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Mechanistic Evaluation and Calibration of the AASHTO Design Equations and Mechanistic Analysis of the SHRP Asphalt Surfaced Pavement Sections

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MECHANISTIC EVALUATION OF THE AASHTO FLEXIBLE DESIGN EQUATIONS

ABSTRACT

Mechanistic evaluation of the AASHTO flexible design equations was conducted by using 243 artificial pavement sections with various layer properties, roadbed soil modulus, and traffic volumes. Throughout the analyses it is assumed that the mechanistic responses (stresses, strains, and deflections) of the pavement sections due to an applied 9000-pound of load are indicative of the level of damage delivered to these sections. Results of the analyses indicated that while the AASHTO design method produces pavement sections with an almost equal level of protection, the damage delivered to the various layers vary from one section to another.

It is also shown that the AASHTO method does not consistently accounts for the effects of the drainage quality (drainage coefficient) on the layer thicknesses and/or on the pavement responses. A mechanistic-based modification procedure of the effects of the AASHTO drainage coefficient is presented. It is shown that the mechanistic-based method produces more consistent pavement sections and that the variations of their mechanistic responses are much less than those produced by the AASHTO method. Further, a nomograph for estimating the effects of drainage coefficients on the expected life of the pavement structures is also presented and discussed.

Finally, the results of the backcalculated layer moduli of some of the SHRP asphalt surfaced GPS sections are presented and the accuracy of the backcalculated modulus values is briefly discussed.

MECHANISTIC EVALUATION OF THE AASHTO FLEXIBLE DESIGN EQUATIONS

EXECUTIVE SUMMARY

1.0 GENERAL

Michigan State university has proposed an innovative and unique approach for the mechanistic evaluation, calibration and revision of the AASHTO design equations. The study is based on mechanistic evaluations of the AASHTO design procedures using the data from the SHRP database relative to the SHRP asphalt surfaced GPS sections. Because of the gaps in the database and missing data elements (e.g., layer moduli or layer coefficients) that are required for the mechanistic analysis, the research plan was modified as follows:

1. Establish a full factorial experiment design matrix that consists of 243 artificial flexible pavement sections. For each section, assign material properties and traffic volumes (in terms of 18-kips ESAL), within the typical ranges used by various State Highway Agencies (SHAs). Design each pavement section (determine the required layer thicknesses) by using the AASHTO design procedure. Use the layer thicknesses and the material properties to calculate the mechanistic responses (stresses, strains, and deflections) of each pavement sections.

2. Analyze the sensitivity of the mechanistic responses to the layer thicknesses determined by the AASHTO procedure. Evaluate and revise as possible the AASHTO design equations and the concept of drainage coefficients.

In addition, when some values of the layer moduli that were backcalculated by using deflection data and the MODULUS backcalculation computer program for some of the SHRP GPS sections became available, they were examined. During the process, the consistency of the MODULUS program was examined. The study has been completed on March 28, 1993. Based on the results, several observations and conclusions were made and are summarized below.

2.0 OBSERVATIONS OF THE AASHTO DESIGN PROCEDURE FOR FLEXIBLE PAVEMENTS

Analyses of the 243 pavement sections and of the AASHTO flexible pavement design equations have confirmed the present knowledge regarding the AASHTO design procedure. This knowledge and findings are enumerated below.

1. The dependent variable of the AASHTO main design equation is the structural number (SN) of the pavement. The SN is a function of the traffic volume (18-kips ESAL), the design reliability, the overall standard deviation, the total serviceability loss during the performance period, and the resilient modulus of the roadbed soil. The structural number is computed so that the pavement will have the required structural capacity to carry the

anticipated traffic load and volume and it will experience the specified loss of serviceability during the performance period. Hence, for any pavement structure, the AASHTO required SN is independent of the quality and properties of the asphalt, base, and subbase layers. The properties (e.g., layer coefficients) of these layers play a major role in determining the thickness of each layer but not the required SN.

2. After determining the required SN of a pavement section, the layer thicknesses are computed by using the AASHTO recommended layer analysis method. In this regard, the AASHTO assumes that the required SN of a pavement is the sum of the structural number of each of its layers. Further, the structural number of any pavement layer is the product of its layer and drainage coefficients and its thickness. That is the SN of a relatively weak pavement layer can be enhanced by increasing its thickness.

3. Although the AASHTO design guide advocates the use of good quality materials with reasonable costs, the AASHTO design procedure assumes that the effects of drainage on the pavement performance can be eliminated by adjusting the thickness (by using a drainage coefficient) of the affected layer. That is a base layer with an excellent drainage quality would perform exactly the same as that with poor drainage quality if the thickness of the latter is increased by the ratio of the values of their drainage coefficients.

4. The effects of serviceability loss due to environmental conditions (freeze-thaw and swelling soils) can be eliminated by increasing the required SN of the pavement. Higher environmental loss of serviceability requires higher SN.

3.0 MECHANISTIC EVALUATION/CALIBRATION OF THE AASHTO DESIGN PROCEDURE

An experiment design matrix consists of 243 pavement sections was designed and, for each section, the thicknesses of its layers were determined by using the AASHTO design procedure. The mechanistic responses (stresses, strains, and deflections) of each pavement section were then computed and their sensitivity to the AASHTO determined layer thicknesses was analyzed. Results of the sensitivity analysis indicates:

1. For pavement sections with various layer properties that have been designed by using the AASHTO procedure to be supported on the same roadbed soil, to carry the same traffic volume, and to have the same serviceability loss during an equal performance period, the mechanistic analyses indicate that:

    a) The peak pavement surface deflection (a mechanistic response) is almost the same for all sections. This implies that the AASHTO design procedure produces consistent pavement sections relative to the deflection delivered to the pavements. Hence, the results of the mechanistic analyses tend to support the structure and validity of the SN concept in the main AASHTO design equation.

b) The induced stresses and strains experienced by any one pavement layer vary from one pavement section to another. This implies that the AASHTO design method produces inconsistent results relative to these mechanistic responses. Hence, the results of the mechanistic analyses do not support the AASHTO layer coefficient nor the AASHTO concept that the SN of the pavement is the sum of the SN of its layers.

c) The tensile stress and the ratio of the tensile stress to the asphalt layer modulus induced at the bottom of the AC layer vary from one pavement section to another and they are dependent on the properties and thicknesses of all pavement layers. This implies that the AASHTO design procedure produces inconsistent pavement sections relative to fatigue damage. Once again, the results of the mechanistic analyses do not support the AASHTO layer coefficient nor the AASHTO concept that the SN of the pavement is the sum of the SN of its layers.

