# OVERSEAS ROAD NOTE

# 8

## A users manual for a program to analyse dynamic cone penetrometer data

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**OVERSEAS ROAD NOTES**

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## INDEMNITY NOTE

Note must be taken by all users of this program that TRRL DCP is not intended to replace normal engineering judgement. The procedures described in this manual are intended for users who already have a thorough understanding of DCP analysis and are capable of deciding which method of analysis is most appropriate for individual situations. The user must be aware of the limitations of the program and, most importantly, that incorrect data input must lead to incorrect data output. The user should be capable of assessing the accuracy of any results produced. No warranty can be given on the validity of the results and the ultimate responsibility for acceptance and subsequent use of any results lies solely with the user.

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Transport and Road Research Laboratory
Crowthorne
Berkshire
United Kingdom

## INTRODUCTION

TRRL DCP is a program designed to help with the interpretation and presentation of DCP test results.

TRRL DCP has been written to operate under MSDOS and PCDOS compatible microcomputer operating systems. The program is totally interactive with `Help' facilities, and is highly user-friendly with rigorous error checking at data input.

Throughout this manual, whenever the user is required to enter text in response to prompts from the program, the text is denoted thus: [TEXT]. Input commands in the form of single keystrokes are denoted: <COMMAND>.

# 1.    INSTALLATION INSTRUCTIONS

The TRRL DCP analysis software is contained on an installation floppy disc which MUST be installed on the host computer before it will operate. (i.e. the software will not work from the floppy disc).

There are three stages of installation. Firstly the relevant files are copied automatically from the installation disc to the host computer's hard disc, then the type of computer display and graphics standard is specified and finally the data disc drive, printer controls, test graphics, etc are defined.

The three stages are carried out as follows. (It is assumed that the floppy disc is in drive A and the hard disc is drive C. The appropriate characters must be substituted for A and C if other disc configurations are used.)

Insert the floppy disc in drive A and type:

A: [INSTALL A C] <Return>. This instruction causes the required files to be copied from drive A to a new sub directory named DCP on drive C. On completion, remove the floppy disc and store safely.

The computer graphics screen must be either CGA, MDA, EGA or HERC and will be either MONO or COLOUR. To install the graphics system type the following sequence: e.g. for a Hercules system:

[DCPINST HERC MONO]

An unacceptable combination of graphics and screen type will result in an error message.

Start the program by typing [DCP] <RETURN>. Press any key to clear the first display and choose Option 2 (File Maintenance) from the main option list. A new option list will appear.

Select Option 1 to specify the data drive (i.e. where data files will be stored). Option 2 to set paper length.

Options 3 and 4 should already have been preset and need not be changed.

Options 5 and 6 should be used to test the graphics screen and to test graphics on the printer. In both cases a standard `test card' should appear.

By <ESC>aping back through the options the user will leave the program. The software will now be fully installed and may be used at any time by typing [DCP] <RETURN>. A data file named TEST is available on disc and may be used to demonstrate the scope of the software. This file is referred to throughout the manual.

Once the program has been successfully installed a back-up copy should be made and stored safely.

## 2. PROGRAM OPERATION

### 2.1 Starting the Program

The computer should be started in the normal way. TRRL DCP will be in a sub-directory of the hard disc. To start the program change to the sub-directory, and type [DCP] <RETURN>. After loading the necessary graphics devices the computer will display the following notice to the authorised user.

```
TRRL Dynamic Cone Penetrometer
------------------------------------------------------------------------
                    DYNAMIC CONE PENETROMETER ANALYSIS


This program has been developed by Contract Data Research Ltd. under
contract to the Overseas Unit of the Transport and Road Research Laboratory.

The analysis follows the methodology outlined in Overseas Unit working
papers 217 and 233.

Any queries concerning the use of this program must be referred to the
Overseas Unit.



Press any key to continue


------------------------------------------------------------------------
                                                          ?=Help ESC=End
```

Pressing a key at this point gives access to the main option list.

### 2.2 TRRL DCP Option List

```
TRRL Dynamic Cone Penetrometer                            Version 1.05
------------------------------------------------------------------------
                          TRRL DCP OPTION LIST
Data drive C:
------------------------------------------------------------------------
  1 [*] Process DCP data          2    File maintenance
------------------------------------------------------------------------









Press RETURN for  Process DCP data
------------------------------------------------------------------------
                                                          ?=Help ESC=End
```

The user may move around the option list by using the left or right arrow keys until the required option is highlighted with an asterisk. This option is also shown towards the bottom left-hand corner of the screen and will be selected if the <RETURN> key is pressed. Alternatively the user may press the number shown in front of the required option.

On completion of any option, the user is returned to this main option list.

If the <ESC>ape key is pressed, the user is offered the opportunity to end and to return to the computer's operating system.

### 2.3 How to Enter Data

The programs operate in an `interactive' style. Questions or requests for information are displayed within `fields' on the computer screen and responses from the operator are made through the computer keyboard. Every time an item of information has been entered through the keyboard, the <RETURN> key must be pressed for the computer to accept the data, if the data field (spaces between square brackets) has not been entirely occupied. However, if the response totally fills the data field the computer automatically accepts the data. For computers with a reverse video facility, the data field and square brackets are shown in reverse video. The computer will wait indefinitely until a response is entered to a request and, subject to the conditions above, the <RETURN> key is pressed.

The program displays a series of `pages' on the computer screen. The name of the program appears in the top left corner. At the bottom left-hand side of the screen is an `error' line for the display of error messages, while in the bottom right-hand corner of the screen the user is shown which key (usually <ESC>ape) to press to end a particular operation and proceed to the next logical step in the program.

```
------------------------------------------------------------------------
                                                          ?=Help ESC=End
```

The <ESC>ape key may be used at most points in the program to leave certain pages, either when data entry is completed or the user wishes to abort.

Also shown at the bottom right hand corner is the `Help' key. On most computers the <SHIFT> and [?] must be pressed simultaneously.

If help is selected a message will be displayed at the top of the screen which will give further

information or instructions on how to proceed with the program. A typical example is:

```
OPTION: Move cursor to required option and press RETURN key. Use up, down,
left or right arrow keys to move cursor. Alternatively, press option number. -
Press ESC to end program.
                     TRRL DCP OPTION LIST

Data drive C:
-------------------------------------------------------------------
1 [*] Process DCP data          2       File maintenance
-------------------------------------------------------------------
```

The program incorporates an error-checking system to ensure that the data entered is logical and consistent in relation to the data requested. At the bottom of the screen is an error line which will display error messages in the event of invalid data being entered.

For example, if a number is being requested and an alphabetic character is entered in error, an `Invalid Data' message will appear as follows and the correct data must be re-entered.

```
-------------------------------------------------------------------
Invalid data                                    ?=Help ESC=End
```

The invalid data message may appear for many reasons and will usually be obvious. However, the `Help' system may give some indication of why data is not accepted.

## 2.4    Amend/Review Data

At any stage of entering or amending the data a simple editing facility is available. This involves the use of two keys which are pressed simultaneously to perform each function, one of which is the control <CTRL> key.

