AHTD TRC TRANSPORTATION RESEARCH COMMITTEE

TRC0209

Improvements to ROADHOG Overlay Design Program

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Final Report

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FINAL REPORT

TRC-0209

Improvements to the ROADHOG Overlay Design Program

by

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Improvements to the ROADHOG Overlay Design Program

EXECUTIVE SUMMARY

The ROADHOG overlay design system and associated computer program has been used by the Arkansas State Highway and Transportation Department (AHTD) for the design of flexible pavement overlays. The program is based on the results of research conducted for AHTD and has been through two modifications since its original inception. While the technical aspects of the program continued to meet expectations, the program itself needed updating. AHTD acquired a new falling weight deflectometer (FWD) in the 1990s, which uses a file format that is not compatible with the original version of ROADHOG. In addition, the original ROADHOG software was written in a DOS-based computer language that would not run consistently on Windows-based personal computers. Finally, a revision could provide additional features to assist designers with overlay designs and provide researchers an opportunity to re-investigate some of the basic relationships underlying the computational algorithms contained in ROADHOG.

The two primary global objectives for the proposed research included completely upgrading the existing ROADHOG computer program into an Excel based, interactive system; the second involved incorporating identified improvements to the existing ROADHOG system. In general, all project objectives were met. The ROADHOG system was programmed into Microsoft™ EXCEL® for ease of use. A new, more streamlined equation was developed for estimating the effective structural number of an existing flexible pavement. The sensitivity of ROADHOG to the (required) input of existing pavement thickness was evaluated; it appears that a one-inch difference in input existing pavement thickness results in a difference in recommended overlay thickness ranging from 0.05 to 0.2 inches. Comparisons to the ELMOD system indicated that ROADHOG continues to provide reasonable overlay thicknesses comparable to those provided by the ELMOD “basin fit” procedure. A user’s guide for ROADHOG was developed to aid designers in using the Excel based system.

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CHAPTER ONE

Problem Statement

The ROADHOG overlay design system and associated computer program is currently used by the Arkansas State Highway and Transportation Department (AHTD) for the design of flexible pavement overlays. The program is based on the results of research conducted for AHTD (TRC-8705, TRC-9403) and has been through two modifications since its original inception. While the technical aspects of the program continued to meet expectations, the program itself needed updating.

AHTD acquired a new falling weight deflectometer (FWD) in the 1990s, which uses a file format that is not compatible with the original version of ROADHOG. This incompatibility necessitated an update of the software so that it can read both the data file generated by the new FWD and the files previously collected by the “old” FWD. Also, the original software was written in a DOS-based computer language that would not run consistently on Windows-based personal computers. Finally, a revision could provide additional features to assist designers with overlay designs. In addition to updates of the software, Project TRC-0209 also provided researchers an opportunity to re-investigate some of the basic relationships underlying the computational algorithms contained in ROADHOG.

CHAPTER TWO

Project Objectives

There were two primary global objectives for the proposed research. One was to completely upgrade the existing ROADHOG computer program into an Excel based, interactive system. The second was to incorporate any improvements to the existing ROADHOG system, both from a user-defined “operational” perspective, and from a technical design perspective. Specific project objectives included:

- *Ensure specific algorithms used by ROADHOG represent current state-of-the-practice in overlay design*.
- *Incorporate desired features into the ROADHOG computer program*.
- *Completely reprogram the ROADHOG computer system.*
- *Provide user training and design aids to designers.*

In general, all project objectives were met. The ROADHOG system was programmed into Microsoft™ EXCEL® for ease of use. The computational algorithms contained in ROADHOG were examined to ensure they continued to provide consistent, reasonable values for required overlay thickness. After two meetings with AHTD personnel, additional features were incorporated into the ROADHOG spreadsheet. Finally, users were given a demonstration regarding the use of the system at a session held at AHTD headquarters.

CHAPTER THREE

Background

Structural pavement design concepts developed by the American Association of State Highway and Transportation Officials (AASHTO) are based primarily on analyses of data collected at the (then) AASHO road test conducted in Illinois from 1957 to 1961. These concepts were first published for routine use by designers in the 1972 *AASHO Interim Guide for the Design of Pavement Structures*. ***(1)*** The 1972 Guide, however, did not include information relating to the design of overlays (overlays were not included in the original AASHO road test).

A completely updated and revised AASHTO *Guide* was published in 1986. ***(2)*** The 1986 *Guide* did include some design information relating to structural overlays, but did not include specific procedures to be followed by designers. Recognizing this, the Arkansas State Highway and Transportation Department (AHTD) sponsored research project TRC-8705, "NDT Overlay Design", conducted by the Dept. of Civil Engineering at the University of Arkansas. ***(3)*** The goal of the research was to develop a comprehensive design procedure for flexible overlays of existing flexible pavements, based on surface deflection data generated by the falling weight deflectometer (FWD). The two major technical achievements of TRC-8705 were methods for estimating the effective structural number of an existing flexible pavement system (SN_{eff}) and for estimating the *in-situ* resilient modulus of the subgrade soil underlying the structure (M_R). These two methodologies developed by the researchers were actually departures from the analyses suggested in the 1986 *Guide*. Complete descriptions of the specific procedures used by ROADHOG are available elsewhere. ***(3,4)***

The final product of TRC-8705 was ROADHOG, a computer-based flexible pavement overlay design procedure incorporating all necessary analyses related to AASHTO structural pavement design. ***(4)*** The ROADHOG program was written in a compiled, executable database language to allow for the handling of large amounts of FWD deflection data. ***(5)*** After a period of comparative analyses with the then-existing overlay designs used by AHTD, ROADHOG was implemented by AHTD for routine use.

Amid advances in pavement design technology and the growing need for rehabilitation strategies for existing, deteriorating pavement structures, AASHTO published an updated version of its *Guide* in 1993. ***(6)*** The 1993 *Guide* included full procedures for the design of overlays of both flexible and rigid existing structures. To ensure ROADHOG provided overlay designs consistent to those provided by the procedures detailed in the 1993 *Guide*, AHTD sponsored research project TRC-9403, "Reliability and Design Procedure Revisions of ROADHOG". The analyses conducted under TRC-9403 confirmed that ROADHOG indeed provided overlay designs comparable to, and in many cases preferable to, those provided by the "new" AASHTO procedures in the 1993 *Guide*. Complete details of the comparisons are available elsewhere. ***(7,8)***

While TRC-9403 confirmed the efficacy of the ROADHOG procedure, the computer program itself was not updated to operate fully in a WINDOWS computing environment. At that time, the program performed its functions adequately, and a complete re-programming was felt to be beyond the scope of the research project in terms of time and available funds. Continued advances in computing have rendered the original ROADHOG system increasingly obsolete. Thus, a complete re-programming of ROADHOG is needed. During the re-programming process, algorithms contained in ROADHOG should be re-evaluated to ensure ROADHOG continues to provide reasonable, consistent recommendations for overlay thickness.

CHAPTER FOUR

Research Approach

Programming

The research team decided, in conjunction with AHTD, that the best approach to providing a user-friendly version of ROADHOG was to program the procedure into EXCEL® via embedded macros. This way, the user is free to manipulate required overlay thickness for each FWD result as needed in a spreadsheet environment. It was anticipated that AHTD personnel would develop relatively “standardized” reporting and data plotting formats for overlay data. Such an approach greatly reduced the complexity of the re-programming by taking out generic data reporting routines.

After experimenting with a variety of methods to “launch” ROADHOG from within a spreadsheet, it was decided to include the ROADHOG modules in a pull-down menu placed in the menu bar of EXCEL®. Figure 1 shows the pull-down menu containing ROADHOG.

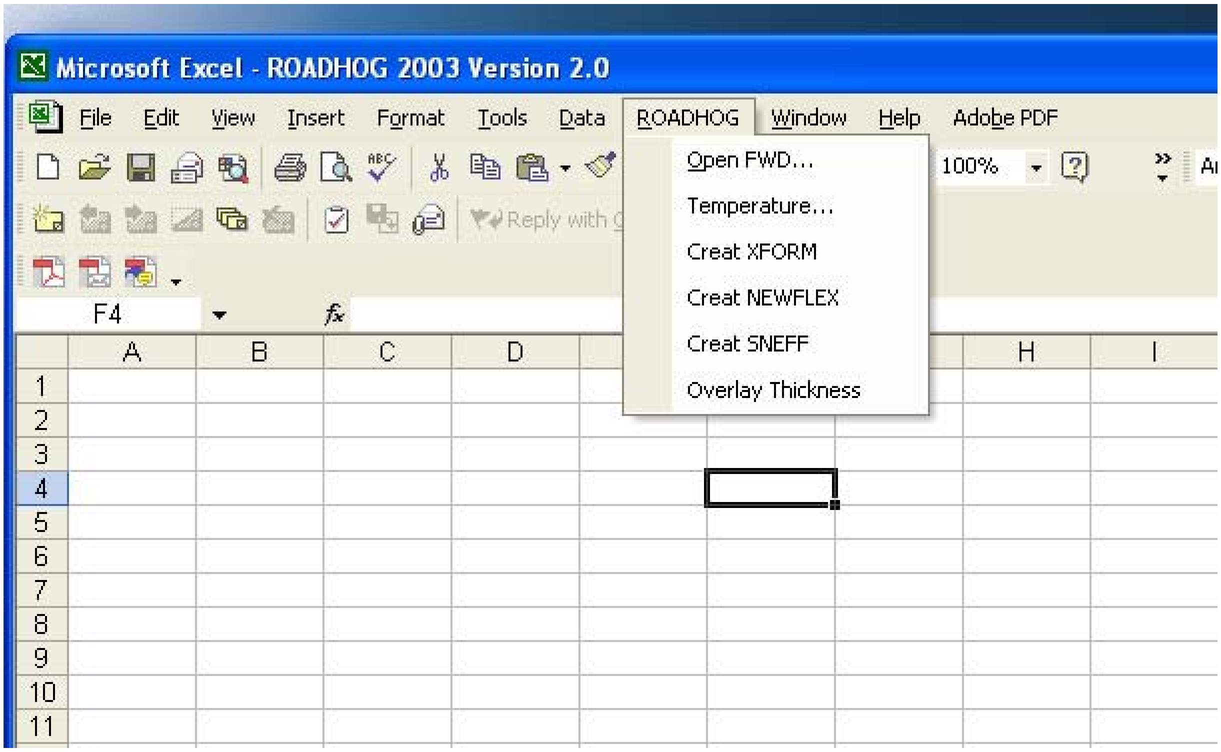

Figure 1. ROADHOG Pull-Down Menu

By using a pull-down menu approach, the ROADHOG program remains “modular” in format – that is, at any time a single module of the program can be updated with little to no effect on the operation as a whole. The user simply follows the menu options downward in order to complete a design. Specific procedures to be followed for each option on the main pull-down menu are contained in Appendix A, Implementation Report.

Procedure Upgrades

Specific algorithms contained in the original ROADHOG program source code were re-evaluated prior to programming within macros. In some cases, computational algorithms and procedures were improved (see Chapter 5). In all cases, dialog boxes containing user prompts were re-envisioned.

Literature relating to procedures followed in the overlay design process was scrutinized for new and/or improved design approaches. It is noted that a thorough evaluation of the ROADHOG system relative to procedures contained in the most current AASHTO pavement design guide (1993) was performed in TRC-9403. ***(7,8)*** AASHTO-based flexible pavement overlay procedures have not significantly changed since that evaluation. Most new approaches in overlay design are related to *mechanistic* design concepts – the modeling of stresses and strains in the pavement structure, and subsequently relating these stresses and strains to pavement performance. It was beyond the scope of this project to develop and/or include mechanistic design concepts in the ROADHOG system.

One area related to FWD deflection-based procedures scrutinized by the research team involved temperature corrections of field deflections. An extensive study carried out in North Carolina recommended guidelines for correcting FWD deflections based on pavement temperature. ***(9)*** However, the amount and type(s) of data required to accomplish the recommended corrections is not routinely measured by AHTD personnel during deflection surveys. The research team decided to continue with the temperature correction originally developed for ROADHOG by Kong in TRC-8705. ***(3)***

CHAPTER FIVE

Design Algorithm Modifications and Investigations

In the process of reprogramming design algorithms used in the ROADHOG system into EXCEL® macros, equations were examined for accuracy and consistency. As a result, some adjustments to ROADHOG calculation procedures were made. The sections that follow detail these investigations and adjustments.

Deflection / Effective Structural Number Relationship

The centerpiece of the ROADHOG procedure -- the specific algorithm that is unique to ROADHOG – is the methodology used to estimate the effective structural number of the existing flexible pavement structure (SN_{eff}). The concept was originally developed by Kong. ***(10)*** The effective structural number of the existing pavement is related to *Delta-D,* the difference between the FWD surface deflection measured directly under the load (the maximum deflection, d_0) and the deflection measured at a distance from the applied load equal to the thickness of the pavement structure, t (d_t). Figure 2 illustrates the Delta-D concept.