2. For pavement sections with the same layer properties that have been designed by using the AASHTO procedure to be supported on various roadbed soils, to carry the same traffic volume, and to have the same serviceability loss during an equal performance period, the mechanistic analyses indicate that the stresses, strains, and deflections induced in the pavements are not the same. This implies that the role of the resilient modulus of the roadbed soil in the AASHTO main design equation is not accurate.

3. For pavement sections with the same layer properties but different drainage coefficients that have been designed by using the AASHTO procedure to be supported on the same roadbed soils, to carry the same traffic volume, and to have the same serviceability loss during an equal performance period, the results of the mechanistic evaluations indicate that:

   a) The magnitudes of the deflections, stresses, and strains induced in the various pavement sections due to a 9000-pounds load vary from one pavement section to another. That is the AASHTO design method does nor produce consistent results relative to the mechanistic responses. Hence, the results of the mechanistic analyses do not support the role of the drainage coefficient (in adjusting the layer thicknesses) in the AASHTO design procedure.

   b) Mechanistic calibration of this role was undertaken. After several trials, the following mechanistic-based modifications of the role of the AASHTO drainage coefficients are recommended:

$a_{ei} = (a_i)(m_i)^{0.5}$; and $MR_{RBd} = (MR_{EFF})(m_3)^{0.5}$

where a_{ei} = the effective layer coefficient of layer "i";
a_i = the layer coefficient of layer "i"; and
m_i = the drainage coefficient of layer "i".

MR_{DSN} = the design value of the resilient modulus of the roadbed soil;
MR_{EFF} = the effective resilient modulus of the roadbed soil; and
m_3 = the drainage coefficient of the subbase material or of the layer immediately above the roadbed soil.

The mechanistic-based modification of the effects of the AASHTO drainage coefficients produces consistent pavement sections where the mechanistic responses due to traffic loads are almost the same.

4. The effects of drainage coefficient on the pavement performance was also analyzed from different perspective. Rather than using the drainage coefficient to decrease or increase the layer thicknesses, the impact of the quality of drainage on the service life of the pavement was assessed and presented in an easy to read nomograph. The method allows the pavement design engineer to analyze the cost and benefits of improving the drainage quality. This makes the effects of drainage quality on the pavement performance compatible with that for loss of serviceability due to environmental factors.

5. Results of the mechanistic evaluation of the AASHTO concept of loss of serviceability due to environmental factors indicated that:

   a) The AASHTO loss of serviceability concept is a linear one (the total loss of pavement serviceability is the sum of the loss of serviceability due to traffic and the losses due to swelling and frost heave potentials). The concept does not account for the interaction between the various serviceability losses. Although, from the mechanistic viewpoint, the AASHTO concept seems to be reasonable.

   b) The loss of serviceability due to environmental conditions can also be expressed in term of the effective roadbed resilient modulus.

4.0 MECHANISTIC EVALUATION OF THE ASPHALT SURFACED GPS SECTIONS

Mechanistic evaluation of the asphalt surfaced pavement sections was conducted on the basis of the values of the layer moduli backcalculated by using the MODULUS program and the layer thicknesses found in the NPPD. The evaluation was limited to those pavement sections and deflection test locations where the backcalculated layer modulus values have passed the SHRP quality control check. Results of the analysis indicates that:

1. The values of the layer moduli backcalculated by using the SHRP modified version of MODULUS program are neither accurate nor reasonable.

2. The degree of confidence in the backcalculated layer modulus values is poor at best.

3. The MODULUS program needs further evaluation and calibration prior to its use in future backcalculation of layer moduli.

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 GENERAL

This report presents the procedures used for the mechanistic evaluation and calibration of the AASHTO flexible pavement design equations and the mechanistic evaluation of the SHRP's GPS asphalt surfaced pavement sections. These procedures were proposed to be used in contract P-020b "Data Analysis" of the Long Term Pavement Performance (LTPP) studies of the Strategic Highway Research Program (SHRP).

The goal of the LTPP studies established by the "Strategic Transportation Research Study" and adopted by the Advisory Committee on Pavement Performance is:

> **"TO INCREASE PAVEMENT LIFE BY INVESTIGATION OF THE VARIOUS DESIGNS OF PAVEMENT STRUCTURES AND REHABILITATED PAVEMENT STRUCTURES, USING DIFFERENT MATERIALS AND UNDER DIFFERENT LOADS, ENVIRONMENTS, SUBGRADE SOIL, AND MAINTENANCE PRACTICES."**

The objectives of contract P-020b "Data Analysis" of the SHRP's LTPP program and the technical approach and tasks to accomplish these objectives are presented in the next subsections.

1.1.1 Study Objectives

The objectives of this study are:

1. Develop a strategic approach to the analysis of the LTPP database.
2. Implement the analytical approach.
3. Develop plans for future data analysis.

1.1.2 Technical Approach

Use a mechanistic-based analysis procedure and the LTPP database (to the extent pertinent data is available when needed) to evaluate the AASHTO design equations.

Conduct mechanistic analyses of asphalt-surfaced General Pavement Sections (GPS) using the layer thicknesses found in the LTPP database and backcalculated layer moduli determined by the SHRP-specified procedure.

1.1.3 Technical Tasks

Task 1 - Review BRE/ERES research plan and other P-020 proposals. Attend DAWG Meeting (Washington, D.C., July 1990). Prepare and present a research plan at SHRP midcourse meeting (Denver, Colorado, August 1990). Prepare and submit a revised research plan.

Task 2 - Evaluate AASHTO design equations using a mechanistic-based design procedure. Assess the concepts of (a) layer coefficient, (b) loss of serviceability, and (c) drainage coefficient.