<CTRL> + [X] move down to next batch of fields
<CTRL> + [E] move back to last field
<CTRL> + [D] move right on command line
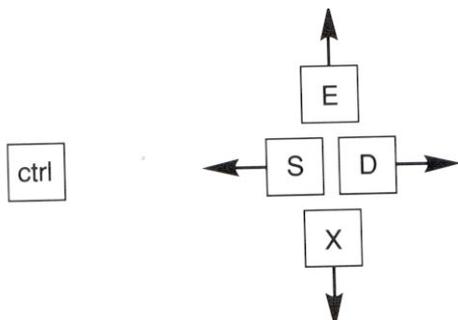


On most computers, these commands are available using the arrow keys on the keyboard. The simplest way to erase data in a complete cell is to enter a space followed by a <RETURN>. On reviewing data a <RETURN> skips to the next data field.

## 2.5    Do Not...

The program is equipped with thorough error checking routines but there are still a number of operations that the user may carry out which would have disastrous consequences but which cannot be overruled by the program.

(a)    *NEVER* RESET  or BOOT the computer while the program is in operation. This will re-set the whole system with the loss of data.

(b)    *NEVER* open the disc drive doors and remove or replace discs unless specifically instructed by the computer. This may result in a system failure and the loss of data.

(c)    *NEVER* press the <CTRL>  and [C] keys simultaneously while the program is in operation. This may stop the program and cause the loss of data.

(d)    *NEVER* turn the computer off until instructed to do so.

## 2.6    What to do in the Event of a Computer Failure

If for any reason, there is a failure, it will be fairly obvious which data has and has not been recorded successfully. If there is any doubt, the back-up copies of the data should be used to start the data input session again.

## 2.7    Always . . .

There is one cardinal rule for any computerised system. *ALWAYS* make back-up copies of all current data after entering ANY new information. The copying procedure will vary between the different types of computer and reference should be made to the Operating System manual and Section 2.12 for details of relevant filenames.

## 2.8    Command Line

Throughout the program the user is presented with a command line near the bottom of the screen thus:

```
-------------------------------------------------------------------
New/Recall/Edit/Ins/Del/Kill/Save/More/Options      Command [Recall ]
-------------------------------------------------------------------
                                                    ?=Help ESC=End
```

If your screen supports reverse video, the current option will be shown in reverse video, and will appear to the right of the word `Command'. To select options, the user may press the space bar or the left and right cursor keys, until the desired option has been highlighted. To enter the option the user presses the <RETURN> key. The user may also jump to an option by entering the first letter of the required option. To exit from the command line the user must press the <ESC>ape key.

## 2.9 OK? Prompt

Throughout the program the user will be asked to confirm that the displayed data is OK with the following message at the bottom of the screen.

```
-------------------------------------------------------------------

                        OK ?                ?=Help ESC=End
-------------------------------------------------------------------
```

The user has three possible responses to this request:

Enter [Y] for yes and continue
Enter [N] for no, go back and review
Enter <ESC>ape for no and quit this operation.

## 2.10 Recall File

The user may recall data files previously saved on disc by moving the cursor to the RECALL command and pressing <RETURN>.

```
Filename (or DIR) [        ].
```

Use of this option will clear any data in memory and load the recalled data. The user has only to enter the filename. Sub-directories, data drives or file extensions must not be specified. Alternatively, the user may enter [DIR] to obtain a list of those files which may be recalled.

## 2.11 Save File

The user may save data files on disc by moving the cursor to the SAVE command and pressing <RETURN>.

```
Filename (or DIR) [        ]
```

Use of this option will save the data currently displayed to the specified file. If the specified file already exists it will be overwritten. Note that it is only necessary to enter the filename and that file extensions, data drives and sub-directories are not required. A list of files already saved on disc can be displayed by typing [DIR].

## 2.12 Data Filenames

Throughout the program, data files are created and stored on the data disc. [FILENAME] is a user-specified filename of up to 8 characters. A three character filename extension, [FILENAME].DCP, is automatically given to each data file. The user is not required to enter the drive specification nor the filename extension in response to filename requests.

When batch printing a file, a new file is automatically created with the same filename as the data filename but with the file extension .FIL. (See Section 4.9).

# 3. PROCESSING DCP DATA

## 3.1 Introduction

This option allows the entry of new data as well as the editing and storage of existing data. Data printouts and plots of the DCP curves may also be obtained in this option.

On selecting the 'Process DCP Data' option, the following screen is displayed:

```
TRRL Dynamic Cone Penetrometer                      NO CURRENT FILENAME
-------------------------------------------------------------------------

Site            [          ] Date          [                ]
Section no.     [          ] Start layer   [                ]
Test no.        [          ] Condition     [                ]
Chainage        [          ] Zero error (mm) [    ]
Direction/lane  [          ] Surf thick (mm) [    ]
Position/offset [          ] Extens @ line   [    ]
-------------------------------------------------------------------------
    Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng
  1    0 [    ] 11 [   ][    ] 21 [   ][    ] 31 [   ][    ] 41 [   ][    ]
  2 [   ][    ] 12 [   ][    ] 22 [   ][    ] 32 [   ][    ] 42 [   ][    ]
  3 [   ][    ] 13 [   ][    ] 23 [   ][    ] 33 [   ][    ] 43 [   ][    ]
  4 [   ][    ] 14 [   ][    ] 24 [   ][    ] 34 [   ][    ] 44 [   ][    ]
  5 [   ][    ] 15 [   ][    ] 25 [   ][    ] 35 [   ][    ] 45 [   ][    ]
  6 [   ][    ] 16 [   ][    ] 26 [   ][    ] 36 [   ][    ] 46 [   ][    ]
  7 [   ][    ] 17 [   ][    ] 27 [   ][    ] 37 [   ][    ] 47 [   ][    ]
  8 [   ][    ] 18 [   ][    ] 28 [   ][    ] 38 [   ][    ] 48 [   ][    ]
  9 [   ][    ] 19 [   ][    ] 29 [   ][    ] 39 [   ][    ] 49 [   ][    ]
 10 [   ][    ] 20 [   ][    ] 30 [   ][    ] 40 [   ][    ] 50 [   ][    ]
-------------------------------------------------------------------------
New/Recall/Edit/Ins/Del/Kill/Save/More/Options       Command [New    ]
-------------------------------------------------------------------------
                                                      ?=Help ESC=End
```

Along the bottom of the screen a menu is displayed and these options are explained in turn below.

## 3.2 The NEW Command

The NEW command is used to clear all existing data and start the entry of new data. If data already exists, the user is required to confirm that this data is to be cleared from memory as follows:

```
-------------------------------------------------------------------------
Current data saved              OK ?               ?=Help ESC=End
-------------------------------------------------------------------------
```

If data is not to be lost irretrievably it should first be saved using the 'save' command as detailed in Section 2.11.

