (Only applies to automatic searches with circles.)
Critical shear surface point	Click on one of the points on the critical shear surface to select it.
Critical trial shear surface line	Click on a segment of the critical shear surface (between coordinate points) to select it. Segments of the critical shear surface coincide with the base of individual slices.
Distributed load point	Click on one of the points where the distributed load is specified.
Distributed load normal distribution	Click on the tail end of the distributed load vectors or on the line drawn to connect the tail of the vectors that represent the normal component of the distributed load.
Distributed load shear distribution	Same as selecting the normal load except click on the shear load distribution. Note: If both shear and normal loads exist the distribution represents the resultant of the normal and shear component; only the resultant is drawn and can be selected.
Factor of safety	Click on the text representing the computed factor of safety (and side force inclination, if applicable).
Factor of safety contours.	Click inside the area of the grid used for the search. Use the pop-up menu that is displayed to select the contours, rather than the triangulation of grid points or the grid lines. Only applicable to searches conducted with the "fixed" grid.
Factor of safety triangles	Click inside the area of the grid used for the search. Use the pop-up menu that is displayed to select the triangles, rather than the contours or the grid lines. Only applicable to searches conducted with the "fixed" grid.
Grid for search	Click inside the perimeter of the search "grid".
Horizontal axis	Click on the line representing the horizontal coordinate axis.
Initial trial/individual circle center	Click on the center point for the initial trial or individual circle. Applicable to circles only.
Initial trial shear surface point	Click on one of the points that were specified to define the initial trial noncircular shear surface.
Initial trial shear surface line	Click on the line/arc representing the initial trial circular or noncircular shear surface.

Table 6.1 - continued

Items that Can be Selected

Item	How to Select Item
Line load point	Click on the tip of the vector that represents the line load.
Line load vector	Click on the end of the tail of the vector representing the line load.
Line of thrust	Click on a segment of the line of thrust - the line of thrust represents the location of the "side forces" between slices.
Material number	Click on one of the material numbers located in the area beneath the corresponding Profile Line.
Material region	Click in the space beneath the Profile Line.
Material property table boundary grid lines	Click on one of the four lines around the exterior boundary of the material property table to select a boundary grid line.
Material property table interior grid lines	Click on one of the interior lines inside the material property table to select an interior grid line.
Material property table (table text)	Click anywhere inside the outer boundary of the table of material properties.
N-Most Critical Shear Surfaces	Click on the line or arc representing any one of the "n-most critical" (circular or noncircular) shear surfaces.
Profile line segment	Click on a line segment between two points on a Profile Line.
Profile line point	Click on a Profile Line point (symbol).
Profile line number	Click on one of the Profile Line numbers (text); Profile Line numbers are located along the Profile Lines.
Piezometric line points	Click on a piezometric line point (symbol).
Piezometric line segments	Click on a line segment between two points on a piezometric line.
Piezometric line number	Click on one of the piezometric line numbers (text); piezometric line numbers are located along the piezometric lines.
Pressure, r_u or shear strength interpolation point	Click on one of the interpolation data points (symbols).
Pressure, r_u or shear strength interpolation triangle	Click inside the perimeter of one of the triangles comprising the triangulation of interpolation points.
Reinforcement point	Click on one of the points on a reinforcement line.
Reinforcement line segment	Click on a line segment between any two points on the reinforcement line.
Reinforcement longitudinal force distribution.	Click on a segment of the line drawn to represent the magnitude of the longitudinal reinforcement force distribution.
Reinforcement transverse force distribution.	Click on a segment of the line drawn to represent the magnitude of the transverse reinforcement force distribution.
Slice	Click on the area inside the perimeter of a slice.

Table 6.1 - continued

Items that Can be Selected

Item	How to Select Item
Slice boundary	Click on one of the vertical lines representing the boundaries between slices.
Slope line segments	Click on a line segment between any two points on the slope line.
Slope points	Click on a slope point (center of symbol).
Total normal stress, effective normal stress and pore water pressure distribution.	Click on the appropriate line representing the magnitude of the total or effective normal stress or pore water pressure distribution along the shear surface. The distribution is represented by a polygon drawn at the base of each slice, click on the portion/side of the polygon farthest from the shear surface (parallel to the shear surface). Total stresses, effective stresses, pore water pressures may each be selected independently.
Vertical axis	Click on the line representing the vertical coordinate axis.