Task 3 - Conduct mechanistic analyses of asphalt-surfaced GPS sections using backcalculated layer moduli and layer thicknesses found in the LTPP database. Tabulate all results (stresses, strains, and deflections).

Task 4 - Develop future research recommendations and prepare a final report.

To this end, the materials in this report are divided according to its topics and they are organized into 8 chapters and 1 appendix as follows:

Chapter 1 - Introduction and background.

Chapter 2 - Research approach.

Chapter 3 - Mechanistic evaluation of the AASHTO flexible pavement design equation.

Chapter 4 - Mechanistic evaluation of the AASHTO drainage coefficients.

Chapter 5 - Mechanistic evaluation of the AASHTO loss of serviceability due to environmental conditions.

Chapter 6 - Mechanistic analysis of the asphalt surfaced pavement sections.

Chapter 7 - Conclusions.

Chapter 8 - Recommendations.

Appendix A contains the results (mechanistic responses) of the mechanistic analysis of the asphalt surfaced General Pavement Sections (GPS).

1.2 BACKGROUND AND GENERAL OBSERVATIONS

Empirical pavement design procedures are derived from experience or observation alone, often without detailed consideration of system behavior or pavement theory.

Empirically derived relationships defining the interaction between performance, load, and pavement thickness for a given geographical location and climatic condition are the basis for many existing design methods. These methods or models are generally used to determine the required pavement layer thicknesses, the number of load applications required to cause failure or the occurrence of distress due to pavement material properties, subgrade type, environmental, and traffic conditions (1 through 6).

One advantage in using empirical models is that they tend to be simple and easy to use. Unfortunately, they are usually only accurate for the exact range of conditions for which they have been developed. They may be invalid outside the range of variables used in the development of the method. In addition, the engineering interpretations of most purely empirical equations are meaningless and/or misleading. The AASHTO, Corps of Engineers, Louisiana, and Utah design methods are among a large family of empirical pavement design methods that were primarily developed on the basis of observed field performance (1).

The AASHTO pavement design methods for flexible pavements are based on results obtained from the AASHO Road Test conducted in the late 1950's and early 1960's in northern Illinois. The methods are empirical and relate pavement performance measurements and the loss of serviceability directly to the traffic volume and loading characteristics, the modulus of subgrade reaction, layer coefficients, and environmental factors that were present at the road test. The methods (design equations) have been generalized to make them applicable to broader sets of design variables (1, 5).

Recently, the AASHTO design equations were enhanced to include design reliability, the resilient modulus of the roadbed soil, material variability and drainability, and construction quality. Further, the pavement performance period can be adjusted for environmentally-induced losses of serviceability such as frost heave.

The present AASHTO model contains several deficiencies and limitations because of the nature of the AASHO Road Test experiment. For example, the model is directly applicable only to the northern Illinois climate and the specific subgrade and materials used for the pavement/ subgrade structure at the Road Test. Further, the model is based on an accelerated procedure for accumulating traffic, which includes only two years of environmental effects in conjunction with several years of traffic load. These deficiencies have been reduced to some extent by the incorporation of the experience of several State Highway Agencies (SHA) with pavements located in different climatic conditions and with different materials and traffic.

For overlays, the AASHTO method requires the estimation of remaining life factor of the existing pavement. This factor can be estimated using various procedures presented in the 1986 AASHTO design guide. The experience of many State Highway Agencies has indicated the inadequacy of the overlay procedure due to the lack of sufficient guidance to estimate the remaining life factor (1, 5, 8).

Since the AASHO Road Test, many other pavement performance and distress prediction models have been developed for both flexible and rigid pavements and have been incorporated into various design models. Each model was developed by using a specific pavement database and model development techniques and is, therefore, subject to limitations and is generally applicable only for specific conditions. None of these models were developed on the basis of mechanistic response of the various pavement layers to the applied traffic load. Hence, a new and innovative approach needs to be developed whereby observed pavement distresses are directly related to the mechanistic responses of the various pavement layers due to a passing wheel load (1 through 16).

1.3 MECHANISTIC BASED APPROACHES

A proper pavement performance prediction model that yields reasonable engineering interpretations should be based on the mechanistic responses (stresses, strains, and deflections) of the pavement structure due to a passing wheel load. The performance models can be obtained using two approaches, statistical and theoretical. The statistical approach consists of relating the calculated pavement mechanistic responses to the observed pavement distresses (this is called mechanistic-empirical models) (1). The theoretical approach, on the other hand, models the pavement structure and its boundary values, and the load related distresses (e.g., rutting and alligator cracking) using various available theories (1, 5). The main disadvantage of the theoretical approach is that it tends to be complicated and it requires substantial material and boundary value inputs that are not available or are not measured by most State Highway Agencies (SHA). The main advantage of the mechanistic-empirical models, on the other hand, is that the required inputs are readily available in most SHA. Hence, such models can be developed using data from the National Pavement Performance Database and/or any other pavement management system database that contains pavement distress data and the mechanistic responses of the pavement structures in question.

For any pavement section, the mechanistic response due to an applied load cannot be obtained unless data elements relative to the pavement section in question, the engineering properties of the paving materials, the environment, and loads are known. Unfortunately, some of these data elements are not available in the National Pavement Performance Database (NPPD). Consequently, a procedure needs to be established to assign values to the necessary but missing data elements based upon the descriptive terms found in the database. Such a procedure is presented in the next section.

After developing the performance models, the AASHTO design equations can then be evaluated, calibrated and revised. To optimize the benefits of such evaluation and revision, the procedure(s) must be capable of properly investigating the validity of the various concepts and assumptions embedded in the AASHTO procedures.

1.4 MECHANISTIC ANALYSIS - MISSING DATA ELEMENTS

As stated earlier, some of the data elements that are required for mechanistic analysis of the asphalt surfaced pavement sections are currently missing from the National Pavement

Performance Database (NPPD). In the following subsections, procedures to establish the values of the missing data elements for mechanistic analysis of the asphalt surfaced GPS pavement sections are presented.