If the user enters [Y] to the 'Current data saved OK?' prompt then the data currently displayed will be cleared both from the screen and from the memory, and the cursor will move to the first field in the table ready for the input of new data.

| | |
|---|---|
| Site: | Description of the site [20 characters] |
| Section no. | Details of the section no. [20 characters] |
| Text: | Details of the test no: [20 characters] |
| Chainage: | Details of the chainage [20 characters] |
| Direction/lane | Details of the direction and lane [20 characters] |
| Position/offset | Details of the position of offset [20 characters] |
| Date: | Date of the test [20 characters] |
| Start layer: | Description of the surface or upper layer [20 characters] |
| Condition: | Condition of the start layer [20 characters] |
| Zero error (mm): | If, for various reasons while conducting the DCP test, the reading is not zero at zero blows the reading should be entered here. |
| Surf thick (mm): | Enter the thickness of the surface layer in millimetres. This layer will generally be a very hard layer through which a hole has been chiselled or drilled. |
| Extens @ line- | Here the user should enter the line number at which any extension rod was added to the DCP apparatus. At this point the scale reading will have been recalibrated and the user will have entered two readings for the same number of blows. In the example below an extension rod of 400 mm was added after 169 blows when the reading was 466 mm. The new scale reading is 66 mm after which the data entry can continue as normal. |

```
TRRL Dynamic Cone Penetrometer                         DATA FILE : TEST
-----------------------------------------------------------------------
Site          [KENANA         ] Date         [22/9/84           ]
Section no.   [2              ] Start layer  [Not Specified      ]
Test no.      [6              ] Condition    [                   ]
Chainage      [48+00          ] Zero error (mm) [ 63]
Direction/lane [SOUTH         ] Surf thick (mm) [ 60]
Position/offset [VERGE         ] Extens @ line   [ 25]
-----------------------------------------------------------------------
    Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng
 1    0 [  63] 11 [100] [ 215] 21 [160] [ 408] 31 [175] [ 192] 41 [185] [ 404]
 2 [ 10] [  75] 12 [110] [ 230] 22 [165] [ 434] 32 [176] [ 220] 42 [   ] [    ]
 3 [ 20] [  89] 13 [120] [ 253] 23 [168] [ 457] 33 [177] [ 247] 43 [   ] [    ]
 4 [ 30] [  99] 14 [125] [ 269] 24 [169] [ 466] 34 [178] [ 264] 44 [   ] [    ]
 5 [ 40] [ 118] 15 [130] [ 289] 25 [169] [  66] 35 [179] [ 286] 45 [   ] [    ]
 6 [ 50] [ 130] 16 [135] [ 307] 26 [170] [  80] 36 [180] [ 305] 46 [   ] [    ]
 7 [ 60] [ 149] 17 [140] [ 326] 27 [171] [  91] 37 [181] [ 324] 47 [   ] [    ]
 8 [ 70] [ 166] 18 [145] [ 347] 28 [172] [ 113] 38 [182] [ 344] 48 [   ] [    ]
 9 [ 80] [ 181] 19 [150] [ 364] 29 [173] [ 139] 39 [183] [ 364] 49 [   ] [    ]
10 [ 90] [ 204] 20 [155] [ 385] 30 [174] [ 165] 40 [184] [ 384] 50 [   ] [    ]
-----------------------------------------------------------------------

-----------------------------------------------------------------------
                                                        ?=Help ESC=End
```

Once the data has been entered the user should <ESC>ape in the normal way, see section 2.3 and a recalculation message will be displayed. After the program has made provision for any extension rods the above data input will appear as follows. The user is required to enter yes [Y] to confirm that the recalculation is satisfactory.

```
TRRL Dynamic Cone Penetrometer                         DATA FILE : TEST
-----------------------------------------------------------------------
Site          [KENANA         ] Date         [22/9/84           ]
Section no.   [2              ] Start layer  [Not Specified      ]
Test no.      [6              ] Condition    [                   ]
Chainage      [48+00          ] Zero error (mm) [ 63]
Direction/lane [SOUTH         ] Surf thick (mm) [ 60]
Position/offset [VERGE         ] Extens @ line   [   ]
-----------------------------------------------------------------------
    Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng
 1    0 [  63] 11 [100] [ 215] 21 [160] [ 408] 31 [176] [ 620] 41 [   ] [    ]
 2 [ 10] [  75] 12 [110] [ 230] 22 [165] [ 434] 32 [177] [ 647] 42 [   ] [    ]
 3 [ 20] [  89] 13 [120] [ 253] 23 [168] [ 457] 33 [178] [ 664] 43 [   ] [    ]
 4 [ 30] [  99] 14 [125] [ 269] 24 [169] [ 466] 34 [179] [ 686] 44 [   ] [    ]
 5 [ 40] [ 118] 15 [130] [ 289] 25 [170] [ 480] 35 [180] [ 705] 45 [   ] [    ]
 6 [ 50] [ 130] 16 [135] [ 307] 26 [171] [ 491] 36 [181] [ 724] 46 [   ] [    ]
 7 [ 60] [ 149] 17 [140] [ 326] 27 [172] [ 513] 37 [182] [ 744] 47 [   ] [    ]
 8 [ 70] [ 166] 18 [145] [ 347] 28 [173] [ 539] 38 [183] [ 764] 48 [   ] [    ]
 9 [ 80] [ 181] 19 [150] [ 364] 29 [174] [ 565] 39 [184] [ 784] 49 [   ] [    ]
10 [ 90] [ 204] 20 [155] [ 385] 30 [175] [ 592] 40 [185] [ 804] 50 [   ] [    ]
-----------------------------------------------------------------------

-----------------------------------------------------------------------
Recalculated for extension         OK ?                  ?=Help ESC=End
```

Blows/Rdng:  Enter the number of blows in the left hand column and the corresponding reading or depth of the DCP probe in the column to the right. Once all the required data fields have been entered, (100 max) <ESC>ape from the New option.

The data in each file is split into 3 sections called:

(i) Descriptive data: As the name suggests this data describes the site and conditions and is found on the top half of the screen.

(ii) Test data page 1: These are the blows and corresponding readings for the first 50 data records

(iii) Test data page 2: These are the blows and corresponding readings for the second 50 data records

During data input the screen will move automatically to page 2 after page 1 has been filled with data. In order to move back to view page 1 again, it is necessary to save the file (see section 2.11) after which it is possible to select the edit facility (see section 3.4) and make any corrections required.

## 3.3   The RECALL Command

The RECALL command is used to recall and display a previously saved data file, see Section 2.11. This data file will replace any data already displayed. The user is required either to enter the filename or to enter [DIR] to produce a list of all existing filenames. If a filename has already been specified for the data shown, its name will be displayed in the data box. If the <RETURN> key is pressed, the filename will default to the display name.

```
Filename (or DIR) [test    ]
-----------------------------------------------------------------------
                                                        ?=Help ESC=End
```

After the data has been recalled from disc it is displayed. Any errors will be displayed as an error message to remind the user of invalid data. The name of the current DCP data file will be displayed in the top right hand corner of the screen, as follows:

```
TRRL Dynamic Cone Penetrometer                         DATA FILE : test
-----------------------------------------------------------------------
```

The DCP data may then be edited, viewed, printed etc. If the user tries to recall a file which does not exist an error message will appear `File not found'.

## 3.4   The EDIT Command

The EDIT command is used to edit data in an existing data file. The cursor moves to the site cell and may be moved from cell to cell or field to field either by entering modified data or by

pressing the <RETURN> key. If the only data to be modified is further down the file then the down arrow key may be pressed to move down until the line to be changed is reached. The <ESC>ape key may be pressed to end an edit of the particular page as explained in section 3.2. To move back to page 1 from page 2 it is necessary to follow the procedure outlined in section 3.2.