Section 7 – MOVING (RELOCATING) ITEMS ON THE DISPLAY

The table of material properties and the text showing the computed factor of safety (and side force inclination if Spencer's procedure is used) are initially displayed at default locations determined by TexGraf4. You can relocate these two items by selecting them and repositioning them with the mouse (or other pointing device). The procedure to move either item depends on whether the item is the only item located at the point where you click with the mouse or if several items exist at that point. If the item is the only item located at that point, you can simply click and while still holding the mouse button down, drag the item to a new location. Release the mouse button when the item is positioned at the desired location. If, instead, several items are located where you click with the mouse, you must first select the item to be moved from the pop-up menu that appears. Then, to move the item you must choose "**Move**" from the **Edit** menu. The text in the Edit menu normally reads "**Move**" and is dimmed when nothing is selected. Once you choose either the material property table (lines or text) or the text with the computed factor of safety the **Edit** menu text changes to either "**Move Material Property Table**" or "**Move Factor of Safety Text**" to reflect what you have selected. As soon as you have selected one of these items and chosen to move it with the Edit menu, a rectangle appears with the outline of the item being moved; the rectangle will follow the cursor as you move the mouse. Position the outline where you want the item located. Click again with the mouse to set the new location for the item.

Except for the material property table and the text with the factor of safety the position of all of the other items on the display is controlled by the coordinates for the problem, the current scale, and the amount of zooming, panning and scrolling that has been done. None of the other items displayed can be repositioned. Generally, if you wish to create drawings or figures with multiple illustrations of the slope geometry or with different slopes on the same drawing, the preferred way is to create DXF files, import them into CAD software and, then, use the capabilities of the CAD software to reposition items in the drawing.

Section 8 – "TRACKING" DISPLAY

TexGraf4 will "track" the cursor and display the values of a variable depending on the current selection and position of the cursor. The values for the item being tracked are displayed in the last (fourth) box in the Status Bar at the bottom of the display window. The x and y world coordinates of the cursor are always "tracked" and appear in the second and third boxes in the Status Bar.

The items that can be tracked and the quantities displayed are listed in Table 8.1. For tracking to display values you must first activate tracking by choosing "**Tracking On**" in the **Window** menu. Note that when tracking is "On" the words "**Tracking Off**" appear as the text for the tracking item in the Windows menu.

Once tracking is activated the information displayed ("tracked") depends on what is selected; an appropriate selection must be made for tracking to display information in the Status Bar. The required selections and items than can be tracked are listed in Table 8.1.

Several items have "alternate" quantities that are tracked when the **Shift** or **Ctrl** keys are pressed. Instead of displaying values for the normal quantity, values of the alternate quantity are displayed when the appropriate key (**Shift** or **Ctrl**) is depressed. The alternate quantities that are displayed are also listed in Table 8.1. You can "toggle" between the display of quantities and their alternates by simply depressing and releasing the **Shift** or **Ctrl** keys in the keyboard.

Table 8.1

Items and Information That Can Be "Tracked"

Item Tracked	Quantity Displayed	Alternate Quantity	Required Selection
Profile line.	Shear strength – See Table 8.2.	Shear strength - See Table 8.2.	Select either a point or segment on the Profile Line for which you wish to track shear strength.
Piezometric line.	Pore water pressure.	None	Select either a point or line segment on the Piezometric Line for which you want pore water pressures to be displayed.
Pore water pressure interpolation points.	Interpolated value of pore water pressure.	None	Select either a point or a triangle in the triangulation of points for pore water pressure interpolation. Select the specific data set for which you want values tracked.
Pore water pressure coefficient (r_u) interpolation points.	Interpolated value of the pore water pressure coefficient, r_u.	None	Select either a point or a triangle in the triangulation of points for pore water pressure coefficient (r_u) interpolation. Select the specific data set for which you want values tracked.
Shear strength interpolation points.	Interpolated value of shear strength.	None	Select either a point or a triangle in the triangulation of points for shear strength interpolation. Select the specific data set for which you want values tracked.
Distributed loads – <u>normal stress</u>.	Normal (perpendicular) component of the distributed load.	Shear stress (**Shift** or **Ctrl** key)	Select either a point where the distributed loads were specified or a segment of the outline of distributed normal stresses.
Distributed loads – <u>shear stress</u>.	Shear (tangential) component of the distributed load.	Normal stress (**Shift** or **Ctrl** key)	Select a segment of the outline of distributed shear stresses. Also, if the normal stresses are NOT displayed you can select a <u>point</u> where the distributed loads were specified.
Reinforcement line – <u>longitudinal forces</u>	Longitudinal force in the reinforcement.	Transverse reinforcement force (**Shift** or **Ctrl** key).	Select either (a) a point on the reinforcement line, (b) a segment of the reinforcement line, or (c) a portion of the outline of the longitudinal force distribution in the reinforcement.