1.4.1 Load

It is suggested herein that a 9,000-pound wheel load (half of the standard 18-kips Equivalent Single Axle Load "ESAL") be used in the analysis of all pavement sections. The advantage of this is that the mechanistic responses (stress and strain) can be directly compared and/or related to the AASHTO design equations without the need to use equivalent single axle load factors. In addition, it is recommended that a tire pressure of 82 psi be used throughout the mechanistic analysis. This represents a typical tire pressure value for a semi and it produces a tire-pavement contact radius of 5.91-inch which is compatible to that of the Falling Weight Deflectometer (FWD).

1.4.2 Resilient Modulus

Since the resilient modulus of any road element is not available, efforts is being expanded to obtain such data from the appropriate State Highway Agency. If such efforts are fruitless, then the descriptive terms found in the SHRP database regarding that road element should be used to estimate its resilient modulus. Values of the resilient modulus can also be obtained by using the nondestructive deflection data of the pavement section in question. However, since one of the major objectives of this study is to calibrate the AASHTO design equations, it is highly recommended that, if available, the laboratory values of the resilient modulus be used rather than those obtained by using backcalculation routines. The reason for this is that, during the design process of new or reconstructed pavements, the only values of the resilient moduli available at the time are those obtained from laboratory tests. Hence, these values are to be used as input to the AASHTO design equations. If these values are not available, then layer moduli backcalculated by using nondestructive deflection testing data can be used.

For each pavement layer, the descriptive terms in the database can be directly or indirectly used to estimate the types of roadbed material and other layers, aggregate angularity, material drainability, and, perhaps, classification of the various materials. Using these characteristics, one can assign a resilient modulus value for each layer by using either:

1. The AASHTO layer coefficient and the equivalent resilient modulus (charts are provided in the AASHO design guide); or
2. The data listed in Table 1.

For each pavement layer, the assigned value of the resilient modulus depends on several factors including:

Table 1. Recommended values and ranges of resilient moduli for various materials.

Soil/aggregate type	Resilient modulus (psi)			
	Mean	Upper	Lower	Saturated
Silty sands	8,000	12,000	6,000	4,000
Sand & gravel	12,000	20,000	8,000	6,000
Sand/aggregate blends	20,000	26,000	10,000	7,000
Crushed stone	25,000	40,000	15,000	12,000
Limerock	40,000	60,000	30,000	25,000
Slag	55,000	70,000	45,000	40,000
Asphalt stabilized	120,000	200,000	90,000	70,000
Cement stabilized	500,000	700,000	400,000	300,000
Lime stabilized	Depends on type (increase modulus by 20%)			

1. The thickness of the materials above the layer in question, since the value of the resilient modulus is stress dependent.
2. The gradation of the aggregates.
3. The time period that the degree of saturation of the material exceeds 80 percent.
4. The angularity of the aggregates.
5. The type and amount of stabilizing agent.

For the asphalt course, the resilient modulus of the asphalt mix depends upon the penetration of the asphalt binder, the percent air voids in the asphalt, the percent and type of mineral filler, the angularity and type of the aggregate in the mix, aggregate gradation, and the range of air temperature. It is recommended that the original penetration data of the asphalt binder be used to estimate the resilient modulus of the asphalt mix. The modulus can be estimated either by using the Asphalt Institute equation or by using the following equation developed by Baladi for the FHWA (1, and 15 through 20):

$$\ln(M_R) = 16.1 - 0.0366(T) - 0.140(AV) - 0.000341(CL) - 0.0435(ANG) + 0.000979(KV) \quad \text{(Eq. 1.1)}$$

$$R^2 = 0.997 \qquad S.E. = 0.033$$

where:
ln = Natural logarithm;
M_R = resilient modulus (psi);
T = average yearly temperature (°F)
AV = air voids in the asphalt mix (%);
ANG = aggregate angularity (1 rounded, 2 river gravel, 4 crushed, and 3 a combination by weight of 50% crushed and 50 percent river gravel);
KV = kinematic viscosity of the asphalt mix (centistoke);
R^2 = ; and
S.E. = standard error.

If data concerning the indirect tensile or indirect compressive strength is available, then the following equations can be used to estimate the resilient modulus (17):

$$\ln(M_R) = 6.1776 + 1.08108[\ln(INCS)] + 0.14(AV) - .00034(L) \quad \text{(Eq. 1.2)}$$

$$R^2 = 0.996 \qquad S.E. = 0.085$$

$$\ln(M_R) = 7.3667 + 1.08335[\ln(INTS)] + 0.14(AV) - .00034(L) \quad \text{(Eq. 1.3)}$$

$R^2 = 0.996 \qquad S.E. = 0.083$

where:
INTS = indirect tensile strength (psi);
INCS = indirect compressive strength; and
L = load (pounds).

1.4.3 Poisson's Ratios

The value of Poisson's ratio has a minimum impact on the mechanistic responses of a pavement section. Hence it is recommended herein that (unless Poisson's ratio data is available in the data bank) the values listed in table 2 be used for all pavement sections.

1.4.4 Layer Thicknesses

Layer thickness data is one of the most important element relative to mechanistic analysis. The effects of layer thicknesses on the mechanistic response of any pavement section are very high. For most asphalt surfaced pavement sections, data elements relative to layer thicknesses are available in the SHRP data bank. Some of these data have been, or are in the process of being, verified by coring the pavement sections in question. In addition, regardless of the accuracy of the thickness data, the actual layer thickness will vary. It is recommended herein that the data in the data bank relative to layer thicknesses be used and that only a small number of sites be analyzed by using the thickness data as well as the standard deviation of each layer thickness if available.

1.4.5 Environmental Data

The performance of asphalt surfaced pavements is also dependent on the environmental factors such as temperature, freezing index, number of freeze-thaw cycles, and intensity and duration of rainfall. In general, temperature has substantial effects on the asphalt course and lesser effects on the other layers. On the other hand, moisture has substantial effects on all layers under the asphalt course and much lesser effects on the asphalt course itself (assuming that the AC mix is not moisture susceptible). That is, the effects of moisture on the asphalt course relative to rutting and alligator cracking are derived from the effects of moisture on the other pavement layers. For the mechanistic analysis, it is suggested herein that the average annual air temperature be used to determine the resilient modulus of the asphalt course and that the moduli of the other pavement layers be estimated at or near saturation point (spring condition), if applicable. However, in the event that detailed data regarding the effects of moisture and temperature on the resilient characteristics of the pavement layers becomes available, then this data should be used.

