

APPENDIX C

ASPECTS OF THE COMPUTER PROGRAMS TO PLOT DCP DATA

## PREFACE

The Dynamic cone penetrometer (DCP) was developed for direct evaluation of the in situ strength properties of road pavement layers. Evaluation of the measurements obtained through the use of this instrument is facilitated by a representation in graphic form.

The programs DCPBP or DCPBL, AVEBP or AVEBL and DCPF1 and DCPF2 was developed on the basis of a computer program obtained from Transvaal Roads Department (TRD), (E G Kleyn). It calculates penetration rate (mm/blow), CBR and UCS values for user defined layers. It determines which standard pavement balance curve is closest to the data curve and on the bases of a curve fitting procedure. Further the layers are redefined and new penetration rates and CBR and UCS values are calculated for the redefined layers. (De Beer, et al, 1988 and Chapter 1 of this dissertation)) Two plots are produced, the first shows pavement characteristics, average equivalent strength, a DCP curve (field data), a Balance curve and a Layer Strength Diagram. The second plot shows the deviation from the standard pavement balance curve with depth, a Layer Strength Diagram for redefined layers and penetration rates and CBR and UCS values for the redefined layers.

The programs DCPF1 and DCPF2 are used to plot the sections of the plots that does not change for different data. DCPBP is used for data entry and to process data for single points. AVEBP uses data files created by DCPBP and can produce plots of the average of up to 50 points.

The manual is organised as follows:

- Paragraph C.1 Tells you how to install and run the DCP software.
- Paragraph C.2 Gives background information.
- Paragraph C.3 Discusses the running of DCPF1 and DCPF2.
- Paragraph C.4 Discusses the running of DCPBP.
- Paragraph C.5 Discusses the running of AVEBP.
- Paragraph C.6 Discusses the running of DCPBL and AVEBL.

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## CONTENTS

### C.1 GETTING STARTED

Hardware requirements

Installing the DCP software

### C.2 Background Information

### C.3 Drawing DCP forms

### C.4 Running DCPBP

### C.5 Running AVEBP

## LIST OF FIGURES

Figure C.1 Example of form produced by DCPF1

Figure C.2 Example of form produced by DCPF2

Figure C.3 Example of first plot produced by DCPBP

Figure C.4 Example of second plot produced by DCPBP

Figure C.5 Example of printout of DCPBP

Figure C.6 Example of first plot produced by AVEBP

Figure C.7 Example of first plot produced by AVEBP

Figure C.8 Example of second plot produced by AVEBP

Figure C.9 Example of second plot produced by AVEBP

Figure C.10 Example of printout of AVEBP

## C.1 GETTING STARTED

Before running a DCP program , make sure you have the following hardware and software:

### C.1.1 HARDWARE REQUIREMENTS

- An IBM Personal Computer, or compatible. The DCP programs will run on a single disk drive PC, though ideally the PC should have two floppy disk drives, or one floppy disk and one hard disk.
- A monochrome or colour monitor.
- At least 256 Kbytes of memory.
- A parallel or serial printer, if hard copy is required. For printing speed, a parallel printer is recommended.
- A Math Co-processor (INTEL 8087 chip).
- A plotter that interfaces with HP-GL language  
or
- A laser printer with HP-GL capabilities and driver

### C.1.2 SOFTWARE REQUIREMENTS

- PC-DOS or MS-DOS, version 2.1 or later.
- An ASCII text file editor, for example MS-DOS/PC-DOS EDIT; EDLIN, or SIDEKICK.

We would recommend that you make a BACK UP COPY of the DCP diskette, using the DOS command DISKCOPY or COPY. Store this backup in a safe place in case something happens to the original diskette.

### C.1.3 INSTALLING THE DCP SOFTWARE

The following procedure will create a copy of the DCP programs, either on floppy disk or hard disk. If you are loading DCP from a floppy disk, the installation procedure described below will make a "boot" disk.

#### A. Dual Floppy Disk computers

Steps (a) to (e) will format a new floppy disk, with your DOS system files and copy the DCP programs onto the disk.

- a. Place your DOS diskette in drive A and switch on the PC.
- b. When the DOS prompt displays, put a new floppy disk in drive B:
- c. Type **FORMAT B:/S** and press <RETURN>.
- d. When the disk in drive B: has been formatted, take out your DOS disk from drive A:, and replace it with the original DCP disk.
- e. Type **COPY A:\*. \* B:** and press <RETURN>.

Finally, ensure that your new DCP disk has a CONFIG.SYS file to set up the computers files and buffers. DOS allows by default 3 buffers and 8 files to be open at the same time. It is best to increase this to improve the operating speed of your PC. The CONFIG.SYS file is created by typing:

```
COPY CON B:CONFIG.SYS and press <RETURN>  
FILES=15 press <RETURN>  
BUFFERS=15 press <RETURN>  
<CONTROL>Z press <RETURN>
```

## B. Hard Disk computers

Switch on the computer and boot up on drive C: and ensure that you are in the root directory. Put the original DCP disk in Drive A: and type:

```
C>MD DCP          press <RETURN> to create a new directory
CD DCP           <RETURN> to change to the new DCP
                  directory.
COPY A:*. * C:   <RETURN> to copy the DCP files.
```

The comments on the CONFIG.SYS file on the previous page are also relevant if you are running from a hard disk. However, this file, if it does exist, must lie in the hard disk root directory. You would use the following command to create the file if it does not already exist:

```
C>COPY CON C:\CONFIG.SYS <RETURN>
```

If the CONFIG.SYS file does exist, it can be changed using your DOS edit program (EDIT, EDLIN or SIDEKICK).

### C.1.4 RUNNING THE DCP PROGRAMS

If you have a dual floppy system, and you have installed the DCP programs as described above, place your copy of the DCP disk in drive A and a formatted disk (for data files) in drive B and switch your PC on. Type DCPF1, DCPF2, DCPBP OR AVEBP at the DOS prompt, depending on which program is to be run.

If DCP has been installed on a hard disk, you can go to the DCP directory:

```
C>CD DCP
```

and run the required DCP program by typing the name of the program at the DOS prompt.

### C.1.1.5 SETTING UP THE PLOTTER

#### C.1.1.5.1 Serial interface between PC and Plotter

If the connection interface between the PC and the Plotter is serial the following procedure must be set up.

Ascertain the baud rate, parity, data bits and the stop bits on the plotter. Using the DOS MODE command type the following before running the program for the first time.

```
MODE COMn:baud rate,parity,data bits,stop bits,P *  
MODE LPT2:=COMn
```

Where    baud rate is 110,150,etc  
          parity is either E,0,N  
          data bits is either 7 or 8  
          stop bits is either 1 or 2  
          n is either 1 or 2 depending on the serial port  
          number

\* refer to the DOS manual for details.

#### C.1.1.5.2 Parallel interface between PC and Plotter

If the plotter is connected to a parallel port check whether it is connected to the first or second parallel port. If it is connected to the first parallel port type the following:

```
MODE LPT2:=LPT1
```

#### C.1.1.5.3 Serial interface between PC and Printer

If the printer is serial ascertain the baud rate, parity, data bits and stop bits and which serial port it is connected to. Using the DOS MODE command set it up as follows:

```
MODE COMn:baud rate,parity,data bits,stop bit,P  
MODE LPT1:=COMn
```

## C.2 BACKGROUND INFORMATION

The DCP programs discussed here are based on original work done by Mr E G Kleyn of the Transvaal Roads Department (TRD). (See list of references at the back of this document). Later work, using some of these original work, as well as adding additional calculations and new concepts was undertaken by Mr M De Beer of the Division of Roads and Transport Technology, CSIR, Pretoria. The most important aspect of the latest work is the development of a DCP-classification system. This system is used to classify DCP data for relatively lightly cementitious and granular base thin surfaced flexible pavements. See De Beer et al., 1988 or Chapter 1 of this dissertation, for a description of the classification system.

These computer programs automatically classify the DCP data using the calculated relevant parameters, A and B, and also calculates:

- average penetration rates in mm/blow
- pavement structural number,  $DSN_{800}$ , in blows, which is the actual number of blows to penetrate 800 mm (approximately 31,5 inches) from the surface of the pavement.
- CBR values derived from the following formula :

If average penetration rate (DN)  $\geq$  2 mm/blow :

$$\text{then CBR} = 405,3 \times DN^{(-1,259)}$$

and if DN  $\leq$  2 mm/blow :

$$\text{then CBR} = (66,66 \times DN^2) - (330 \times DN) + 563,33$$

- UCS values derived from the following formula :

$$\text{UCS} = 15 \times \text{CBR}^{0,88}$$



- Structural capacity in million E80s derived from the following formula :

$$\text{Million Standard Axles (MISA)} = C_m \times (\text{DSN}_{800})^{3,5} \times 10^{-9}$$

where  $C_m$  = moisture condition = 6,5 for wet  
= 14,0 for moist  
= 30,0 for optimum (omc)  
= 64,0 for dry conditions

These  $C_m$  values are automatically taken into account when selecting the general moisture condition during data input phase, see Section C.4.1.

- Balance Number at 100 mm depth,  $BN_{100}$ , which is the DSN percentage at a depth of 100 mm of the pavement.
- Standard Pavement Balance Curve (SPBC) B-value for the data, which is the B-value describing the best fit standard pavement balance curve for the data, as is indicated in the second graph on Figures C.3 and C.6.
- Graphical output of penetration rates (See third graph on Figures C.3 and C.6.
- A Normalised curve, which is a summary of the deviation in terms of area versus depth of the DCP-data from the best fit Standard Pavement Balance Curve (SPBC). Maximum and minimum peaks on this curve are indicative of layer interfaces and give the depths where layers of different penetration rates are encountered. Basically the peaks are indicative of the interface between a relatively softer layer (high penetration rate) and a relatively harder layer (low penetration rate) or vice versa. These peaks are then used to redefine the depth and thickness of the different layers on the basis of relative strength in terms of penetration rate. See first graph on Figures C.4, C.8 or C.9.
- Lastly, a layer strength diagram of the redefined layers is given. See Figures C.4, C.8 and C.9.

### C.3. DRAWING DCP FORMS

The programs DCPF1 and DCPF2 can be used to produce plots as shown in Figures C.1 and C.2.

These plots can be produced once and photocopied as this constant part of the DCP plots takes quite long to do. Photocopies of the plots can then be used when DCPBP or AVEBP is run. If a plot which is completely drawn by the plotter is required DCPF1 or DCPF2 can be run followed by DCPBP or AVEBP without removing the paper.