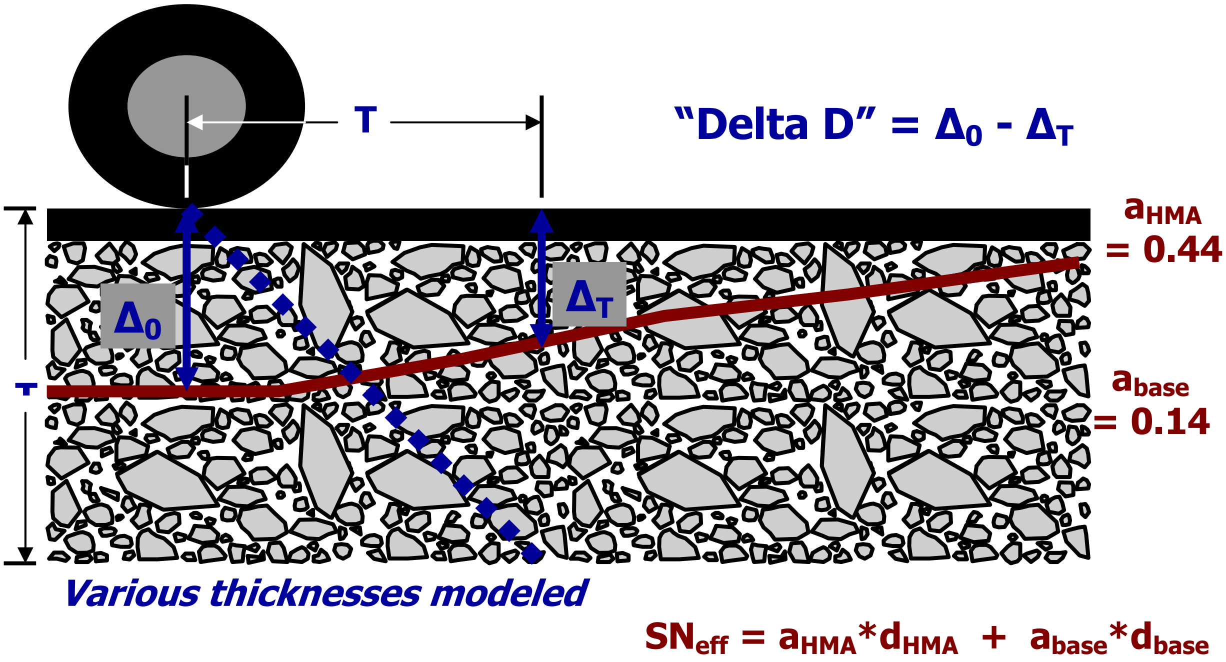

Figure 2. Effective Structural Number "Delta D" Concept

The SN_{eff} approach used in ROADHOG requires the existing pavement structure thickness to be known, or closely estimated. The SNEFF module contained in ROADHOG contains three equations relating SN_{eff} and Delta-D originally developed by Kong. ***(10)*** These three equations represent total existing pavement structure thicknesses of 8, 12, and 24 inches. Existing pavement structures with thicknesses different than these three require interpolation in the module. For example, a pavement structure of 10 inches requires the SN_{eff} to be determined for both the 8-inch and 12-inch relationship, and interpolated for the given 10-inch thickness.

Each of Kong's relationships was originally programmed into ROADHOG using 4th-order polynomial equations, which gave the "best fit" to the data. ***(4)*** However, in testing the equations after being placed into macro-based modules for this project using field FWD files supplied by AHTD, it was noted that for certain FWD results a very erroneous SN_{eff} was obtained. Additional investigation revealed that, due to the nature of a polynomial equation, large values of Delta-D caused the equation to produce errors, as shown in Figure 3.

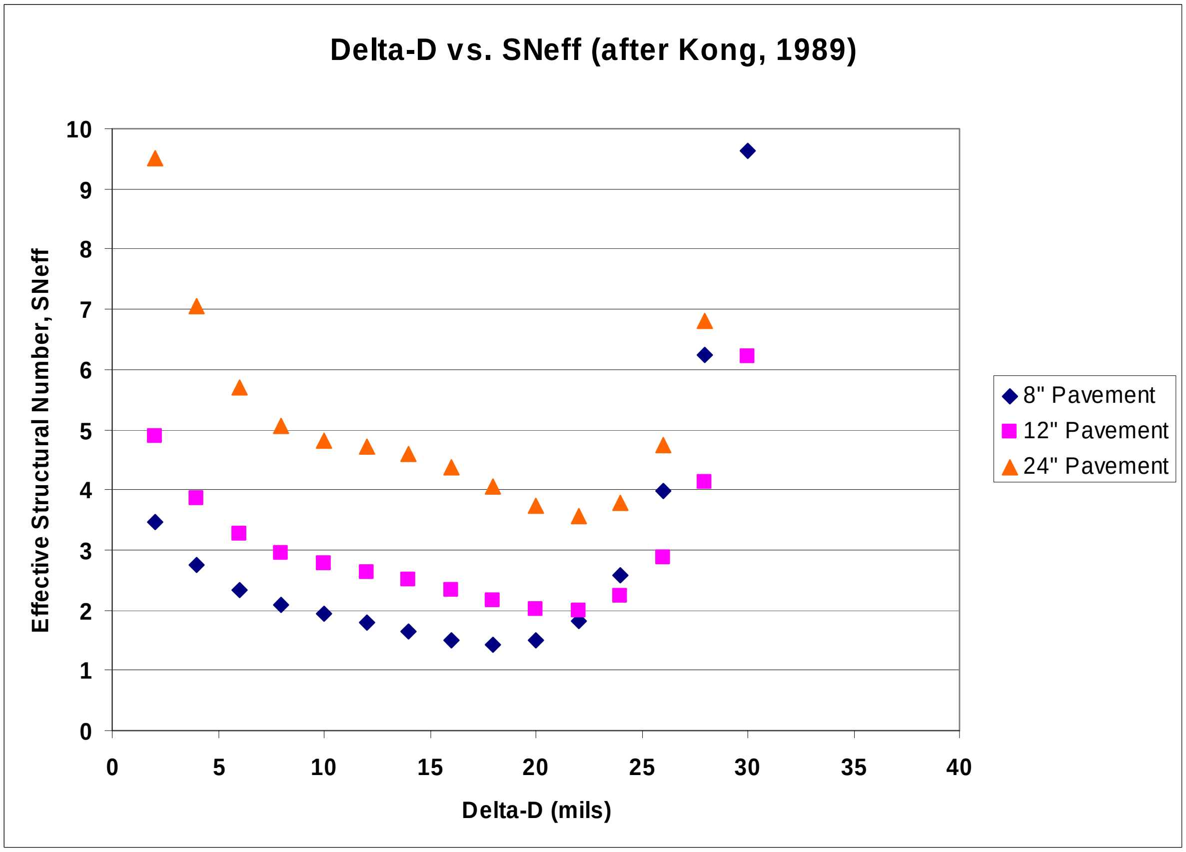

Figure 3. Delta-D / SN_{eff} Relationship (after Kong, 1989)

As shown in Figure 3, the equation used to represent Kong's Delta-D / SN_{eff} relationship contains an inflection point at Delta-D values between 20 and 25 mils (one mil is equal to 1/1000 inch). Therefore, large values of Delta-D result in erroneous SN_{eff} values.

To solve the issue illustrated in Figure 3, new equations were developed to represent Kong's original data. Figure 4 shows Delta-D / SN_{eff} curves generated using the new equations.

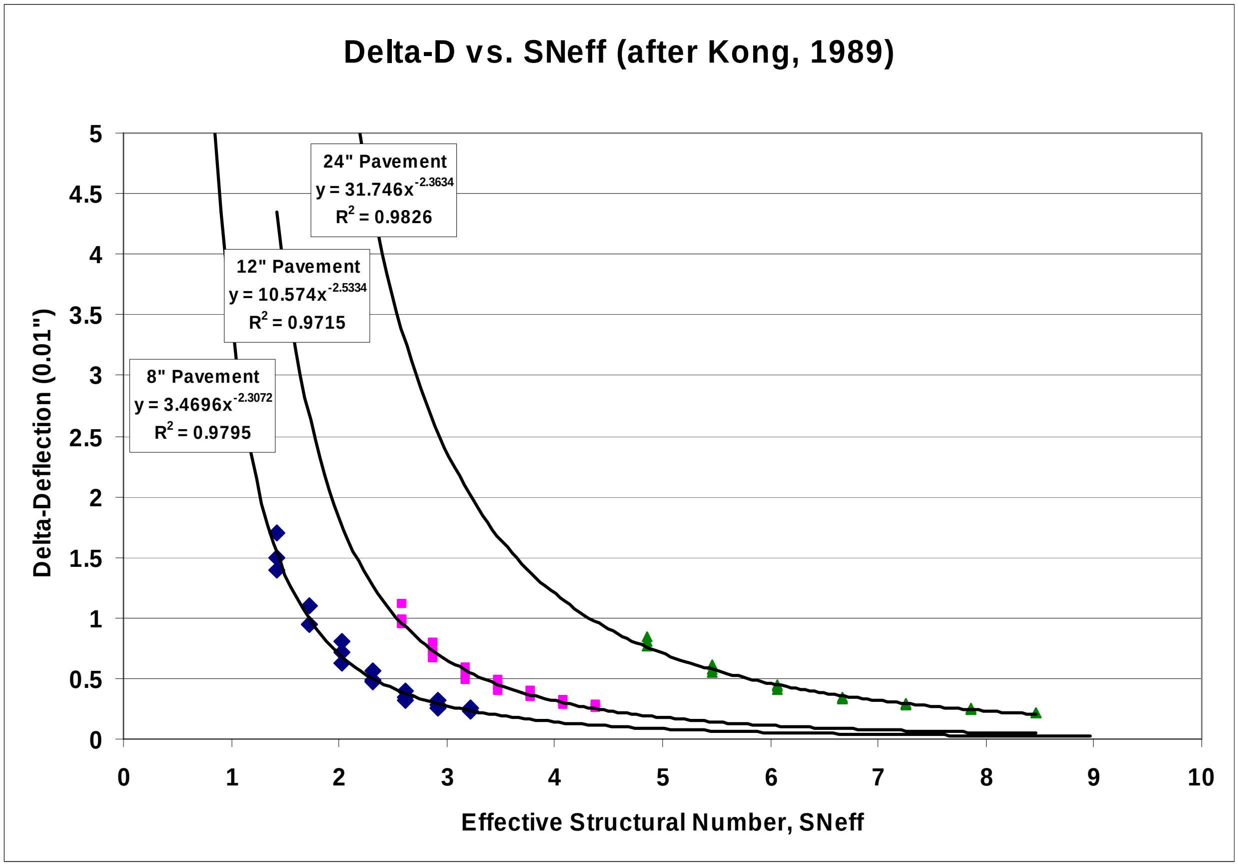

Figure 4. Improved Delta-D / SN_{eff} Relationships

It is noted that in Figure 4, the "x" and "y" axes have been reversed from those shown in Figure 3. The equations shown in Figure 4 were proven valid for any value of Delta-D. One problem remained, however. Implementation of the equations shown in Figure 4 would still require the interpolation of SN_{eff} for existing pavement thicknesses different than those shown – 8, 12, and 24 inches. The interpolation used in ROADHOG is linear; that is, it is assumed that the SN_{eff} value for existing pavement thicknesses between those shown in Figure 4 is linearly related to those values for which SN_{eff} is known. It is obvious from the curves shown in Figure 4 that an assumption of linearity is a simplification.

Additional analyses of Kong's original Delta-D / SN_{eff} data led to the development of a single equation that incorporates any given existing pavement thickness. Figure 5 shows the equation and resulting curves in relation to Kong's data. It is apparent from Figure 5 that the new equation is adequate to describe the Delta-D / SN_{eff} relationship. The equation shown in Figure 5 is reproduced as Equation 1, and is now included in ROADHOG.

$$SN_{eff} = 0.3206\,(Delta\ D)^{-0.42}\,(Pavement\ Thickness)^{0.8175} \qquad Eq.\ 1$$

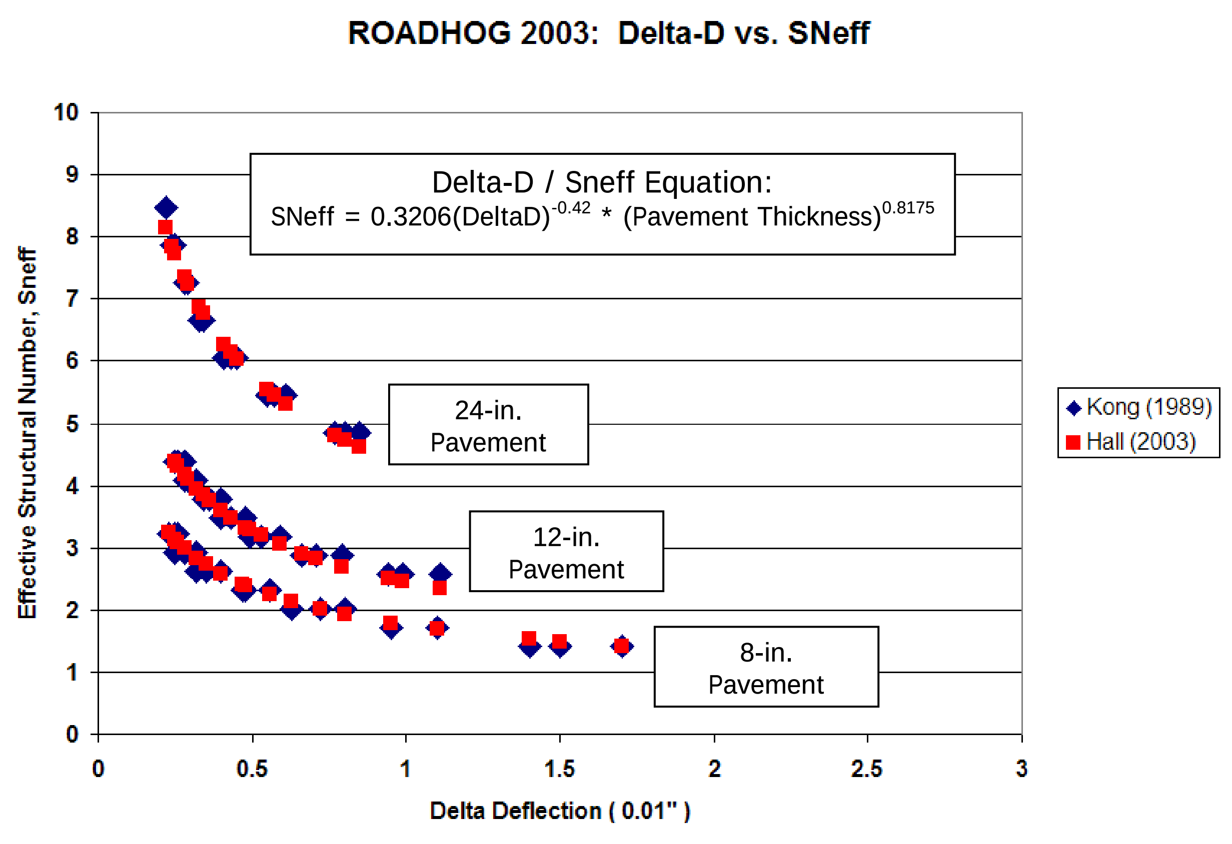

Figure 5. New ROADHOG Delta-D / SN_{eff} Relationship

ROADHOG Overlay Thickness Sensitivity

The ROADHOG overlay design procedure is primarily deflection based; that is, most inputs into the design procedure are calculated using pavement surface deflections obtained using the falling weight deflectometer (FWD). The NEWFLEX module does require the designer to input AASHTO new flexible pavement design variables: Traffic, Reliability, Standard Deviation, and Delta PSI (for in-depth discussions of these inputs refer to the AASHTO Guide ***(6)***). The Arkansas State Highway and Transportation Department (AHTD) provides guidance for selecting these inputs. ***(11)***

Additional designer inputs are required by the SNEFF module – total pavement structure thickness and total thickness of the hot-mix asphalt (ACHM) layers (surface, base, and binder courses). In many cases these values are known; in other cases pavement thickness is only estimated. AHTD provided a field FWD file for Job No. 110384, Route 49, Section 10, located in Phillips County. The nominal measured pavement thickness on site was determined to be approximately twelve inches, including approximately six inches of ACHM. A number of design "runs" were performed with ROADHOG 2003, using various pavement and ACHM thickness values within the SNEFF module. All other inputs were held constant. Figure 6 is a plot of required overlay thickness versus ACHM thickness for Job 110384.

