

ROADSEG User's Guide

Version 1.0

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INTRODUCTION

The analysis of continuous radar data taken over a given route will generate predictions of layer thicknesses at specified intervals. For pavement management purposes, it becomes necessary to divide the given route into a number of homogeneous sections based on the interpretation of the radar predictions. For instance, examination of a plot of predicted surface thickness versus distance along a given route will likely show variations in surface thickness. To improve the functionality of the radar predictions, it is useful to divide the route into a number of segments within which the predicted thicknesses are more or less uniform. Summary data, such as mean surface and base thicknesses on the different sections, can then be reported.

A computerized procedure for route segmentation using predicted layer thicknesses was developed by the Texas Transportation Institute (TTI) as part of a research study to implement radar technology for establishing an inventory of layer thicknesses for pavement management. This study, sponsored by the Florida Department of Transportation (FDOT), led to the development of a Windows-based program, called ROADSEG, for delineating homogeneous sections based on predicted layer thicknesses from the radar data. The segmentation procedure is discussed in Fernando and Chua (1993 and 1994) and will not be described here. This document provides instructions on how to run the ROADway SEGmentation (ROADSEG) program which uses the cumulative difference method for delineating pavement sections. The reader is referred to AASHTO (1986) for particulars about the cumulative difference algorithm and to Fernando and Chua (1993 and 1994) on how this method is applied for delineating homogeneous segments based on predicted layer thicknesses from radar data. Familiarity with the DOS and Windows operating systems is required to run the program.

SYSTEM REQUIREMENTS

ROADSEG runs on IBM compatible microcomputers with the Windows 3.1 or 3.11 operating system. A personal computer with a 486-DX or better microprocessor, and at least 8 Mb of memory is recommended. In addition, a VGA color monitor and graphics card are required, and a 3.5-inch floppy disk drive is needed to install the program on the computer's hard disk. The hard drive must be large enough to accommodate the files generated from the radar data processing.

PROGRAM INSTALLATION

To install the program, follow these instructions:

1. Insert the program diskette into the computer's 3.5-inch floppy disk drive.
2. Go to File Manager in Windows and create a subdirectory on the computer's hard drive where the program files will be stored, for example, **ROADSEG**. Use the *Create Directory* command under the File option in File Manager to do this.
3. Copy the files in the program diskette onto the subdirectory created for ROADSEG. Use the *Copy* command under the File option in File Manager.
4. Exit File Manager and create a group for the ROADSEG program. To do this, click the mouse on, *File*, in Program Manager and choose, *New*. When the dialog box shown in Figure 1 appears on the computer monitor, specify that you want to create a new program group by clicking on this option. Confirm your choice by clicking on the OK button. The next dialog box, shown in Figure 2, is then displayed on screen. Enter in the Description field, **RoadSeg**, to give a name to the group in which the ROADSEG program will be installed. Click on the OK button to confirm your entry for the Description field. After you do this, the RoadSeg group window shown in Figure 3, is displayed on screen. The window is still empty because the program has not yet been installed. This is done in the next step.
5. To install the ROADSEG program in the group created, click on, *File*, in Program Manager and select, *New*. The New Program Object dialog box, shown in Figure 1, is again displayed. This time specify that you want to install an item in the RoadSeg group by clicking the mouse on the Program Item option. Click on the OK button to confirm your choice. Another dialog box (Figure 4) is displayed to specify the properties for the program to be installed. Enter the following information in the appropriate fields of the dialog box. To move the cursor to a specific field, click the mouse on that field.
 - a. Description: **RoadSeg 1.0**
 - b. Command Line: **C:\ROADSEG\ROADSEG.EXE** (assuming that the program files where copied onto a subdirectory called ROADSEG on the hard drive)
 - c. Working Directory: **C:\ROADSEG**

After you have finished entering the above information, the dialog box should appear like the one shown in Figure 4. Confirm your entries by clicking on the OK button. The icon for

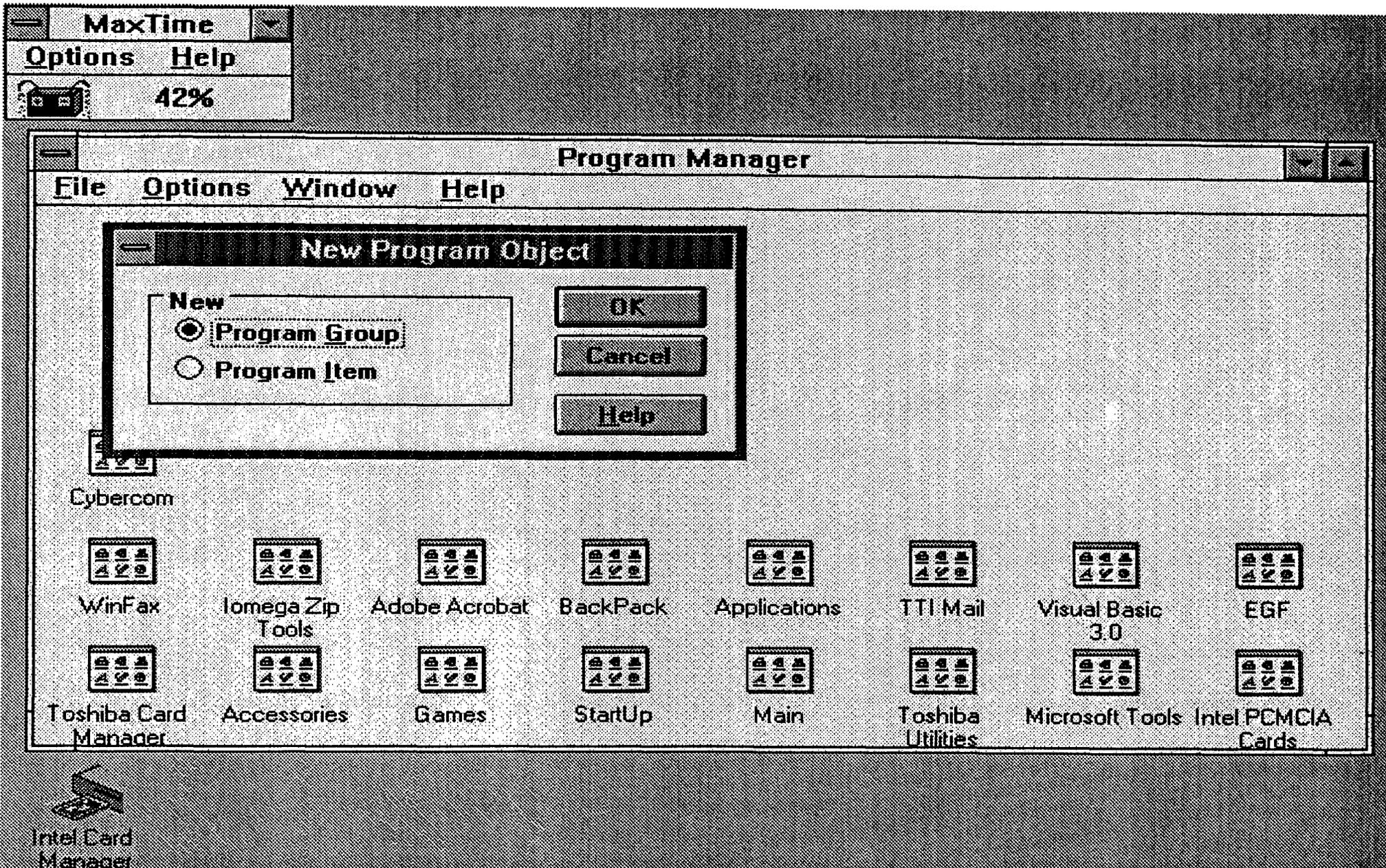


Figure 1. Dialog Box to Create a New Program Group in Windows.

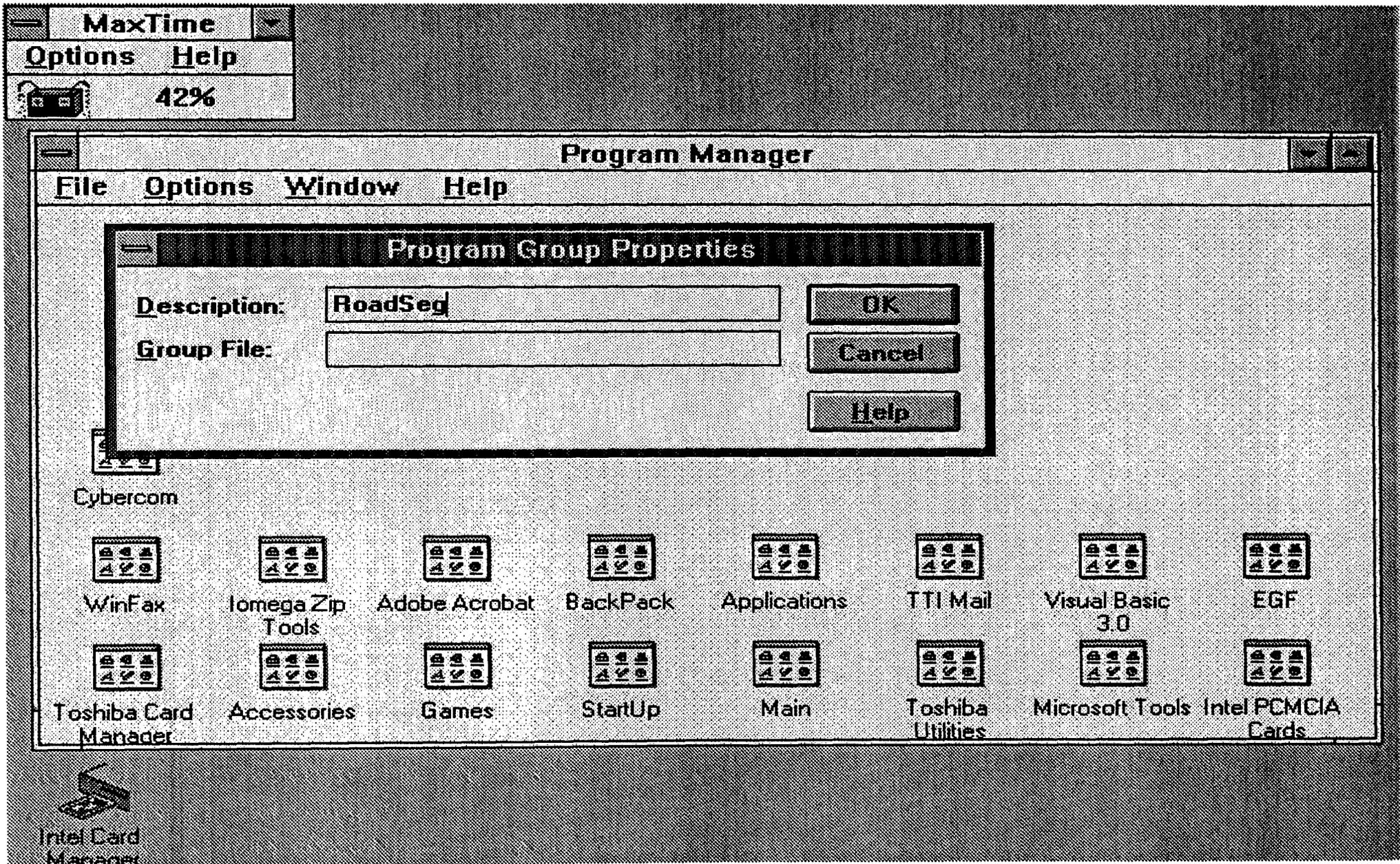


Figure 2. Dialog Box to Assign Properties to a New Program Group.