#### C.3.1 RUNNING DCPF1 AND DCPF2

To run the programs type: DCPF1  
or DCPF2

The program displays only one prompting message:

PLACE PAPER ON THE PLOTTER  
PRESS RETURN WHEN READY TO PLOT

When RETURN is pressed the program will draw the form on the plotter.

#### C.3.2 OUTPUT

Examples of the forms are shown in Figures C.1 and C.2.

#### C.4. RUNNING DCPBP

To run the program type: DCPBP

##### C.4.1 INPUT

A list of the prompting messages generated by the program is given below with explanations of the input required where necessary.

DO YOU WANT THE OUTPUT

1....ON THE SCREEN

2....ON THE PRINTER

ENTER 1 OR 2

If a 1 is entered the results of the calculations will be displayed on the screen.

If a 2 is entered a file named DCPBOUT will be created and the results of the calculations will be written to this file. This file can then, after the run is completed, be copied to a printer. If the output in the file is to be preserved the file must be renamed before a subsequent run is done as the contents of DCPBOUT will then be overwritten with new output.

DO YOU WANT TO:

1....ENTER MANUALLY RECORDED DATA

2....USE AN EXISTING COMPLETE DATA FILE

ENTER THE APPROPRIATE NUMBER

If a 2 is entered:

ENTER THE NAME OF THE FILE FROM WHICH DATA MUST BE READ

If a 1 is entered:

ENTER THE NAME OF THE FILE WHERE THE DATA MUST BE STORED

E.G. B:ABC123.DAT (MAX. DRIVE SPECIFICATION + 6 CHARACTERS + EXTENSION)

The drive specification is optional. If the program is run from drive A on a dual floppy system the data files can be stored on drive B, B: must then be specified when a file name is entered. If omitted the data file will be created on the default drive. If the drive specification is omitted (when a hard disk system is used it is not necessary) the file name can be eight characters long. The first character of the file name must be a letter and the last four characters must be .DAT. The name must not contain a character '/' or a '\' or a '.' before the .DAT.

Information about the DCP investigation can now be entered.

ENTER THE NAME OF THE REGION WHERE THE INVESTIGATION WAS DONE

MAXIMUM 34 CHARACTERS

ENTER THE ROAD NUMBER

MAXIMUM 34 CHARACTERS

ENTER THE Km DISTANCE

ENTER THE DATE IN THE FORMAT YY/MM/DD E.G. 84/01/26

-----  
! SHL ! ! ! ! M ! ! ! ! SHR!  
-----

1 2 3 4 5 6 7 8 9

ACCORDING TO THE ABOVE CODE, ENTER POSITION OF DCP TEST ACROSS THE ROAD PROFILE

ENTER A NUMBER BETWEEN 1 AND 9

-----  
! SEVERE ! WARNING ! SOUND !  
!(TERMINAL)! ! !  
-----

1 2 3

ACCORDING TO THE ABOVE CODE, WHAT IS THE CONDITION OF THE ROAD?  
ENTER 1, 2 OR 3

WHICH OF THE FOLLOWING DISTRESS CONDITIONS APPLY TO THE ROAD?  
ENTER an upper case Y OR N FOR EACH CONDITION

RUTTING ? (ENTER Y OR N)

DEFORMATION (OTHER THAN RUTTING) ? (ENTER Y OR N)

PUMPING ? (ENTER Y OR N)

CROCODILE CRACKS ? (ENTER Y OR N)

LONGITUDINAL CRACKS ? (ENTER Y OR N)

OTHER CRACKS ? (ENTER Y OR N)

-----  
! DRY ! OPTIMUM ! WET ! SOAKED !  
-----

1 2 3 4

WHAT IS THE GENERAL MOISTURE CONDITION  
UNDER WHICH THE PAVEMENT MUST FUNCTION?  
ENTER 1, 2, 3 OR 4

FUNCTIONAL CLASSIFICATION (TPA)

CODE	DESCRIPTION	TRAFFIC(E80S)
1	VERY LIGHT TRAFFIC	<0,1x10**6
2	LIGHT TRAFFIC	0,1-0,2x10**6
3	MEDIUM TRAFFIC	0,2-1,0x10**6
4	HEAVY TRAFFIC	1-3x10**6
5	VERY HEAVY TRAFFIC	3-10x10**6

ENTER 1, 2, 3, 4 OR 5

ENTER THE ROAD CATEGORY A, B OR C

Category A:

E.g. Inter urban freeways and major inter urban roads with a very high level of service. 95th and 5th percentile values used where applicable.

Category B:

E.g. Inter urban collectors, major rural roads and major industrial roads with a high level of service. 90th and 10th percentile values are applicable.

Category C:

E.g. Lightly trafficked rural roads with a moderate level of service. 80th and 20th percentile values are applicable.

DEFAULT IS 5 PAVEMENT LAYERS OF 150mm EACH  
IF YOU WANT TO SPECIFY LAYERS (MAXIMUM 10)  
ENTER THE NUMBER OF LAYERS YOU WANT TO SPECIFY  
TO USE THE DEFAULT PRESS RETURN

If a number between 1 and 10 is entered the user will be prompted to enter the beginning and end of the specified number of layers. The last layer must not end before the end of the data. It is preferable to end the last layer at 800 mm.

All the information entered so far will then be displayed in the following format:

ROAD INFORMATION ENTERED

1....REGION :  
2....ROAD NUMBER :  
3....DISTANCE :  
4....DATE :  
5....POSITION :  
6....ROAD CONDITION :  
7....RUTTING :  
8....DEFORMATION (NOT RUTTING) :  
9....PUMPING :  
10...CROCODILE CRACKS :  
11...LONGITUDINAL CRACKS :  
12...OTHER CRACKS :  
13...MOISTURE CONDITION :  
14...FUNCTIONAL CLASSIFICATION :  
15...ROAD CATEGORY :  
16...NUMBER OF LAYERS :  
17...LAYERS:  
DATA FILE NAME:

DO YOU WANT TO CHANGE ANY OF THE ABOVE INFORMATION?  
TO CHANGE AN ITEM ENTER THE NUMBER NEXT TO IT  
FOR NO CHANGE PRESS RETURN

If a number is entered, the prompt for the item next to the number will be displayed. The user must then enter the correct information for the item. The display of the information entered will be repeated showing the changed information. When only RETURN is pressed after the display the program will continue.

ENTER THE NUMBER OF DCP POINTS FOR WHICH DATA WILL BE ENTERED  
MAXIMUM 300

(PLEASE CHECK DATA, THERE MUST NOT BE MORE THAN ONE DEPTH OF 800 OR MORE)

It is important that there must not be more than one depth value of 800 or higher. If more values beyond 800 were recorded it must not be entered.

THE NUMBER OF BLOWS FOR EACH DCP POINT WILL BE INCREMENTED BY 5  
IF YOU WANT A DIFFERENT INCREMENT, ENTER THE NEW INCREMENTAL NUMBER  
E.G.10  
TO USE THE DEFAULT OF 5 PRESS RETURN

The next prompt will then be displayed for the number of points specified. The number of blows will be incremented automatically and displayed each time. Only the depth reading at each point need be entered.

ENTER THE DEPTH (mm) FOR POINT 1  
NUMBER OF BLOWS: 0 DEPTH (mm): \_

The depths in a set of data must start at 0. If a number larger than 0 is entered for the first depth, the program will deduct this number from all the depths entered to meet this requirement.

When data for all the points are entered the data will be displayed under the following headings:

DCP DATA		
POINT NUMBER	NUMBER OF BLOWS	DEPTH

DO YOU WANT TO CHANGE ANY OF THE DCP DATA?  
TO CHANGE SINGLE POINTS ENTER 1  
TO CHANGE A NUMBER OF CONSECUTIVE POINTS ENTER THE NUMBER OF POINTS TO BE CHANGED  
FOR NO CHANGE PRESS RETURN



If a 1 is entered:

ENTER THE NUMBER OF THE POINT YOU WANT TO CHANGE

If a number larger than 1 is entered:

ENTER THE NUMBERS OF THE FIRST AND LAST POINTS TO BE CHANGED  
WITH A SPACE BETWEEN THE TWO NUMBERS

Prompts will then be displayed to change the depth of the points specified.

If the last depth entered is less than 800 the following prompts will be displayed:

THE LAST DEPTH IS \_\_\_\_

DO YOU WANT TO:

- 1...USE THIS DEPTH TO CALCULATE STRUCTURE NUMBER
- 2...USE THE SLANT OF THE LAST LINE TO ADD POINTS TO A DEPTH OF 800
- 3...MANUALLY ENTER POINTS TO A DEPTH OF 800

ENTER 1 2 OR 3

The last line referred to is the last line on the DCP curve, see Figure 2.

If the slant calculated is 0, i.e. when the depths of the last points are the same, an error message will be displayed:

THE LAST DEPTHS ARE THE SAME THEREFORE SLANT CAN NOT BE CALCULATED  
DELETE LAST FEW DEPTHS FROM THE DATA FILE OR ADD POINTS MANUALLY  
REMEMBER TO CHANGE THE NUMBER OF POINTS (LINE 3 OF THE DATA FILE)  
IF YOU DELETE POINTS

ENTER:

- 1...TO END PROGRAM AND EDIT FILE WITH ASCII FILE EDITOR
- 2...TO ADD POINTS MANUALLY THROUGH THE PROGRAM

If option 1 is selected to delete points from the data file it can be edited using an ASCII text file editor. If option 2 is selected the prompt displayed will be:

LAST NUMBER OF BLOWS IS \_\_\_\_ LAST DEPTH IS \_\_\_\_  
HOW MANY MORE POINTS DO YOU WANT TO ADD?  
MAXIMUM \_\_\_\_ CAN BE ADDED

When a number is added prompts to enter this number of points will be displayed.

If there is very little difference between the last few points in the data, the calculated number of points to be added may exceed the limit of 300. If this happens the following message will be displayed:

THE NUMBER OF POINTS TO BE ADDED IS TOO LARGE  
ADDITIONAL POINTS WILL HAVE TO BE ADDED MANUALLY

This message will be followed by the prompt for the number of points to be added as above.

When the data entry is completed or when an existing file is used the program will display:

CALCULATING BALANCE CURVE

DO YOU WANT TO PLOT THE DCP CURVE, BALANCE CURVE  
AND LAYER STRENGTH DIAGRAM  
ENTER Y OR N

If a Y is entered a plot as shown in Figure 3 will be produced after display of the following message:

PLEASE PLACE PAPER ON THE PLOTTER  
PRESS RETURN WHEN READY TO PLOT

The DCP curve and Balance curve will be drawn. Before the Layer Strength Diagram is drawn the following prompt will be displayed:

DO YOU WANT TO PLOT:

1...SINGLE POINTS

2...POINTS IN GROUPS OF FIVE

3...LAYERS

4...MEAN PENETRATION/LAYER AND PERCENTILE VALUES

ENTER 1 2 3 OR 4

If a 1 is entered the value for each data point (as measured) will be plotted on the layer strength diagram.