If an error exists in the data the user will be reminded by the `Invalid data' message which will appear at the bottom of the screen. Once EDIT is selected the cursor will automatically go to the line containing the error. When the user <ESC>apes from the EDIT option, the file is checked for errors and if any are found they are displayed in a message as before. The user is then prompted for yes [Y] or no [N] as to whether he wishes to leave the EDIT option. If no [N] is selected because an error message has been displayed by the error analysis, the cursor will go to the box containing the erroneous value.

## 3.5    The Insert (INS) Command

This command is used to add data either in the middle or at the end of an existing data set. The user is required to enter the line number at which the new data is to be inserted.

```
Insert at line number [  ]
--------------------------------------------------------------
                                               ?=Help ESC=End
```

The existing data is automatically re-displayed showing blank data boxes for that line. The Edit command is automatically invoked and the user may move the cursor to the new line and enter the completion of the data entry the <ESC>ape key may be pressed and a re-calculation and error analysis will check the integrity of the data.

## 3.6    The Delete (DEL) Command

This allows the user to delete a line of data and automatically moves all the succeeding data up to fill the place of the deleted line. The user is prompted for the line number by the following:

```
Delete line number    [  ]
--------------------------------------------------------------
                                               ?=Help ESC=End
```

The data will be re-displayed and re-calculated to check that the new data is valid. When the user

enters the required line number and presses <RETURN>, he is then asked to confirm this choice by yes [Y] or no [N] in answer to the question `Are you sure?' If [Y] is selected the deletion is performed.

## 3.7    The KILL Command

This command is used to delete an entire data file which has been recalled and is currently displayed. If the data displayed does not have a filename (i.e. has not been previously saved) then a message `No data file to kill' will appear. Once kill has been selected the user will be required to confirm the action in response to the message `Delete (filename)-Are you sure OK? If [Y] is entered the file is removed from the disc, the screen and the memory.

## 3.8    The SAVE Command

This option will store data in a user specified disc file, see section 2.11. Once a filename has been entered the file will be saved with this name. Care must be taken not to give the file the same name as one that already exists as this will overwrite the old file without any warning. If the user types [DIR] for a filename a list of all existing filenames will appear on the screen. However, if the <ESC>ape is pressed the save option will be abandoned but the data will remain on the screen, so that SAVE can be reselected if necessary.

## 3.9    The MORE Command

Once a file is recalled to the screen the first 50 sets of data on page 1 are displayed. The MORE option displays the second 50 sets of data on page 2. If the MORE option is selected again the first 50 sets of data are returned to the screen.

## 3.10   The OPTIONS Toggle Command

This command displays a second menu as shown.

```
Analyse/View/Print/Tol/SN/File/Options          Command [Analyse]
--------------------------------------------------------------
                                                  ?=Help ESC=End
```

These menu options are selected in the same manner as described in section 2 i.e. by entering the first letter of the option required or by moving the cursor and pressing the <RETURN> key. This menu also has an OPTION command which will take the user back to the first menu.

## 3.11   The ANALYSE Command

This option calculates layer thickness and CBR values for the data entered, the processed data appearing on the screen thus:

When the user selects ANALYSE, the program identifies layer boundaries in the material based on the rate of penetration, which is an indicator of the material strength. The sensitivity of this routine can be adjusted by changing tolerances and the EM value (see section 3.15).

The results table displays the strength, CBR and thickness of each of the layers identified by the program. The layers are zones of constant penetration rate within the given tolerance and are shown graphically in Figure 3.1.

Transition zones are defined between layers when the gradient of the blow/penetration curve changes gradually over a certain depth thus not permitting the positioning of a distinct layer boundary.

A bracketed CBR value may appear next to the calculated CBR value for a layer when the calculated value is very high. In these cases the bracketed value is suggested as being more realistic for analysis purposes.

The formula used for the CBR calculation is displayed beneath the table (see Section 4.10).

## 3.12  The VIEW Command

The VIEW command is used to display analysed data in graphical form on the screen or to plot it on a printer or plotter.

When VIEW is selected the following menu appears on the screen:

These options perform the following plots.

(i) Blow-pen:  Plots blows versus penetration, (mm) see figure 3.2.

(ii) mm-blow:  Plots a histogram of the penetration rate in mm/blow versus depth in mm. No boundaries are drawn to distinguish the individual layers but they may be identified by the `steps' in the plot, see figure 3.3. This plot is useful for assessing the boundary positions chosen by the program.

(iii) CBR:  Plots a histogram of CBR versus depth, see figure 3.4.

(iv) All:  Plots all the above on one drawing, see figure 3.5.

The format of the initial graphics display is selected automatically. A scale is fixed so that the complete plot can appear on the computer screen with a superimposed grid. Thereafter a number of graphics functions may be used.

A command line listing the various graphics display options is located at the top right hand corner of the screen. Each function is selected simply by typing the appropriate characters.
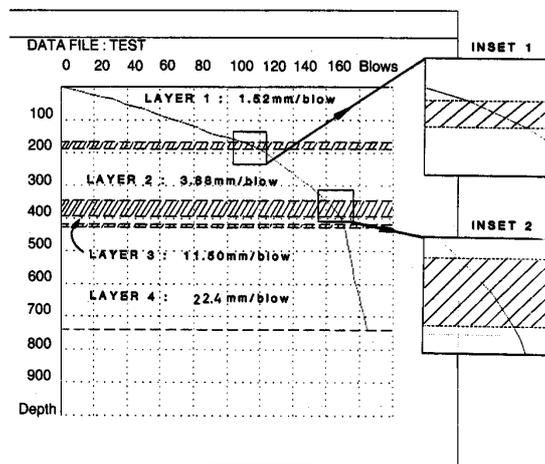


**Figure 3.1**
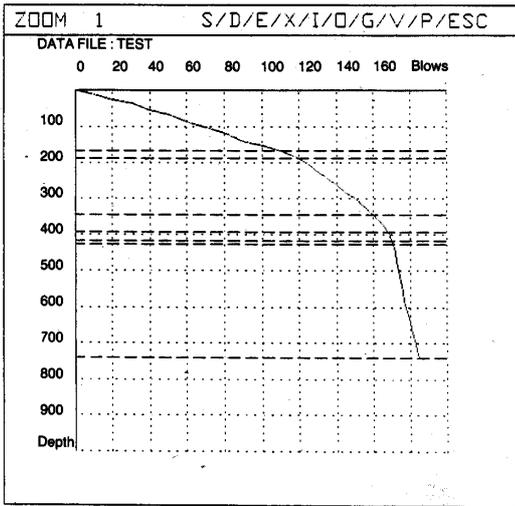
**Figure 3.2 Blows versus penetration curve**
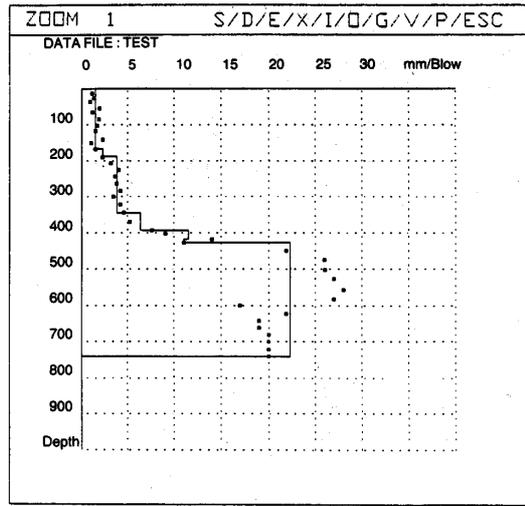