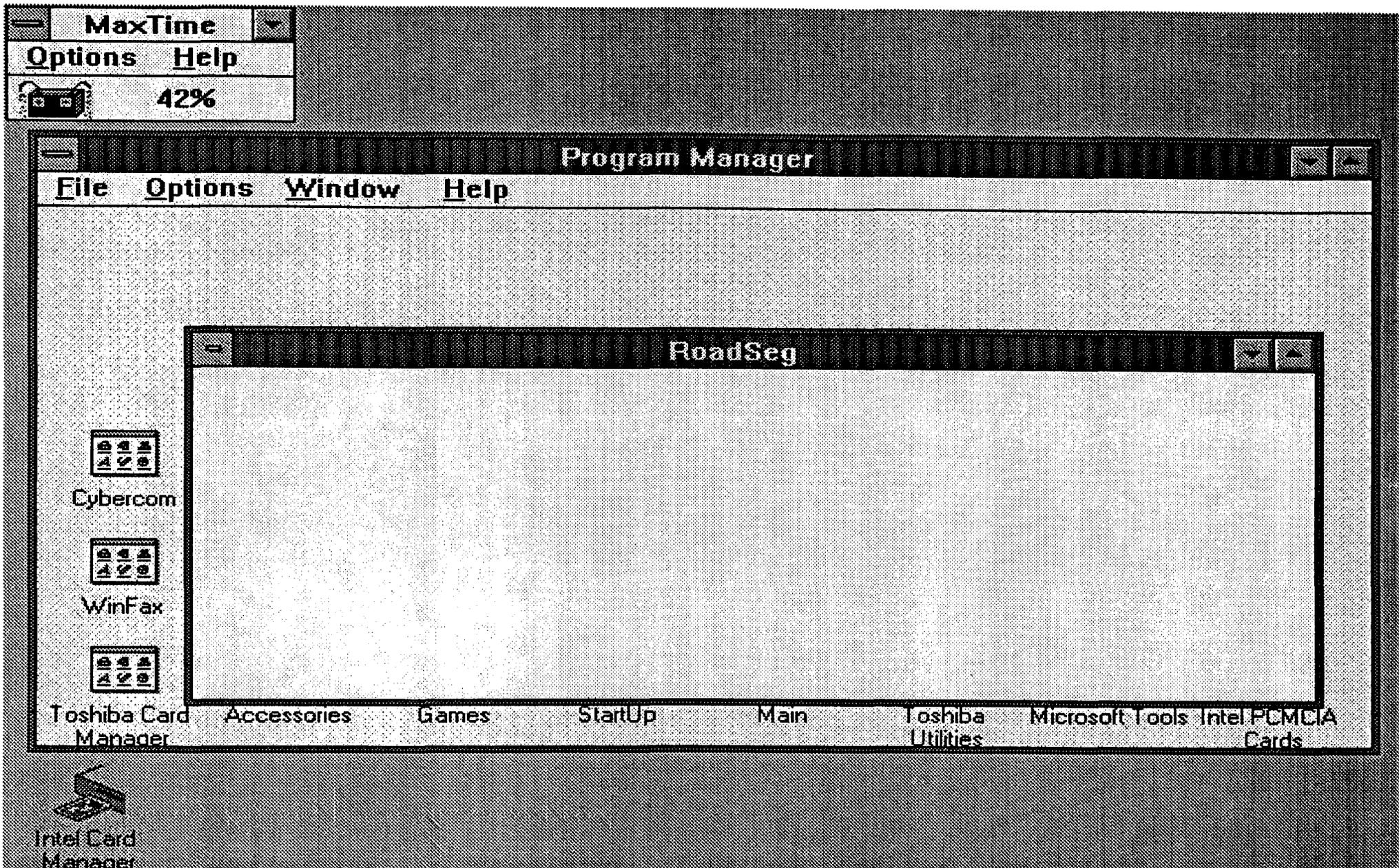


Figure 3. RoadSeg Group Window Created to Install the Segmentation Program.

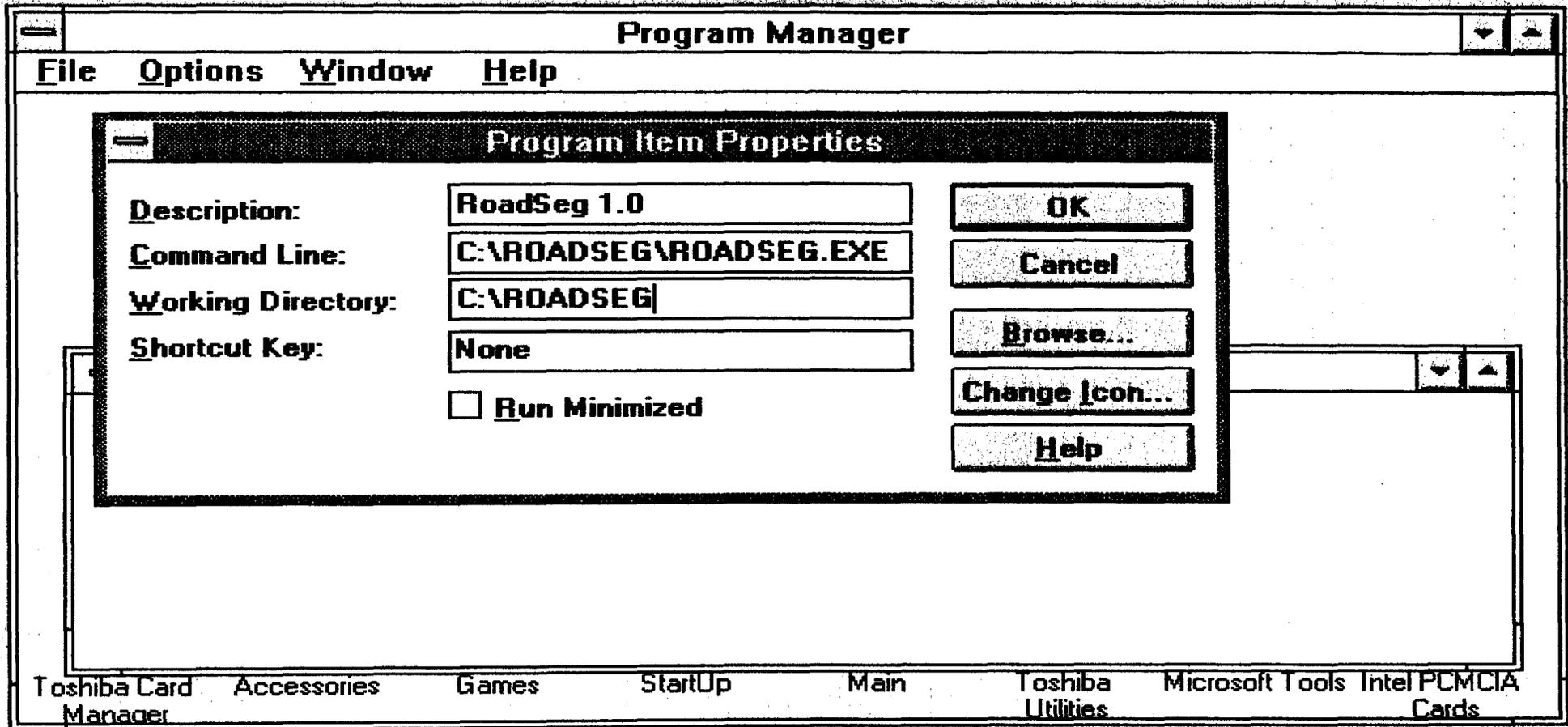


Figure 4. Dialog Box to Specify ROADSEG Program Properties.

the ROADSEG program is then stamped into the RoadSeg group as illustrated in Figure 5. At this point, installation is complete. To invoke the program, simply double click on its icon while in the RoadSeg Group. The user will then go through a series of menus for entering input data, performing analyses, and viewing and/or printing output. These are described in the following.

PROGRAM MENUS

The program menus are categorized according to function as follows:

1. Data Entry
2. Data Analysis
3. Program Output

When the program is invoked, the Main Menu, illustrated in Figure 6, is initially displayed. As shown in the figure, there are 3 buttons corresponding to the functions listed above, and one for the Quit option. To select an option, simply click on the corresponding button with the mouse. Choose Enter Data to input the parameters for one or more runs; select Analyze to perform segmentations using data previously entered; and click on View Result to look at output from different runs and get printouts. To terminate the program, click on the Exit button of the Main Menu. This will bring the user back to Program Manager.

DATA ENTRY MENUS

Figure 7 shows the screen that is displayed after the Enter Data option is selected from the Main Menu. The buttons at the top of the screen show the options that are available in the Data Entry Menu. To select a particular option, simply click on its button with the mouse. The available options during data entry are described below.

Available Options

1. **Select In File** - permits the user to view the directories of drives that are available on the computer and to select an input file to analyze in the segmentation program (Figure 8). The input file selected must follow a certain format. Figure 9 shows a view of a sample input file. Note that the file is in ASCII or text format. The first 15 records of the file contain information that identify the processed data. These include:

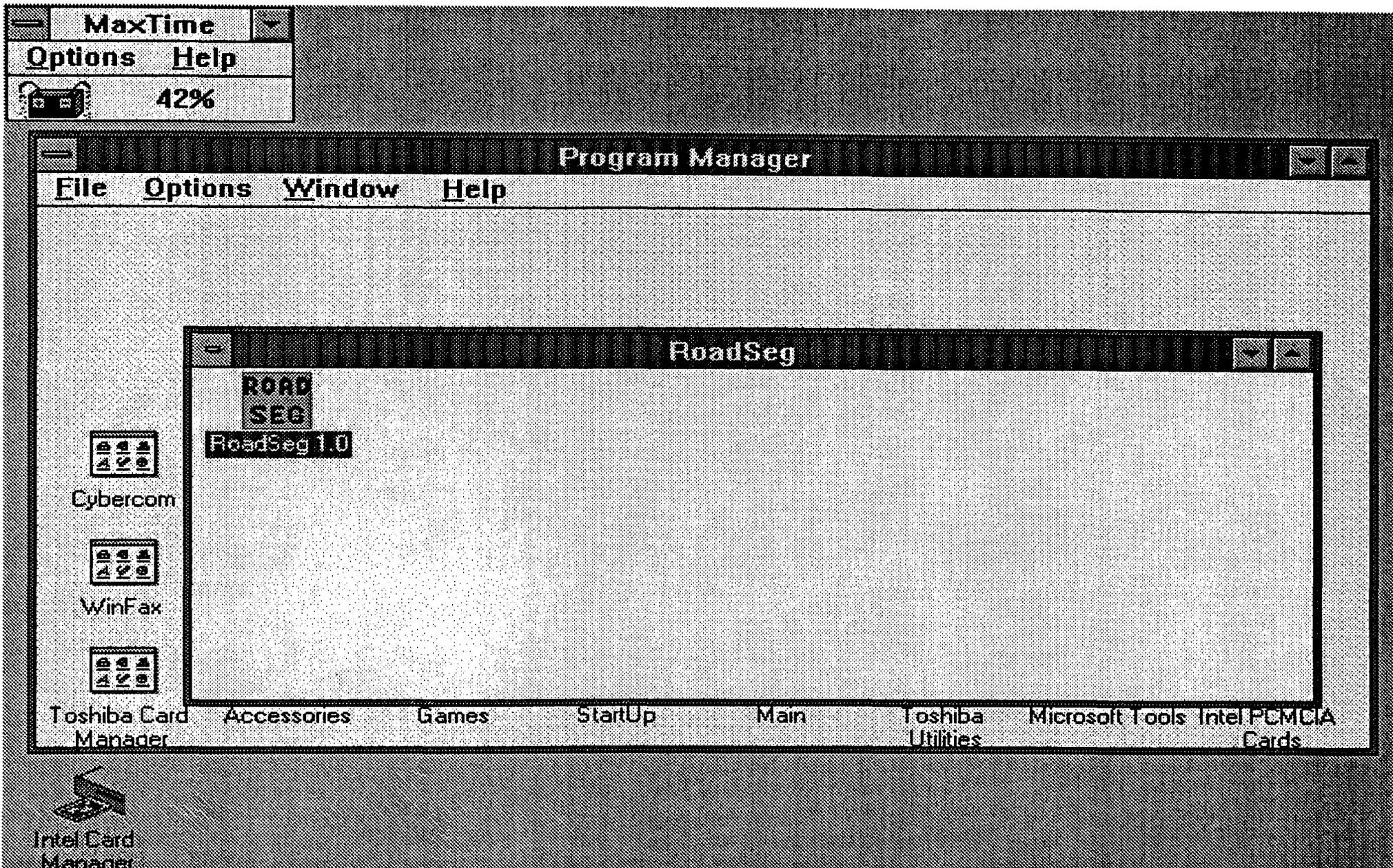


Figure 5. ROADSEG Program Icon Added to RoadSeg Group After Installation.