Table 8.1 - continued

Items and Information That Can Be "Tracked"

Item Tracked	Quantity Displayed	Alternate Quantity	Required Selection
Reinforcement line – <u>transverse forces</u>	Transverse force in the reinforcement.	Longitudinal reinforcement force (**Shift** or **Ctrl** key).	Select a portion of the outline of the transverse force distribution in the reinforcement. Also, if the longitudinal forces are not displayed you can select either a point on the reinforcement line or a segment of the reinforcement line and the transverse force will be tracked.
Stress distribution on the shear surface – <u>total normal stresses</u>	Total normal stress on the shear surface.	Pore water pressure (**Shift** key); Effective normal stress (**Ctrl** key).	Select either (a) a point on the shear surface, (b) a line segment of the shear surface, or (c) a portion of the outline of the normal stress distribution.
Stress distribution on the shear surface – <u>pore water pressures</u>	Pore water pressure on the shear surface.	Total normal stress (**Shift** key); Effective normal stress (**Ctrl** key).	Select a point on the outline of the distribution of pore water pressure on the shear surface. Also, if the total normal stress is not displayed you can select either a point on the shear surface, or a line segment of the shear surface and the pore water pressure will be tracked.
Stress distribution on the shear surface – <u>effective normal stresses</u>	Effective normal stress on the shear surface.	Total normal stress (**Shift** key); Pore water pressure (**Ctrl** key).	Select a point on the outline of the distribution effective normal stress on the shear surface. Also, if neither the total normal stress <u>nor</u> the pore water pressure distribution is displayed you can select either a point on the shear surface, or a line segment of the shear surface and the effective normal stress will be tracked.

Table 8.2

Shear Strength Information that is Displayed when a Profile Line is Selected and Shear Strengths are being "Tracked"

Shear Strength Option	Quantity Displayed	Alternate Quantity
Option 1: Conventional c, ϕ strength	Friction angle in degrees.	Cohesion value.
Option 2: Linear increase in shear strength below Profile Line	Undrained shear strength, c ($\phi = 0$)	None
Option 3: Linear increase in shear strength below horizontal reference datum	Undrained shear strength, c ($\phi = 0$)	None
Option 4: Constant $c/\bar{p}$ ratio	The $c/\bar{p}$ ratio	The "intercept" strength, c_o.
Option 5: Anisotropic shear strengths	The words "Anisotropic Strength"	None
Option 6: Nonlinear, curved failure envelope	The words "Nonlinear Envelope"	None
Option 7: Interpolation of shear strength	The words "Interpolated Su"	None
Option 8: Two-stage strength - linear strength envelopes	The words "2-Stage - Linear"	None
Option 9: Two-stage strength - nonlinear strength envelopes	The words "2-Stage - Nonlinear"	None
Option 10: "Very high" shear strengths	The words "Very High Strength"	None

Note: Alternate quantities are displayed when the Control (**Ctrl**) key is pressed. When multi-stage computations are designated, the strength values for the second and third stage computations are displayed when the **Shift** key is depressed.

Section 9 – DXF FILE EXPORT

TexGraf4 can export drawing information in the DXF file format into an ASCII text file. This file can be read/imported into CAD software for viewing and further enhancement, such as addition of supplemental information required to prepare presentation quality drawings.

The information contained in the DXF file will be the same as the information that is currently displayed in the main display window at the time the DXF file is created. The size of points (symbols) and text will be set so they are in the same proportion to other objects as they are on the display screen. The entire extent of the geometry is always included in the DXF file; nothing is "clipped" to the limits of the axes or display window. Before creating the DXF file you may find it advantageous to "zoom" in or out so that the text and the symbols have the proportion relative to the overall geometry that you want in the DXF file.

The setting of much of the information regarding the format and content of the DXF file is done using the **DXF File Drawing Layers**, **DXF File Line Styles**, **DXF Item Colors** and **DXF File Miscellaneous** items in the **Settings** menu. It is generally preferable to place different types of items, e. g. Profile Lines and piezometric lines, in different "layers" so that the display of this information can be controlled independently once it is imported into the CAD software (layers can be selectively turned "on" and "off" in the CAD software).