**Figure 3.3 Penetration rate versus depth**
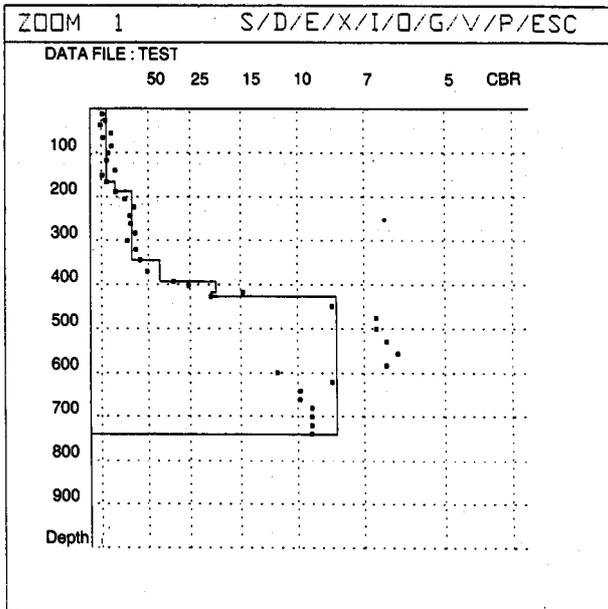


**NOTE:** Beware, on the CBR scale values are shown getting *smaller* as you move along the "x" axis.



**NOTE**: Beware, on the CBR scale values are shown getting smaller as you move along the "x" axis.

**Figure 3.4    California Bearing Ratio versus depth**
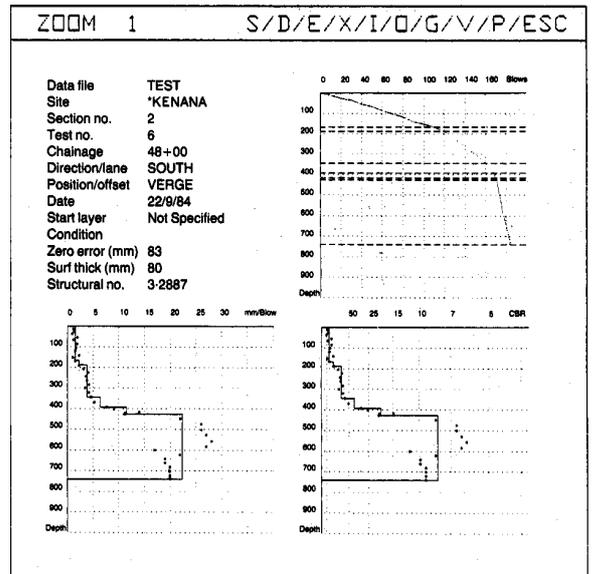
**Figure 3.5    Combination of Figures 3.2, 3.3, and 3.4**

10

### 3.12.1 I/O: Zoom Functions

The I and O zoom functions allow a zoom-in or zoom-out on the current plot. Two rates of zooming are available. Pressing the [I] or [O] keys will zoom slowly, each step being 0.1 times the original scale, but zooming can be speeded up by pressing the <CTRL> key simultaneously which doubles the zooming rate. After using [I] or [O] the new zoom level is shown in the top left-hand corner of the screen and, in the case of [I], a dotted box will show the portion of the plot which will be displayed full screen when [V] (View) is pressed.



Normally, if a zoom-in is required, CTRL [I] will be used to zoom-in the large steps and then [I] for fine adjustment.

A maximum zoom level of 500 (500 times the original plot) is the limit for zooming in, and 0.2 for zooming out.

### 3.12.2 S/D/E/X: Panning Functions

[S], [D], [E] and [X] may be used to pan a new plot to the left, right, up and down, respectively. (It should be noted that these are the same as the Wordstar cursor movement keys). On some computers, the arrow cursor keys will achieve the same effect.

The panning functions will normally be used after zooming-in to position the window of the new plot as required.

Two panning steps are available. A `fine' movement using the [S], [D], [E] or [X] alone and a `coarse' movement using <CTRL> with [S], [D], [E] or [X].

Panning appears as follows and the new plot may be displayed by pressing [V] as before.
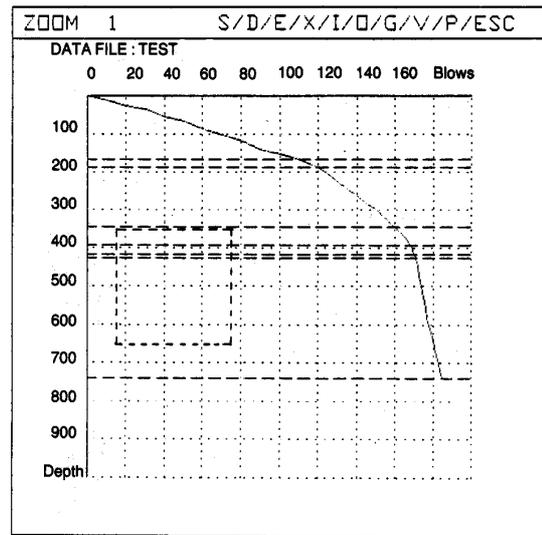


### 3.12.3 G: Grid Toggle

[G] may be pressed to apply/remove a grid overlay: it acts as a toggle.
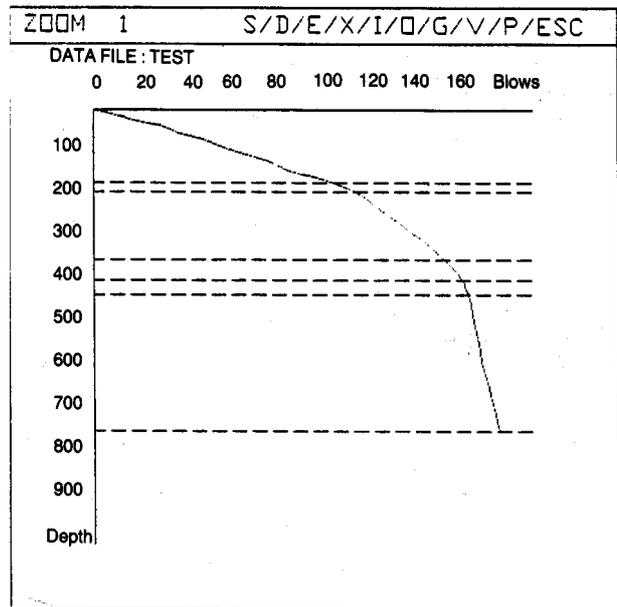


### 3.12.4 V: View Plot

To view a plot on screen, press [V]. This would normally be used after zooming or panning and the new plot would be of the zoomed/panned window.

### 3.12.5 P: Print or Plot

The currently displayed plot of the new window, if zooming or panning has been carried out, may be reproduced on a printer or plotter by pressing [P]. The computer screen will clear and a `Preparing Graphics Image' message will appear. On completion of printing or plotting, the current plot will be re-displayed on the screen.