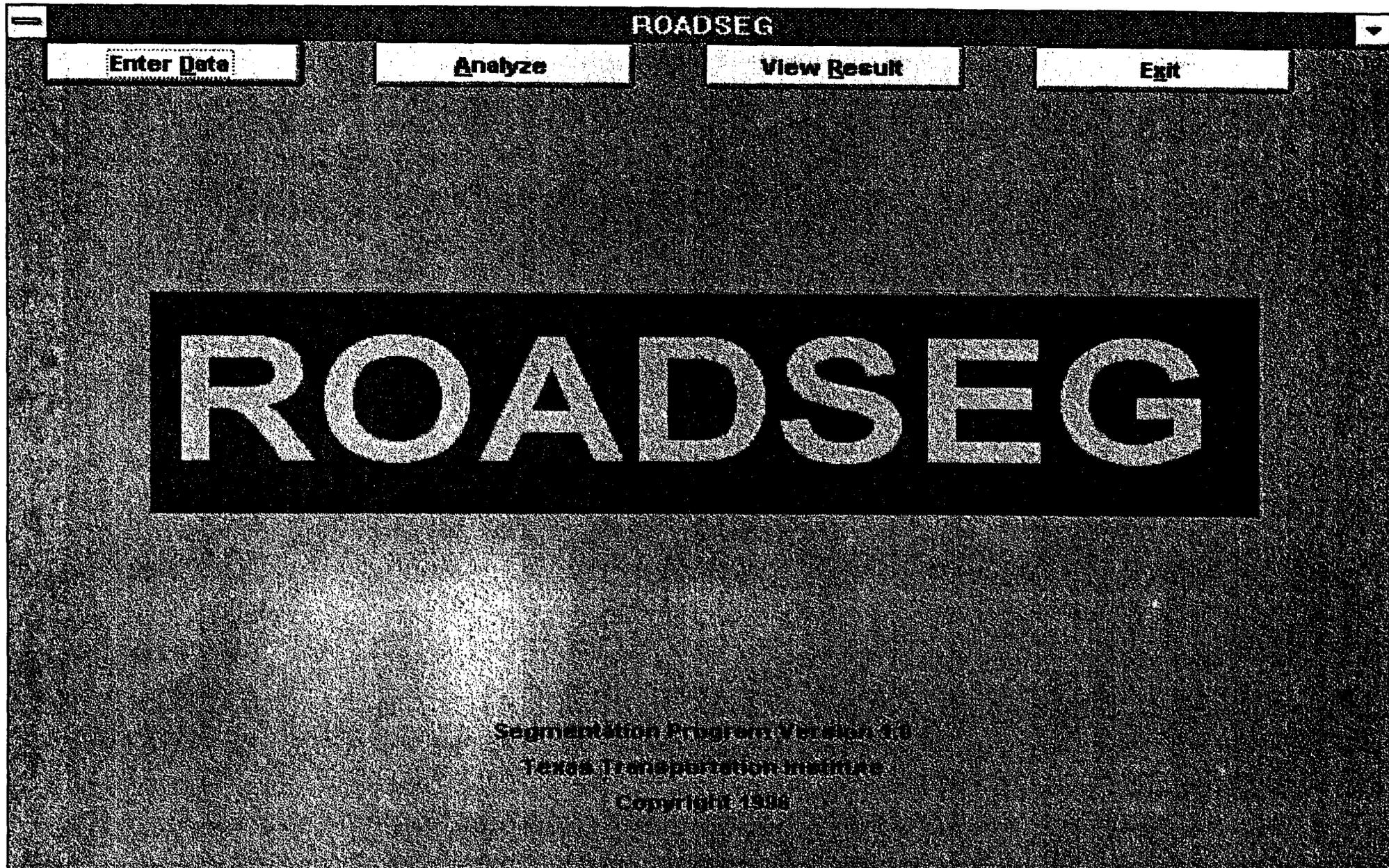


Figure 6. ROADSEG Main Menu.

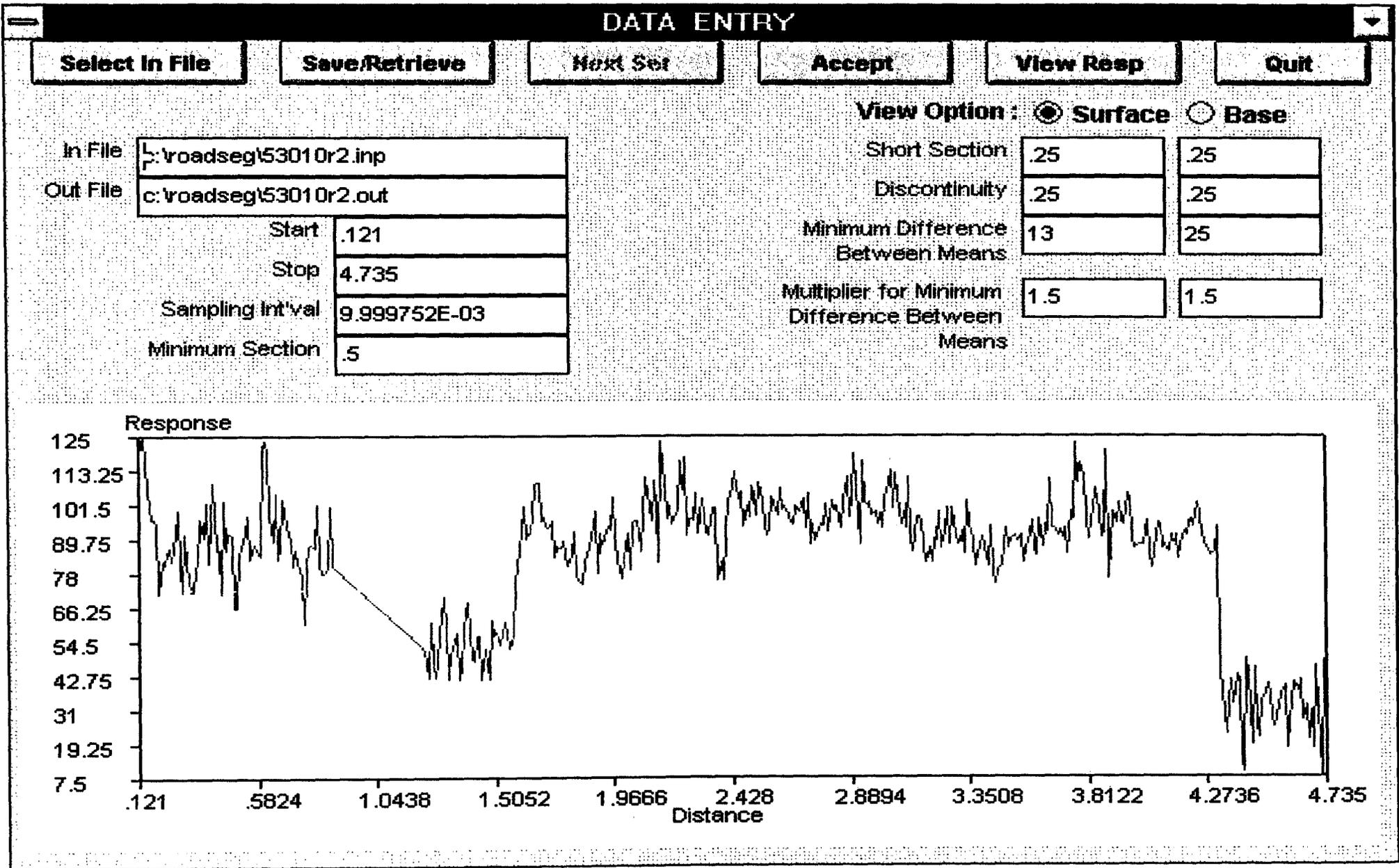


Figure 7. ROADSEG Data Entry Menu.

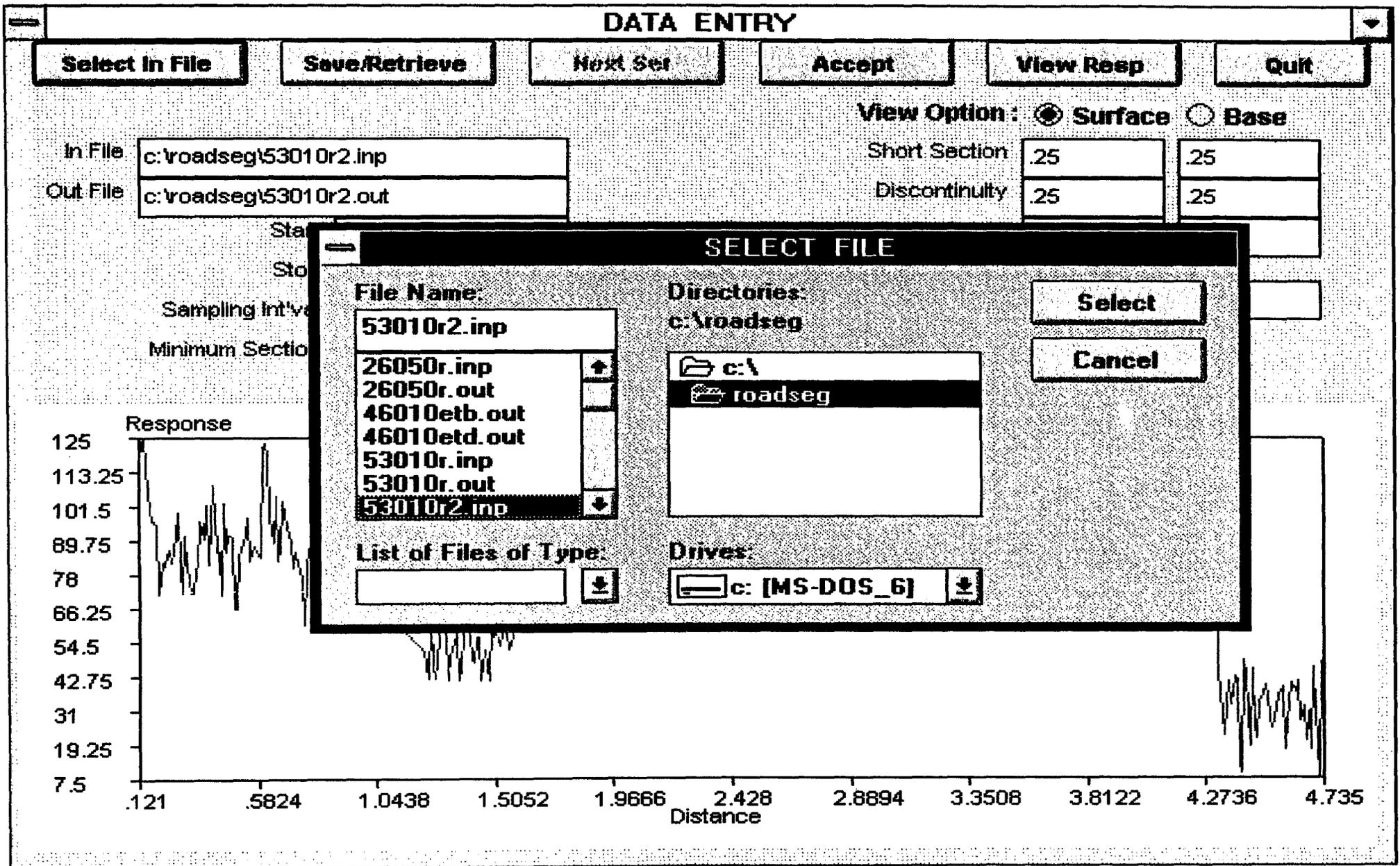


Figure 8. ROADSEG Select File Menu for Specifying Input File During Data Entry.

File Edit Search Help

Date of Collection: 10/13/92

Roadway ID: 53010

Beginning Milepost: 0.000

Ending Milepost: 4.728

Roadway Side: R

Lane: 1

WheelPath Surveyed: Inside

Comments: Pre-Production Survey Data on US 90 (Washington County - US 231)

Reporting interval: 0.01 miles

53010R.DAT

DISTANCE (miles)	THICKNESS		DIELECTRIC CONST	
	ASPHALT (mm)	BASE (mm)	BASE	SUBGRADE
.000	78.486	.000	11.400	.000
.121	83.566	.000	4.890	.000
.131	89.662	.000	11.600	.000
.141	90.932	.000	10.700	.000
.151	72.644	.000	6.960	.000
.161	66.802	.000	10.300	.000
.171	62.992	.000	8.510	.000
.181	62.738	.000	9.750	.000
.191	61.468	.000	9.050	.000
.201	37.338	.000	7.840	.000
.211	48.260	.000	6.530	.000
.221	47.498	.000	7.320	.000
.231	51.562	.000	8.400	.000

Figure 9.

View of a Sample ROADSEG Input File.

- a. the date the radar data were collected;
- b. the roadway ID of the segment surveyed;
- c. the milepost at the beginning of the segment surveyed;
- d. the ending milepost;
- e. the roadway side which indicates the direction of the radar survey;
- f. the lane and wheelpath surveyed;
- g. comments made by the person who analyzed the radar data;
- h. the reporting interval or the frequency with which radar thickness predictions are reported.
- i. the file name of the radar data analyzed; and
- j. column labels for data items written into the input file.

The ROADSEG program expects the first record of processed data to start at line 16 of the input file. Each record must contain the following information in the order cited:

- a. Distance (miles);
- b. Asphalt thickness (mm);
- c. Base thickness (mm);
- d. Base dielectric constant; and
- e. Subgrade dielectric constant.

Each record must have only the five data items noted above with at least a space separating each item. Thicknesses must be reported in millimeters (mm) and zeroes are used to denote missing data for thickness and dielectric constant. In addition, no blank lines or blank records are allowed beginning at line 16 of the input file.