If a 2 is entered average values for groups of five data points will be plotted.

If a 3 or 4 is entered:

DO YOU WANT TO REDEFINE THE LAYERS?

(THE LAST LAYER MUST NOT END BEFORE THE END OF THE DATA)

ENTER Y OR N

If a Y is entered:

ENTER THE NUMBER OF LAYERS

MAXIMUM 10

ENTER THE BEGINNING AND END OF LAYER 1 WITH A SPACE BETWEEN THE TWO NUMBERS E.G. 0 125

This prompt will be repeated for the number of layers specified.

The layer strength diagram will then be drawn and the plot completed.

DO YOU WANT TO PLOT THE NORMALISED CURVE AND LAYER STRENGTH DIAGRAM AND AVERAGE EQUIVALENT STRENGTH FOR REDEFINED LAYERS?

ENTER Y OR N

If a Y is entered a plot as shown in Figure 4 will be produced after display of the following messages:

PLEASE PREPARE THE PLOTTER  
PRESS RETURN WHEN READY TO PLOT

DO YOU WANT TO PLOT:  
1...LAYERS  
2...MEAN PENETRATION/LAYER AND PERCENTILE VALUES  
ENTER 1 OR 2

The second plot will then be drawn.

DO YOU WANT TO DO ANOTHER CALCULATION  
ENTER Y OR N

If a Y is entered the program will run again from the beginning.  
If a N is entered the program will end.

#### C.4.2 OUTPUT

The program will write a curve fitting table with DCP category classification, an average equivalent strength table for the user defined layers, a table of DCP penetration rate with CBR and UCS values, an average equivalent strength table for redefined layers and a summary of + and - areas (Normalised curve) to a file named DCPBOUT. This file can be copied to a printer to obtain a printed output. If the output file is to be preserved it must be renamed before the next run of DCPBP as DCPBOUT will be overwritten. An example of the printed output of DCPBP is shown in Figure C.5.

The program can produce two plots. An example of the first plot is shown in Figure C.3. The second plot is shown in Figure C.4.

## C.5. RUNNING AVEBP

To run the program type: AVEBP

### C.5.1 INPUT

The prompting messages displayed by AVEBP is given below with explanations of the input required where necessary.

ENTER THE NUMBER OF SETS OF DATA YOU WANT TO USE  
MAXIMUM 50

ENTER THE NAME OF DATA FILE 1

This prompt will be repeated for the number of files specified above. If a file is not found an error message will be displayed giving the name of the file and the IBM Professional FORTRAN error number:

FILE \_\_\_\_\_ NOT FOUND \_\_\_\_

ENTER THE NUMBER OF LAYERS (MAXIMUM 10)

ENTER THE BEGINNING AND END OF LAYER 1 WITH A SPACE BETWEEN THE NUMBERS  
E.G. 0 125

This prompt will be repeated for the number of layers specified.

DO YOU WANT TO PLOT THE DCP CURVE, BALANCE CURVE  
AND LAYER STRENGTH DIAGRAM  
ENTER Y OR N

If a Y is entered:

PLEASE PREPARE THE PLOTTER  
PRESS ANY KEY WHEN READY TO PLOT

A number of options can be selected to determine what the plots will show:

DO YOU WANT TO PLOT:

- 1...ALL LAYER STRENGTH DIAGRAMS, AND AVERAGE VALUES ON OTHER DIAGRAMS
  - 2...AVERAGE VALUES ON ALL DIAGRAMS
  - 3...AVERAGE AND PERCENTILE VALUES ACCORDING TO ROAD CATEGORIES ON ALL DIAGRAMS
  - 4...AVERAGE AND 95, 90, 80, 20, 10 AND 5 TH PERCENTILE VALUES ON BALANCE AND NORMALISED CURVES
  - 5...ONLY AVERAGE NORMALISED CURVE AND REDEFINED LAYER STRENGTH DIAGRAM
- ENTER 1 2 3 OR 4

If option 1 is selected:

The Layer Strength Diagram on plot one will show the layer strength diagrams for all the data sets as well as an average layer strength diagram, all drawn on the same diagram. The rest of the diagrams will show only average values.

If option 2 is selected:

All diagrams on both plots will show only average values.

If option 3 is selected:

Plot one will show an average DCP curve as well as a Balance Curve and Layer Strength Diagram showing the average values and the 95th and 5th percentile or the 90th and 10th percentile or the 80th and 20th percentile, according to the road category specified for the last data file entered. The Normalised Curve and Layer Strength Diagram on plot two will show average and percentile values according to the road category.

If option 4 is selected:

The Balance Curve on plot one and the Normalised Curve on plot two will show the average values and the 95th, 90th, 80th, 20th, 10th and 5th percentile values. The other diagrams will show average values.

If option 5 is selected:

This option can be used when only plot two is required. It will show only average values on both diagrams.

DO YOU WANT TO PLOT ON LAYER STRENGTH DIAGRAM

1...EVERY MILLIMETRE

2...LAYERS

ENTER 1 OR 2

CALCULATING BALANCE TABLE

If the option to draw plot one is selected:

The diagrams on plot one will be drawn.

ENTER A FILE IDENTIFICATION (MAX 30 CHARACTERS)

The string entered here will be written on the plot to indicate which files were used.

The first plot will then be completed.

DO YOU WANT TO DRAW THE NORMALISED CURVE AND  
LAYER STRENGTH DIAGRAM AND AVERAGE EQUIVALENT  
STRENGTH FOR REDEFINED LAYERS

ENTER Y OR N

If a Y is entered:

PLEASE PREPARE THE PLOTTER

PRESS ANY KEY WHEN READY TO PLOT

The second plot will then be drawn.

DO YOU WANT TO:

1...DO ANOTHER RUN WITH THE SAME DATA FILES

2...DO ANOTHER RUN WITH NEW DATA FILES

3...END THE PROGRAM

If option 1 is selected another run can be done without the user having to enter all the file names again if they are not changed.

### C.5.2 OUTPUT

The program will write information about the DCP investigation, a curve fitting table with category classification, an average equivalent strength table for the user defined layers, a table of DCP penetration rate with CBR and UCS values, an average equivalent strength table for redefined layers and a summary of + and - areas to a file named AVEBOUT. This file can be copied to a printer to obtain a printed output. If the output file is to be saved it must be renamed before the next run of AVEBP as it will be overwritten. An example of the printed output is shown in Figure C.10.

AVEBP can produce two plots. Examples of the first plot for different options are shown in Figures C.6 and C.7. Examples of the second plot for different options are shown in Figures C.8 and C.9.

### C.6 RUNNING DCPBL AND AVEBL

The versions of the programs ending with a L is prepared to write the HP-GL commands to an output file which can then be used by a laser plotter interface program to produce the plots on a laser printer. The programs were tested using the package 'LaserPlotter' of Insight Development Corporation.

The programs are run as described in the preceding paragraphs, except for the fact that it prompts the user for a output file name for each of the two plots.



## C.7 REFERENCES

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KLEYN, E G, VAN HEERDEN, M J J and ROSSOUW, A J, 1982. "An Investigation to determine the Structural Capacity and Rehabilitation Utilization of a Road Pavement using the Pavement Dynamic Cone Penetrometer." International Symposium on Bearing Capacity of Roads and Airfields, 23-25 June 1982, Trondheim, Norway, 1982.

KLEYN, E G, DE WET, L F and SAVAGE, P F, 1987. The Development of an Equation for the Strength- Balance of Road Pavement Structures. Transvaal Provincial Administration, Roads Branch, Report L7/87, PRETORIA, 1987.

KLEYN, E G, 1984. Aspects of Pavement Evaluation and Design as determined with the Dynamic Cone Penetrometer. M Eng thesis (in Afrikaans), Faculty of Engineering, University of Pretoria, Pretoria, 1984.

DE BEER M, KLEYN E G and SAVAGE P F, 1988. Towards a classification system for the strength-balance of thin surfaced flexible pavements. Eighth Quinquennial convention of SAICE in co-operation with the Annual Transportation Convention (ATC 1988), Session 3D, 4 - 8 July 1988, University of Pretoria, South Africa, 1988.

C.9 FIGURES

# SUMMARY OF DCP INVESTIGATION

## AVERAGE EQUIVALENT STRENGTH

FROM - TO AV. PENETRATION SD P CBR UCS

DATA FILE :  
 REGION :  
 ROAD NUMBER :  
 DISTANCE :  
 POSITION : 

L		M		R
---	--	---	--	---

  
 CONDITION : 

FAILED	OVERSTRESSED	SOUND
--------	--------------	-------

RUT	DEFORM	PUMP	CRACKS	CROCK	LONG	OTHER
-----	--------	------	--------	-------	------	-------

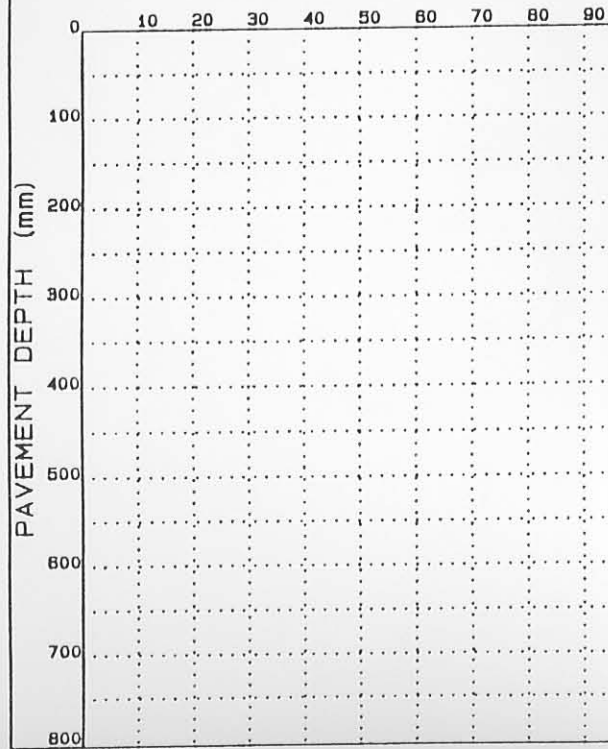
  
 DATE :