1.4.6 Cumulative Number of 18-kips Equivalent Single Axle Load Applications

For a roadway segment, a SHA typically estimates the number of 18-kips equivalent single axle load (ESAL) applications by multiplying the average daily traffic (ADT) data by the percent commercial (or percent trucks) and by an ESAL factor. Although, the ADT and

Table 2. Values of Poisson's ratios used in the mechanistic analysis.

Pavement Material	Poisson's Ratio
Asphalt concrete	0.30
Base layer	
Unbound granular material	0.35
Stabilized granular material	0.30
Subbase layer	
Unbound subbase layer	0.40
Stabilized granular subbase layer	0.35
Subgrade soil	
Clay	0.45
Silt	0.42
Sand	0.40
Expansive soils	0.50

the percent commercial data elements are relatively accurate, the ESAL factor being used needs to be verified. Some highway agencies have used weigh in motion data to verify or to establish a new ESAL factor. In some cases, the ESAL factor was increased by as much as 50 percent.

For this study, it is recommended that the number of 18-kips ESAL data (when available) be examined to determine the source of the estimation. If the data are based on an unverified ESAL factor, then weigh in motion data should be requested when possible. Otherwise, engineering judgement should be used to determine the possible variation in the data. If the number of ESAL is not available in the data base, then the number can be estimated from weigh in motion and ADT data.

For studying rut and fatigue cracking, using the ESAL data alone implies that all other types of traffic (e.g., automobiles, pickups) are assumed to have a little to no contribution to rutting and/or fatigue cracking (the values of the AASHTO Load Equivalency Factors (LEF) for these vehicles are very small). While this assumption may be correct for sound pavements with thick asphalt course (thicker than 2 to 4 inches), it may not be correct for thin pavements. Hence, the ADT data should also be included in conjunction with the ESAL data to analyze rut and fatigue cracking.

CHAPTER 2

RESEARCH APPROACH

2.1 DATA ANALYSIS - THE ORIGINAL PLAN

In this study, an original plan consisting of several steps was developed to accomplish the data analysis. These steps are:

1. Establish a databank for mechanistic analysis and assign values to the missing data elements from the NPPD. The procedures to be used in assigning the values of the missing data elements are outlined in chapter 4 of this report.

2. Conduct mechanistic analysis of each pavement section and tabulate the mechanistic responses (stresses, strains, and surface deflection) at various locations in a data base (file). The data file will include the following data and mechanistic responses and their corresponding locations:

    a) The SHRP ID number.
    b) The number of layers.
    c) The layer number.
    d) Layer type (AC, base, subbase, and roadbed), layer modulus (psi), and the layer poisson's ratio.
    e) The depth in inches under the center of the loaded area at which the mechanistic responses are tabulated.
    f) The deflection; radial, vertical, and shear stresses; and the vertical and radial strains at the top and bottom of the AC, base, and subbase layers, and at the top of the subgrade.
    g) The radial distances in inches from the center of the loaded area at which the mechanistic responses are tabulated.
    h) The surface deflection, vertical and radial stresses, and radial strains at the center of the loaded area and at radial distances of 8, 12, 18, 24, 36, and 60 inches from the center of the loaded area.

3. Use the same databank and the AASHTO design procedure to estimate the structural number of each pavement section and the number of design ESAL.

4. Statistically correlate the mechanistic responses to the distress data (rut depth and alligator cracks) to develop mechanistic-based pavement performance models.

5. Analyze the sensitivity of the mechanistically-based performance models and the AASHTO design equations to the various input variables including layer moduli and layer coefficients to investigate the validity of the concepts of layer coefficient and the loss of serviceability due to environmental factors. In this regard, two basic questions need to be addressed:

   a) Are the existing AASHTO nomographs relating material properties (e.g., modulus) and layer coefficients valid and accurate?

   b) What are the engineering interpretations of such correlations? For example, for similar pavement performance, the AASHTO design equations assume that (for the same input parameters) if the value of a layer coefficient is increased by a factor of 2 then the thickness of that layer can be halved. That is, the problem of a weak material can be solved by increasing its thickness. From the engineering point of view, decreasing strength yields higher strains (higher damage) and hence, higher rut potential. Hence, using weaker material (for economic reasons) may not be economical after all. In addition, the AASHTO design guide indicates that loss of serviceability due to environmental factors (i.e., swelling soil and frost heave) is additive to that due to traffic. In this regard, can the problems of swelling soil and frost heave be overcome by providing a thicker AC surface?

6. The validity of the overall statistical correlation of each equation (that is, the engineering interpretations of the equations) needs to be fully explained so that a proper diagnosis of the pavement problems can be obtained.

7. Examine the concept of the AASHTO drainage coefficients and their effects on the pavement design outcome. In this regard, the 1986 AASHTO design guide allows the use of thicker layers to solve drainage problems. That is, bad drainage implies lower drainage coefficient and hence, a thicker pavement layer. This concept/problem needs to be investigated along with the values of the drainage coefficients. Only after obtaining an accurate solution of the problem, the highway engineer can make a correct decision regarding the cost (a thin drainable layer versus a thick and nondrainable one) of the pavement structure and its expected performance.

8. Examine the concept of the Load Equivalency Factor (LEF). In this regard, two issues must be considered:

   a) For a given pavement section, is the value of LEF constant with time?. That is, since pavement deteriorates with time and its effective structural number, thickness, or structural capacity decreases with increasing traffic, should the value of LEF increase? Or, is the value of the LEF representative of the average value during the life of the pavement? If this is so, what is the validity of the AASHTO LEF since it was developed based on only two years of environmental damage? That is, should the LEF of two similar pavement sections located in different environmental regions be the same?

   b) For a given pavement section and a given truck type and load, is the value of LEF relative to roughness the same as that relative to fatigue? Stated differently, is the relative roughness damage delivered by a given truck equal to the relative fatigue damage delivered by the same truck? If not, then what values of LEF should be used for the various distress prediction models?