2. Save/Retrieve - permits the user to save input data to a batch job file or to retrieve an existing file for editing in the Data Entry Menu.
3. Next Set - allows the user to step sequentially through each set of run parameters in a batch job file. This button is only active when the user is viewing/editing the contents of an existing batch job file that has been retrieved into the Data Entry Menu.
4. Accept - writes the current set of run parameters entered by the user into a buffer which may later be written to a batch job file for storage. When the user clicks on the Accept button, the current set of input parameters are initially checked for possible input errors such as an invalid input file. If errors are detected, the user is prompted to make changes. Otherwise, the current set of run parameters is written into the program's buffer. The

user must click on the Accept button to tell the program that data entry for the current set of input parameters is complete and to validate the data entered. Otherwise, the parameters entered will not be saved. The program also uses the Accept button to determine whether a subsequent call to the Save/Retrieve function from the Data Entry Menu is for a Save operation or for a Retrieve operation. If the Accept button has never been used since the last save, a subsequent call to the Save/Retrieve function will be interpreted by the program as a Retrieve operation. However, if the user clicked on the Accept button since the last save, the save mode will be invoked when the Save/Retrieve button is pressed.

5. View Resp - plots the predicted thicknesses for the specified start and stop range on the screen.
6. Quit - terminates data entry and brings the user back to the Main Menu. To minimize the possibility of data loss, the dialog box shown in Figure 10 is displayed. If input parameters have not yet been saved, this feature allows the user to do so before quitting the Data Entry menu. The user should click on, "No", to remain in this menu and save data previously entered. Otherwise, the user should click on, "Yes", to go back to the Main menu (Figure 6). Any unsaved data are lost.

Required Run Parameters

1. In File - is the file where the predicted layer thicknesses from radar data processing are stored. The user may choose to type the file name in the In File box or click on the Select In File button to view the directories of drives that are available on the computer and to select a particular file for the In File field. The Select File Menu is shown in Figure 8. To select a particular file, highlight the name by clicking on it. Then, click on the Select button to go back to the Data Entry Menu. The name of the file selected is entered into the In File field by the program.
2. Out File - specifies the file where the output associated with a given set of run parameters will be saved.
3. Start and Stop - defines the limits of the data interval which will be segmented. This data interval must be within the limits of the selected input file. The Start and Stop parameters control what gets displayed on screen when the View Resp button is clicked. The chart displayed is tied to the range specified by the user.

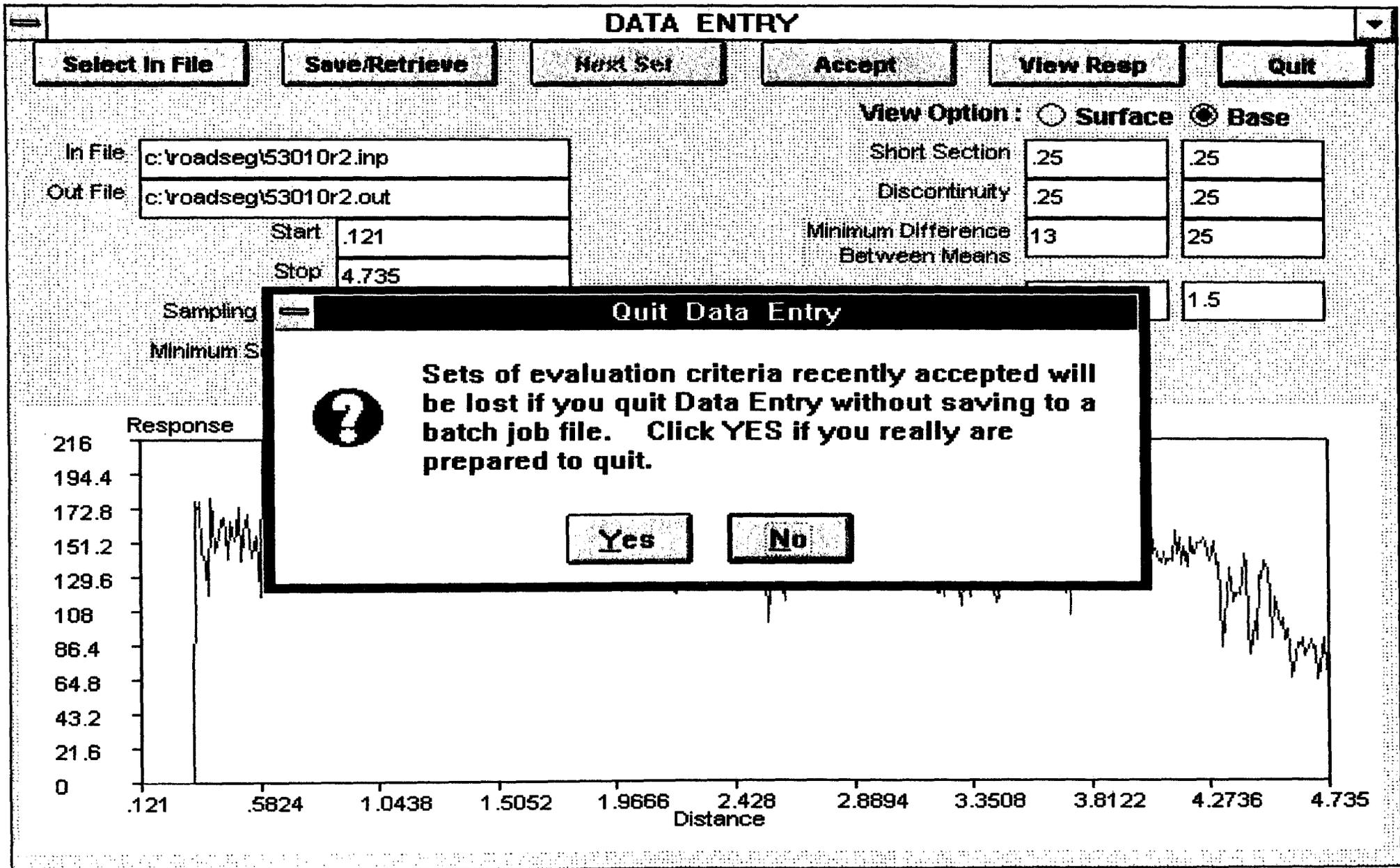


Figure 10. Dialog Box to Quit Data Entry Menu.

4. **Sampling interval** - is the interval between data points for analysis of the given input file. By default, the sampling interval is the minimum distance between predicted layer thicknesses for the Start and Stop range specified. If the default value is used, all data points within the range will be processed. By specifying an interval larger than the default value, the user can control the resolution of the analysis. For example, he/she may choose to process only every other point within the specified range of the prescribed input file.
5. **Minimum section** - this is the minimum length that is required of a given segment. In the program, segments of shorter length are combined with adjacent segments so that the minimum section length criterion is met. There are, however, exceptions to this criterion which are discussed later. It is important to take into consideration the intended applications of the radar data in deciding what minimum section length to use. Undoubtedly, there can be a great amount of variability in pavement structure along the length of a given highway, and, the lower the minimum section length, the better the chances of minimizing the variability within delineated segments, and of establishing more uniform sections. However, in practice, there is a limit to how short a section can get before it ceases to be a viable resurfacing project. On a 10-mile stretch of highway, for example, it is unlikely that different overlays will be constructed for individual 0.1-mile sections. It is more likely that such short sections will be combined with other sections, or the highway divided into sections of much longer length, for purposes of overlay design and construction. The important guideline to remember is that the segmentation should be consistent with the intended applications, and in this regard, it is important to distinguish between project level and network level applications. Shorter segment lengths are generally more applicable for project level work. For network level purposes, the minimum section length should probably be no smaller than 0.25 miles which is generally the smallest length of roadway surveyed in FDOT's PCS data base. For developing an inventory of layer thicknesses over the Florida highway network, a minimum section length of 0.5 to 1.0 mile is recommended.
6. **Minimum Difference Between Means** - the average layer thicknesses of adjacent segments must differ by at least this value for the segments to exist individually. Otherwise, the segments are combined in the analysis. This criterion can vary between the surface and base layers as indicated in Figure 7. In general, the criterion to use should be consistent with the observed variability of layer thicknesses within uniform pavement sections.

Coring data taken from different pavement sections where radar measurements were made indicate that the within-section variability of layer thicknesses, as measured by the standard deviation, varies over a range, with the base thickness showing more variability than the asphalt surface thickness. Table 1 shows various measures of central tendency of standard deviations of core thicknesses.

Table 1. Measures of Central Tendency of Standard Deviations of Core Thicknesses.

Statistic	Asphalt Thickness (mm)	Base Thickness (mm)
Mode	7	31
Median	10	26
Mean	15	25

The above statistics can be used as guidelines in selecting the value to use for the minimum difference between section means. Because of the larger within-section variability associated with base thickness, a larger value for this criterion is more appropriate. For the base, a value of 25 mm is recommended based on the information obtained from coring. For the surface layer, a criterion of 8 to 13 mm is recommended.

Exceptions to the Minimum Segment Length Criterion

Cases are encountered where segments are so distinct that it becomes appropriate to establish them as individual segments even though their lengths are shorter than the minimum specified. Exceptions to this rule are handled through the following criteria:

1. discontinuity threshold;
2. short section length; and
3. multiplier to the minimum difference between means.

In the context of segment delineation, a discontinuity is an interval with missing data. This condition typically arises when layer interfaces cannot be observed from the radar data thus precluding the prediction of asphalt and/or base layer thicknesses. For example, the pavement surveyed may consist of a concrete slab over a cement-treated base which may not provide enough dielectric contrast. In this instance, the signal from the bottom of the slab may be so

faint that the interface cannot be seen and the slab thickness cannot be predicted from the radar data. Figure 11 illustrates a discontinuity, 0.34 miles in length, brought about by missing data on predicted surface thickness. If a minimum segment length of 0.5 miles is specified, the discontinuity shown will be merged with an adjacent segment since its length is less than the minimum allowed. This is illustrated in Figure 12 where the horizontal bars show the limits of the segments delineated from ROADSEG as well as the average of the predicted surface thicknesses for each segment. Note that, in this example, the discontinuity is included in the second segment. Since the discontinuity is an interval with missing data, the average surface thickness for this segment is computed using only the available surface thickness predictions within the segment. This is evident from Figure 12 where the horizontal bar representing the mean surface thickness for segment 2 plots approximately midway across the available data. To provide an option for delineating discontinuities as separate segments, the discontinuity criterion is used. This criterion is simply the minimum length a discontinuity must have for it to exist as a separate segment. In the previous example, a discontinuity threshold of 0.25 miles may be specified, resulting in the segmentation shown in Figure 13. Note that the results obtained are preferable to those shown in Figure 12.

Another exception to the required minimum segment length arises when a short interval exists where the predicted thicknesses are very much different from those in the adjoining segments. An example of a short section is the segment after the discontinuity in Figure 13. Just like the discontinuity, this section, 0.36 miles in length, fails to meet the minimum segment length criterion of 0.50 miles. Unlike the discontinuity, however, surface thickness predictions are available. It is also observed that the surface thickness predictions are quite different from those of the adjacent segments, one of which is a discontinuity. To provide the option of delineating the short section as a separate segment under these conditions, two additional criteria are used:

1. The minimum required length for a short section, referred to herein as the short section length; and
2. A multiplier to the minimum difference between means to establish the significance level at which the mean response for a short section has to differ from the mean response of each adjacent segment.

Both of the above criteria must be met for the short section to exist as a separate segment. In Figure 13, a short section length of 0.25 miles was specified. In addition, a multiplier of 1.5

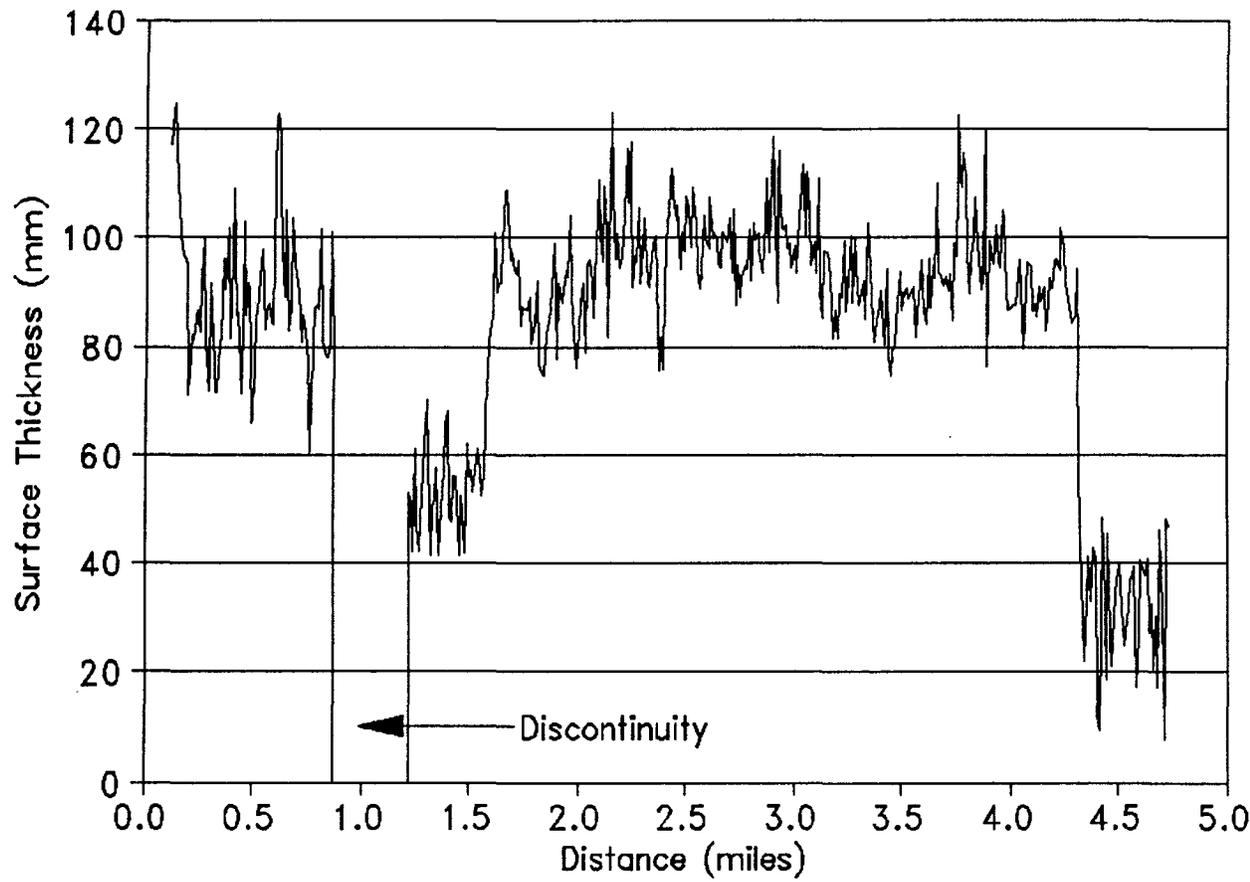


Figure 11. Illustration of a Discontinuity in Predicted Surface Thicknesses.