Of primary interest in Figure 6 is the slope(s) of the lines shown that represent various total input pavement thickness values. These slopes range from 0.05 to 0.21; the slope relates to the relative sensitivity of the required overlay thickness to the input ACHM thickness. For this job, underestimating the ACHM thickness (in the SNEFF input) by one inch could result in underestimating the required overlay thickness by 0.05 to 0.2 inches. Thus, in order to ensure the required overlay thickness remains within about one-half inch of the "true" required overlay thickness (the overlay thickness which would result from using a precise, known measurement of pavement layer thicknesses) a designer would need to estimate total and ACHM thicknesses within about two inches.

The relative sensitivity of ROADHOG-generated overlay thickness values shown in Figure 6 are typical for most of the jobs provided by AHTD. In general, overestimating or underestimating ACHM thickness in the SNEFF module by one inch may result in over- or underestimating required overlay thickness by up to one-quarter inch.

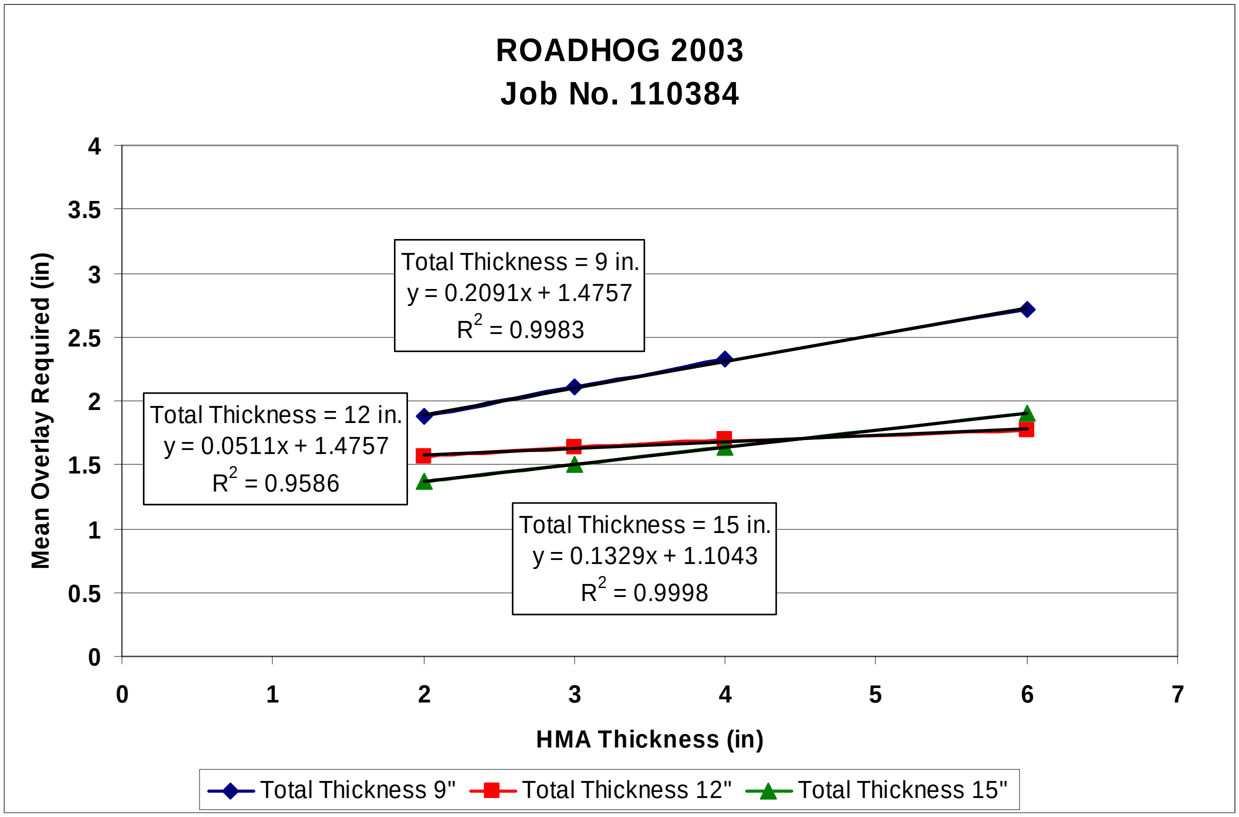

Figure 6. Sensitivity of Overlay Thickness to Pavement / ACHM Thickness (Job 110384)

ROADHOG versus ELMOD

Four overlay design projects were provided by AHTD to perform a comparison between the ROADHOG design procedure and the ELMOD (Elastic Layer Method Overlay Design) procedure. Routine use of ROADHOG was discontinued due to difficulties running the software on Windows-based computers, and deflection-based overlay design analyses have subsequently been performed using ELMOD. The comparison is based on overlay thickness values obtained from ELMOD when performed using the 'deflection basin fit' protocol. Traffic inputs and pavement layer thicknesses used in ROADHOG were taken from the ELMOD output files. Table 1 lists the projects used in the comparison. Figure 7 shows the comparison of overlay thickness values.

Job No.	Route	Section	County	Total Thickness (in)	ACHM Thickness (in)	No. of FWD Observations
050100	36	3	White	10	8	59
110384	49	10	Phillips	12	6	229
110337	64	17	Crittenden	13	7	108
R60032	70	8	Garland	15	7.5	66

Table 1. Projects Used for ROADHOG / ELMOD Comparison

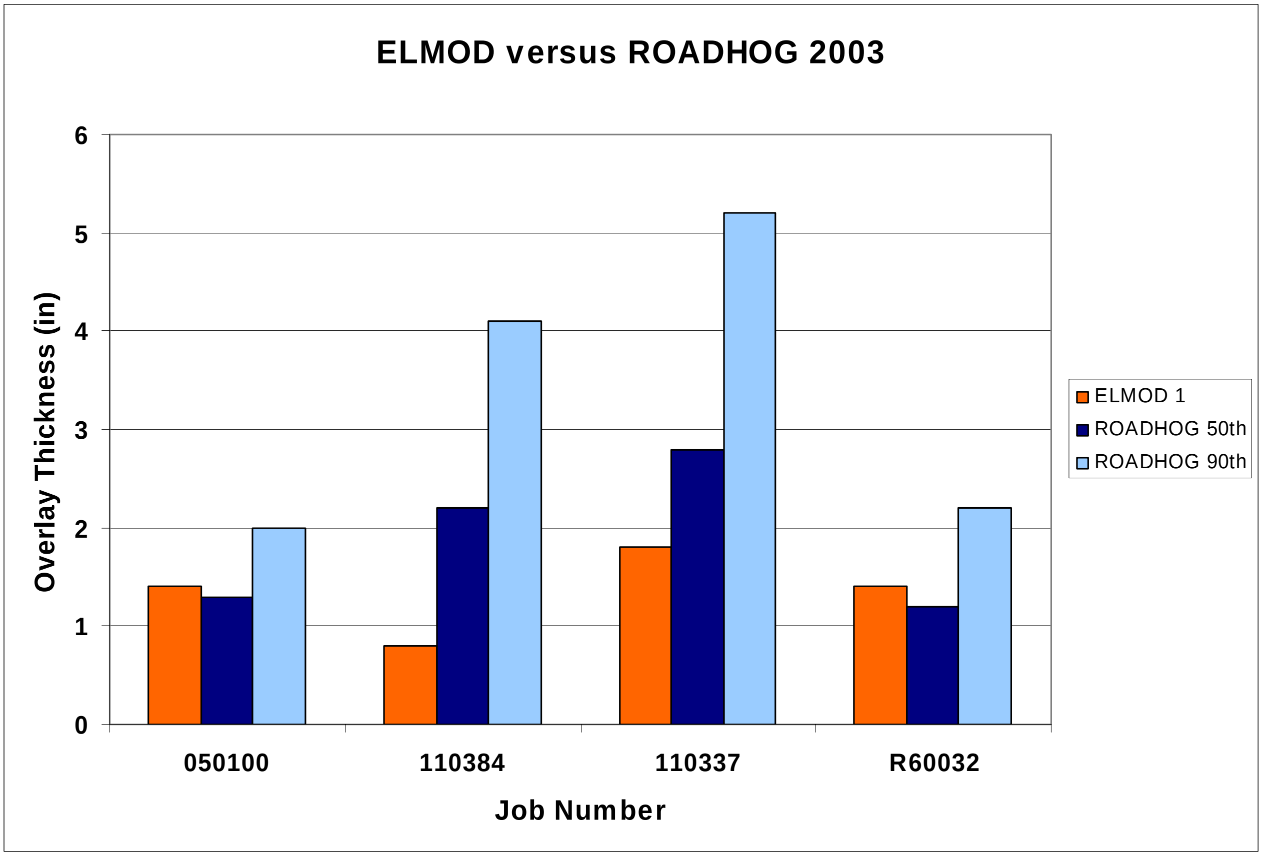

Figure 7. Overlay Thickness Comparison – ROADHOG versus ELMOD

Figure 7 shows a mixed-bag of results. A comparison of ELMOD results with the 50th Percentile (average) ROADHOG results suggests the two procedures provide similar recommendations regarding overlay thickness. However, the ELMOD results shown represent a 90th Percentile value. A comparison of ELMOD results with the 90th Percentile ROADHOG values indicates that ROADHOG recommends a higher overlay thickness for all jobs shown – yet it must be noted that the “average” (50th Percentile) ROADHOG result is typically used for design. Reiterating the first observation, it appears that ROADHOG provides a similar, if not only slightly more conservative, recommended overlay thickness than does ELMOD.

CHAPTER SIX

Conclusions and Recommendations

As stated earlier, all project objectives were generally met. Specific observations, conclusions, and recommendations related to the project are contained in the listing that follows.

- The ROADHOG overlay design system has been programmed into Microsoft™ EXCEL®.
- Design procedures contained in ROADHOG continue to reflect current AASHTO flexible pavement design and rehabilitation principles.
- Specific ROADHOG algorithms related to the estimation of the effective structural number (SN_{eff}) of the existing pavement were upgraded. A new equation was developed and incorporated which includes a direct input of existing pavement thickness – eliminating the need to interpolate results for thicknesses other than 8, 12, and 24 inches.
- The sensitivity of the ROADHOG procedure was evaluated in terms of the accuracy of the existing pavement thickness input. It appears that a change in the existing pavement structure thickness and/or ACHM thickness input of one inch results in an associated change in required overlay thickness ranging from 0.05 to 0.2 inches.
- A comparison of required overlay thickness generated by ROADHOG with thickness generated by ELMOD shows that ROADHOG provides overlay thickness comparable to the “basin fit” ELMOD model (90th percentile value).
- Overall, the ROADHOG procedure may be used with confidence to design ACHM overlays of existing flexible pavements.

An Implementation Report containing a user guide for the ROADHOG system is included in this report as Appendix A.

REFERENCES

1. *Interim Guide for the Design of Pavement Structures*, American Association of State Highway Officials, Washington, D.C., 1972.
2. *AASHTO Guide for the Design of Pavement Structures,* American Association of State Highway and Transportation Officials, Washington, D.C., 1986.
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10. Kong, S.H., "Determination of Effective Structural Number in Flexible Pavement Overlay Design", Master's Thesis, University of Arkansas, Fayetteville, Arkansas, 1987.
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APPENDIX A

IMPLEMENTATION REPORT
ROADHOG User's Manual

ROADHOG User's Manual

The ROADHOG design procedure is contained in macro programming within a Microsoft Excel spreadsheet. This document provides information related to running the ROADHOG program. It does not provide details concerning the theory and concepts behind AASHTO pavement design or specific ROADHOG algorithms. For design concepts, refer to the Project Final Reports for TRC-8705, TRC-9403, and TRC-0209.

This document does not contain detailed instructions regarding the normal file operations associated with the Windows operating environment, nor detailed instructions regarding normal operations associated with Microsoft Excel.

Opening ROADHOG

ROADHOG is started by double-clicking the ROADHOG 2003 Version 2.0 icon – this opens an Excel spreadsheet containing the ROADHOG macro. ROADHOG cannot be started from within the Excel program – it must be started “externally” using the icon.