9. The concept of Present Serviceability Index (PSI) and roughness - The AASHTO equations are based on the PSI which is highly correlated to pavement roughness in terms of the average slope variance in the wheel paths. Patching, cracking, and rutting have minor effects on the PSI. In addition, most State Highway Agencies use roughometers that measure pavement roughness in terms of inch/mile (1, 8 and 21 through 38). Some agencies have already calibrated their devices to the 1/4 car International Roughness Index (IRI) while others are in the process of calibrating their devices. Hence, the present PSI equations cannot be used by most SHA. A correlation between the IRI and the PSI <u>must</u> be developed prior to the evaluation of the AASHTO equations. Such correlation will have countless benefits to all SHA as well as to their pavement management systems. Nevertheless, two preliminary statistical equations relating the PSI and the IRI have been developed and are being used by the State of Maine DOT and the State of South Carolina DOT as follows:

State of Maine DOT

$$PSI = 9.577 - \{4.394[\log(IRI/5.9597)]\}; \quad 5 > PSI > 0.0 \qquad \text{(Eq. 1.5)}$$

State of South Carolina DOT

$$PSI = 5\{\exp[-0.0286(IRI)]\} \qquad \text{(Eq. 1.6)}$$

where: IRI = the International Roughness Index (in/mile);
PSI = pavement serviceability index;
log = log to base 10; and
exp = exponential.

Although the South Carolina's equation seems to be better (it has the standard PSI range) than the Maine's (maximum possible PSI is 5), the accuracy and sensitivity of both equations need to be examined prior to their use in this research.

The implication of the original plan for data analysis is that the AASHTO equations must be evaluated using several techniques. Each technique should be capable of providing the proper engineering interpretations of the resulting equation. The specific technique to be used will depend on the data availability. For example, the inventory data (layer thicknesses and properties) from the National Database can be used to conduct a mechanistic analysis of the various pavement sections for the purposes of calculating the stresses and strains induced in the pavement due to a wheel load and the resulting pavement surface deflections. The mechanistic analysis can be conducted using several available computer programs such as ILLI-PAVE, MICHPAVE, VESYS, CHEVRON and others (MICHPAVE will be used in this study)(1, 25, 34). Statistical analysis can then be used to correlate the load related distress data (e.g., rutting, fatigue cracking) to the calculated stresses, strains, deflections, and layer thicknesses and properties. If such correlations can be found then the effects of the various material properties (e.g., resilient modulus) on pavement distresses can be found. Since selected material properties are correlated to layer coefficient in the AASHTO procedure, then the validity of such correlations can be investigated and, perhaps, calibrated. Such an investigation can be accomplished by studying the sensitivity of the AASHTO loss of serviceability to variations in the values of the layer coefficients. It is the opinion of the authors that mechanistic-based pavement prediction models can be found for most pavement distresses and that this technique will lead to the proper evaluation of the AASHTO equations and will optimize the benefits of the study.

Using the mechanistic evaluation procedure, another type of verification may be appropriate to determine whether specific material parameters/properties can be ignored from consideration in the pavement performance model (it possesses a little to no effect on the results). The following discussion is for illustrative purposes only, insofar as reference to statistical correlations between material properties and their mechanistic responses (stresses, strains, and deflections) to load and pavement performance is concerned. Several results (again, using LTPP data and material properties) are possible including:

1. Certain material properties (e.g., resilient modulus) appear to have specific effects on pavement performance which can be related to certain identifiable patterns of those properties using the inventory data of the various pavement sections.

2. Certain material properties (e.g., Poisson's ratio) appear to have no effect on pavement performance. That is, regardless of the range of the property and its variation, the pavement performance is more or less constant for the range of that property.

3. Variations in the values of the pavement performance appear to be related to variations in the material properties.

The results of such evaluations will have potential impacts on this study as well as on other SHRP projects such as A-005 and A-003A. Hence, preliminary and final findings obtained by other SHRP contractors and by SHA will be consulted and the findings of this study must be communicated to them.

One additional and very important point should be addressed relative to the overall objectives of the LTPP studies. The findings of the studies <u>must</u> address the concerns of the State Highway Agencies. Hence, they should be delivered in an implementable form without causing additional burden on the agencies.

The original plan for data analysis was designed with the end results in mind. It was thought that implementation of the end results of the original plan will benefit all State Highway Agencies, in particular, and the highway community, in general. These benefits include:

1. Calibrated and revised AASHTO design equations based on the mechanistic response of the various pavement layers.

2. Quantified understanding of the effects of loading, environment, material properties and variability, construction quality, and maintenance levels on pavement distress and performance.

3. Mechanistic-based pavement distress prediction models that include most load related distresses.

4. Development of a strategic approach for the analysis of future LTPP data that supports the overall goals of SHRP and LTPP and reflects the priority needs of the State Highway Agencies through the appraisal of the potential of the data to effectively meet those needs.

5. An equation for the calculation of PSI and loss of serviceability based on the IRI.

6. Modification or recommendations for modifications of the equivalent load factors (LEF) to be used in the design of pavement structures as well as in the prediction of pavement distresses.

7. A better understanding of the factors that affect pavement design and performance.

8. Improvement to existing pavement management systems

9. Improved method for calculating the remaining life of the pavement structure and hence, improved overlay design procedure.

10. Implementation of the analysis approach so that final products are delivered by September of 1992.

As stated above, the original plan calls for the conduct of the mechanistic evaluation of the AASHTO design equations by using the data elements (resilient moduli or layer coefficients) of the SHRP GPS sections. However, such data elements were not available throughout the duration of this study. Consequently, a new plan for the mechanistic-based evaluation of the AASHTO design equations was established. This plan is presented in the next section.

2.2 MODIFIED WORK PLAN FOR THE MECHANISTIC EVALUATION OF THE AASHTO FLEXIBLE DESIGN EQUATIONS

As stated earlier, originally, it was planned to conduct the mechanistic evaluation of the AASHTO design equations by using the appropriate data elements (resilient moduli or layer coefficients and layer thicknesses) of the NPPD data base for the SHRP GPS sections. However, such data elements were not available during this study. Hence, the exercise to assign values to the missing data elements according to an approved research plan (see section 1.4) was not performed. After consultation with the SHRP office and the members of the Expert Technical Group (ETG) of this study, a modified work plan for the mechanistic evaluation of the AASHTO design equation was established and approved. The modified work plan consists of five phases as follows:

PHASE 1 - Establish a full factorial experiment design matrix that consists of 243 cells (each cell represents a pavement section). Design each pavement section by using the 1986 AASHTO design procedure and establish the layer thicknesses. The full factorial experiment design matrix is shown in figure 1.