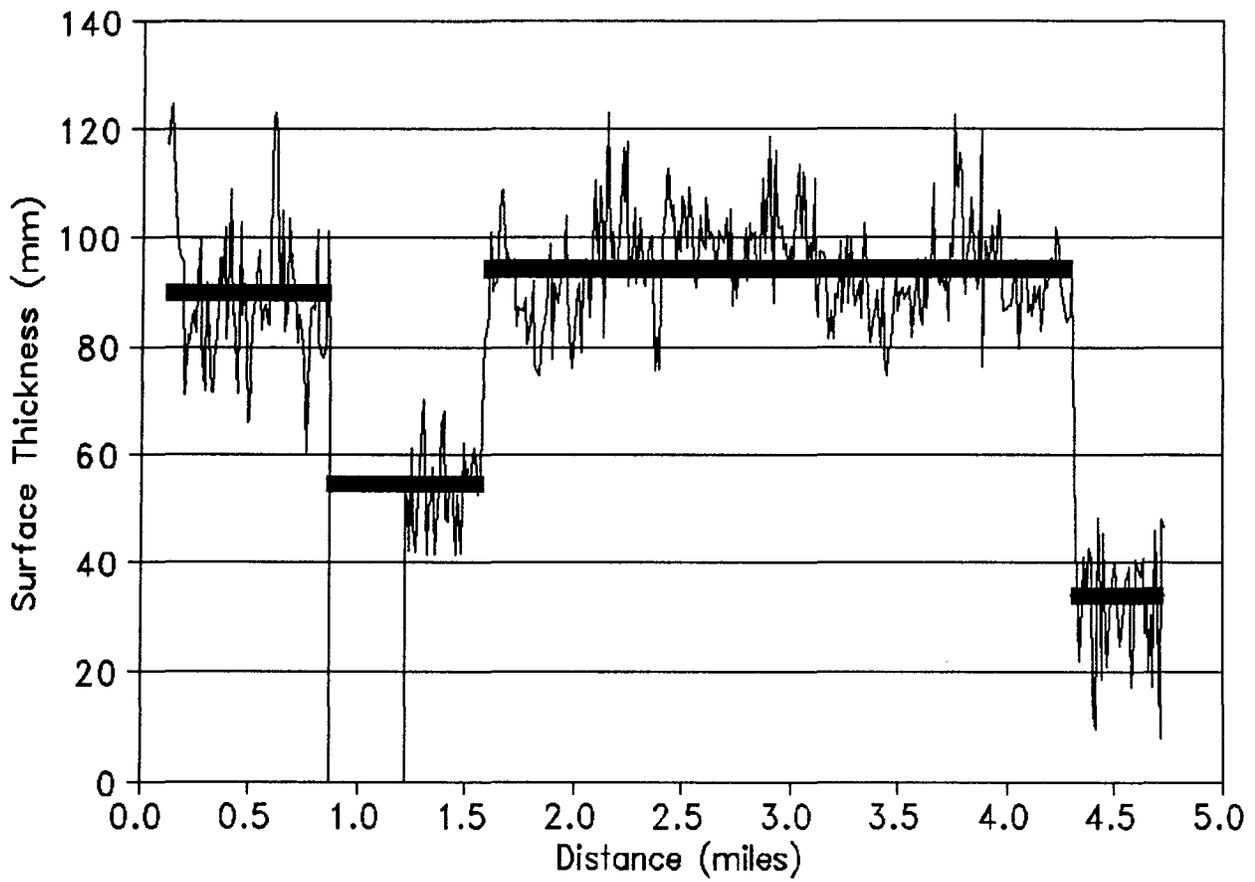


Figure 12. Discontinuity Merged With Adjacent Segment.

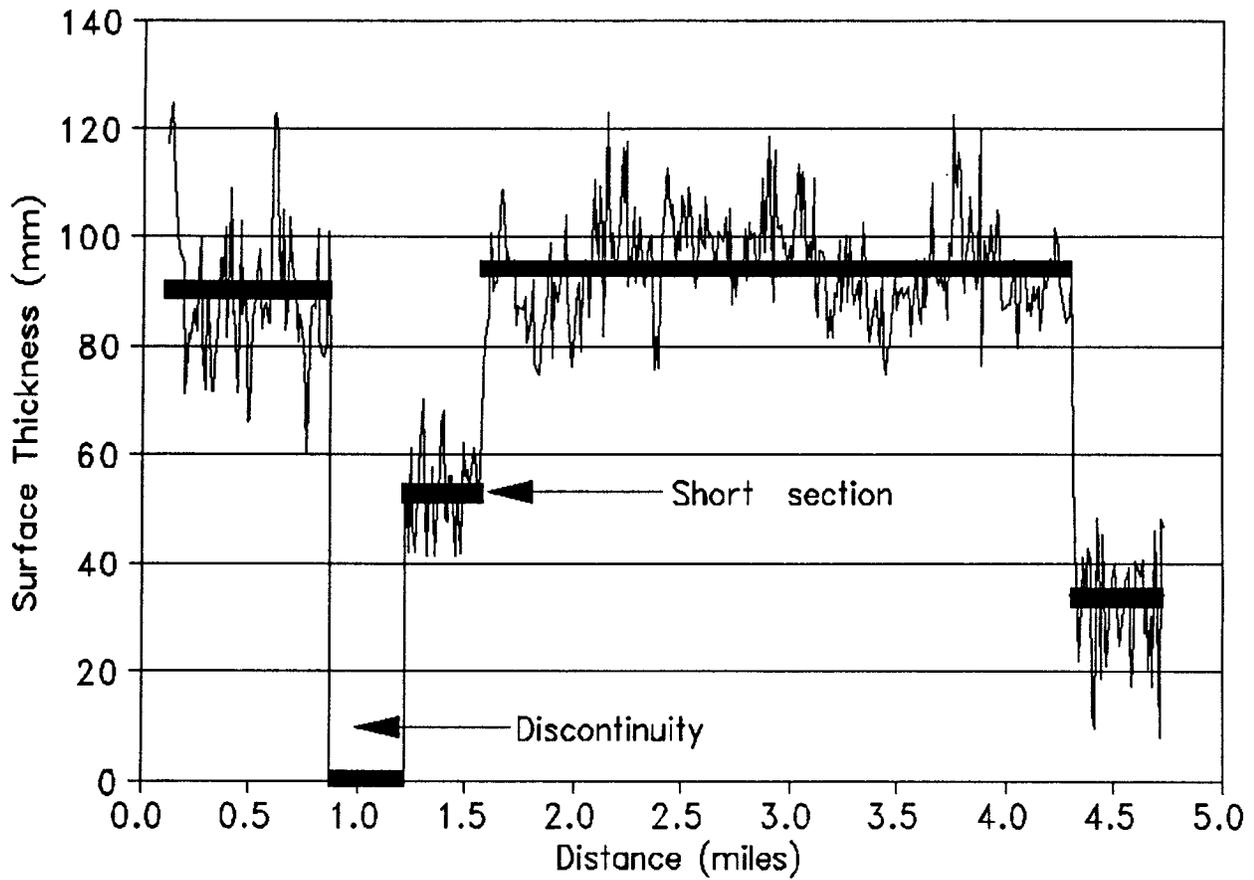


Figure 13. Effect of Discontinuity Criterion on Roadway Segmentation.

was applied to the minimum difference between means where a value of 13 mm (0.50 inches) was specified. The difference between the mean response for the short section and the mean response for an adjacent segment must then be equal to or greater than the product of the multiplier and the minimum difference between means (19 mm for this example). The short section length, discontinuity, minimum difference between means, and the multiplier for minimum difference are specified separately for the surface and base layers as indicated in Figure 7.

Saving/Retrieving Input Files

To write the input data to a disk file, click on the Save/Retrieve button on the Data Entry Menu. Only run parameters accepted previously will be saved. As indicated in Figure 14, the user has 20 storage registers for saving input data. The user selects a particular register by clicking on it. Each register is referred to by a batch job number where a given batch job file can have one or more sets of run parameters. Batch jobs in blue indicate empty registers while those in red indicate registers in use, i.e., the registers contain data previously entered and saved. The user can choose to overwrite existing data in a given batch job file. When a storage register is selected, a file descriptor field is displayed on the screen. This feature allows the user to attach comments to the batch file. To include comments, move the cursor to the file descriptor field by clicking on it with the mouse. Then, type in any comments. Writing information in the file descriptor field to document batch job files is good practice and is strongly recommended.

By clicking on the Save button, the information in the program's buffer is written to the selected batch job file and the buffer is cleared. The program then returns to the Data Entry Menu. While in the Save/Retrieve Menu shown in Figure 14, the user has the option of retrieving an existing file in lieu of saving the current contents of the program buffer. To do this, the contents of the buffer must first be cleared by clicking on the Clear Buffer button. The dialog box shown in Figure 15 is then displayed on screen. The program verifies that this is the option selected by the user before clearing the buffer. If it is, the buffer is cleared. Otherwise, the user is again given the opportunity to save the contents of the buffer to a batch job file. When the buffer is cleared within the Save/Retrieve Menu, the user can retrieve a previously saved batch job file by selecting the file and then clicking on the Retrieve button.

DATA ENTRY : SAVE / RETRIEVE BATCH JOB

Blue: Not Used

Red: In Used

Batch Job 1

Batch Job 6

Batch Job 11

Batch Job 16

Batch Job 2

Batch Job 7

Batch Job 12

Batch Job 17

Batch Job 3

Batch Job 8

Batch Job 13

Batch Job 18

Batch Job 4

Batch Job 9

Batch Job 14

Batch Job 19

Batch Job 5

Batch Job 10

Batch Job 15

Batch Job 20

File Descriptor

Sample Problem for ROADSEG User's Guide

Save

Clear Buffer

Retrieve

Next Set

Cancel

Figure 14.

ROADSEG Save/Retrieve Batch Job Menu For Saving Input Data Entered.

DATA ENTRY : SAVE / RETRIEVE BATCH JOB

Blue: Not Used

Red: In Used

- Batch Job 1
- Batch Job 2
- Batch Job 3
- Batch Job 4
- Batch Job 5

- Batch Job 6
- Batch Job 7
- Batch Job 8
- Batch Job 9

- Batch Job 11
- Batch Job 12
- Batch Job 13
- Batch Job 14

- Batch Job 16
- Batch Job 17
- Batch Job 18
- Batch Job 19
- Batch Job 20

File Descripto

Clear Temporary Buffer

 **Note that the evaluation parameters recently accepted are stored in the temporary buffer. Click YES to clear the buffer without saving.**

Save

Clear Buffer

Retrieve

Next Set

Cancel

Figure 15. Dialog Box to Clear Buffer Prior to Retrieving a Batch File.

To retrieve a file in the Data Entry Menu, click on the Save/Retrieve button. The Retrieve Batch Job Menu (Figure 16) is displayed. Select a batch job file to retrieve by clicking on the appropriate batch job number. The program then displays the descriptor associated with the file along with the first set of run parameters. The user can browse the contents of the file sequentially using the Next Set button. The number of sets of input data stored in a given batch job file is displayed beside the batch job number in the menu. To retrieve the selected file, click on Retrieve. Otherwise, select another batch job file to display, or click on Cancel to return to the Data Entry Menu.