ROADHOG 2003
Version 2.0

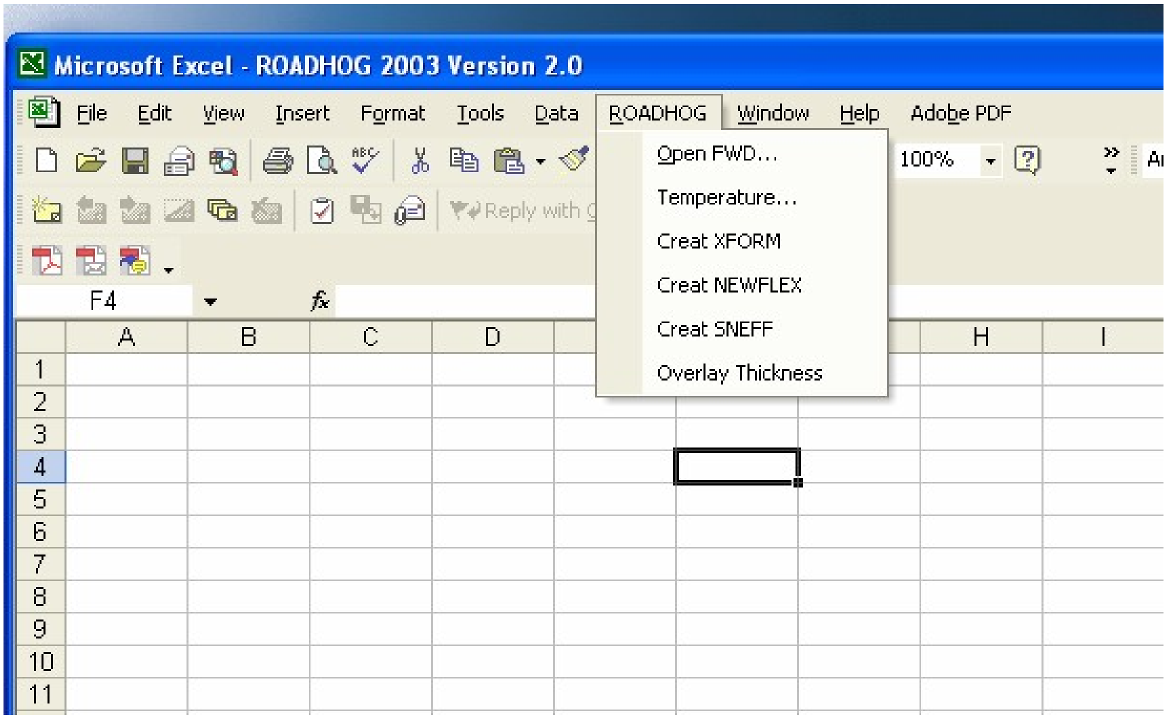
Since ROADHOG is programmed as a macro within Excel, a macro-enable dialog box will appear when the spreadsheet opens. Click the “Enable Macros” button to ensure ROADHOG is available.

Microsoft Excel

C:\Documents and Settings\Administrator\Desktop\ROADHOG 2003 Version 2.0.xls contains macros.

Macros may contain viruses. It is always safe to disable macros, but if the macros are legitimate, you might lose some functionality.

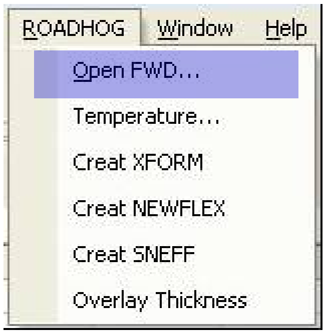
The ROADHOG macro program places a pulldown menu in the main menu bar of Excel. To initiate ROADHOG and access its modules, simply click on the ROADHOG entry in the menu bar. The modules contained in ROADHOG will appear. Clicking on any entry in the pull-down menu will launch that module.

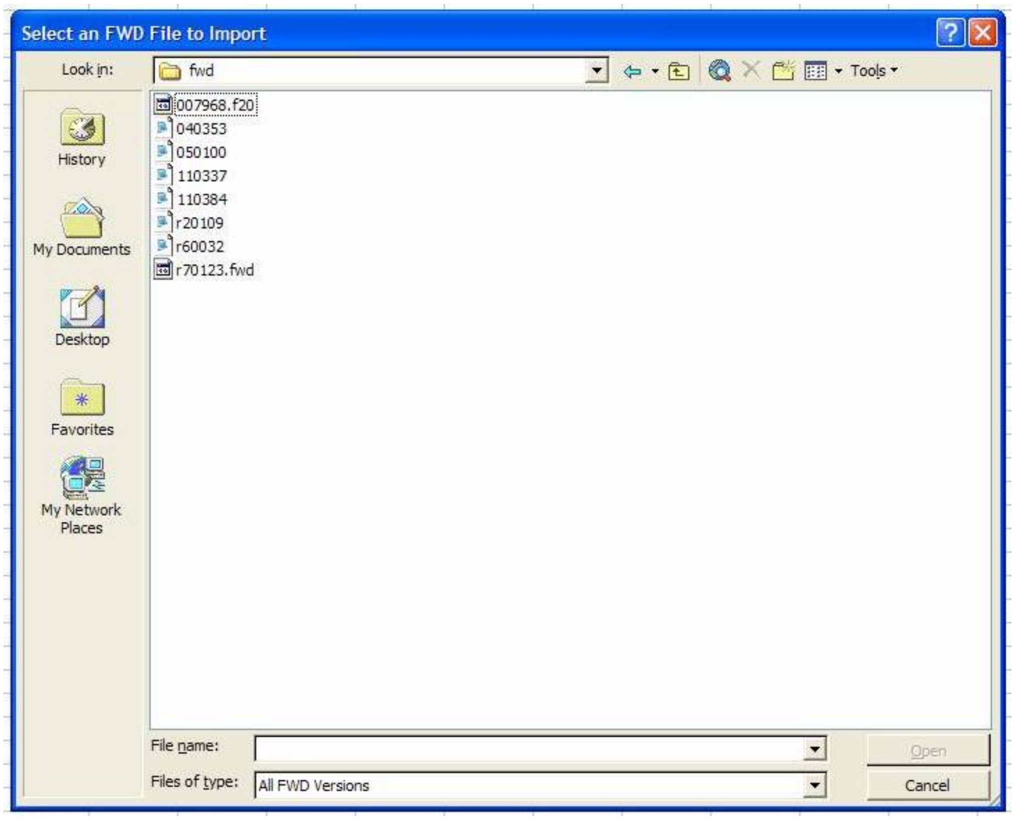


The sections that follow detail the use of each module in ROADHOG.

Importing an FWD File into ROADHOG

- Click on the ROADHOG entry in the Excel menu bar.
- Highlight and click the "Open FWD" entry in the ROADHOG pull-down menu.
- Select the desired FWD file within the file selection dialog box (this box operates identically to any Windows-based program).



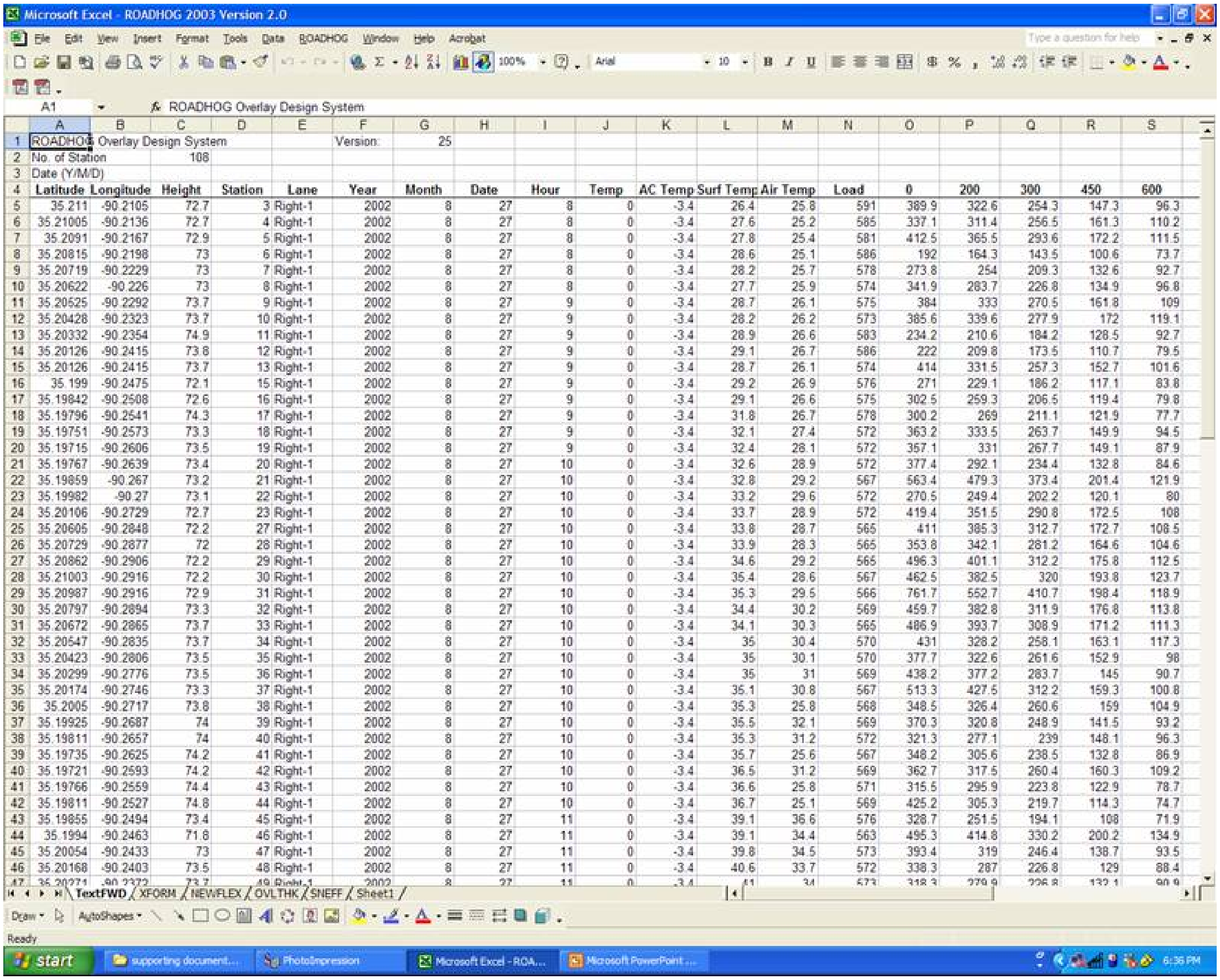


- Once a file has been selected, the user is informed of the FWD version number (15, 20, 25). Click the "OK" button to acknowledge the selection.


Version 25

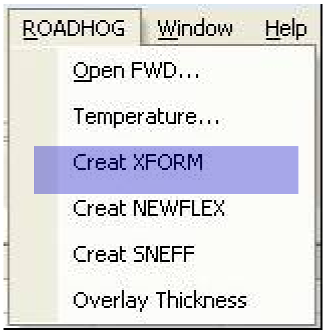
- ROADHOG reads the field FWD file into a spreadsheet. The worksheet TAB (the name of the worksheet, located at the bottom of the worksheet) will read “TextFWD”.

  This file is a delimited text file – it must be transformed into a ROADHOG data file before use.