### 3.12.6 ECS: End Graphics

The <ESC>ape key may be pressed to end graphics and to return to the option list or Command line.

### 3.13 The PRINT Command

This option prints the data in the following format, once the user has checked that the printer is ready for printing and confirmed this to the program.

```
=================================================================
TRRL Dynamic Cone Penetrometer                     Data file : test
=================================================================
16/11/89
Site              KENANA           Date              22/9/84
Section no.       2                Start layer       Not Specified
Test no.          6                Condition
Chainage          48+00            Zero error (mm)   63
Direction/lane    SOUTH            Surf thick (mm)   60
Position/offset   VERGE            Extens # line     0
-----------------------------------------------------------------
     Blw  Rdng     Blw  Rdng     Blw  Rdng     Blw  Rdng    Blw  Rdng
-----------------------------------------------------------------
|  1        63 | 11 100   215 | 21 160   408 | 31 176   620 | 41      |
|  2  10    75 | 12 110   230 | 22 165   434 | 32 177   647 | 42      |
|  3  20    89 | 13 120   253 | 23 168   457 | 33 178   664 | 43      |
|  4  30    99 | 14 125   269 | 24 169   466 | 34 179   686 | 44      |
|  5  40   118 | 15 130   289 | 25 170   480 | 35 180   705 | 45      |
|  6  50   130 | 16 135   307 | 26 171   491 | 36 181   724 | 46      |
|  7  60   149 | 17 140   326 | 27 172   513 | 37 182   744 | 47      |
|  8  70   166 | 18 145   347 | 28 173   539 | 38 183   764 | 48      |
|  9  80   181 | 19 150   364 | 29 174   565 | 39 184   784 | 49      |
| 10  90   204 | 20 155   385 | 30 175   592 | 40 185   804 | 50      |
|                                                                     |
| 51       | 61       | 71       | 81       | 91       |
| 52       | 62       | 72       | 82       | 92       |
| 53       | 63       | 73       | 83       | 93       |
| 54       | 64       | 74       | 84       | 94       |
| 55       | 65       | 75       | 85       | 95       |
| 56       | 66       | 76       | 86       | 96       |
| 57       | 67       | 77       | 87       | 97       |
| 58       | 68       | 78       | 88       | 98       |
| 59       | 69       | 79       | 89       | 99       |
| 60       | 70       | 80       | 90       |100       |
-----------------------------------------------------------------
E1 : 0.35    E2 : 0.80    E3 : 2.50    E4 : 5.00    EM : 2.00
-----------------------------------------------------------------
      Layer      Strength      CBR      Thick      Depth
                 mm/blow                 mm         mm
        1          1.52        251       167        167
      Trans        2.30        148        23        190
        2          3.88         76       155        345
      Trans        6.43         42        49        394
        3         11.33         19        34        428
        4         22.36          8       313        741
-----------------------------------------------------------------
Kleyn equation · log10(CBR) = 2.632 - 1.28 * log10(STRENGTH)
```

### 3.14 The FILE Command

This option writes the data to a print file in ASCII format. The format of the file is as follows:

```
=================================================================
TRRL Dynamic Cone Penetrometer                     Data file : test
=================================================================
16/11/89
Site              KENANA           Date              22/9/84
Section no.       2                Start layer       Not Specified
Test no.          6                Condition
Chainage          48+00            Zero error (mm)   63
Direction/lane    SOUTH            Surf thick (mm)   60
Position/offset   VERGE            Extens # line     0
-----------------------------------------------------------------
     Blw  Rdng     Blw  Rdng     Blw  Rdng     Blw  Rdng    Blw  Rdng
-----------------------------------------------------------------
|  1        63 | 11 100   215 | 21 160   408 | 31 176   620 | 41      |
|  2  10    75 | 12 110   230 | 22 165   434 | 32 177   647 | 42      |
|  3  20    89 | 13 120   253 | 23 168   457 | 33 178   664 | 43      |
|  4  30    99 | 14 125   269 | 24 169   466 | 34 179   686 | 44      |
|  5  40   118 | 15 130   289 | 25 170   480 | 35 180   705 | 45      |
|  6  50   130 | 16 135   307 | 26 171   491 | 36 181   724 | 46      |
|  7  60   149 | 17 140   326 | 27 172   513 | 37 182   744 | 47      |
|  8  70   166 | 18 145   347 | 28 173   539 | 38 183   764 | 48      |
|  9  80   181 | 19 150   364 | 29 174   565 | 39 184   784 | 49      |
| 10  90   204 | 20 155   385 | 30 175   592 | 40 185   804 | 50      |
| 51       | 61       | 71       | 81       | 91       |
| 52       | 62       | 72       | 82       | 92       |
| 53       | 63       | 73       | 83       | 93       |
| 54       | 64       | 74       | 84       | 94       |
| 55       | 65       | 75       | 85       | 95       |
| 56       | 66       | 76       | 86       | 96       |
| 57       | 67       | 77       | 87       | 97       |
| 58       | 68       | 78       | 88       | 98       |
| 59       | 69       | 79       | 89       | 99       |
| 60       | 70       | 80       | 90       |100       |
-----------------------------------------------------------------
```

The file name is always the same as the data file name. However, the suffix becomes [FILENAME]. FIL as explained in section 2.12. These files are used in the batch print, see section 4.9, and the final printed format is as shown above.

### 3.15 The Tolerance (TOL) Command

When the user selects this he will be presented with the following screen:

```
TRRL Dynamic Cone Penetrometer                     DATA FILE : TEST
-----------------------------------------------------------------
Site              [ KENANA   ] Date              [22/9/84       ]
Section no.       [2         ] Start layer       [Not Specified ]
Test no.          [6         ] Condition         [              ]
Chainage          [48+00     ] Zero error (mm)   [ 63]
Direction/lane    [SOUTH     ] Surf thick (mm)   [ 60]
Position/offset   [VERGE     ] Extens # line     [   ]
-----------------------------------------------------------------
     Blows  Rdng     Blows Rdng    Blows Rdng    Blows Rdng    Blows Rdng
 1    0 [  63] 11 [100] [ 215] 21 [160] [ 408] 31 [176] [ 620] 41 [   ] [   ]
 2 [ 10] [  75] 12 [110] [ 230] 22 [165] [ 434] 32 [177] [ 647] 42 [   ] [   ]
 3 [ 20] [  89] 13 [120] [ 253] 23 [168] [ 457] 33 [178] [ 664] 43 [   ] [   ]
 4 [ 30] [  99] 14 [125] [ 269] 24 [169] [ 466] 34 [179] [ 686] 44 [   ] [   ]
 5 [ 40] [ 118] 15 [130] [ 289] 25 [170] [ 480] 35 [180] [ 705] 45 [   ] [   ]
 6 [ 50] [ 130] 16 [135] [ 307] 26 [171] [ 491] 36 [181] [ 724] 46 [   ] [   ]
 7 [ 60] [ 149] 17 [140] [ 326] 27 [172] [ 513] 37 [182] [ 744] 47 [   ] [   ]
 8 [ 70] [ 166] 18 [145] [ 347] 28 [173] [ 539] 38 [183] [ 764] 48 [   ] [   ]
 9 [ 80] [ 181] 19 [150] [ 364] 29 [174] [ 565] 39 [184] [ 784] 49 [   ] [   ]
10 [ 90] [ 204] 20 [155] [ 385] 30 [175] [ 592] 40 [185] [ 804] 50 [   ] [   ]
-----------------------------------------------------------------
E1 [0.35]    E2 [0.80]    E3 [2.00]    E4 [5.00]    EM [2.00]
-----------------------------------------------------------------
                                             ?=Help ESC=End
```