## PAVEMENT CHARACTERISTICS

STRUCTURE NUMBER :  
 BALANCE NUMBER :  
 DIFFERENCE IN BN100 :  
 BALANCE CURVE IS WHERE B =  
 STRUCT. CAP. (E80 X 10<sup>6</sup>) :  
 ROAD CATEGORY :  
 TRAFFIC :

### DCP CURVE

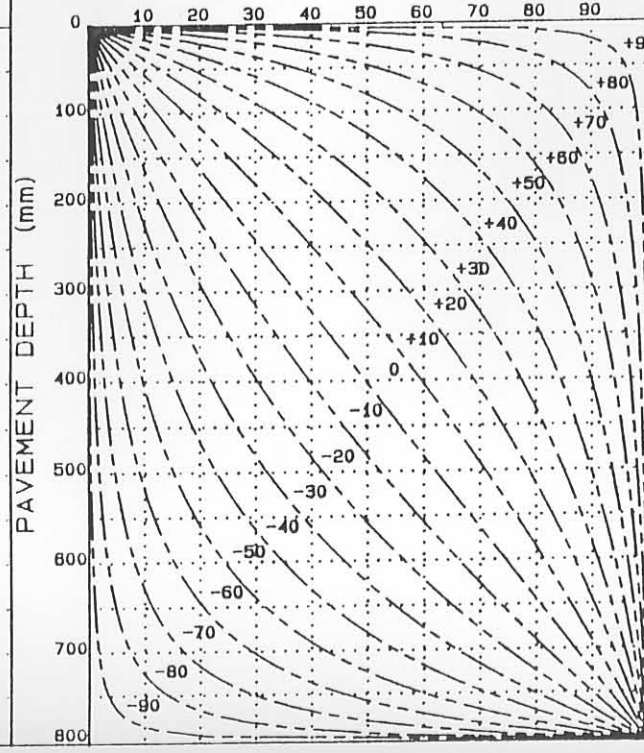
NUMBER OF BLOWS



### BALANCE CURVE

(-90 ≤ B ≤ +90)

% OF PAVEMENT STRUCTURE NUMBER



### LAYER STRENGTH DIAGRAM

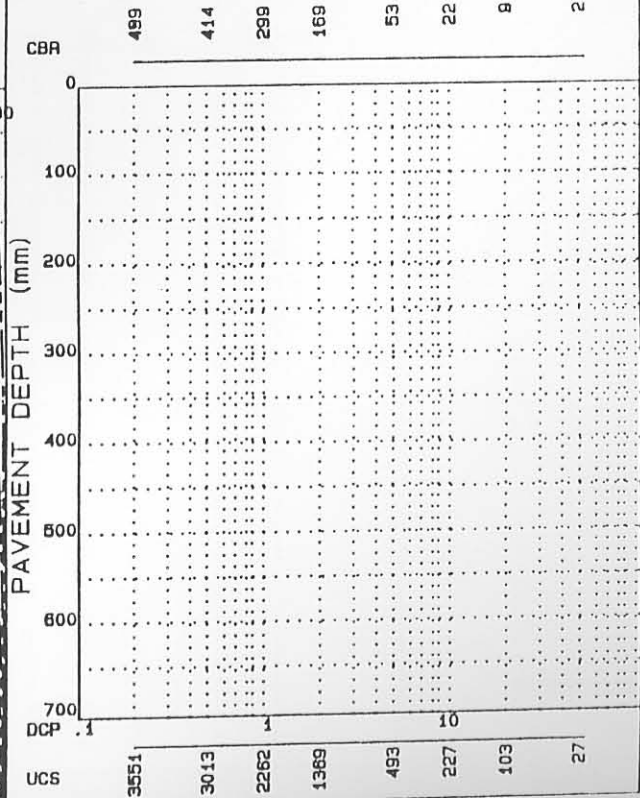


Figure C.1 Example of form produced by DCPFI

SUMMARY OF DCP INVESTIGATION

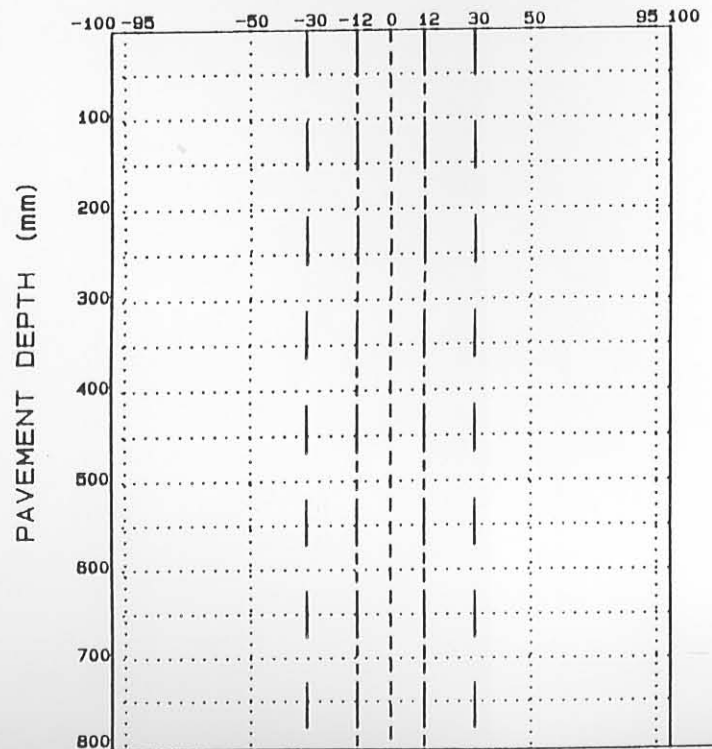
AVERAGE EQUIVALENT STRENGTH (REDEFINED)

EBQM -- IQ AV. PENETRATION SD -- P CBR% UCS (kPa)  
(mm) (mm/blow)

DATA FILE:

NORMALIZED CURVE

DEVIATION ( $A_1$ ) FROM STANDARD PAVEMENT BALANCE CURVE (SPBC), % .mm



LAYER STRENGTH DIAGRAM (REDEFINED)

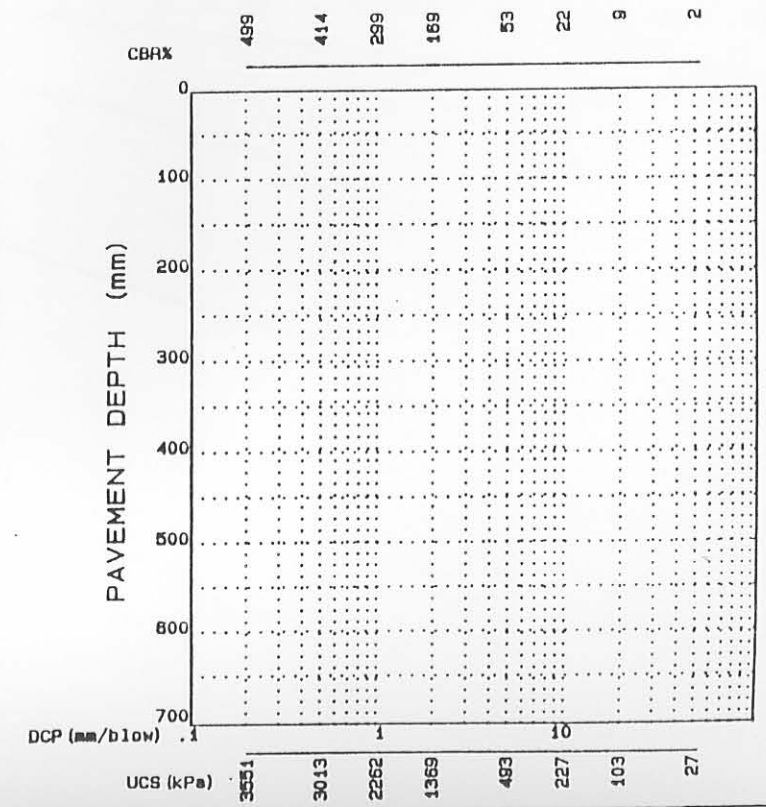


Figure C.2 Example of form produced by DCPF2

### SUMMARY OF DCP INVESTIGATION

DATA FILE : R3.DAT  
 REGION : RODIHAL (N=10)  
 ROAD NUMBER : P1932  
 DISTANCE : 2.9  
 POSITION : 

L										R
---	--	--	--	--	--	--	--	--	--	---

  
 CONDITION : 

FAILED	OVERSTRESSED	SOUND
--------	--------------	-------

  
~~DEFORM.~~ ~~PUMP.~~ ~~CRACKS~~ : ~~CRACK~~ ~~LONG.~~ ~~OTHER~~  
 DATE : 85/06/06

**PAVEMENT CHARACTERISTICS**

	DATA	B/CURVE	FROM - TO
STRUCTURE NUMBER	382		0-180
BALANCE NUMBER (BN 100)	29	22	181-330
			331-480
DIFFERENCE IN BN100	7		481-600
			601-800
BALANCE CURVE IS WHERE B =	17	A = 2515	
STRUCT. CAP. (E80 X 10 <sup>6</sup> )	>10	*	
ROAD CATEGORY	C		
TRAFFIC	LIGHT TRAFFIC		

\* Structural capacity not reliable

**AVERAGE EQUIVALENT STRENGTH**

AV. PENETRATION	SD	BO P	CBR	UCS
1.2	0.6	1.7	267	2048
2.2	0.4	2.6	150	1233
2.4	0.8	3.1	134	1116
5.0	1.0	5.9	52	485
2.6	1.2	3.6	122	1028

CATEGORY V : AVERAGELY BALANCED DEEP STRUCTURE (ABD)