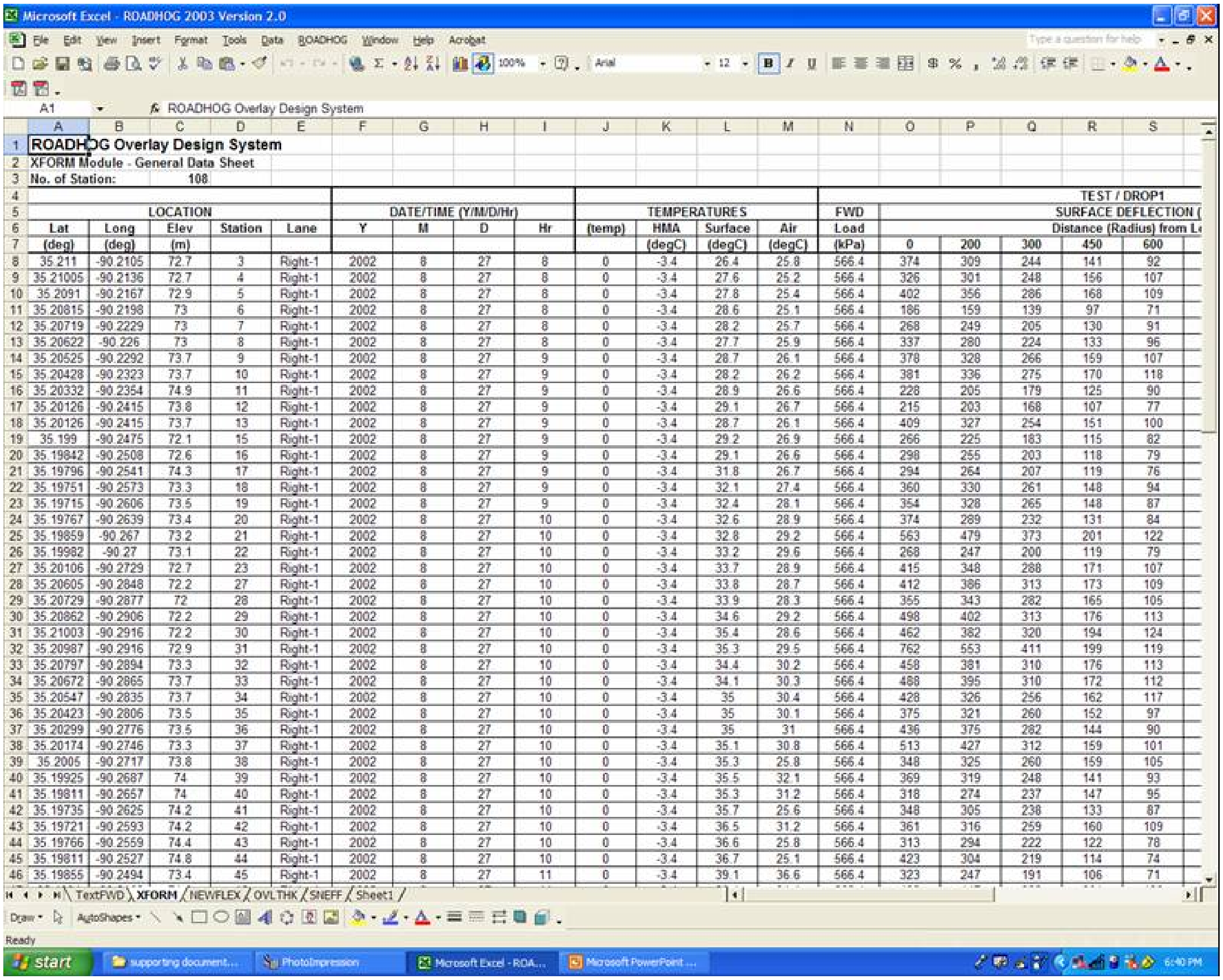


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	ROADHOG Overlay Design System					Version:	25												
2	No. of Station		108																
3	Date (Y/M/D)																		
4	**Latitude**	**Longitude**	**Height**	**Station**	**Lane**	**Year**	**Month**	**Date**	**Hour**	**Temp**	**AC Temp**	**Surf Temp**	**Air Temp**	**Load**	**0**	**200**	**300**	**450**	**600**
5	35.211	-90.2105	72.7	3	Right-1	2002	8	27	8	0	-3.4	26.4	25.8	591	389.9	322.6	254.3	147.3	96.3
6	35.21005	-90.2136	72.7	4	Right-1	2002	8	27	8	0	-3.4	27.6	25.2	585	337.1	311.4	256.5	161.3	110.2
7	35.2091	-90.2167	72.9	5	Right-1	2002	8	27	8	0	-3.4	27.8	25.4	581	412.5	365.5	293.6	172.2	111.5
8	35.20815	-90.2198	73	6	Right-1	2002	8	27	8	0	-3.4	28.6	25.1	586	192	164.3	143.5	100.6	73.7
9	35.20719	-90.2229	73	7	Right-1	2002	8	27	8	0	-3.4	28.2	25.7	578	273.8	254	209.3	132.6	92.7
10	35.20622	-90.226	73	8	Right-1	2002	8	27	8	0	-3.4	27.7	25.9	574	341.9	283.7	226.8	134.9	96.8
11	35.20525	-90.2292	73.7	9	Right-1	2002	8	27	9	0	-3.4	28.7	26.1	575	384	333	270.5	161.8	109
12	35.20428	-90.2323	73.7	10	Right-1	2002	8	27	9	0	-3.4	28.2	26.2	573	385.6	339.6	277.9	172	119.1
13	35.20332	-90.2354	74.9	11	Right-1	2002	8	27	9	0	-3.4	28.9	26.6	583	234.2	210.6	184.2	128.5	92.7
14	35.20126	-90.2415	73.8	12	Right-1	2002	8	27	9	0	-3.4	29.1	26.7	586	222	209.8	173.5	110.7	79.5
15	35.20126	-90.2415	73.7	13	Right-1	2002	8	27	9	0	-3.4	28.7	26.1	574	414	331.5	257.3	152.7	101.6
16	35.199	-90.2475	72.1	15	Right-1	2002	8	27	9	0	-3.4	29.2	26.9	576	271	229.1	186.2	117.1	83.8
17	35.19842	-90.2508	72.6	16	Right-1	2002	8	27	9	0	-3.4	29.1	26.6	575	302.5	259.3	206.5	119.4	79.8
18	35.19796	-90.2541	74.3	17	Right-1	2002	8	27	9	0	-3.4	31.8	26.7	578	300.2	269	211.1	121.9	77.7
19	35.19751	-90.2573	73.3	18	Right-1	2002	8	27	9	0	-3.4	32.1	27.4	572	363.2	333.5	263.7	149.9	94.5
20	35.19715	-90.2606	73.5	19	Right-1	2002	8	27	9	0	-3.4	32.4	28.1	572	357.1	331	267.7	149.1	87.9
21	35.19767	-90.2639	73.4	20	Right-1	2002	8	27	10	0	-3.4	32.6	28.9	572	377.4	292.1	234.4	132.8	84.6
22	35.19859	-90.267	73.2	21	Right-1	2002	8	27	10	0	-3.4	32.8	29.2	567	563.4	479.3	373.4	201.4	121.9
23	35.19982	-90.27	73.1	22	Right-1	2002	8	27	10	0	-3.4	33.2	29.6	572	270.5	249.4	202.2	120.1	80
24	35.20106	-90.2729	72.7	23	Right-1	2002	8	27	10	0	-3.4	33.7	28.9	572	419.4	351.5	290.8	172.5	108
25	35.20605	-90.2848	72.2	27	Right-1	2002	8	27	10	0	-3.4	33.8	28.7	565	411	385.3	312.7	172.7	108.5
26	35.20729	-90.2877	72	28	Right-1	2002	8	27	10	0	-3.4	33.9	28.3	565	353.8	342.1	281.2	164.6	104.6
27	35.20862	-90.2906	72.2	29	Right-1	2002	8	27	10	0	-3.4	34.6	29.2	565	496.3	401.1	312.2	175.8	112.5
28	35.21003	-90.2916	72.2	30	Right-1	2002	8	27	10	0	-3.4	35.4	28.6	567	462.5	382.5	320	193.8	123.7
29	35.20987	-90.2916	72.9	31	Right-1	2002	8	27	10	0	-3.4	35.3	29.5	566	761.7	552.7	410.7	198.4	118.9
30	35.20797	-90.2894	73.3	32	Right-1	2002	8	27	10	0	-3.4	34.4	30.2	569	459.7	382.8	311.9	176.8	113.8
31	35.20672	-90.2865	73.7	33	Right-1	2002	8	27	10	0	-3.4	34.1	30.3	565	486.9	393.7	308.9	171.2	111.3
32	35.20547	-90.2835	73.7	34	Right-1	2002	8	27	10	0	-3.4	35	30.4	570	431	328.2	258.1	163.1	117.3
33	35.20423	-90.2806	73.5	35	Right-1	2002	8	27	10	0	-3.4	35	30.1	570	377.7	322.6	261.6	152.9	98
34	35.20299	-90.2776	73.5	36	Right-1	2002	8	27	10	0	-3.4	35	31	569	438.2	377.2	283.7	145	90.7
35	35.20174	-90.2746	73.3	37	Right-1	2002	8	27	10	0	-3.4	35.1	30.8	567	513.3	427.5	312.2	159.3	100.8
36	35.2005	-90.2717	73.8	38	Right-1	2002	8	27	10	0	-3.4	35.3	25.8	568	348.5	326.4	260.6	159	104.9
37	35.19925	-90.2687	74	39	Right-1	2002	8	27	10	0	-3.4	35.5	32.1	569	370.3	320.8	248.9	141.5	93.2
38	35.19811	-90.2657	74	40	Right-1	2002	8	27	10	0	-3.4	35.3	31.2	572	321.3	277.1	239	148.1	96.3
39	35.19735	-90.2625	74.2	41	Right-1	2002	8	27	10	0	-3.4	35.7	25.6	567	348.2	305.6	238.5	132.8	86.9
40	35.19721	-90.2593	74.2	42	Right-1	2002	8	27	10	0	-3.4	36.5	31.2	569	362.7	317.5	260.4	160.3	109.2
41	35.19766	-90.2559	74.4	43	Right-1	2002	8	27	10	0	-3.4	36.6	25.8	571	315.5	295.9	223.8	122.9	78.7
42	35.19811	-90.2527	74.8	44	Right-1	2002	8	27	10	0	-3.4	36.7	25.1	569	425.2	305.3	219.7	114.3	74.7
43	35.19855	-90.2494	73.4	45	Right-1	2002	8	27	11	0	-3.4	39.1	36.6	576	328.7	251.5	194.1	108	71.9
44	35.1994	-90.2463	71.8	46	Right-1	2002	8	27	11	0	-3.4	39.1	34.4	563	495.3	414.8	330.2	200.2	134.9
45	35.20054	-90.2433	73	47	Right-1	2002	8	27	11	0	-3.4	39.8	34.5	573	393.4	319	246.4	138.7	93.5
46	35.20168	-90.2403	73.5	48	Right-1	2002	8	27	11	0	-3.4	40.6	33.7	572	338.3	287	226.8	129	88.4
47	35.20271	-90.2372	73.7	49	Right-1	2002	8	27	11	0	-3.4	41	34	573	318.3	279.9	226.8	132.1	90.9

Transforming a Field FWD File into a ROADHOG Data File



- Click on the ROADHOG entry in the Excel menu bar.
- Highlight and click the “Creat XFORM” entry in the ROADHOG pull-down menu.



A1 ROADHOG Overlay Design System

ROADHOG Overlay Design System

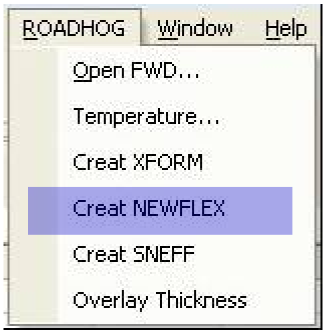
XFORM Module - General Data Sheet

No. of Station: 108

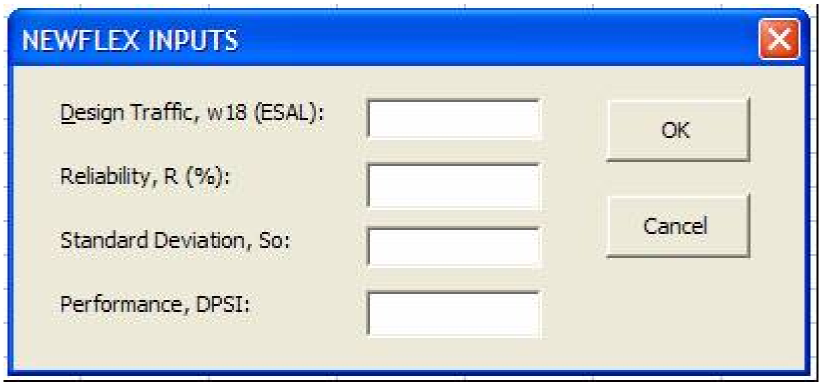
	LOCATION					DATE/TIME (Y/M/D/Hr)				TEMPERATURES				FWD	TEST / DROP1 SURFACE DEFLECTION (Distance (Radius) from L				
	Lat (deg)	Long (deg)	Elev (m)	Station	Lane	Y	M	D	Hr	(temp)	HMA (degC)	Surface (degC)	Air (degC)	Load (kPa)	0	200	300	450	600
8	35.211	-90.2105	72.7	3	Right-1	2002	8	27	8	0	-3.4	26.4	25.8	566.4	374	309	244	141	92
9	35.21005	-90.2136	72.7	4	Right-1	2002	8	27	8	0	-3.4	27.6	25.2	566.4	326	301	248	156	107
10	35.2091	-90.2167	72.9	5	Right-1	2002	8	27	8	0	-3.4	27.8	25.4	566.4	402	356	286	168	109
11	35.20815	-90.2198	73	6	Right-1	2002	8	27	8	0	-3.4	28.6	25.1	566.4	186	159	139	97	71
12	35.20719	-90.2229	73	7	Right-1	2002	8	27	8	0	-3.4	28.2	25.7	566.4	268	249	205	130	91
13	35.20622	-90.226	73	8	Right-1	2002	8	27	8	0	-3.4	27.7	25.9	566.4	337	280	224	133	96
14	35.20525	-90.2292	73.7	9	Right-1	2002	8	27	9	0	-3.4	28.7	26.1	566.4	378	328	266	159	107
15	35.20428	-90.2323	73.7	10	Right-1	2002	8	27	9	0	-3.4	28.2	26.2	566.4	381	336	275	170	118
16	35.20332	-90.2354	74.9	11	Right-1	2002	8	27	9	0	-3.4	28.9	26.6	566.4	228	205	179	125	90
17	35.20126	-90.2415	73.8	12	Right-1	2002	8	27	9	0	-3.4	29.1	26.7	566.4	215	203	168	107	77
18	35.20126	-90.2415	73.7	13	Right-1	2002	8	27	9	0	-3.4	28.7	26.1	566.4	409	327	254	151	100
19	35.199	-90.2475	72.1	15	Right-1	2002	8	27	9	0	-3.4	29.2	26.9	566.4	266	225	183	115	82
20	35.19842	-90.2508	72.6	16	Right-1	2002	8	27	9	0	-3.4	29.1	26.6	566.4	298	255	203	118	79
21	35.19796	-90.2541	74.3	17	Right-1	2002	8	27	9	0	-3.4	31.8	26.7	566.4	294	264	207	119	76
22	35.19751	-90.2573	73.3	18	Right-1	2002	8	27	9	0	-3.4	32.1	27.4	566.4	360	330	261	148	94
23	35.19715	-90.2606	73.5	19	Right-1	2002	8	27	9	0	-3.4	32.4	28.1	566.4	354	328	265	148	87
24	35.19767	-90.2639	73.4	20	Right-1	2002	8	27	10	0	-3.4	32.6	28.9	566.4	374	289	232	131	84
25	35.19859	-90.267	73.2	21	Right-1	2002	8	27	10	0	-3.4	32.8	29.2	566.4	563	479	373	201	122
26	35.19982	-90.27	73.1	22	Right-1	2002	8	27	10	0	-3.4	33.2	29.6	566.4	268	247	200	119	79
27	35.20106	-90.2729	72.7	23	Right-1	2002	8	27	10	0	-3.4	33.7	28.9	566.4	415	348	288	171	107
28	35.20605	-90.2848	72.2	27	Right-1	2002	8	27	10	0	-3.4	33.8	28.7	566.4	412	386	313	173	109
29	35.20729	-90.2877	72	28	Right-1	2002	8	27	10	0	-3.4	33.9	28.3	566.4	355	343	282	165	105
30	35.20862	-90.2906	72.2	29	Right-1	2002	8	27	10	0	-3.4	34.6	29.2	566.4	498	402	313	176	113
31	35.21003	-90.2916	72.2	30	Right-1	2002	8	27	10	0	-3.4	35.4	28.6	566.4	462	382	320	194	124
32	35.20987	-90.2916	72.9	31	Right-1	2002	8	27	10	0	-3.4	35.3	29.5	566.4	762	553	411	199	119
33	35.20797	-90.2894	73.3	32	Right-1	2002	8	27	10	0	-3.4	34.4	30.2	566.4	458	381	310	176	113
34	35.20672	-90.2865	73.7	33	Right-1	2002	8	27	10	0	-3.4	34.1	30.3	566.4	488	395	310	172	112
35	35.20547	-90.2835	73.7	34	Right-1	2002	8	27	10	0	-3.4	35	30.4	566.4	428	326	256	162	117
36	35.20423	-90.2806	73.5	35	Right-1	2002	8	27	10	0	-3.4	35	30.1	566.4	375	321	260	152	97
37	35.20299	-90.2776	73.5	36	Right-1	2002	8	27	10	0	-3.4	35	31	566.4	436	375	282	144	90
38	35.20174	-90.2746	73.3	37	Right-1	2002	8	27	10	0	-3.4	35.1	30.8	566.4	513	427	312	159	101
39	35.2005	-90.2717	73.8	38	Right-1	2002	8	27	10	0	-3.4	35.3	25.8	566.4	348	325	260	159	105
40	35.19925	-90.2687	74	39	Right-1	2002	8	27	10	0	-3.4	35.5	32.1	566.4	369	319	248	141	93
41	35.19811	-90.2657	74	40	Right-1	2002	8	27	10	0	-3.4	35.3	31.2	566.4	318	274	237	147	95
42	35.19735	-90.2625	74.2	41	Right-1	2002	8	27	10	0	-3.4	35.7	25.6	566.4	348	305	238	133	87
43	35.19721	-90.2593	74.2	42	Right-1	2002	8	27	10	0	-3.4	36.5	31.2	566.4	361	316	259	160	109
44	35.19766	-90.2559	74.4	43	Right-1	2002	8	27	10	0	-3.4	36.6	25.8	566.4	313	294	222	122	78
45	35.19811	-90.2527	74.8	44	Right-1	2002	8	27	10	0	-3.4	36.7	25.1	566.4	423	304	219	114	74
46	35.19855	-90.2494	73.4	45	Right-1	2002	8	27	11	0	-3.4	39.1	36.6	566.4	323	247	191	106	71

The XFORM process executes automatically – the TextFWD worksheet is used to create a new worksheet – XFORM – that is formatted for further use in ROADHOG. Note that multiple FWD drops are separated in the XFORM worksheet.