PHASE 2 - Conduct mechanistic analysis of each pavement section of step 1 by using MICHPAVE computer program and determine its mechanistic responses due to an 18-kip single axle load.

PHASE 3 - Compare the resulting mechanistic responses to determine whether or not the outputs of the AASHTO design procedure are reasonable.

Phase 4 - Select pavement sections from figure 1. Redesign (by using the AASHTO design procedure) the layer thicknesses based on four additional values of the drainage coefficients of the base layer and two values of the drainage coefficients of the subbase layer. Conduct mechanistic analysis of each redesigned section and then mechanistically evaluate the concept of drainage coefficients.

Phase 5 - Select pavement sections from figure 1. Redesign (by using the AASHTO design procedure) the layer thicknesses based on two additional values of loss of serviceability due to environmental factors. Conduct mechanistic analysis of each redesigned section and then mechanistically evaluate the concept of loss of serviceability.

Each of the three phases were accomplished in several steps. Details for each phase and the corresponding steps are presented in the next chapter of this report.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	Roadbed (ksi)																											
1	5	1	10	19	28	37	46	55	64	73	82	91	100	109	118	127	136	145	154	163	172	181	190	199	208	217	226	235
	10	2	11	20	29	38	47	56	65	74	83	92	101	110	119	128	137	146	155	164	173	182	191	200	209	218	227	236
	20	3	12	21	30	39	48	57	66	75	84	93	102	111	120	129	138	147	156	165	174	183	192	201	210	219	228	237
5	5	4	13	22	31	40	49	58	67	76	85	94	103	112	121	130	139	148	157	166	175	184	193	202	211	220	229	238
	10	5	14	23	32	41	50	59	68	77	86	95	104	113	122	131	140	149	158	167	176	185	194	203	212	221	230	239
	20	6	15	24	33	42	51	60	69	78	87	96	105	114	123	132	141	150	159	168	177	186	195	204	213	222	231	240
10	5	7	16	25	34	43	52	61	70	79	88	97	106	115	125	133	142	151	160	169	178	187	196	205	214	223	232	241
	10	8	17	26	35	44	53	62	71	80	89	98	107	116	125	134	143	152	161	170	179	188	197	206	215	224	233	242
	20	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180	189	198	207	216	225	234	243

Figure 1. Full factorial experiment design matrix, material properties, and levels of traffic volume in terms of 18-kip equivalent single axle load.

CHAPTER 3

MECHANISTIC EVALUATION OF THE AASHTO FLEXIBLE PAVEMENT DESIGN EQUATION

3.1 PHASE 1 - THE 1986 AASHTO DESIGN PROCEDURE

The outputs (thickness design) of the AASHTO design equations are affected by numerous variables. While some of these variables are very important to this study, others have no significant impacts. Therefore, the variables affecting the AASHTO design procedure were separated into three categories as follows:

1. Variables that have immediate impacts on this study and they should be included as primary variables. These include material properties (resilient modulus and/or layer coefficient), the resilient modulus of the roadbed soil, and the traffic volume in terms of 18-kips single axle load (1, 4, 8, and 39 through 58).

2. Variables that have some impact on this study but they can be considered as secondary variables. Hence, their effects on the AASHTO design outputs can be addressed after analyzing the effects of the primary variables. The secondary variables are the drainage coefficients and loss of serviceability due to environmental factors (1, 8, and 51 through 58).

3. Variables that have no impact on the objectives of this study (insignificant variables) and hence they can be ignored by assuming a constant value for each one. These variables include reliability level of the design, the overall standard deviation, performance period, analysis period, economic factors (e.g., material costs, salvage value, discount rate, inflation rate), initial serviceability index, and terminal serviceability index (1).

Because of the lack of the appropriate data elements in the National Pavement Performance Database (NPPD) and based on the three categories of variables listed above, the analysis of the AASHTO design equations was accomplished in several steps as presented below.

3.1.1 Step 1 - Full Factorial Experiment Design Matrix

Based on the three categories of variables presented in the previous section and in order to address the variability of the AASHTO design outputs due to changes in the value of each of the primary variables, a full factorial experiment design matrix was constructed. During the construction process, each of the five primary variables (resilient modulus of the AC, base, and subbase layers, resilient modulus of the roadbed soil, and cumulative traffic volume in terms of 18-kips ESAL) was given three values that fall within a typical range of values of each variable. These values are:

1. Resilient modulus of the AC materials of 100, 300, and 500 ksi.
2. Resilient modulus of the base materials of 10, 25, and 40 ksi.
3. Resilient modulus of the subbase material of 10, 15, and 25 ksi.
4. Effective resilient modulus of the roadbed soils of 1, 5, and 10 ksi.
5. Cumulative 18-kips ESAL of 5,000,000, 10,000,000, and 20,000,000.

Hence, the total number of cells (pavement sections) in the full factorial experiment design matrix is 243 (three levels for each of the five variables, $3^5 = 243$ cells). Figure 1 depicts the full factorial experiment design matrix. The matrix consists of 243 cells (for convenience and easy reference, the cells are numbered from 1 to 243). Each cell represents one artificial pavement section. For each cell (pavement section) the material properties (resilient modulus) assigned to the asphalt surface, base and subbase layers, and roadbed soil, and the traffic volume in terms of 18-kips equivalent single axle load are shown in the figure.

3.1.2 Step 2 - Secondary Variables

The following values of the secondary variables (variables that have some impacts on this study but they can be considered as secondary variables) were used in the AASHTO design of a flexible pavement section for each cell of figure 1 are:

1. Loss of Serviceability Due to Environmental Factors - It is assumed that the pavement material experiences no loss of serviceability due to frost heave or swelling soil. The evaluation of the concept of loss of serviceability due to frost and heave is presented in a later section of this report.