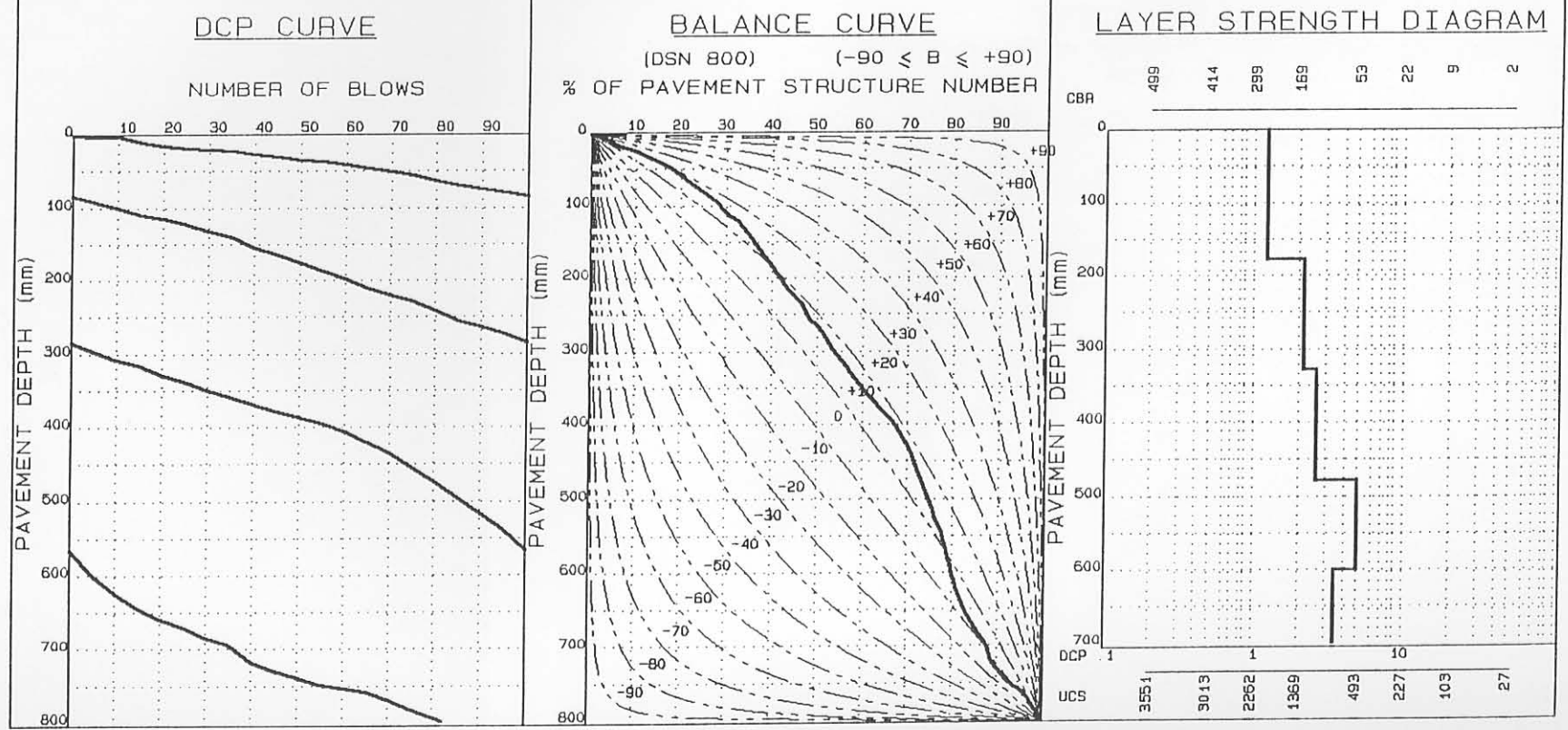


Figure C.3

Example of first plot produced by DCPBP

### SUMMARY OF DCP INVESTIGATION

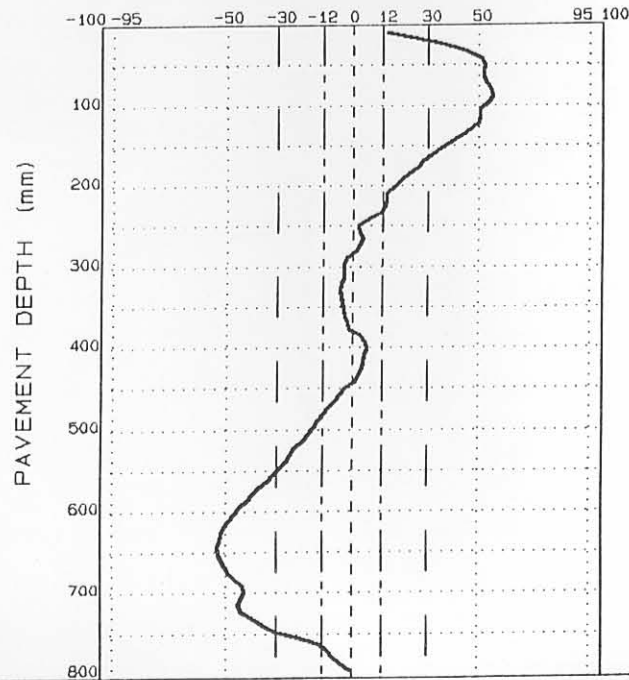
#### AVERAGE EQUIVALENT STRENGTH (REDEFINED)

FROM - TO (mm)	AV. PENETRATION (mm/blow)	SD	BOP	CBR <sub>R</sub>	UCS (kPa)
0-88	0.9	0.4	1.2	330	2468
89-248	2.0	0.5	2.3	173	1398
249-264	2.2	1.1	3.2	150	1233
265-328	2.2	0.3	2.4	153	1254
329-400	2.0	0.3	2.3	171	1383
401-640	4.2	1.3	5.2	67	606
641-696	2.8	0.8	3.6	110	938
697-800	2.2	1.1	3.2	146	1204

DATA FILE: R3.DAT

#### NORMALIZED CURVE

DEVIATION ( $A_i$ ) FROM STANDARD PAVEMENT BALANCE CURVE  
(SPBC), % .mm



#### LAYER STRENGTH DIAGRAM (REDEFINED)

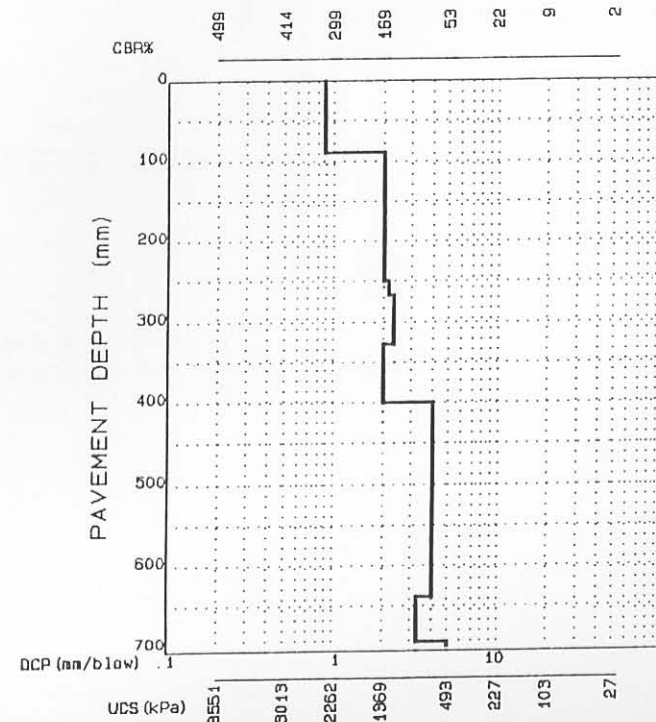


Figure C.4

Example of second plot produced by DCPBP

DCP INVESTIGATION  
-----

DATA FILE NAME : R3.DAT  
 REGION : ROOIWAL(N=10)  
 ROAD NUMBER : P1932  
 Km DISTANCE : 2.9  
 DATE : 85/06/06  
 STRUCTURE NUMBER (DSN 800) : 382  
 BALANCE NUMBER (BN 100) OF DATA : 29  
 BN 100 OF BALANCE CURVE : 22  
 STRUCTURAL CAPACITY(E80 x10\*\*6) : 32.7 (TPA method (Kleyn)) \*  
 ROAD CATEGORY : C  
 TRAFFIC : LIGHT TRAFFIC

BALANCE CURVE IS WHERE B = 17 A = 2515 , RK = 811

CATEGORY V: AVERAGELY BALANCED DEEP STRUCTURE (ABD)

KATEGORIE V: REDELIK GEBALANSEERDE DIEPSTRUKTUUR (RGD)

AVERAGE EQUIVALENT STRENGTH (Existing structure)  
-----

FROM - TO (mm)	AV. PENETRATION (mm/blow)	SD	80P	CBR%	UCS (kPa)
0 - 180	1.2	0.6	1.7	267	2048
181 - 330	2.2	0.4	2.6	150	1233
331 - 480	2.4	0.8	3.1	134	1116
481 - 600	5.0	1.0	5.9	52	485
601 - 800	2.6	1.2	3.6	122	1028

DCP PENETRATION RATE  
-----

DEPTH (mm)	NO OF BLOWS	mm/BLOW	CBR%	UCS (kPa)
DCP ( 0 - 2)	5	0.4	441	3185
DCP ( 2 - 2)	10	0.0	563	3949
DCP ( 2 - 10)	15	1.6	205	1623
DCP ( 10 - 15)	20	1.0	299	2262
DCP ( 15 - 18)	25	0.6	389	2852
DCP ( 18 - 20)	30	0.4	441	3185
DCP ( 20 - 22)	35	0.4	441	3185
DCP ( 22 - 26)	40	0.8	341	2540
DCP ( 26 - 30)	45	0.8	341	2540
DCP ( 30 - 34)	50	0.8	341	2540
DCP ( 34 - 36)	55	0.4	441	3185
DCP ( 36 - 40)	60	0.8	341	2540
DCP ( 40 - 46)	65	1.2	263	2021
DCP ( 46 - 50)	70	0.8	341	2540
DCP ( 50 - 56)	75	1.2	263	2021
DCP ( 56 - 63)	80	1.4	231	1803
DCP ( 63 - 70)	85	1.4	231	1803