ANALYZE MENU

To do an analysis, the Analyze option is invoked in the Main Menu. The Analyze screen, shown in Figure 17, is then displayed. This screen permits the user to select one or more previously saved batch job files for analysis. This is done by clicking inside the box to the left of the batch job number that the user wants to run. An "X" is placed inside the box to indicate that the given file has been selected. To deselect the file, simply click on its box again. Clicking the box functions like a toggle switch. To run all previously saved batch job files, simply click on the Select All button. After all selections have been made, proceed with the segmentation by clicking on the Start button of the Analyze Menu. The program will then go through each set of run parameters for each of the batch jobs selected. As the analysis proceeds, a status window (Figure 18) is also displayed showing the input data set currently processed, as well as date and time stamps. The status window is useful for keeping track of the runs made. At the end of the runs, a dialog box, such as that illustrated in Figure 19, is displayed. For normal program termination, the dialog box should show an exit code of 0. Click on, "Yes", to exit the dialog box. Otherwise, click on, "No", to browse the job log within the status window. The contents of this window can be copied to the system buffer and pasted to a file using the Notepad editor of the Windows operating system or a word processor, such as the Windows Write program. This permits the job log to be saved to a disk file for later use.

To copy the contents of the status window to the system buffer, click on the *Edit* option at the top of the window. The Edit pulldown menu is then displayed. Click on *Select All* to mark all of the contents of the status window. Click on *Edit* again, and then on *Copy* to copy everything that was marked in the status window into the system buffer. The items copied to the buffer can then be pasted later into a document using Notepad or a word processor.

DATA ENTRY: RETRIEVE BATCH JOB

Blue: Not Used Red: In Used

<input type="radio"/> Batch Job 1	<input type="text" value="0"/>	<input type="radio"/> Batch Job 6	<input type="text" value="0"/>	<input type="radio"/> Batch Job 11	<input type="text" value="0"/>	<input type="radio"/> Batch Job 16	<input type="text" value="0"/>
<input type="radio"/> Batch Job 2	<input type="text" value="0"/>	<input type="radio"/> Batch Job 7	<input type="text" value="0"/>	<input type="radio"/> Batch Job 12	<input type="text" value="0"/>	<input type="radio"/> Batch Job 17	<input type="text" value="0"/>
<input type="radio"/> Batch Job 3	<input type="text" value="0"/>	<input checked="" type="radio"/> Batch Job 8	<input type="text" value="1"/>	<input type="radio"/> Batch Job 13	<input type="text" value="0"/>	<input type="radio"/> Batch Job 18	<input type="text" value="0"/>
<input type="radio"/> Batch Job 4	<input type="text" value="0"/>	<input type="radio"/> Batch Job 9	<input type="text" value="0"/>	<input type="radio"/> Batch Job 14	<input type="text" value="0"/>	<input type="radio"/> Batch Job 19	<input type="text" value="0"/>
<input type="radio"/> Batch Job 5	<input type="text" value="0"/>	<input type="radio"/> Batch Job 10	<input type="text" value="0"/>	<input type="radio"/> Batch Job 15	<input type="text" value="0"/>	<input type="radio"/> Batch Job 20	<input type="text" value="0"/>

File Descriptor

Sample Problem for ROADSEG User's Guide

In File	<input type="text" value="c:\roadseg\53010r2.inp"/>		
Out File	<input type="text" value="c:\roadseg\53010r2.out"/>		
Start	<input type="text" value=".121"/>	Short Section	<input type="text" value=".25"/>
Stop	<input type="text" value="4.735"/>	Discontinuity	<input type="text" value=".25"/>
Sampling Int'val	<input type="text" value=".01"/>	Minimum Difference Between Means	<input type="text" value="13"/>
Minimum Section	<input type="text" value=".5"/>	Multiplier for Minimum Difference Between Means	<input type="text" value="1.5"/>
		Surface	<input type="text" value="25"/>
		Base	<input type="text" value="25"/>

Figure 16. ROADSEG Retrieve Batch Job Menu.

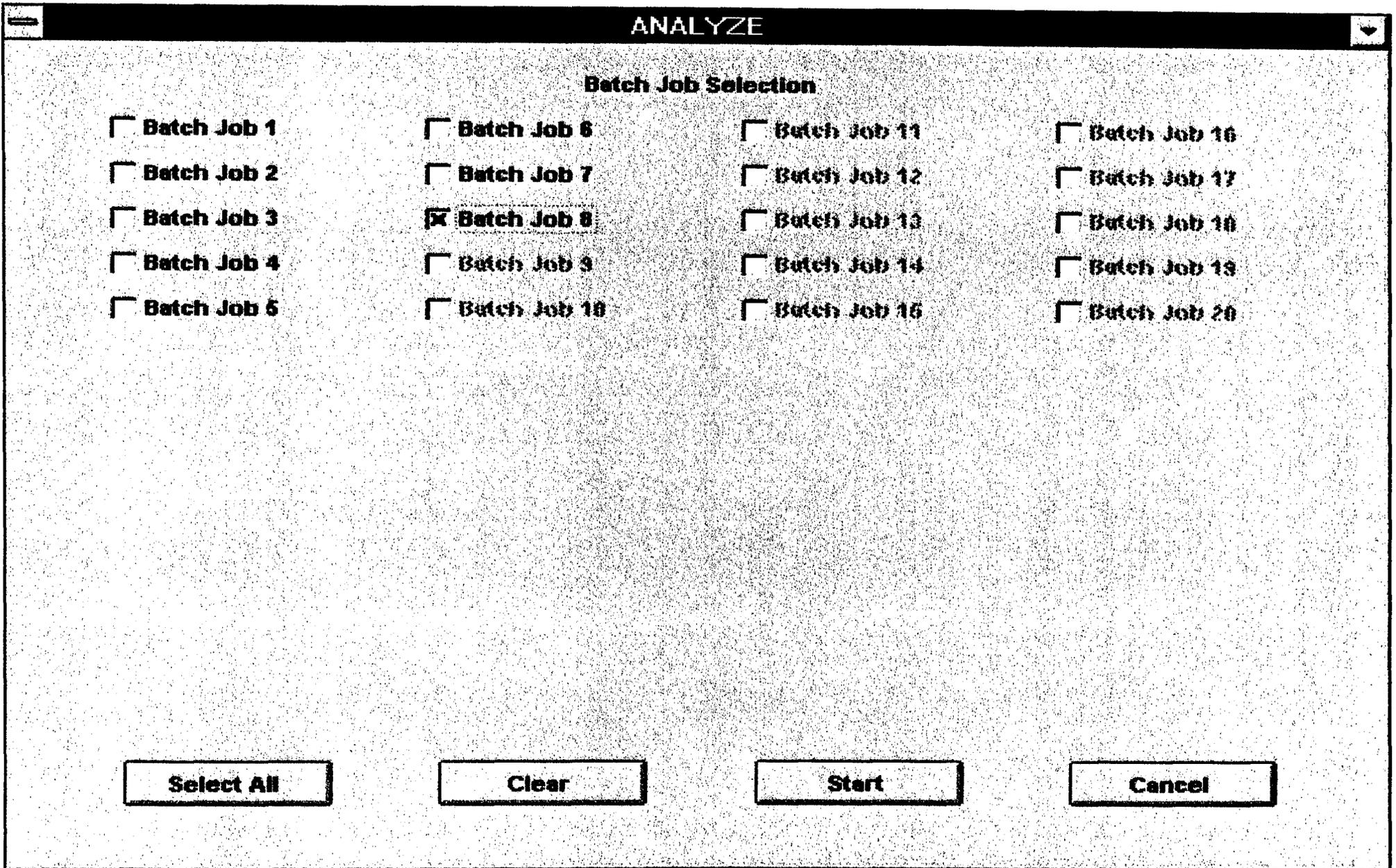


Figure 17. ROADSEG Analyze Menu For Selecting Batch Job Files to Analyze.

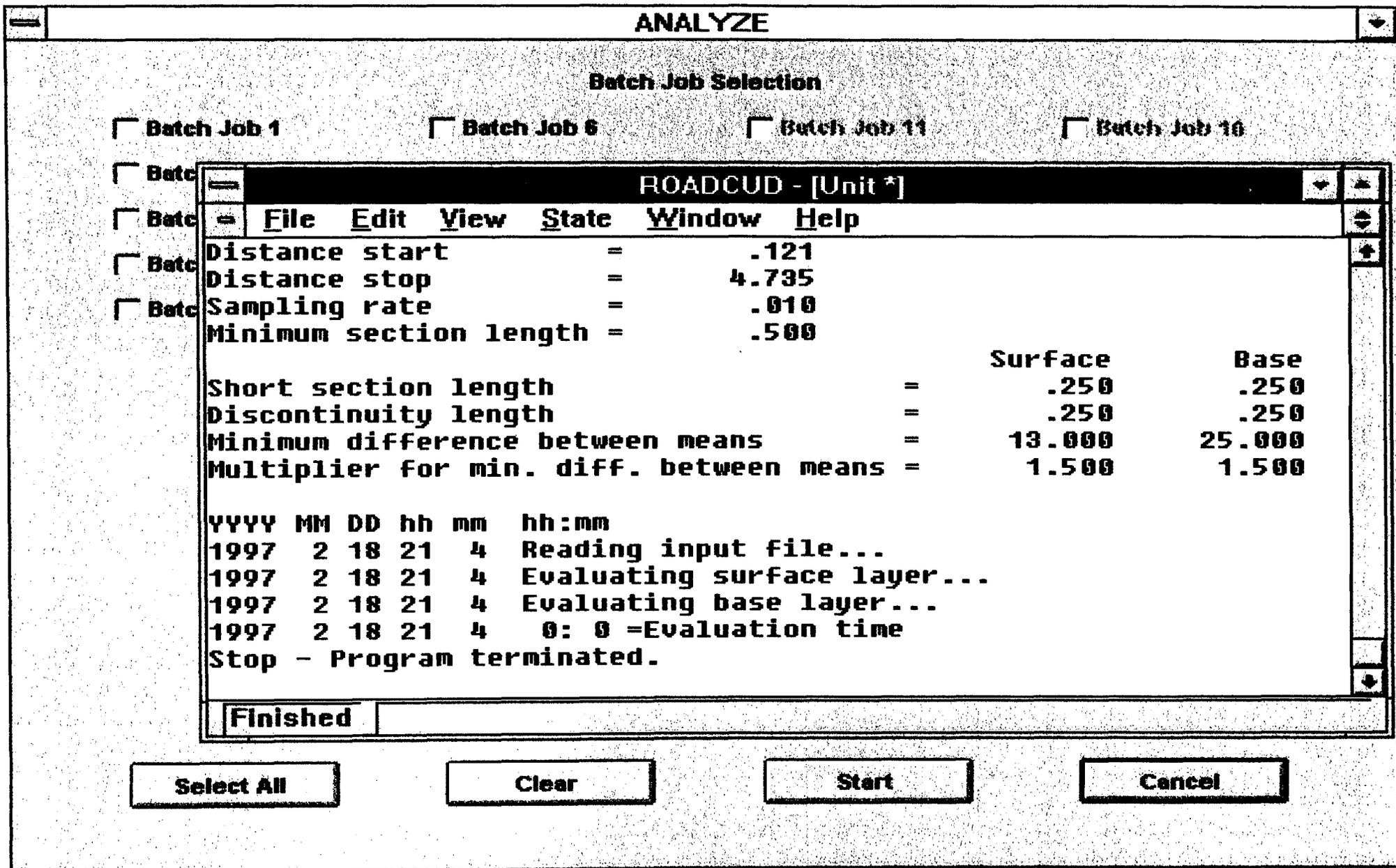


Figure 18. Status Window Displayed During Program Execution in Analyze Menu.