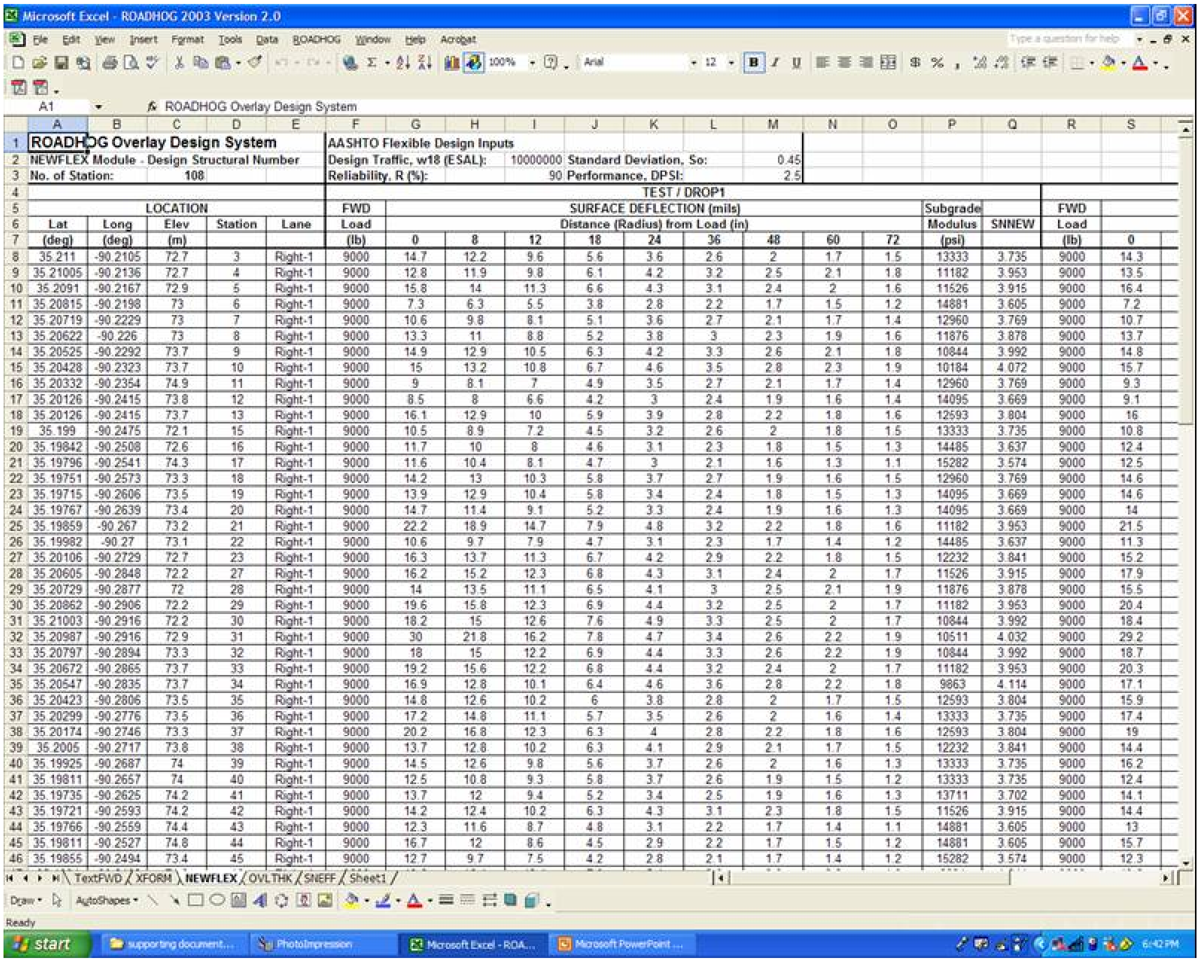
Determination of SN_{future} – New Pavement Design: NEWFLEX Module



- Click on the ROADHOG entry in the Excel menu bar.
- Highlight and click the "Creat NEWFLEX" entry in the ROADHOG pull-down menu.
- Supply pavement design input values in the NEWFLEX dialog box (shown below). Click "OK" in the dialog box to complete the NEWFLEX module.



Values used for pavement design required by the NEWFLEX module are established by the AHTD Roadway Design section. AHTD policy for new pavement design may be found in the AHTD *Roadway Plan Development Guidelines*.



ROADHOG Overlay Design System

NEWFLEX Module - Design Structural Number

No. of Station: 108

AASHTO Flexible Design Inputs

Design Traffic, w18 (ESAL): 10000000 Standard Deviation, So: 0.45

Reliability, R (%): 90 Performance, DPSI: 2.5

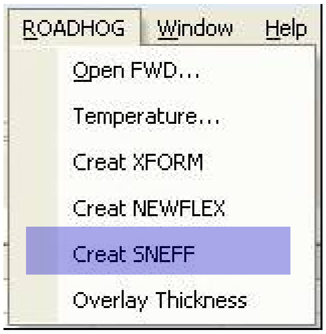
										TEST / DROP1								
LOCATION					FWD	SURFACE DEFLECTION (mils)									Subgrade		FWD	
Lat	Long	Elev	Station	Lane	Load	Distance (Radius) from Load (in)									Modulus	SNNEW	Load	
(deg)	(deg)	(m)			(lb)	0	8	12	18	24	36	48	60	72	(psi)		(lb)	0
35.211	-90.2105	72.7	3	Right-1	9000	14.7	12.2	9.6	5.6	3.6	2.6	2	1.7	1.5	13333	3.735	9000	14.3
35.21005	-90.2136	72.7	4	Right-1	9000	12.8	11.9	9.8	6.1	4.2	3.2	2.5	2.1	1.8	11182	3.953	9000	13.5
35.2091	-90.2167	72.9	5	Right-1	9000	15.8	14	11.3	6.6	4.3	3.1	2.4	2	1.6	11526	3.915	9000	16.4
35.20815	-90.2198	73	6	Right-1	9000	7.3	6.3	5.5	3.8	2.8	2.2	1.7	1.5	1.2	14881	3.605	9000	7.2
35.20719	-90.2229	73	7	Right-1	9000	10.6	9.8	8.1	5.1	3.6	2.7	2.1	1.7	1.4	12960	3.769	9000	10.7
35.20622	-90.226	73	8	Right-1	9000	13.3	11	8.8	5.2	3.8	3	2.3	1.9	1.6	11876	3.878	9000	13.7
35.20525	-90.2292	73.7	9	Right-1	9000	14.9	12.9	10.5	6.3	4.2	3.3	2.6	2.1	1.8	10844	3.992	9000	14.8
35.20428	-90.2323	73.7	10	Right-1	9000	15	13.2	10.8	6.7	4.6	3.5	2.8	2.3	1.9	10184	4.072	9000	15.7
35.20332	-90.2354	74.9	11	Right-1	9000	9	8.1	7	4.9	3.5	2.7	2.1	1.7	1.4	12960	3.769	9000	9.3
35.20126	-90.2415	73.8	12	Right-1	9000	8.5	8	6.6	4.2	3	2.4	1.9	1.6	1.4	14095	3.669	9000	9.1
35.20126	-90.2415	73.7	13	Right-1	9000	16.1	12.9	10	5.9	3.9	2.8	2.2	1.8	1.6	12593	3.804	9000	16
35.199	-90.2475	72.1	15	Right-1	9000	10.5	8.9	7.2	4.5	3.2	2.6	2	1.8	1.5	13333	3.735	9000	10.8
35.19842	-90.2508	72.6	16	Right-1	9000	11.7	10	8	4.6	3.1	2.3	1.8	1.5	1.3	14485	3.637	9000	12.4
35.19796	-90.2541	74.3	17	Right-1	9000	11.6	10.4	8.1	4.7	3	2.1	1.6	1.3	1.1	15282	3.574	9000	12.5
35.19751	-90.2573	73.3	18	Right-1	9000	14.2	13	10.3	5.8	3.7	2.7	1.9	1.6	1.5	12960	3.769	9000	14.6
35.19715	-90.2606	73.5	19	Right-1	9000	13.9	12.9	10.4	5.8	3.4	2.4	1.8	1.5	1.3	14095	3.669	9000	14.6
35.19767	-90.2639	73.4	20	Right-1	9000	14.7	11.4	9.1	5.2	3.3	2.4	1.9	1.6	1.3	14095	3.669	9000	14
35.19859	-90.267	73.2	21	Right-1	9000	22.2	18.9	14.7	7.9	4.8	3.2	2.2	1.8	1.6	11182	3.953	9000	21.5
35.19982	-90.27	73.1	22	Right-1	9000	10.6	9.7	7.9	4.7	3.1	2.3	1.7	1.4	1.2	14485	3.637	9000	11.3
35.20106	-90.2729	72.7	23	Right-1	9000	16.3	13.7	11.3	6.7	4.2	2.9	2.2	1.8	1.5	12232	3.841	9000	15.2
35.20605	-90.2848	72.2	27	Right-1	9000	16.2	15.2	12.3	6.8	4.3	3.1	2.4	2	1.7	11526	3.915	9000	17.9
35.20729	-90.2877	72	28	Right-1	9000	14	13.5	11.1	6.5	4.1	3	2.5	2.1	1.9	11876	3.878	9000	15.5
35.20862	-90.2906	72.2	29	Right-1	9000	19.6	15.8	12.3	6.9	4.4	3.2	2.5	2	1.7	11182	3.953	9000	20.4
35.21003	-90.2916	72.2	30	Right-1	9000	18.2	15	12.6	7.6	4.9	3.3	2.5	2	1.7	10844	3.992	9000	18.4
35.20987	-90.2916	72.9	31	Right-1	9000	30	21.8	16.2	7.8	4.7	3.4	2.6	2.2	1.9	10511	4.032	9000	29.2
35.20797	-90.2894	73.3	32	Right-1	9000	18	15	12.2	6.9	4.4	3.3	2.6	2.2	1.9	10844	3.992	9000	18.7
35.20672	-90.2865	73.7	33	Right-1	9000	19.2	15.6	12.2	6.8	4.4	3.2	2.4	2	1.7	11182	3.953	9000	20.3
35.20547	-90.2835	73.7	34	Right-1	9000	16.9	12.8	10.1	6.4	4.6	3.6	2.8	2.2	1.8	9863	4.114	9000	17.1
35.20423	-90.2806	73.5	35	Right-1	9000	14.8	12.6	10.2	6	3.8	2.8	2	1.7	1.5	12593	3.804	9000	15.9
35.20299	-90.2776	73.5	36	Right-1	9000	17.2	14.8	11.1	5.7	3.5	2.6	2	1.6	1.4	13333	3.735	9000	17.4
35.20174	-90.2746	73.3	37	Right-1	9000	20.2	16.8	12.3	6.3	4	2.8	2.2	1.8	1.6	12593	3.804	9000	19
35.2005	-90.2717	73.8	38	Right-1	9000	13.7	12.8	10.2	6.3	4.1	2.9	2.1	1.7	1.5	12232	3.841	9000	14.4
35.19925	-90.2687	74	39	Right-1	9000	14.5	12.6	9.8	5.6	3.7	2.6	2	1.6	1.3	13333	3.735	9000	16.2
35.19811	-90.2657	74	40	Right-1	9000	12.5	10.8	9.3	5.8	3.7	2.6	1.9	1.5	1.2	13333	3.735	9000	12.4
35.19735	-90.2625	74.2	41	Right-1	9000	13.7	12	9.4	5.2	3.4	2.5	1.9	1.6	1.3	13711	3.702	9000	14.1
35.19721	-90.2593	74.2	42	Right-1	9000	14.2	12.4	10.2	6.3	4.3	3.1	2.3	1.8	1.5	11526	3.915	9000	14.4
35.19766	-90.2559	74.4	43	Right-1	9000	12.3	11.6	8.7	4.8	3.1	2.2	1.7	1.4	1.1	14881	3.605	9000	13
35.19811	-90.2527	74.8	44	Right-1	9000	16.7	12	8.6	4.5	2.9	2.2	1.7	1.5	1.2	14881	3.605	9000	15.7
35.19855	-90.2494	73.4	45	Right-1	9000	12.7	9.7	7.5	4.2	2.8	2.1	1.7	1.4	1.2	15282	3.574	9000	12.3

The NEWFLEX module creates a new worksheet – NEWFLEX. Within the NEWFLEX module, three calculations are executed; the results are shown on the NEWFLEX screen. The calculations include:

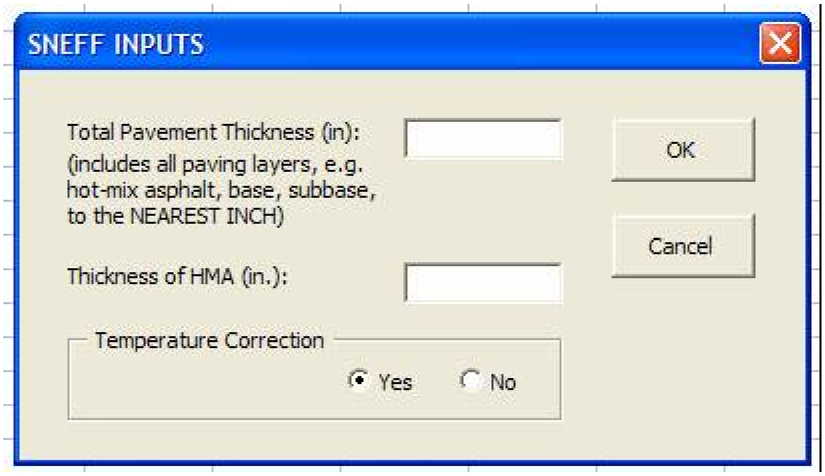
- The FWD load/force is normalized to 9000 pounds; resulting pavement deflections are adjusted to reflect this normalization.
- The subgrade resilient modulus is calculated from normalized FWD deflections.
- The AASHTO flexible design equation is solved, based on the input values provided in the NEWFLEX dialog box and the calculated subgrade resilient modulus.