Figure C.5 Example of printout of DCPBP

DCP ( 70 - 74)	74	90	0.8	341	2540
DCP ( 74 - 80)	80	95	1.2	263	2021
DCP ( 80 - 85)	85	100	1.0	299	2262
DCP ( 85 - 92)	92	105	1.4	231	1803
DCP ( 92 - 100)	100	110	1.6	205	1623
DCP ( 100 - 110)	110	115	2.0	169	1369
DCP ( 110 - 115)	115	120	1.0	299	2262
DCP ( 115 - 122)	122	125	1.4	231	1803
DCP ( 122 - 132)	132	130	2.0	169	1369
DCP ( 132 - 141)	141	135	1.8	185	1483
DCP ( 141 - 154)	154	140	2.6	121	1020
DCP ( 154 - 165)	165	145	2.2	150	1233
DCP ( 165 - 176)	176	150	2.2	150	1233
DCP ( 176 - 187)	187	155	2.2	150	1233
DCP ( 187 - 198)	198	160	2.2	150	1233
DCP ( 198 - 210)	210	165	2.4	134	1116
DCP ( 210 - 220)	220	170	2.0	169	1369
DCP ( 220 - 228)	228	175	1.6	205	1623
DCP ( 228 - 241)	241	180	2.6	121	1020
DCP ( 241 - 256)	256	185	3.0	101	870
DCP ( 256 - 263)	263	190	1.4	231	1803
DCP ( 263 - 273)	273	195	2.0	169	1369
DCP ( 273 - 285)	285	200	2.4	134	1116
DCP ( 285 - 298)	298	205	2.6	121	1020
DCP ( 298 - 308)	308	210	2.0	169	1369
DCP ( 308 - 317)	317	215	1.8	185	1483
DCP ( 317 - 330)	330	220	2.6	121	1020
DCP ( 330 - 340)	340	225	2.0	169	1369
DCP ( 340 - 350)	350	230	2.0	169	1369
DCP ( 350 - 360)	360	235	2.0	169	1369
DCP ( 360 - 370)	370	240	2.0	169	1369
DCP ( 370 - 380)	380	245	2.0	169	1369
DCP ( 380 - 387)	387	250	1.4	231	1803
DCP ( 387 - 396)	396	255	1.8	185	1483
DCP ( 396 - 407)	407	260	2.2	150	1233
DCP ( 407 - 421)	421	265	2.8	110	938
DCP ( 421 - 436)	436	270	3.0	101	870
DCP ( 436 - 455)	455	275	3.8	75	670
DCP ( 455 - 474)	474	280	3.8	75	670
DCP ( 474 - 497)	497	285	4.6	59	542
DCP ( 497 - 518)	518	290	4.2	66	598
DCP ( 518 - 540)	540	295	4.4	62	566
DCP ( 540 - 567)	567	300	5.4	48	452
DCP ( 567 - 600)	600	305	6.6	37	359
DCP ( 600 - 625)	625	310	5.0	53	493
DCP ( 625 - 646)	646	315	4.2	66	598
DCP ( 646 - 660)	660	320	2.8	110	938
DCP ( 660 - 672)	672	325	2.4	134	1116
DCP ( 672 - 685)	685	330	2.6	121	1020
DCP ( 685 - 695)	695	335	2.0	169	1369
DCP ( 695 - 720)	720	340	5.0	53	493
DCP ( 720 - 730)	730	345	2.0	169	1369
DCP ( 730 - 740)	740	350	2.0	169	1369
DCP ( 740 - 750)	750	355	2.0	169	1369
DCP ( 750 - 755)	755	360	1.0	299	2262
DCP ( 755 - 760)	760	365	1.0	299	2262
DCP ( 760 - 770)	770	370	2.0	169	1369
DCP ( 770 - 783)	783	375	2.6	121	1020
DCP ( 783 - 795)	795	380	2.4	134	1116
DCP ( 795 - 800)	800	382	2.5	127	1065

-----  
 AVERAGE EQUIVALENT STRENGTH (Redefined layers)  
 -----



LAYER	DEPTH (mm) FROM - TO	THICKNESS (mm)	DN mm/blow	SD mm/blow	CBR%	UCS (kP)
1	0 - 88	88	0.9	0.4	330	2468
2	89 - 248	160	2.0	0.5	173	1398
3	249 - 264	16	2.2	1.1	150	1233
4	265 - 328	64	2.2	0.3	153	1254
5	329 - 400	72	2.0	0.3	171	1383
6	401 - 640	240	4.2	1.3	67	606
7	641 - 696	56	2.8	0.8	110	938
8	697 - 800	104	2.2	1.1	146	1204

\* TRH 14 and Kleyn M Ing

SUMMARY OF + AND - AREAS (CURVE FITTING TABLE - Existing structure)

DEPTH (mm) FROM - TO	CUMULATIVE AREA (% mm), Ak
0 280	1075.06
281 376	-41.66
377 440	30.46
441 792	-1368.32
<b>ABSOLUTE AREA</b>	<b>2515.49</b>

### SUMMARY OF DCP INVESTIGATION

DATA FILE : R3-R13.DAT  
 REGION : ROOIWAL (N=10)  
 ROAD NUMBER : P1932  
 DISTANCE : 2.9  
 POSITION : 

L				X					R
---	--	--	--	---	--	--	--	--	---

  
 CONDITION : 

FAILED	DVERSTRESSED	BOUND
--------	--------------	-------

RUT.	DEFORM.	PUMP.	CRACKS	CROCK	LONG.	OTHER
------	---------	-------	--------	-------	-------	-------

  
 DATE : 85/06/06

**PAVEMENT CHARACTERISTICS**

	DATA	B/CURVE	FROM - TO
STRUCTURE NUMBER	352		0-180
BALANCE NUMBER (BN 100)	24	25	181-330
			331-480
DIFFERENCE IN BN100	-1		481-600
			601-800
BALANCE CURVE IS WHERE B =	20	A = 956	
STRUCT. CAP. (E80 X 10 <sup>6</sup> )	>10		
ROAD CATEGORY	C		
TRAFFIC	LIGHT TRAFFIC		

**AVERAGE EQUIVALENT STRENGTH**

AV. PENETRATION	SO	BO P	CBR	UCS
1.7	0.5	2.0	200	1588
2.4	0.4	2.7	137	1138
2.8	0.8	3.4	113	961
4.5	0.8	5.2	60	550
5.9	1.6	7.3	43	410

CATEGORY IV : WELL-BALANCED DEEP STRUCTURE (WBD)

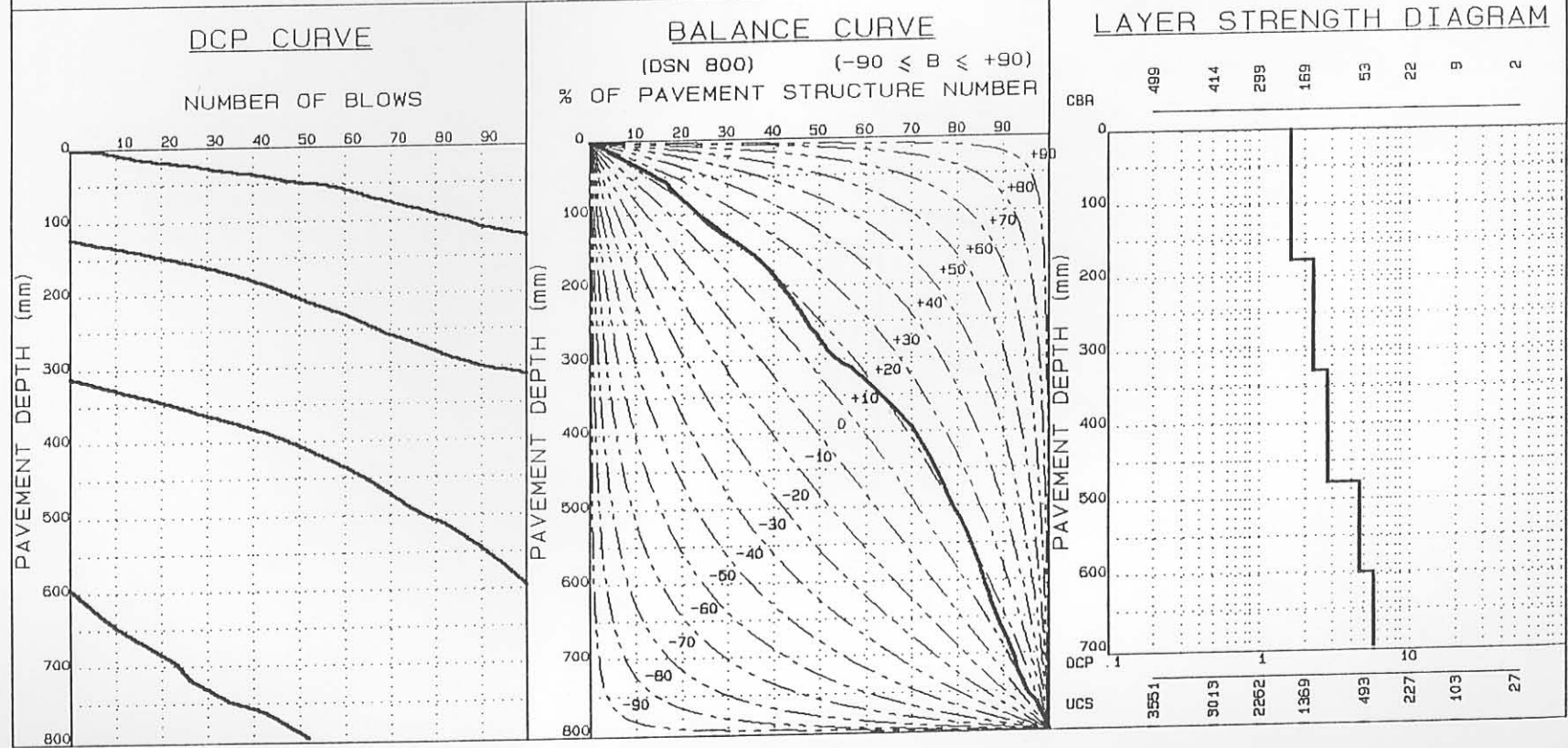


Figure C.6 Example of first plot produced by AVEBP

### SUMMARY OF DCP INVESTIGATION

PAVEMENT CHARACTERISTICS		AVERAGE EQUIVALENT STRENGTH							
		DATA	B/CURVE	FROM - TO	AV. PENETRATION	SD	BO P	CBR	UCS
DATA FILE	R3-R13.DAT	352		0-180	1.7	0.5	2.0	200	1588
REGION	:ROOIWAL (N=10)			181-330	2.4	0.4	2.7	137	1138
ROAD NUMBER	:P1932	24	25	331-480	2.8	0.8	3.4	113	961
DISTANCE	: 2.9	-1		481-800	4.5	0.8	5.2	60	550
POSITION	: <input type="checkbox"/> L <input checked="" type="checkbox"/> M <input type="checkbox"/> R			601-800	5.9	1.6	7.3	43	410
CONDITION	: <input type="checkbox"/> FAILED <input type="checkbox"/> OVERSTRESSED <input checked="" type="checkbox"/> SOUND	BALANCE CURVE IS WHERE B =		20 A= 956					
STRUCTURE NUMBER		STRUCT. CAP. (E80 X 10 <sup>B</sup> )		>10					
ROAD CATEGORY		TRAFFIC		: LIGHT TRAFFIC					
DATE	:85/06/06	CATEGORY IV		: WELL-BALANCED DEEP STRUCTURE (WBD)					