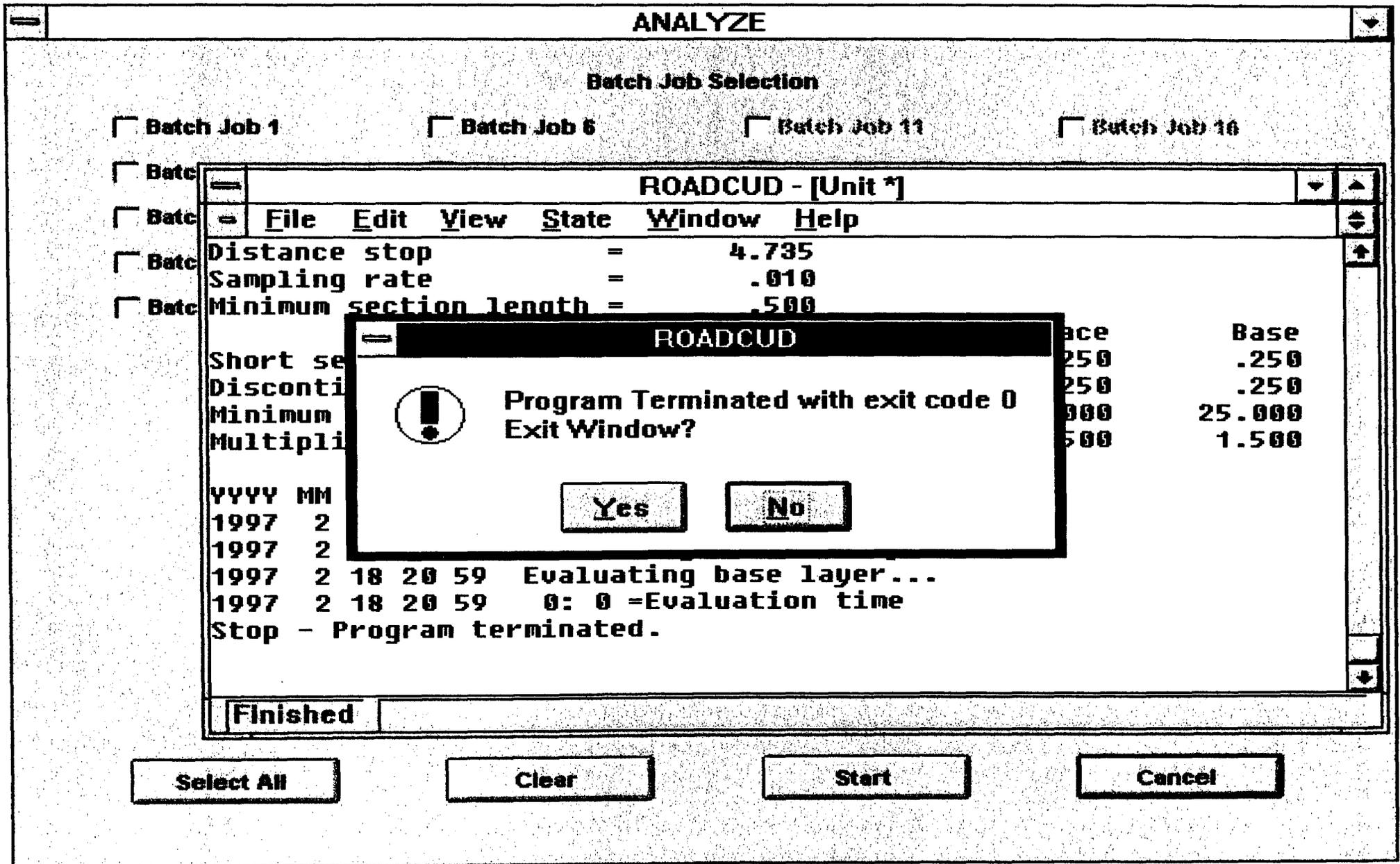


Figure 19. Dialog Box to Exit Status Window in Analyze Menu.

VIEW RESULT MENUS

To view the results from a given batch run, click on the View Result button of the Main Menu. The View Result screen, shown in Figure 20, is then displayed. From this screen, click on the Select Batch Job to choose a job for viewing. The menu, shown in Figure 21, is displayed. Click on a batch job that has previously been submitted and retrieve it for viewing. The program returns to the View Result screen. While in this menu, display the results associated with a given set of run parameters by clicking on the View Chart button. The chart displayed will depend on which View Option (Surface or Base) is selected. In Figure 22, for example, "Surface", has been selected under View Option. As a result, the surface thickness predictions are plotted at the bottom half of the screen when the user clicks on the View Chart button. On the chart, delineated segments are represented by solid horizontal lines. The height of a given line corresponds to the mean layer thickness for a particular segment. The length of a segment is defined by the limits of the corresponding horizontal line. Figure 23 shows the corresponding chart for the base layer. It is observed that a label is attached to the top of each chart consisting of the output file name specified by the user followed by the pavement layer (Surface or Base) selected under View Option.

To print the results for the set of run parameters displayed, click on the Print Set button. The output printed will depend on the Print Selections made. To print the table of the delineated segments, click inside the box to the left of the Print Table option, as illustrated in Figures 22 and 23. Figure 24 shows a sample output table. In addition, to print the charts associated with the surface and base delineations, select the Print Chart button by clicking on its box. Note that the Print Chart box is not tied to the View Option buttons. The View Options are only pertinent for displaying the delineations on the computer monitor using View Chart.

The user can sequentially view the results associated with each set of run parameters by using the Next Set button of the View Result Menu in conjunction with the View Chart and View Option buttons. In this way, he/she can review the results obtained before getting printouts using the Print Set button. Alternatively, the user can click on Print Job to get printouts of the results associated with all sets of run parameters in the batch job file. As mentioned before, the printouts obtained will depend on the print selections made.

The example output table shown in Figure 24 includes information identifying the roadway surveyed and analyzed; the delineations obtained based on the predicted surface thicknesses; the delineations from the predicted base thicknesses; and the composite segmentation based on

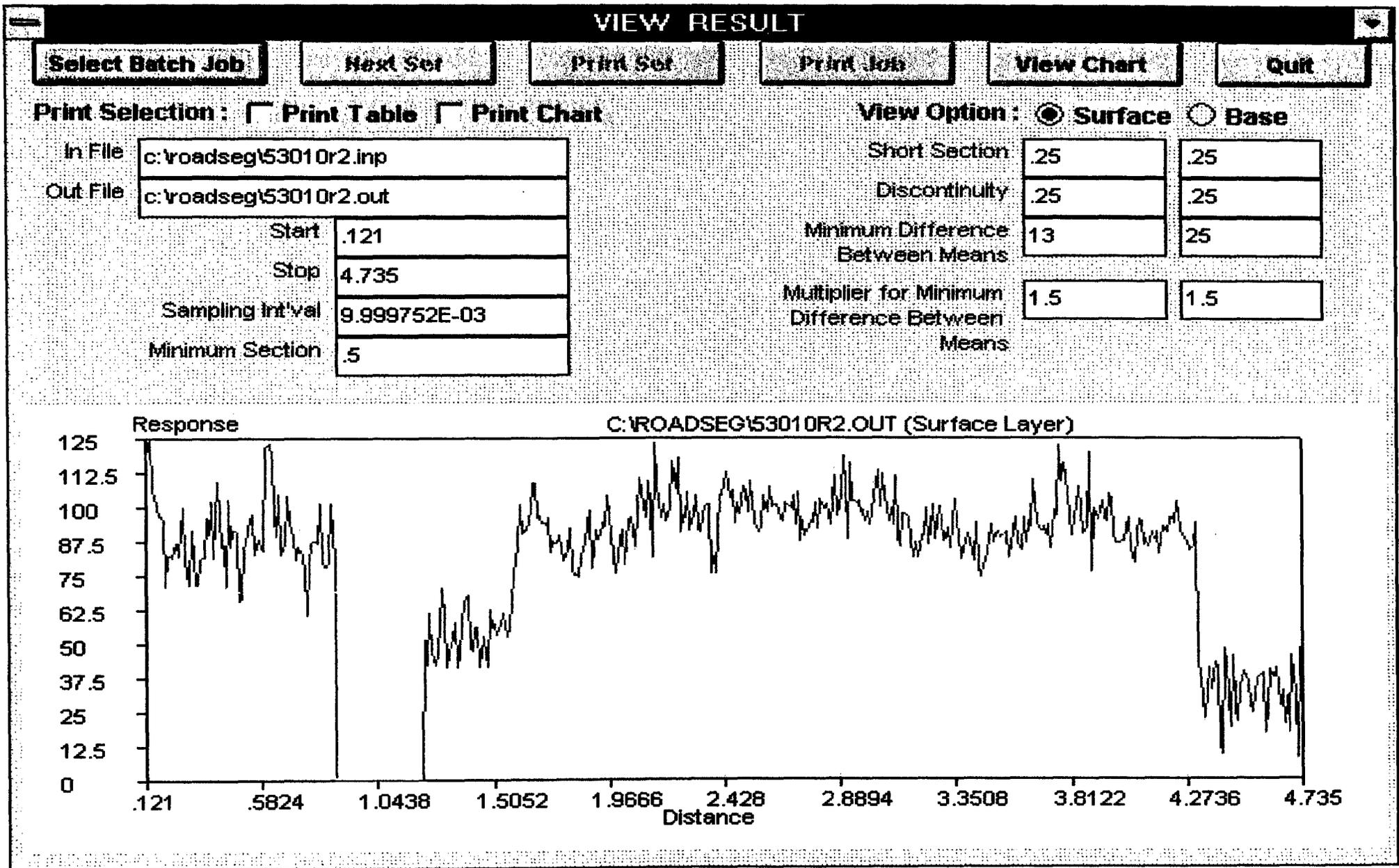


Figure 20. ROADSEG View Result Menu For Viewing/Printing Analysis Results.

VIEW RESULT : SELECT BATCH JOB

- Batch Job 1
- Batch Job 2
- Batch Job 3
- Batch Job 4
- Batch Job 5
- Batch Job 6
- Batch Job 7
- Batch Job 8
- Batch Job 9
- Batch Job 10
- Batch Job 11
- Batch Job 12
- Batch Job 13
- Batch Job 14
- Batch Job 15
- Batch Job 16
- Batch Job 17
- Batch Job 18
- Batch Job 19
- Batch Job 20

File Descriptor

Sample Problem for ROADSEG User's Guide

Retrieve

Cancel

Figure 21. ROADSEG Select Batch Job Menu For Selecting File to View or Print.

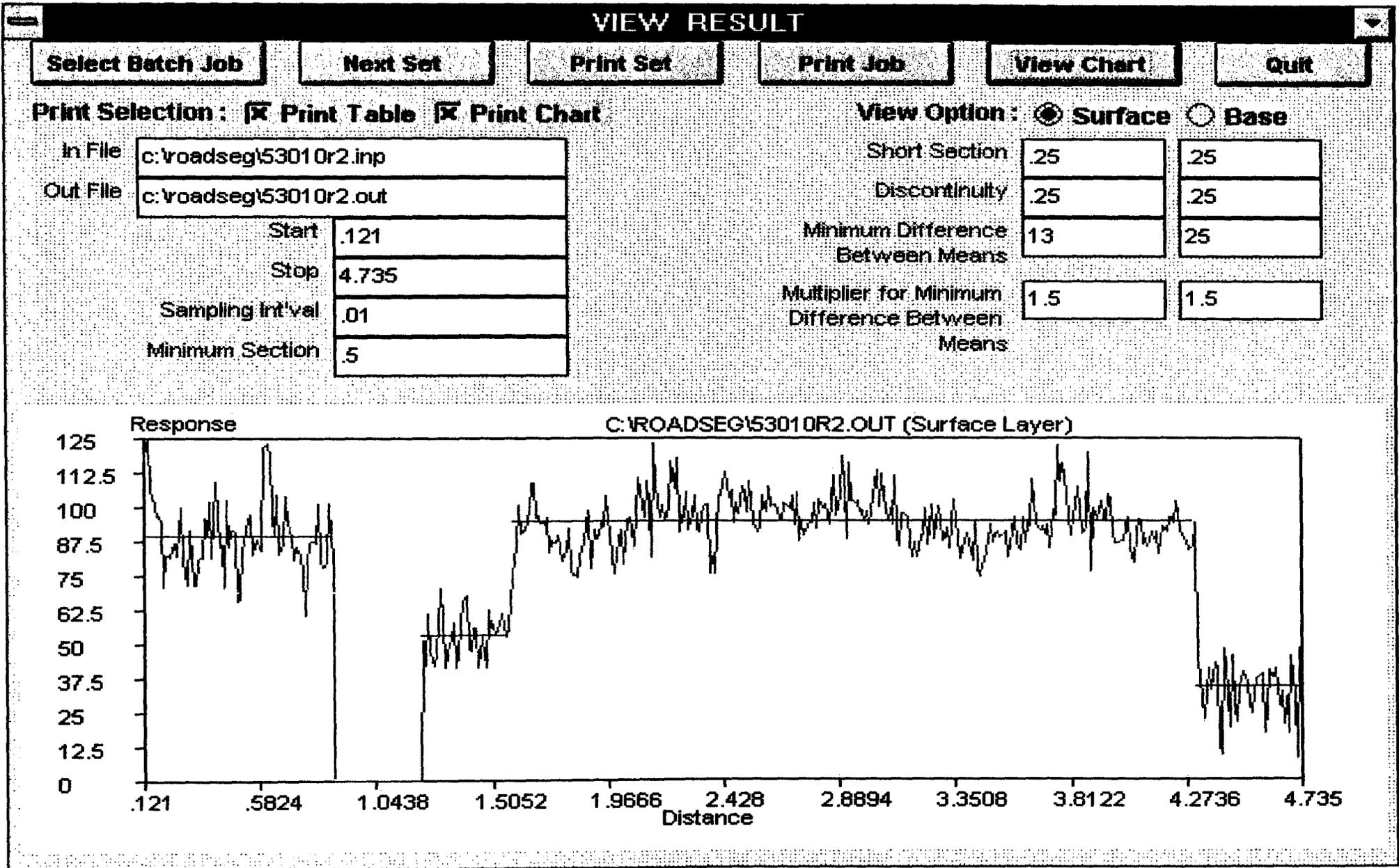


Figure 22. Sample Surface Thickness Plot From View Chart Showing Segmentation.