Layer Names

Information for various items (Profile Lines, Profile Line points, piezometric lines, etc.) can be placed in different drawing "layers" in the DXF file. The names of layers into which each type of item is placed are set using the **Settings->DXF File Drawing Layers** menu item and are stored with the Application Preferences Layer names are strings of alphanumeric characters and must conform to the restrictions on layer names imposed by your CAD software. For example some CAD software restricts layer names to numerical values (1, 2, 3, etc.) and may limit the total number of different layers that can exist.

Layer Colors

Colors are assigned to each layer and item in the DXF file. The colors assigned to each item using the **Settings->DXF Item Colors** menu item are stored with the

Application Preferences. The numbers for colors must be based on the numbering scheme recognized by the CAD software you are using.

Line Types

The line styles used for lines in the DXF file are set using the **Settings->DXF File Line Styles** menu item and are stored with the Application Preferences. The line styles that can be assigned in TexGraf4 are set by information in the Graphics Configuration File and must conform to line styles that are recognized by the CAD software that you are using.

Points Information

Points, such as the points defining Profile Lines and the points used for interpolation of pore water pressures can be represented in the DXF file in either of two ways: (1) They can be represented as drawn symbols much like they are represented when drawn in TexGraf4's main display window and printed, or (2) they can be represented as special Autodesk "Point" entities. When represented as Autodesk Point entities, point sizes can be set so that they are a percentage (decimal fraction) of the display extent. Thus, when you zoom in or out, the points can remain the same size. Information controlling whether points are represented as drawn symbols or Autodesk Point entities can be set using the **Settings->DXF File Miscellaneous** menu item. Once set, this information is saved with the Application Preferences. If you choose to have entities represented as Autodesk Point entities, you should be familiar with the Autodesk system variables PDMODE and PDSIZE. These variables (PDMODE and PDSIZE) are set using the **Settings->DXF File Miscellaneous** menu.

Section 10 – USE WITH MICROSOFT © INTELLIMOUSE POINTING DEVICE ("WHEEL" MOUSE)

TexGraf4 will take advantage of the "wheel" on a Microsoft IntelliPoint or compatible mouse if you have one connected and installed on your computer. The wheel on the mouse is used in two ways, referred to herein as "Modes". In the first (default) Mode the wheel is used to "scroll" the display. In the second, alternate Mode the wheel is used to "zoom" the display in and out. The alternate mode is activated by pressing and holding down the **Ctrl** key on the keyboard while rotating the wheel on the mouse.

"Scroll" Mode

In scroll mode ordinarily the display is scrolled up and down as you rotate the top of the wheel away from and toward you, respectively. However, if you press and hold down the **Shift** key on the keyboard, the display is scrolled horizontally rather than vertically when you rotate the wheel.

"Zoom" Mode

Zoom mode is made active by pressing and holding down the **Ctrl** key on the keyboard. In zoom mode the display is "zoomed" in and out as you rotate the wheel. The display is "zoomed" in when the top of the wheel is rotated away from you and zoomed out when the wheel is rotated toward you. Each "click" (detent) of the wheel will zoom the display in or out by a factor of two (2.0).

GLOSSARY OF TERMS

Term	Definition and Description
Application Preferences	These consist of most of the settings used by TexGraf4. TexGraf4 maintains a default set of preferences and additional sets of preferences can be saved and retrieved for custom purposes.
Current Data Set	When multiple sets of data have been read into TexGraf4 and are stored in memory, the Current Data Set is the data set for which changes can be made, e. g. the items to be displayed can be changed and settings regarding line weights, colors, point sizes, etc. can be changed using the **Settings** menu items. The Current Data Set is slected using the **Utexas** menu.
Display coordinates	These are the scaled coordinates shown on the display screen or printed page. They are typically in units of inches or centimeters.
Graphics Configuration File	This is a text (ASCII) file that contains information used to "customize" TexGraf4. This includes information on optional line weights and point sizes that can be used as well as information on the various line styles that can be used for creation of a DXF (drawing) file. Documentation is contained in the file itself and you may edit the file if you wish.
Graphics Exchange File	This is the file created by UTEXAS4 that is read by TexGraf4 to create graphics. The file is a binary file and cannot be edited or altered by the user.
World coordinates	These are the coordinates used to describe the actual slope geometry and problem. They are typically in units of feet or meters.