The values E1 to E4 along the bottom of the screen are the tolerances which the program will apply to particular ranges of penetration/blow gradient during the analysis phase. These values

can be changed by the user. The gradient ranges to which the tolerances are applied are as follows:

E1 - Tolerance for penetration gradients between 0 and 3 mm/blow

E2 - Tolerance for penetration gradients between 3 and 8 mm/blow

E3 - Tolerance for penetration gradients between 8 and 20 mm/blow

E4 - Tolerance for penetration gradients >20 m/blow

The EM value at the bottom right of the screen is a multiplying factor which is applied to each of the four tolerances allowing the user to manipulate the sensitivity of the layer identification routine.

EM x the zone tolerance (El to E4) gives the amount by which the gradient of the penetration/blow curve is allowed to vary before the program decides that a new layer exists. Decreasing any of the zone variables (El-E4) decreases the tolerance in that zone thereby increasing the number of layers which might be detected.

Changing the value of EM will affect ALL the zones as follows:

Decrease in EM - Increase in sensitivity-
Increase in number of layers

Increase in EM - Decrease in sensitivity-
Decrease in number of layers

## 3.16 Structural Number (SN) Command

For the selection of this option the data file must have been analysed (Section 3.10). If this has not been done an error message `Not yet analysed' will appear. Once analysed this option will display the following:

```
TRRL Dynamic Cone Penetrometer                          DATA FILE : TEST
--------------------------------------------------------------------------

Layer      Strength    CBR      Thick    Depth    Layer              S.N.
           mm/blow              mm       mm       B/S/G
--------------------------------------------------------------------------
  1         1.52     251(150)   167      167
Trans       2.30      148        23      190
  2         3.88       76       155      345
Trans       6.43       42        49      394
  3        11.50       19        23      417
Trans      11.00       20        11      428
  4        22.36        8       313      741
--------------------------------------------------------------------------




--------------------------------------------------------------------------
Basic/Adjusted                               Command [Basic  ]
--------------------------------------------------------------------------
                                             ?=Help ESC=End
```

The user must then choose whether he wishes to use the basic or adjusted structural number equation.

The basic structural number is similar to the original AASHTO definition but with the addition of the subgrade contribution. The adjusted structural number takes account of the way that layer contributions decrease with depth. This option is recommended whenever the subbase is thick or multilayered and whenever the exact definition of the top of the subgrade is difficult.

Once an equation has been chosen, a prompt will appear under the layer (B/S/G) column. The user must either press <RETURN>, which leaves the field blank, or enter

[B] - Base
[S] - Subbase
or [G] - Subgrade

to define the pavement layers. The program then assigns coefficients to the three layer types for use in the structural number calculation.

Once layers have been defined, the user is presented with the following screen:

```
TRRL Dynamic Cone Penetrometer                          DATA FILE : TEST
--------------------------------------------------------------------------

Layer      Strength    CBR      Thick    Depth    Layer              S.N.
           mm/blow              mm       mm       B/S/G
--------------------------------------------------------------------------
  1         1.52     251(200)   167      167     [B]  Base        0.986
Trans       2.30      148        23      190     [B]  Base        0.130
  2         3.88       76       155      345     [S]  Subbase     0.696
Trans       6.43       42        49      394     [S]  Subbase     0.206
  3        11.50       19        23      417     [S]  Subbase     0.079
Trans      11.00       20        11      428     [S]  Subbase     0.039
  4        22.36        8       313      741     [G]  Subgrad
--------------------------------------------------------------------------




Surface [    ] Base    1.117  Subbase 1.019  Subgrad 1.050   Total 3.186
--------------------------------------------------------------------------

--------------------------------------------------------------------------
                                             ?=Help ESC=End
```

The program now prompts for the structural number of the surface layer to be input by the user. This value, if entered, is simply added to the total for the other layers specified as base, sub-base or sub-grade. If any of these layers have not been specified the user will be prompted to input additional structural numbers. If a surface layer is not present the field can be left blank.

Once values have been entered and <RETURN> pressed, the following screen is displayed:

```
TRRL Dynamic Cone Penetrometer                         DATA FILE : TEST
------------------------------------------------------------------------

Layer      Strength    CBR      Thick    Depth   Layer              S.N.
           mm/blow               mm       mm     B/S/G
------------------------------------------------------------------------
  1         1.52      251(200)  167      167     [B]   Base         0.986
Trans       2.30       148       23      190     [B]   Base         0.130
  2         3.88        76      155      345     [S]   Subbase
Trans       6.43        42       49      394     [S]   Subbase
  3        11.50        19       23      417     [S]   Subbase
Trans      11.00        20       11      428     [S]   Subbase
  4        22.36         8      313      741     [G]   Subgrad


Surface [   ] Base   1.117  Subbase  1.199  Subgrad  0.971   Total  3.287
------------------------------------------------------------------------

------------------------------------------------------------------------
                                                        ?=Help ESC=End
```

Structural numbers for selected layers together
with a total value for the entire pavement are
given along the bottom of the screen.

The suggested CBR values in brackets, see section
3.10, may change according to the designation of the
particular layer.

## 4.    FILE MAINTENANCE

### 4.1    Introduction

The file maintenance option allows the user to define
which data drive is active, the number of lines per
page for the printer paper and the printer controls. It
also allows him to assign the active graphics devices,
to test the graphics interface and to specify the
graphics parameters. The definable variables are
stored in the file DCPCO and the graphics parameter
file DCPGRF. If the DCPCO file is modified for
colour etc, check the specified parameters.

The following program menu is displayed:

```
TRRL Dynamic Cone Penetrometer                      FILE MAINTENANCE
----------------------------------------------------------------------

                          DCP FILE MAINTENANCE

----------------------------------------------------------------------
1 [*] Assign data drive          5      Test graphics screen
2     Paper length/Beeper control 6     Test graphics printer
3     Enter printer controls      7     Specify graphics parameters
4     Assign graphics devices     8     Batch print
                                  9     CBR relationships
----------------------------------------------------------------------






Press RETURN for  Assign data drive
----------------------------------------------------------------------
                                                        ?=Help ESC=End
```

Select the required option using cursor and
<RETURN> or the option number. Otherwise press
<ESC>ape to return to the TRRL DCP OPTIONS
LIST. Each of the options is discussed in turn in the
following sections:

### 4.2    Assign Data Drive

This option allows the current data drive to be
reviewed with the following message:

```
        Current Data Drive: [C]
```

Permissible drive letters are A to Z inclusive. Enter
the new drive letter and confirm that the data is OK,
or press <RETURN> to accept the displayed value.
Note that sub-directories cannot be assigned to the
data drive.