Determination of SN$_{effective}$ – SNEFF Module

- Click on the ROADHOG entry in the Excel menu bar.
- Highlight and click the "Creat SNEFF" entry in the ROADHOG pull-down menu.



- Supply pavement layer thickness and hot-mix asphalt layer thickness values in the SNEFF dialog box (shown below).
- ROADHOG contains algorithms for adjusting deflections for measured pavement temperature. To enlist this procedure, click YES in the Temperature Correction area of the SNEFF dialog box. Designers should note that FWD results obtained during periods when pavement temperatures range beyond approximately 65 – 75 deg. F should be corrected for possible temperature effects.
- Click "OK" in the dialog box to complete the SNEFF module.

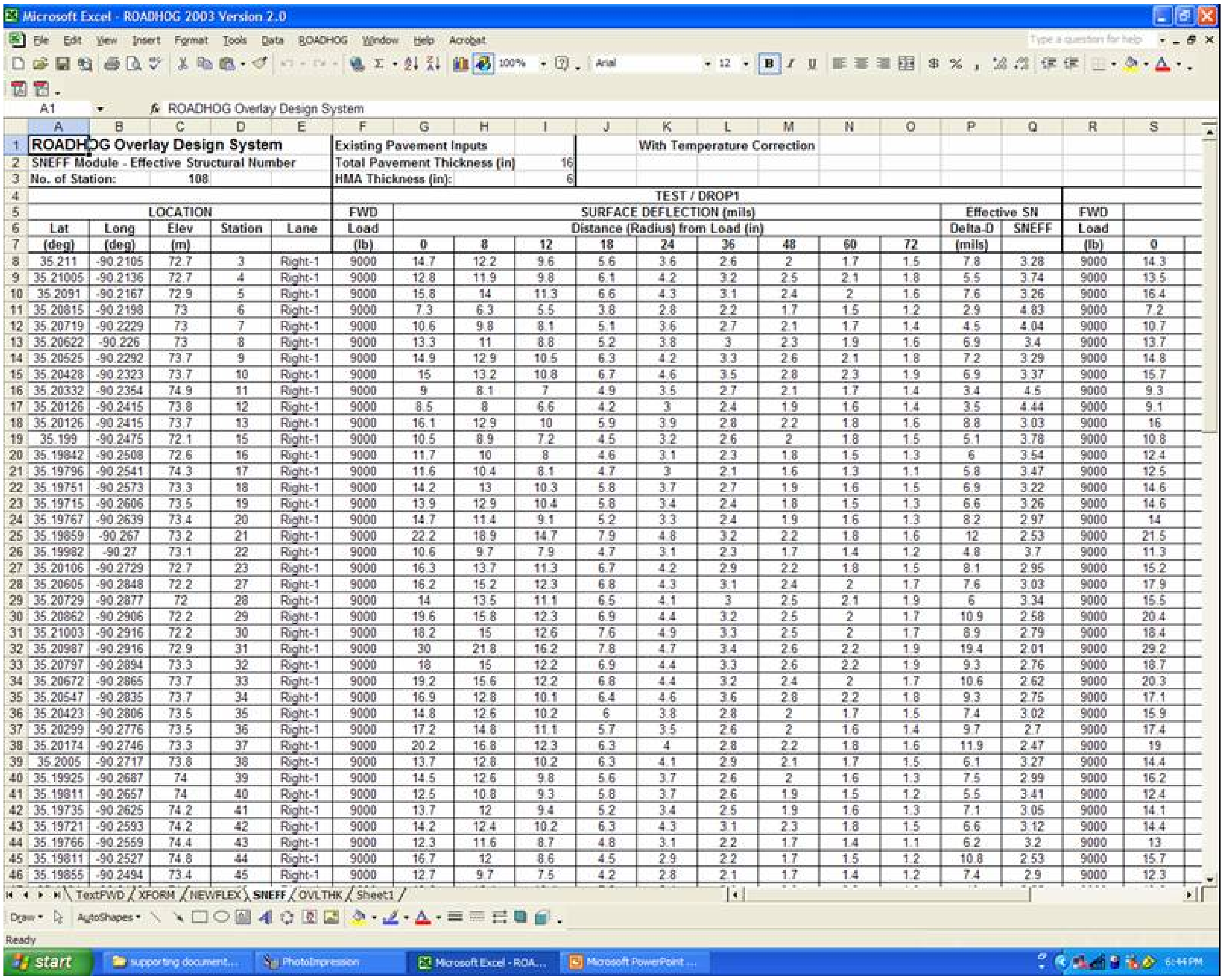


SNEFF INPUTS

Total Pavement Thickness (in):
(includes all paving layers, e.g. hot-mix asphalt, base, subbase, to the NEAREST INCH)

Thickness of HMA (in.):

Temperature Correction
● Yes ○ No



ROADHOG Overlay Design System

SNEFF Module - Effective Structural Number

No. of Station: 108

Existing Pavement Inputs

Total Pavement Thickness (in) 16

HMA Thickness (in): 6

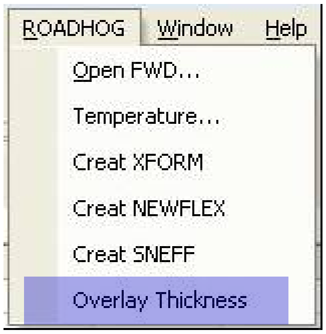
With Temperature Correction

						TEST / DROP1												
LOCATION					FWD	SURFACE DEFLECTION (mils)									Effective SN		FWD	
Lat	Long	Elev	Station	Lane	Load	Distance (Radius) from Load (in)									Delta-D	SNEFF	Load	
(deg)	(deg)	(m)			(lb)	0	8	12	18	24	36	48	60	72	(mils)		(lb)	0
35.211	-90.2105	72.7	3	Right-1	9000	14.7	12.2	9.6	5.6	3.6	2.6	2	1.7	1.5	7.8	3.28	9000	14.3
35.21005	-90.2136	72.7	4	Right-1	9000	12.8	11.9	9.8	6.1	4.2	3.2	2.5	2.1	1.8	5.5	3.74	9000	13.5
35.2091	-90.2167	72.9	5	Right-1	9000	15.8	14	11.3	6.6	4.3	3.1	2.4	2	1.6	7.6	3.26	9000	16.4
35.20815	-90.2198	73	6	Right-1	9000	7.3	6.3	5.5	3.8	2.8	2.2	1.7	1.5	1.2	2.9	4.83	9000	7.2
35.20719	-90.2229	73	7	Right-1	9000	10.6	9.8	8.1	5.1	3.6	2.7	2.1	1.7	1.4	4.5	4.04	9000	10.7
35.20622	-90.226	73	8	Right-1	9000	13.3	11	8.8	5.2	3.8	3	2.3	1.9	1.6	6.9	3.4	9000	13.7
35.20525	-90.2292	73.7	9	Right-1	9000	14.9	12.9	10.5	6.3	4.2	3.3	2.6	2.1	1.8	7.2	3.29	9000	14.8
35.20428	-90.2323	73.7	10	Right-1	9000	15	13.2	10.8	6.7	4.6	3.5	2.8	2.3	1.9	6.9	3.37	9000	15.7
35.20332	-90.2354	74.9	11	Right-1	9000	9	8.1	7	4.9	3.5	2.7	2.1	1.7	1.4	3.4	4.5	9000	9.3
35.20126	-90.2415	73.8	12	Right-1	9000	8.5	8	6.6	4.2	3	2.4	1.9	1.6	1.4	3.5	4.44	9000	9.1
35.20126	-90.2415	73.7	13	Right-1	9000	16.1	12.9	10	5.9	3.9	2.8	2.2	1.8	1.6	8.8	3.03	9000	16
35.199	-90.2475	72.1	15	Right-1	9000	10.5	8.9	7.2	4.5	3.2	2.6	2	1.8	1.5	5.1	3.78	9000	10.8
35.19842	-90.2508	72.6	16	Right-1	9000	11.7	10	8	4.6	3.1	2.3	1.8	1.5	1.3	6	3.54	9000	12.4
35.19796	-90.2541	74.3	17	Right-1	9000	11.6	10.4	8.1	4.7	3	2.1	1.6	1.3	1.1	5.8	3.47	9000	12.5
35.19751	-90.2573	73.3	18	Right-1	9000	14.2	13	10.3	5.8	3.7	2.7	1.9	1.6	1.5	6.9	3.22	9000	14.6
35.19715	-90.2606	73.5	19	Right-1	9000	13.9	12.9	10.4	5.8	3.4	2.4	1.8	1.5	1.3	6.6	3.26	9000	14.6
35.19767	-90.2639	73.4	20	Right-1	9000	14.7	11.4	9.1	5.2	3.3	2.4	1.9	1.6	1.3	8.2	2.97	9000	14
35.19859	-90.267	73.2	21	Right-1	9000	22.2	18.9	14.7	7.9	4.8	3.2	2.2	1.8	1.6	12	2.53	9000	21.5
35.19982	-90.27	73.1	22	Right-1	9000	10.6	9.7	7.9	4.7	3.1	2.3	1.7	1.4	1.2	4.8	3.7	9000	11.3
35.20106	-90.2729	72.7	23	Right-1	9000	16.3	13.7	11.3	6.7	4.2	2.9	2.2	1.8	1.5	8.1	2.95	9000	15.2
35.20605	-90.2848	72.2	27	Right-1	9000	16.2	15.2	12.3	6.8	4.3	3.1	2.4	2	1.7	7.6	3.03	9000	17.9
35.20729	-90.2877	72	28	Right-1	9000	14	13.5	11.1	6.5	4.1	3	2.5	2.1	1.9	6	3.34	9000	15.5
35.20862	-90.2906	72.2	29	Right-1	9000	19.6	15.8	12.3	6.9	4.4	3.2	2.5	2	1.7	10.9	2.58	9000	20.4
35.21003	-90.2916	72.2	30	Right-1	9000	18.2	15	12.6	7.6	4.9	3.3	2.5	2	1.7	8.9	2.79	9000	18.4
35.20987	-90.2916	72.9	31	Right-1	9000	30	21.8	16.2	7.8	4.7	3.4	2.6	2.2	1.9	19.4	2.01	9000	29.2
35.20797	-90.2894	73.3	32	Right-1	9000	18	15	12.2	6.9	4.4	3.3	2.6	2.2	1.9	9.3	2.76	9000	18.7
35.20672	-90.2865	73.7	33	Right-1	9000	19.2	15.6	12.2	6.8	4.4	3.2	2.4	2	1.7	10.6	2.62	9000	20.3
35.20547	-90.2835	73.7	34	Right-1	9000	16.9	12.8	10.1	6.4	4.6	3.6	2.8	2.2	1.8	9.3	2.75	9000	17.1
35.20423	-90.2806	73.5	35	Right-1	9000	14.8	12.6	10.2	6	3.8	2.8	2	1.7	1.5	7.4	3.02	9000	15.9
35.20299	-90.2776	73.5	36	Right-1	9000	17.2	14.8	11.1	5.7	3.5	2.6	2	1.6	1.4	9.7	2.7	9000	17.4
35.20174	-90.2746	73.3	37	Right-1	9000	20.2	16.8	12.3	6.3	4	2.8	2.2	1.8	1.6	11.9	2.47	9000	19
35.2005	-90.2717	73.8	38	Right-1	9000	13.7	12.8	10.2	6.3	4.1	2.9	2.1	1.7	1.5	6.1	3.27	9000	14.4
35.19925	-90.2687	74	39	Right-1	9000	14.5	12.6	9.8	5.6	3.7	2.6	2	1.6	1.3	7.5	2.99	9000	16.2
35.19811	-90.2657	74	40	Right-1	9000	12.5	10.8	9.3	5.8	3.7	2.6	1.9	1.5	1.2	5.5	3.41	9000	12.4
35.19735	-90.2625	74.2	41	Right-1	9000	13.7	12	9.4	5.2	3.4	2.5	1.9	1.6	1.3	7.1	3.05	9000	14.1
35.19721	-90.2593	74.2	42	Right-1	9000	14.2	12.4	10.2	6.3	4.3	3.1	2.3	1.8	1.5	6.6	3.12	9000	14.4
35.19766	-90.2559	74.4	43	Right-1	9000	12.3	11.6	8.7	4.8	3.1	2.2	1.7	1.4	1.1	6.2	3.2	9000	13
35.19811	-90.2527	74.8	44	Right-1	9000	16.7	12	8.6	4.5	2.9	2.2	1.7	1.5	1.2	10.8	2.53	9000	15.7
35.19855	-90.2494	73.4	45	Right-1	9000	12.7	9.7	7.5	4.2	2.8	2.1	1.7	1.4	1.2	7.4	2.9	9000	12.3

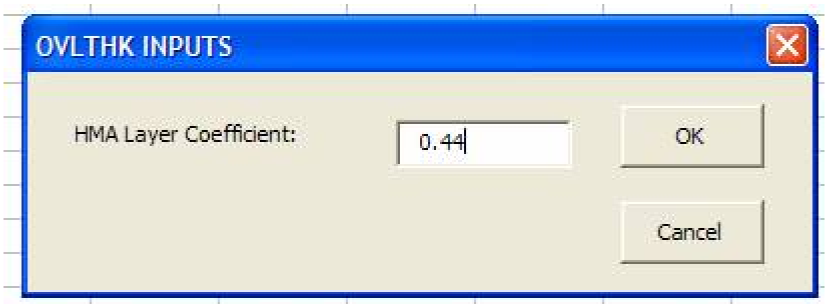
The SNEFF module creates a new worksheet – SNEFF. For each FWD drop, the worksheet shows the calculated "Delta D" (see TRC-0209 Final Report) and the associated effective structural number of the existing pavement structure (SN_{eff}). The worksheet also shows, in the header section, the input total pavement thickness, the input ACHM thickness, and whether temperature correction was chosen.