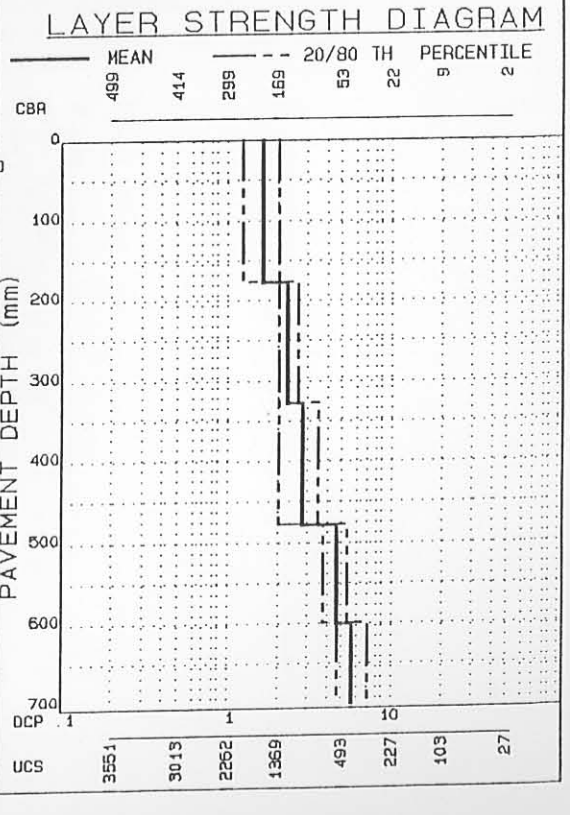
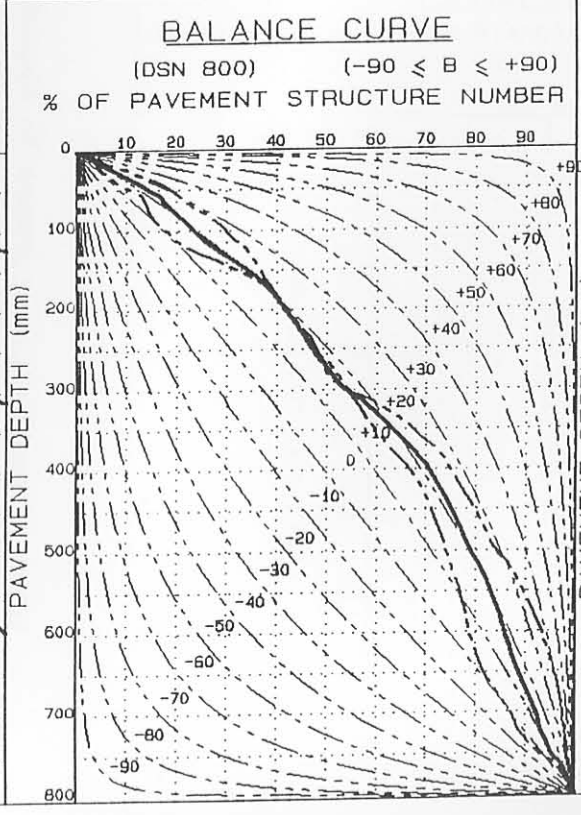
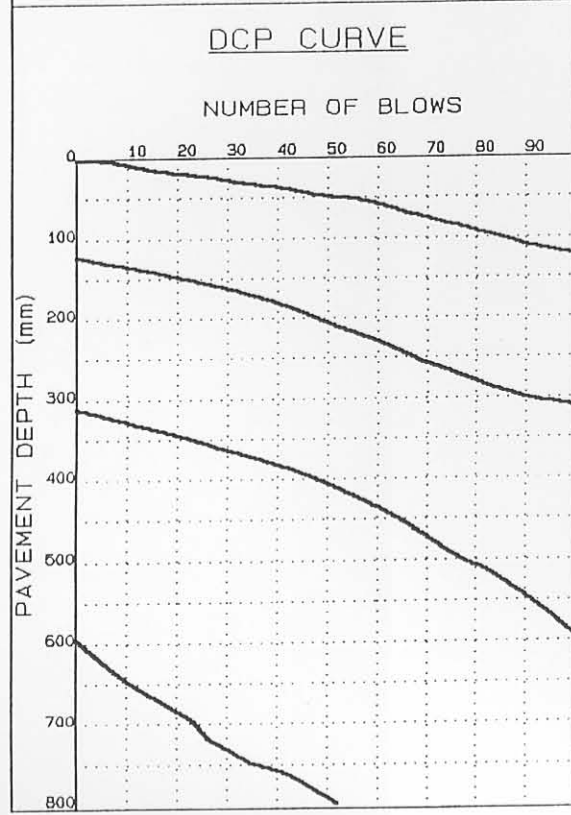


Figure C.7 Example of first plot produced by AVEBP

### SUMMARY OF DCP INVESTIGATION

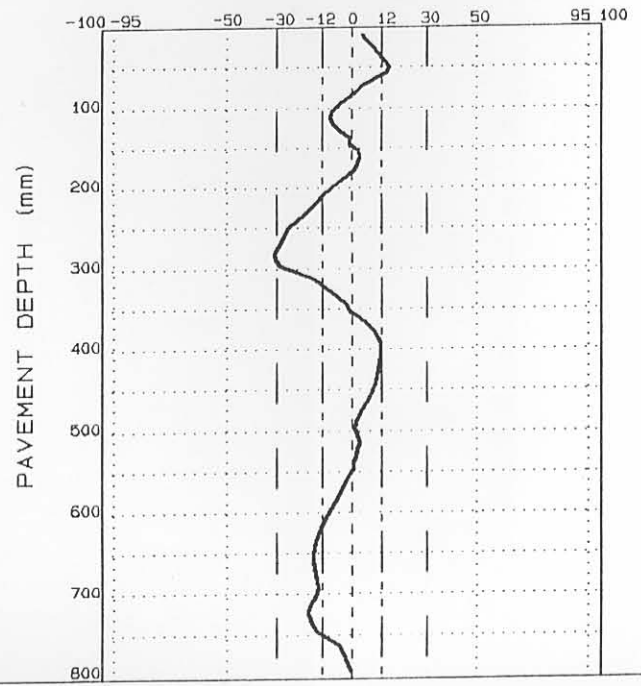
#### AVERAGE EQUIVALENT STRENGTH (REDEFINED)

FROM - TO (mm)	AV. PENETRATION (mm/blow)	SD	SDP	CBR%	UCS (kPa)
0-48	1.2	0.3	1.5	257	1980
49-112	2.0	0.5	2.4	170	1376
113-160	1.5	0.2	1.7	214	1685
161-280	2.5	0.4	2.8	130	1087
281-400	2.0	0.4	2.3	171	1383
401-496	3.5	0.5	4.0	83	732
497-512	3.3	0.3	3.5	91	794
513-648	4.9	0.6	5.5	54	501
649-688	5.0	0.7	5.6	53	493
689-800	6.6	1.9	8.1	37	359

DATA FILE: R3-R13.DAT

#### NORMALIZED CURVE

DEVIATION ( $A_i$ ) FROM STANDARD PAVEMENT BALANCE CURVE (SPBC), % .mm



#### LAYER STRENGTH DIAGRAM (REDEFINED)

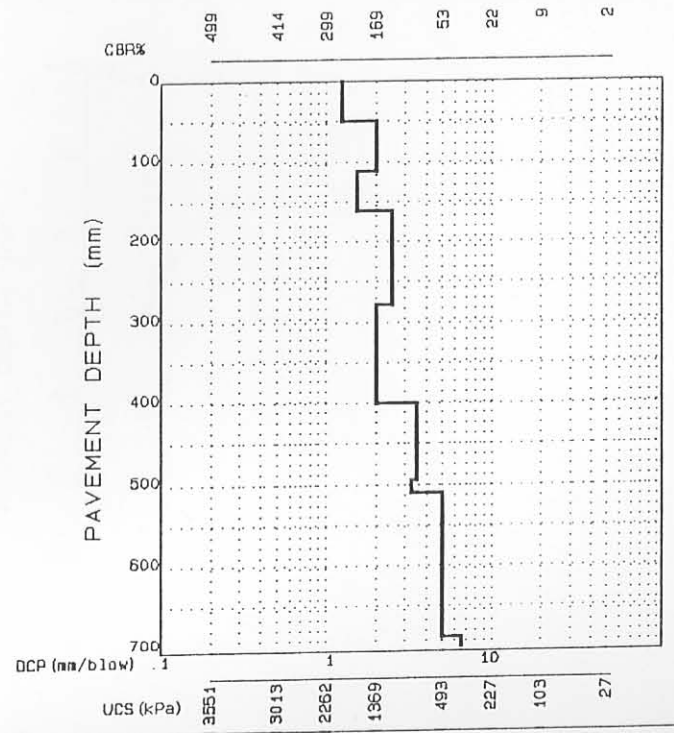


Figure C.8

Example of second plot produced by AVEBP

### SUMMARY OF DCP INVESTIGATION

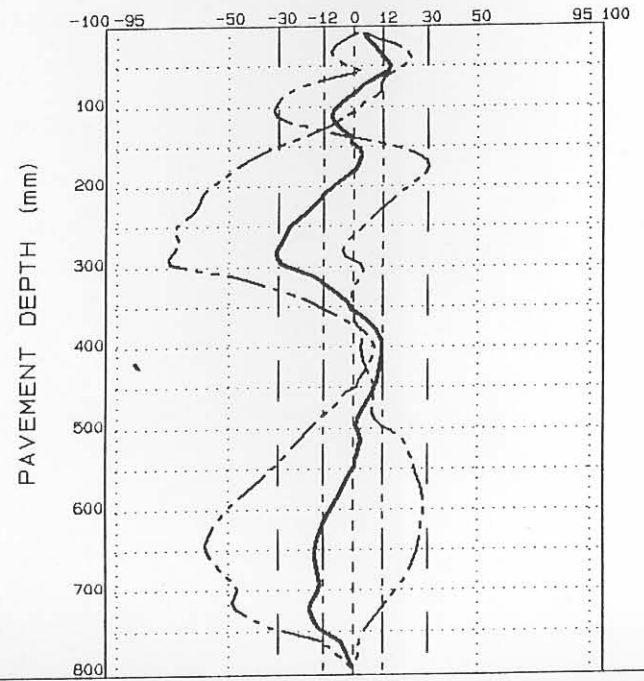
#### AVERAGE EQUIVALENT STRENGTH (REDEFINED)

FROM - TO (mm)	AV. PENETRATION (mm/blow)	SD	SDP	CBR%	UCS (kPa)
0-48	1.2	0.3	1.5	257	1980
49-112	2.0	0.5	2.4	170	1376
113-160	1.5	0.2	1.7	214	1685
161-280	2.5	0.4	2.8	130	1087
281-400	2.0	0.4	2.3	171	1383
401-496	3.5	0.5	4.0	83	732
497-512	3.3	0.3	3.6	91	794
513-648	4.9	0.6	5.5	54	501
649-688	5.0	0.7	5.6	53	493
689-800	6.6	1.9	8.1	37	359