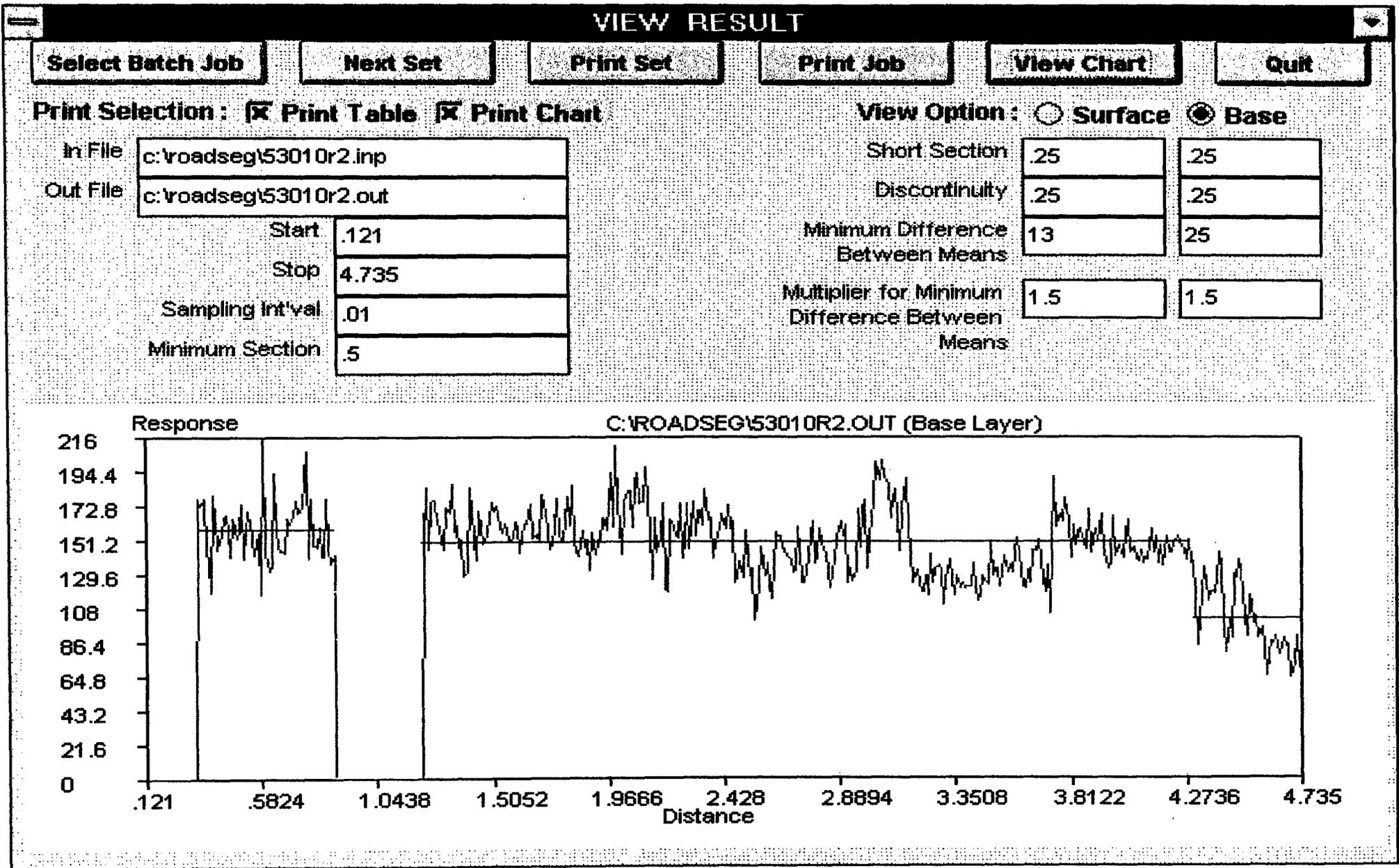


Figure 23. Sample Base Thickness Plot From View Chart Showing Segmentation.

c:\roadseg\53010r2.out

Input file = c:\roadseg\53010r2.inp
 Output file = c:\roadseg\53010r2.out
 Sampling interval = .010
 Minimum section length = .500

Segmentation Based On Surface Thickness

Short section length = .250
 Discontinuity length = .250
 Minimum difference between means = 13.000
 Multiplier for min. diff. between means = 1.500

Sect#	DMI Start	DMI Stop	Mean	Std Dev
1	.121	.872	89.709	13.544
2	.872	1.212	.000	.000
3	1.212	1.571	53.178	7.732
4	1.571	4.303	94.449	9.287
5	4.303	4.735	33.915	14.294

Segmentation Based On Base Thickness

Short section length = .250
 Discontinuity length = .250
 Minimum difference between means = 25.000
 Multiplier for min. diff. between means = 1.500

Sect#	DMI Start	DMI Stop	Mean	Std Dev
1	.121	.321	.000	.000
2	.321	.872	158.025	19.461
3	.872	1.212	.000	.000
4	1.212	4.293	150.134	19.438
5	4.293	4.735	101.287	22.515

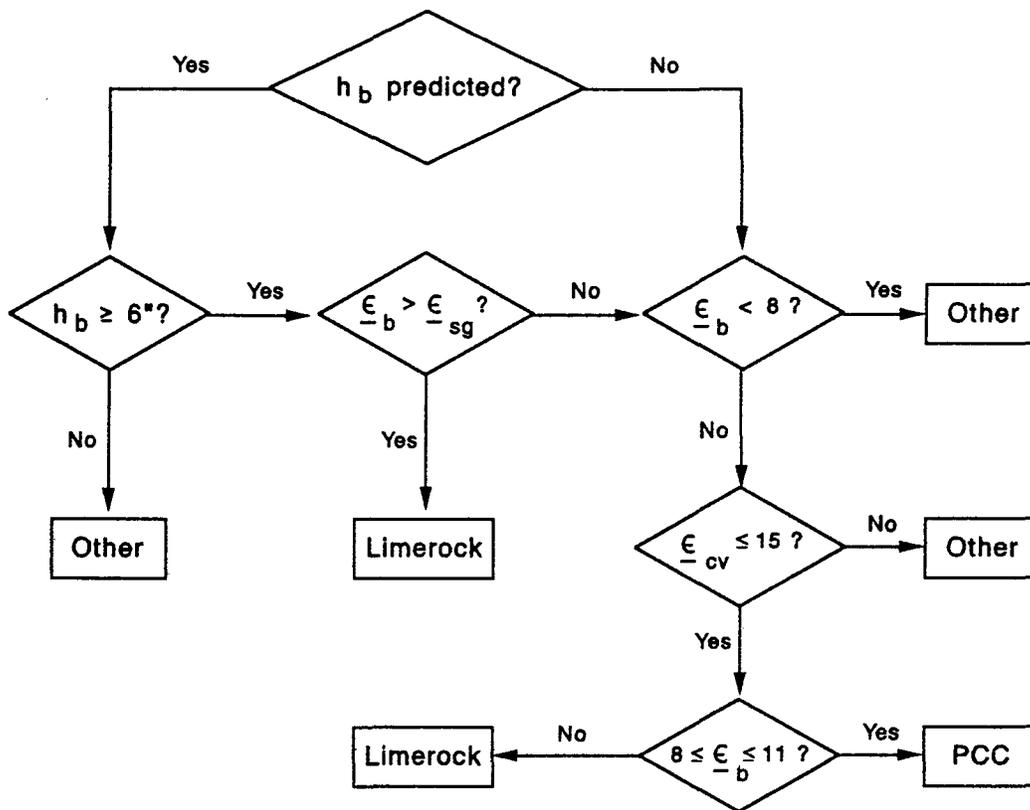
Composite Segmentation

Segment	Begin	End	Thickness (mm)				Base Type
			Average		Std. Dev.		
			Surface	Base	Surface	Base	
1	.121	.321	92.37	.00	15.75	.00	OTHER
2	.321	.872	88.69	158.02	12.62	19.46	OTHER
3	.872	1.212	.00	.00	.00	.00	MISSING
4	1.212	1.571	53.18	160.10	7.73	14.02	PCC
5	1.571	4.293	94.48	148.81	9.29	19.69	OTHER
6	4.293	4.735	35.12	101.29	16.17	22.52	OTHER

Figure 24. Sample Output Table From ROADSEG.

the merging of the delineations using the predicted surface and base thicknesses. Since the output table may consist of several pages, the specified output file name is also printed at the top of each page along with the page number to identify the output.

The composite segmentation in the output table is the final product of radar data processing. For each segment, the variables that are of interest to pavement management are reported. These are the mean and standard deviation of the predicted surface thicknesses; the mean and standard deviation of the predicted base thickness; and the base material type classified into one of the following categories: Limerock, Portland Cement Concrete (PCC) and "Other" base material type. The base classification procedure is based on previous experience with interpreting radar data collected in Phase I and Phase IIA of the FDOT radar project (Fernando, Maser and Dietrich, 1994). From a correlation of radar data with ground truth information on base material type obtained from coring, the base classification chart shown in Figure 25 was developed. As shown in the figure, the variables used in classifying the base are the average predicted base thickness for a given segment, the mean dielectric constants of the base and the subgrade, and the spatial variability of the base dielectric constant as measured by its coefficient of variation. The base type is printed as "Missing" for a given segment if the information needed to classify the base are not available. The results from the composite segmentation can be merged with FDOT's PCS data base to associate layer thickness information and base type identification with the PCS segments. For this purpose, the results are also saved to a disk file with the same name as the specified output file for a given run but with an extension of "TXT" to denote a text file. Thus, for the example output shown in Figure 24, the corresponding text file will be named, "C:\ROADSEG\53010R2.TXT." Figure 26 shows the contents of this sample text file as viewed using the Notepad editor available in Windows. For a given record in the file, the following data are written: 1. an 8-character Roadway ID; 2. beginning milepost for a segment; 3. ending milepost for a segment; 4. roadway side; 5. lane designation following the Florida DOT coring guidelines; 6. date of radar survey; 7. average surface thickness for a given segment; 8. average base thickness for a given segment; 9. predicted base type for a given segment; 10. standard deviation of the predicted surface thicknesses for a given segment; and 11. standard deviation of the predicted base thicknesses for a given segment.



Notes:

h_b - Average predicted base thickness

ϵ_b - Average predicted base dielectric constant

ϵ_{sg} - Average predicted dielectric constant of subgrade or layer beneath the base

ϵ_{cv} - Coefficient of variation of predicted base dielectric constants

Figure 25. Base Classification Chart (Fernando, Maser and Dietrich, 1994).

Notepad - 53010R2.TXT											
File	Edit	Search	Help								
53010000	.121	.321	R R2	10/13/92	92.37	.00	OTHER	15.75	.00		
53010000	.321	.872	R R2	10/13/92	88.69	158.02	OTHER	12.62	19.46		
53010000	.872	1.212	R R2	10/13/92	.00	.00	MISSING	.00	.00		
53010000	1.212	1.571	R R2	10/13/92	53.18	160.10	PCC	7.73	14.02		
53010000	1.571	4.293	R R2	10/13/92	94.48	148.81	OTHER	9.29	19.69		
53010000	4.293	4.735	R R2	10/13/92	35.12	101.29	OTHER	16.17	22.52		

Figure 26. Sample Text File of Composite Segmentation From ROADSEG.

REFERENCES

1. AASHTO Guide For Design of Pavement Structures, 1986. American Association of State Highway and Transportation Officials, Washington, D. C.
2. Fernando, E. G., and Chua, T., 1993. Development of a Procedure for Route Segmentation Using Predicted Layer Thicknesses From Radar Measurements. Florida DOT State Project 99700-7550, Phase IIA Report, Texas Transportation Institute, Texas A&M University, College Station, Texas.
3. Fernando, E.G., and Chua, T., 1994. Development of a Route Segmentation Procedure Using Predicted Layer Thicknesses From Radar Measurements. *Proceedings*, Fifth International Conference on Ground Penetrating Radar, Vol. 1, Ontario, Canada, pp. 335-349.
4. Fernando, E. G., Maser, K., and Dietrich, B., 1994. Implementation of Ground Penetrating Radar for Network-Level Pavement Evaluation in Florida. *Proceedings*, Fifth International Conference on Ground Penetrating Radar, Vol. 1, Ontario, Canada, pp. 351-365.

NOTES