Determination of Overlay Thickness – OVLTHK Module

- Click on the ROADHOG entry in the Excel menu bar.
- Highlight and click the “Overlay Thickness” entry in the ROADHOG pull-down menu.



- Supply the AASHTO structural layer coefficient for hot-mix asphalt in the OVLTHK dialog box (shown below). For ease of use, a default value of 0.44 is supplied.
- Click “OK” in the dialog box to complete the OVLTHK module.

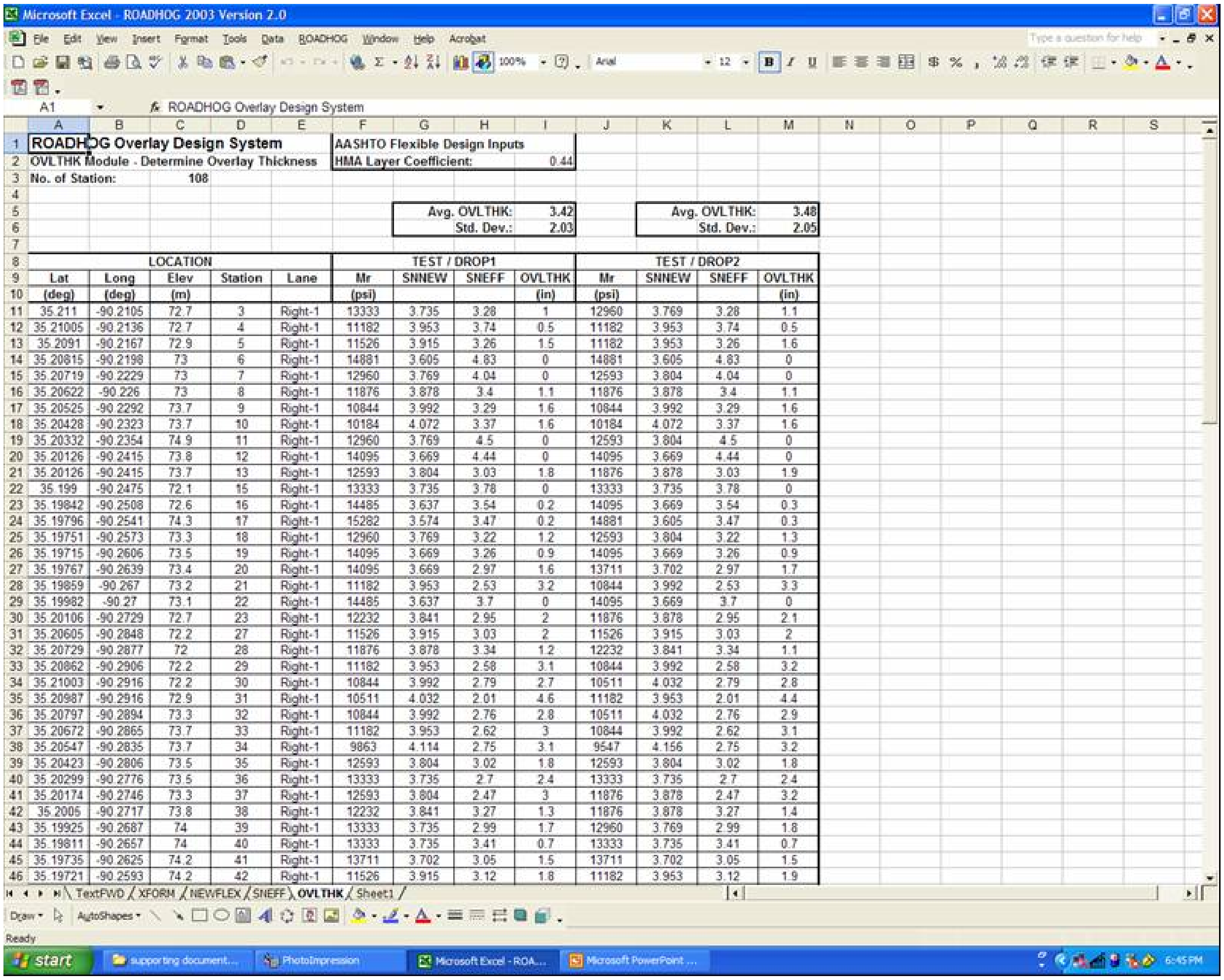


HMA Layer Coefficient: 0.44

- AHTD uses the following ‘a’ values (layer coefficient) for hot-mix asphalt:

Surface (9.5 mm and 12.5 mm nominal maximum size):	0.44
Binder (25 mm nominal maximum size)	0.44
Base (37.5 mm nominal maximum size)	0.36

- The OVLTHK module does not contain a provision for using more than one structural layer coefficient ‘a’ value within a single overlay. In other words, a given recommended overlay thickness may be subdivided into surface and binder layers (since each uses an ‘a’ value of 0.44), but cannot include a base layer.



ROADHOG Overlay Design System

OVLTHK Module - Determine Overlay Thickness

No. of Station: 108

AASHTO Flexible Design Inputs

HMA Layer Coefficient: 0.44

Avg. OVLTHK: 3.42
Std. Dev.: 2.03

Avg. OVLTHK: 3.48
Std. Dev.: 2.05

LOCATION					TEST / DROP1				TEST / DROP2			
Lat (deg)	Long (deg)	Elev (m)	Station	Lane	Mr (psi)	SNNEW	SNEFF	OVLTHK (in)	Mr (psi)	SNNEW	SNEFF	OVLTHK (in)
35.211	-90.2105	72.7	3	Right-1	13333	3.735	3.28	1	12960	3.769	3.28	1.1
35.21005	-90.2136	72.7	4	Right-1	11182	3.953	3.74	0.5	11182	3.953	3.74	0.5
35.2091	-90.2167	72.9	5	Right-1	11526	3.915	3.26	1.5	11182	3.953	3.26	1.6
35.20815	-90.2198	73	6	Right-1	14881	3.605	4.83	0	14881	3.605	4.83	0
35.20719	-90.2229	73	7	Right-1	12960	3.769	4.04	0	12593	3.804	4.04	0
35.20622	-90.226	73	8	Right-1	11876	3.878	3.4	1.1	11876	3.878	3.4	1.1
35.20525	-90.2292	73.7	9	Right-1	10844	3.992	3.29	1.6	10844	3.992	3.29	1.6
35.20428	-90.2323	73.7	10	Right-1	10184	4.072	3.37	1.6	10184	4.072	3.37	1.6
35.20332	-90.2354	74.9	11	Right-1	12960	3.769	4.5	0	12593	3.804	4.5	0
35.20126	-90.2415	73.8	12	Right-1	14095	3.669	4.44	0	14095	3.669	4.44	0
35.20126	-90.2415	73.7	13	Right-1	12593	3.804	3.03	1.8	11876	3.878	3.03	1.9
35.199	-90.2475	72.1	15	Right-1	13333	3.735	3.78	0	13333	3.735	3.78	0
35.19842	-90.2508	72.6	16	Right-1	14485	3.637	3.54	0.2	14095	3.669	3.54	0.3
35.19796	-90.2541	74.3	17	Right-1	15282	3.574	3.47	0.2	14881	3.605	3.47	0.3
35.19751	-90.2573	73.3	18	Right-1	12960	3.769	3.22	1.2	12593	3.804	3.22	1.3
35.19715	-90.2606	73.5	19	Right-1	14095	3.669	3.26	0.9	14095	3.669	3.26	0.9
35.19767	-90.2639	73.4	20	Right-1	14095	3.669	2.97	1.6	13711	3.702	2.97	1.7
35.19859	-90.267	73.2	21	Right-1	11182	3.953	2.53	3.2	10844	3.992	2.53	3.3
35.19982	-90.27	73.1	22	Right-1	14485	3.637	3.7	0	14095	3.669	3.7	0
35.20106	-90.2729	72.7	23	Right-1	12232	3.841	2.95	2	11876	3.878	2.95	2.1
35.20605	-90.2848	72.2	27	Right-1	11526	3.915	3.03	2	11526	3.915	3.03	2
35.20729	-90.2877	72	28	Right-1	11876	3.878	3.34	1.2	12232	3.841	3.34	1.1
35.20862	-90.2906	72.2	29	Right-1	11182	3.953	2.58	3.1	10844	3.992	2.58	3.2
35.21003	-90.2916	72.2	30	Right-1	10844	3.992	2.79	2.7	10511	4.032	2.79	2.8
35.20987	-90.2916	72.9	31	Right-1	10511	4.032	2.01	4.6	11182	3.953	2.01	4.4
35.20797	-90.2894	73.3	32	Right-1	10844	3.992	2.76	2.8	10511	4.032	2.76	2.9
35.20672	-90.2865	73.7	33	Right-1	11182	3.953	2.62	3	10844	3.992	2.62	3.1
35.20547	-90.2835	73.7	34	Right-1	9863	4.114	2.75	3.1	9547	4.156	2.75	3.2
35.20423	-90.2806	73.5	35	Right-1	12593	3.804	3.02	1.8	12593	3.804	3.02	1.8
35.20299	-90.2776	73.5	36	Right-1	13333	3.735	2.7	2.4	13333	3.735	2.7	2.4
35.20174	-90.2746	73.3	37	Right-1	12593	3.804	2.47	3	11876	3.878	2.47	3.2
35.2005	-90.2717	73.8	38	Right-1	12232	3.841	3.27	1.3	11876	3.878	3.27	1.4
35.19925	-90.2687	74	39	Right-1	13333	3.735	2.99	1.7	12960	3.769	2.99	1.8
35.19811	-90.2657	74	40	Right-1	13333	3.735	3.41	0.7	13333	3.735	3.41	0.7
35.19735	-90.2625	74.2	41	Right-1	13711	3.702	3.05	1.5	13711	3.702	3.05	1.5
35.19721	-90.2593	74.2	42	Right-1	11526	3.915	3.12	1.8	11182	3.953	3.12	1.9

The OVLTHK module creates a new worksheet – OVLTHK. For each FWD drop, the worksheet includes the following information:

- Drop location / station
- Subgrade resilient modulus (M_R)
- Future required structural number (SN_{NEW})
- Effective structural number of existing pavement (SN_{EFF})
- Required overlay thickness

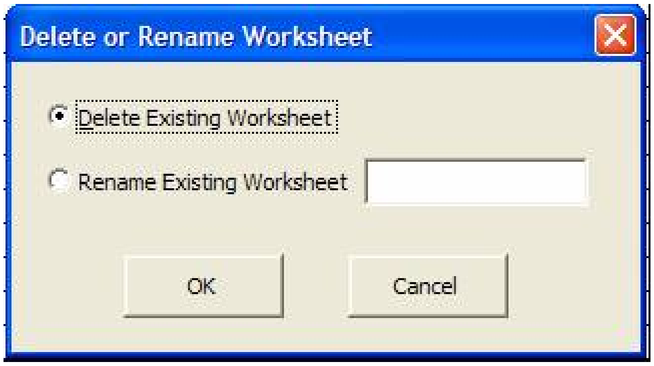
The OVLTHK worksheet also shows, for each drop series, the average recommended overlay thickness and the associated standard deviation. Designers may use this information to determine various "percentile" thickness requirements.

Performing Multiple Overlay Designs Using the Same FWD File

ROADHOG allows the designer to perform multiple design scenarios without restarting the design process ‘from scratch’. Typically, multiple designs may be investigated by the following process:

- A new set of design values, i.e. Reliability, are used in the NEWFLEX module to create a new set of required (future) structural numbers.
- An associated new set of required overlay thicknesses are generated using the OVLTHK module.

When a new design run is desired, simply re-perform the NEWFLEX module. When a new module is started (after the module has been previously performed) the user is given a choice of deleting the previous design, or saving the previous design by saving the worksheet using a different name, as shown in the dialog box below:



● Delete Existing Worksheet
○ Rename Existing Worksheet

The designer is cautioned that if an existing worksheet is deleted in order to create a new design, subsequent modules must still be performed – data is not updated automatically. For example, if a new NEWFLEX module is performed (and a new NEWFLEX worksheet is created) – a new OVLTHK worksheet is not automatically created, nor is the existing OVLTHK worksheet automatically updated. The OVLTHK module must be re-performed in order to use the newly created NEWFLEX module in design.

Saving a ROADHOG Design

Once a design has been completed, the entire Excel workbook file may be saved. **The designer is strongly cautioned to save the completed ROADHOG design file using the 'Save As' command in the File menu in order to avoid overwriting the original ROADHOG file.** The 'Save As' command is shown (below) in the File pull-down menu.