### 4.3    Paper Length/Beeper Control

This option allows the length of printer paper to be
defined as lines per page. The number of lines per
page is reviewed with the following message:-

```
┌─────────────────────────────────────────────┐
│  Number of lines per Page:      [66]         │
│                                              │
│  Beeper on                      [Y]          │
│                                              │
└─────────────────────────────────────────────┘
```

Most printers use a standard 6 lines per inch, so computer paper of 11 inches in length will be 66 lines per page, while A4 paper will be 70 lines per page. Enter the new number of lines per page and confirm that the data is OK or press <RETURN> to accept the displayed value.

The user may also choose whether to have the beeper on [Y] or off [N].

## 4.4 Enter Printer Controls

An explanation of how the printer controls must be entered appears on the following screen:

```
┌─────────────────────────────────────────────────────┐
│ TRRL Dynamic Cone Penetrometer         FILE MAINTENANCE │
│ ----------------------------------------------------- │
│                                                       │
│ This program is to change the printer control characters to suit │
│ an alternative type of printer.                       │
│                                                       │
│ The control codes must be obtained from the printer manual. Each code │
│ consists of a number of ASCII characters. The input for each code consists │
│ of the number of separate ASCII characters, then the ASCII code for each │
│ character                                             │
│                                                       │
│ For example, the control code for starting underline on the Epson MX80 │
│ is ESCape - 1. There are 3 characters, ESCape, - and 1. │
│ ESCcape is CHR$(27), - is CHR$(45) and 1 is CHR$(1)   │
│                                                       │
│ The input for this program would be : 3  27  45  1    │
│  Press any key                                        │
│                                                       │
│                                                       │
│                                                       │
│ ----------------------------------------------------- │
│                                       ?=Help ESC=End  │
└─────────────────────────────────────────────────────┘
```

Having pressed any key the following screen reveals the current control settings:

```
----------------------------------------------------
                                    ?=Help ESC=End
```

Having pressed any key the following screen reveals the current control settings:

```
┌─────────────────────────────────────────────────────┐
│ TRRL Dynamic Cone Penetrometer        PRINTER CONTROLS │
│ ----------------------------------------------------- │
│                                                       │
│                                                       │
│ COMPRESSED PRINT MODE ON    [1]   [ 15] [  ] [  ] [  ] │
│ COMPRESSED PRINT MODE OFF   [1]   [ 18] [  ] [  ] [  ] │
│ UNDERLINE ON                [ ]   [  ]  [  ] [  ] [  ] │
│ UNDERLINE OFF               [ ]   [  ]  [  ] [  ] [  ] │
│ MARGIN SHIFT (characters) ? [  ]                      │
│ BACKSPACE UNDERLINING ?     [Y]                       │
│ VERTICAL SHIFT (lines) ?    [  ]                      │
│                                                       │
│                                                       │
│                                                       │
│ ----------------------------------------------------- │
│                     OK ?               ?=Help ESC=End │
└─────────────────────────────────────────────────────┘
```

The program does *not* at present make use of all the printer controls and they are only included to allow for possible expansion.

The control codes to be used for compressed print on/off and underline on/off will have to be obtained from the printer manual and consist of a series of ASCII values. For each control code, the operator is required to enter first the number of ASCII characters in the control sequence and then the ASCII values of each of the characters. All ASCII values are entered as decimal integer numbers. Three further controls are specified.

Margin Shift: This provides a means of setting the left margin on the printout and is specified in characters, hence a ½ inch margin at 12 cpi would require an input of 6 characters.

Backspace Underlining: If there was no control sequence for underline on/off for the printer, then it should be set to [N] and if the printer is a backspacing `teletype-like' machine then backspace underlining can be used instead by typing [Y]. If there is a control sequence for underline on/off, or backspace underlining cannot be used then type [N].

Vertical Shift: This permits a vertical space to be left at the top of each form/page. Enter the number of lines to be left blank at the top of each page.

Having entered/amended the printer controls the operator is required to confirm that the displayed values are to be stored on disc. These values remain current until they are changed again.

## 4.5 Assign Graphics Devices

This option allows the system to be configured for screen and/or plotter/printer graphics.

The following screen is presented:

```
┌─────────────────────────────────────────────────────┐
│                                                       │
│        Graphics Screen Available        [Y]          │
│                                                       │
│        Graphics Printer Available       [Y]          │
│                                                       │
└─────────────────────────────────────────────────────┘
```

Only devices which support the Digital Research GSX/GEM system may be assigned and their respective drivers must be specified and be available on the current default disc drive. If the devices of your system do not support GSX/GEM graphics then they must be set as *not* being available and an entry [N] must be made.

Otherwise, if the screen or printer/plotter supports GSX/GEM graphics, enter [Y].

Having assigned the graphics devices, the user is required to confirm that the data is `OK' before being returned to the menu.

### 4.6     Test Graphics Screen

Select this option to check the graphics interface and to produce a `test card' on the screen. The test card will contain elements used throughout the DCP options and will be similar to the following:



### 4.7     Test Graphics Printer

Select this option to check the graphics interface and to produce a `test card' on the printer/plotter. The test card will contain elements used throughout the DCP options. It should be compared with the screen image to identify any differences between the two devices.

### 4.8     Specify Graphics Parameters

This option allows various parameters to be modified to suit the user's system. The following screen is presented:



The screen aspect ratio and printer aspect ratio may be specified. These are values between 0.5 and 2.0 to factor the co-ordinates on the relevant axis to accommodate for distribution. These values should normally be set to 1.0. However, should the test card show an incorrect aspect ratio, then suitable values can be entered to correct the distortion.

Two further parameters can be defined. These are:

(i)     Graphics text size
        Changes the size of the text of the graphics on both the screen and printer. The required size may be obtained by experimentation.

(ii)    Printer Border
        The graphical output on dot matrix printers is often hindered by the need to plot out a border, so a flag has been introduced. By entering [Y] a printer border will be included on the plots. Otherwise entering [N] will not print out a border.

### 4.9     Batch Print

Once a data file has been `filed' (see 3.14) it may be printed as a batch print. Selection of this option will display the following:



If the user tries to enter a data file which has not been filed an Error message '"filename" not filed' will appear at the bottom of the screen.

Once the user has confirmed the printer is ready and correctly set, all the files listed will be printed one after another, each starting on a new page. It should be noted that the analysed data is not printed below the data as in the PRINT command of the Process DCP Data options (Section 3.13).

An example of the format of a file printed by this method is found in section 3.14.

## 4.10    CBR Relationships

This option allows the user to choose which relationship between layer strength and Californian Bearing Ratio to use. There is a choice of the following:-

```
--------------------------------------------------------------
1 [*] Kleyn equation          3    Expansive clay equation
2     TRRL equation           4    User defined equation
--------------------------------------------------------------
```

The four options are

1.  Kleyn equation:
    $Log_{10}$ (CBR) = 2.632-1.28 x $Log_{10}$ (Strength)

2.  TRRL equation:
    $Log_{10}$ (CBR) = 2.48-1.057 x $Log_{10}$ (Strength)

3.  Expansive clay equation:
    $Log_{10}$ (CBR) = 2.315-0.858 x $Log_{10}$ (Strength)

4.  User defined equation:
    This option requires a user entered constant and coefficient in the equation:

    $Log_{10}$ (CBR) = Constant-Coefficient $Log_{10}$ (Strength)