DATA FILE: R3-R13.DAT

#### NORMALIZED CURVE

DEVIATION ( $A_i$ ) FROM STANDARD PAVEMENT BALANCE CURVE (SPBC), % .mm



#### LAYER STRENGTH DIAGRAM (REDEFINED)

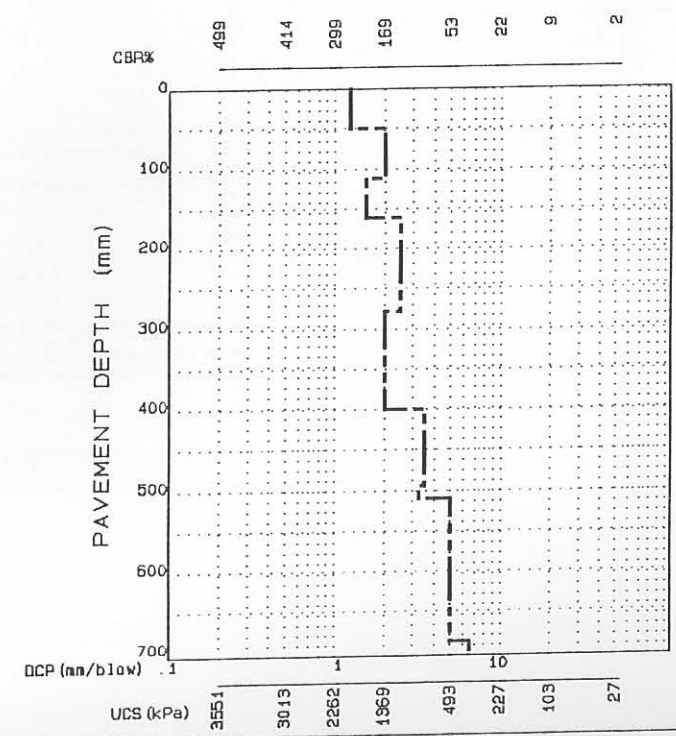


Figure C.9 Example of second plot produced by AVEBP

DCP INVESTIGATION  
-----

DATA FILES:

r3.dat            r13.dat

REGION : ROOIWAL(N=10)  
ROAD NUMBER : P1932  
Km DISTANCE : 2.9  
DATE : 85/06/06  
STRUCTURE NUMBER (DSN 800) : 351  
BALANCE NUMBER (BN 100) OF DATA : 24  
BN 100 OF BALANCE CURVE : 25  
STRUCTURAL CAPACITY(E80 x10\*\*6) : 52 (TPA method (Kleyn))  
ROAD CATEGORY : C  
TRAFFIC : LIGHT TRAFFIC

BALANCE CURVE IS WHERE B = 20 A = 956 , RK = 276

CATEGORY IV: WELL-BALANCED DEEP STRUCTURE (WBD)

KATEGORIE IV: GOED GEBALANSEERDE DIEPSTRUKTUUR (GGD)

AVERAGE EQUIVALENT STRENGTH (EXISTING STRUCTURE)  
-----

FROM - TO (mm)	AV.PENETRATION (mm/blow)	SD	80P	CBR%	UCS (kPa)
0 - 180	1.7	0.5	2.0	200	1588
181 - 330	2.4	0.4	2.7	137	1138
331 - 480	2.8	0.8	3.4	113	961
481 - 600	4.5	0.8	5.2	60	550
601 - 800	5.9	1.6	7.3	43	410

AVERAGE DCP PENETRATION RATE  
-----

DCP (	DEPTH (mm)	NO OF BLOWS	mm/blow	CBR%	UCS (kPa)
1 - 10)	10	11.8	0.85	331	2474
DCP ( 11 - 20)	20	22.5	0.93	313	2355
DCP ( 21 - 30)	30	32.5	1.00	299	2262
DCP ( 31 - 40)	40	43.7	0.89	322	2415
DCP ( 41 - 50)	50	55.0	0.89	322	2415
DCP ( 51 - 60)	60	61.4	1.56	211	1665
DCP ( 61 - 70)	70	66.3	2.07	161	1312
DCP ( 71 - 80)	80	72.5	1.60	205	1623
DCP ( 81 - 90)	90	78.9	1.57	209	1651
DCP ( 91 - 100)	100	85.0	1.63	202	1602
DCP ( 101 - 110)	110	90.0	2.00	169	1369
DCP ( 111 - 120)	120	98.0	1.24	255	1967
DCP ( 121 - 130)	130	105.8	1.30	247	1912

Figure C.10 Example of printout of AVEBP

DCP ( 131 - 140)	140	114.2	1.18	266	2041
DCP ( 141 - 150)	150	121.7	1.33	242	1878
DCP ( 151 - 160)	160	128.4	1.51	217	1706
DCP ( 161 - 170)	170	134.3	1.70	195	1553
DCP ( 171 - 180)	180	139.4	1.94	173	1398
DCP ( 181 - 190)	190	143.8	2.25	145	1197
DCP ( 191 - 200)	200	147.7	2.56	123	1035
DCP ( 201 - 210)	210	151.6	2.59	122	1028
DCP ( 211 - 220)	220	155.8	2.37	137	1138
DCP ( 221 - 230)	230	160.4	2.20	150	1233
DCP ( 231 - 240)	240	164.0	2.79	111	946
DCP ( 241 - 250)	250	167.3	2.98	102	878
DCP ( 251 - 260)	260	171.4	2.44	131	1094
DCP ( 261 - 270)	270	175.9	2.23	147	1211
DCP ( 271 - 280)	280	179.9	2.50	127	1065
DCP ( 281 - 290)	290	184.2	2.35	138	1146
DCP ( 291 - 300)	300	189.6	1.86	180	1447
DCP ( 301 - 310)	310	198.8	1.09	283	2156
DCP ( 311 - 320)	320	204.9	1.64	201	1595
DCP ( 321 - 330)	330	210.7	1.71	194	1546
DCP ( 331 - 340)	340	216.8	1.65	200	1588
DCP ( 341 - 350)	350	222.5	1.75	189	1511
DCP ( 351 - 360)	360	227.5	2.00	169	1369
DCP ( 361 - 370)	370	233.4	1.68	196	1560
DCP ( 371 - 380)	380	238.5	1.99	170	1376
DCP ( 381 - 390)	390	243.6	1.94	174	1405
DCP ( 391 - 400)	400	247.7	2.47	129	1079
DCP ( 401 - 410)	410	251.4	2.71	115	976
DCP ( 411 - 420)	420	254.8	2.90	106	908
DCP ( 421 - 430)	430	258.2	2.99	102	878
DCP ( 431 - 440)	440	261.4	3.13	96	832
DCP ( 441 - 450)	450	264.3	3.35	88	771
DCP ( 451 - 460)	460	266.9	3.90	73	654
DCP ( 461 - 470)	470	269.5	3.90	73	654
DCP ( 471 - 480)	480	271.9	4.12	68	614
DCP ( 481 - 490)	490	274.2	4.28	64	582
DCP ( 491 - 500)	500	277.1	3.44	85	748
DCP ( 501 - 510)	510	280.7	2.80	110	938
DCP ( 511 - 520)	520	283.7	3.35	88	771
DCP ( 521 - 530)	530	286.2	3.96	71	638
DCP ( 531 - 540)	540	288.7	4.07	69	622
DCP ( 541 - 550)	550	290.9	4.46	61	558
DCP ( 551 - 560)	560	293.1	4.60	59	542
DCP ( 561 - 570)	570	295.2	4.71	57	526
DCP ( 571 - 580)	580	297.1	5.28	49	460
DCP ( 581 - 590)	590	299.0	5.28	49	460
DCP ( 591 - 600)	600	300.7	5.89	43	410
DCP ( 601 - 610)	610	302.6	5.28	49	460
DCP ( 611 - 620)	620	304.5	5.28	49	460
DCP ( 621 - 630)	630	306.4	5.19	51	477
DCP ( 631 - 640)	640	308.5	4.94	54	501
DCP ( 641 - 650)	650	310.7	4.42	62	566
DCP ( 651 - 660)	660	313.2	4.00	70	630
DCP ( 661 - 670)	670	316.0	3.57	81	717
DCP ( 671 - 680)	680	318.7	3.75	76	677
DCP ( 681 - 690)	690	321.4	3.62	80	709
DCP ( 691 - 700)	700	323.6	4.68	57	526
DCP ( 701 - 710)	710	325.0	7.22	33	325
DCP ( 711 - 720)	720	326.3	7.22	33	325
DCP ( 721 - 730)	730	329.2	3.47	84	740
DCP ( 731 - 740)	740	332.1	3.47	84	740
DCP ( 741 - 750)	750	335.0	3.47	84	740
DCP ( 751 - 760)	760	340.8	1.74	191	1525
DCP ( 761 - 770)	770	344.0	3.07	98	847

DCP ( 771 - 780)	780	346.7	3.73	77	685
DCP ( 781 - 790)	790	349.4	3.72	77	685
DCP ( 791 - 800)	800	351.9	3.93	72	646

AVERAGE EQUIVALENT STRENGTH (EXISTING STRUCTURE - REDEFINED LAYERS)

LAYER	DEPTH (mm) FROM - TO	THICKNESS (mm)	DN mm/blow	SD mm/blow	80P	CBR%	UCS (kPa)
1	0 - 48	48	1.2	0.3	1.5	257	1980
2	49 - 112	64	2.0	0.5	2.4	170	1376
3	113 - 160	48	1.5	0.2	1.7	214	1685
4	161 - 280	120	2.5	0.4	2.8	130	1087
5	281 - 400	120	2.0	0.4	2.3	171	1383
6	401 - 496	96	3.5	0.5	4.0	83	732
7	497 - 512	16	3.3	0.3	3.5	91	794
8	513 - 648	136	4.9	0.6	5.5	54	501
9	649 - 688	40	5.0	0.7	5.6	53	493
10	689 - 800	112	6.6	1.9	8.1	37	359

WARNING ! MORE THAN TEN LAYERS FOUND

SUMMARY OF + AND - AREAS (CURVE FITTING TABLE - EXISTING STRUCTURE)

DEPTH (mm) FROM - TO	CUMULATIVE AREA (% mm), Ak
0 80	83.37
81 144	-38.32
145 176	9.09
177 352	-359.52
353 544	145.78
545 792	-320.29
ABSOLUTE AREA	956.38