2. Drainage Coefficient - A value of the drainage coefficients of the base and subbase materials of 1.0 was assumed. The evaluation of the concept of drainage coefficient is presented in a later section of this report.

3.1.3 Step 3 Insignificant Variables

The following constant values of the insignificant variables (variables that have no impact on this study) were assumed and are used as inputs to the AASHTO design procedure for the design of a flexible pavement section for each cell of figure 1.

1. Analysis period of 20 years.
2. Performance period of 20 years.
3. Desired level of reliability of 95 percent.
4. An overall standard deviation of 0.45.
5. Serviceability index after initial construction of 4.2.
6. Design terminal serviceability index of 2.5
7. A discount rate of zero.
8. A salvage value of $0.0.

9. For each layer, the material cost is zero.
10. No maintenance and/or rehabilitation cost is allowed.

3.1.4 Step 4 - AASHTO Design Parameters (Layer Coefficients)

In this step, the **1986 AASHTO Guide for Design of Pavement Structure** was used to convert the resilient modulus of each pavement layer to an equivalent layer coefficient. To be specific, the following figures and equations were used:

1. Figure 2.5 of the 1986 AASHTO Guide for the Design of Pavement Structures was used to convert the resilient modulus of the AC layer to an equivalent layer coefficient ($\underline{a}_1$).

2. The layer coefficient of the base material ($\underline{a}_2$) was calculated by using the following AASHTO equation (see page II-18 of the **1986 AASHTO Guide for Design of Pavement Structure**):

$$a_2 = 0.249[LOG_{10}(E_{base})] - 0.977 \qquad \text{(Eq. 1.7)}$$

   where E_{base} = resilient modulus of the base material.

3. The layer coefficient of the subbase material ($\underline{a}_3$) was calculated by using the following AASHTO equation (see page II-21 of the **1986 AASHTO Guide for Design of Pavement Structure**):

$$a_3 = 0.227[\log_{10}(E_{subbase}) - 0.839 \qquad \text{(Eq. 1.8)}$$

   where $E_{subbase}$ = resilient modulus of the subbase material.

In addition, for the thickness design of all pavement sections of figure 1, the layered design analysis found on pages II-37 and II-38 of the **1986 AASHTO Guide for Design of Pavement Structures** was used. Hence, unique layer thicknesses were obtained for each of the 243 pavement sections of figure 1. Stated differently, no subjective solution (arbitrary selection of layer thicknesses) of the AASHTO structural number equation was allowed.

3.1.5 Step 5 - Outputs of the AASHTO Thickness Design

In this step, the 1986 AASHTO design procedure (DNPS86 computer program) was used for the design of each of the 243 pavement sections of figure 1. Figure 2 shows the experiment design matrix of figure 1 except that the value listed in each cell of the matrix represents the structural number of the pavement section in question. It should be noted that the structural number for each pavement was calculated by using the following AASHTO equation:

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	Roadbed (ksi)																											
1	5	8.71	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.71
	10	9.47	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9.47
	20	10.30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.30
5	5	5.41	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.41
	10	5.94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.94
	20	6.51	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6.51
10	5	4.29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.29
	10	4.75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.75
	20	5.25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.25

Figure 2. The AASHTO produced structural number for the 243 pavement sections of figure 1.

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3 \qquad \text{(Eq. 1.9)}$$

a_1, a_2, a_3 = the layer coefficient of the AC surface, base, and subbase, respectively;
D_1, D_2, D_3 = the thicknesses of the AC, base, and subbase layers in inches, respectively; and
m_2, m_3 = 1.0, the drainage coefficient of the base and subbase layers, respectively.

Figures 3, 4, 5, and 6 depict the total thickness, and the thicknesses of the AC, base, and subbase layers for all of the 243 pavement sections. It should be noted that these thicknesses were the direct outputs of the AASHTO DNPS 86 computer program. The software calculates the thickness of each layer by using the layered design analysis found on pages II-37 and II-38 of the **1986 AASHTO Guide for Design of Pavement Structures**.

3.1.6 Observations of the AASHTO outputs

Examination of the AASHTO produced structural number (SN) of the 243 pavement sections (see figure 2) indicates that for constant values of traffic volume, design reliability, standard deviation, serviceability loss, and resilient modulus of the roadbed soil (any one row in figure 2), the SN is constant. That is, for any pavement section, the AASHTO design SN is dependent on only one material variable, the resilient modulus of the roadbed soil. The structural number is independent of the type and properties of the AC, base, and subbase materials. This observation was expected and it is well known to most of the AASHTO users. Recall that the initial and terminal serviceability index of all the 243 pavement sections are constant and are equal to 4.2 and 2.5, respectively, it implies that, during the 20 years performance period, all pavement sections located in any one row of figure 2 will carry the same amount of traffic and will receive an equal amount of damage due to traffic loading. Once again, the important point of this observation is that:

The AASHTO structural number is a function of only one material variable, the resilient modulus of the roadbed soil. It is independent of the type and quality of the AC, base, and subbase layers.

Examination of the thicknesses of the AC, base, and subbase layers depicted in figures 4, 5, and 6 indicates that:

1. The thickness of the AC layer is independent of the quality (resilient moduli) of the subbase material and roadbed soil.
2. The thickness of the base material is independent of the resilient moduli of the AC layer and roadbed soil.
3. The thickness of the subbase material is independent of the resilient moduli of the AC

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	**Roadbed (ksi)**																											
1	5	87.02	64.02	51.52	90.50	67.97	52.34	87.61	66.53	52.51	74.50	51.51	38.94	81.60	59.07	43.44	80.19	59.11	45.09	72.54	49.55	36.98	80.21	57.68	42.05	79.03	57.95	43.93
	10	93.71	69.21	55.91	97.48	73.47	56.81	94.37	71.90	56.99	79.84	55.35	41.97	87.50	63.49	46.83	86.04	63.57	48.66	77.67	53.18	39.80	85.94	61.93	45.27	84.74	62.27	47.36
	20	100.96	74.86	60.56	104.98	79.36	61.59	101.68	77.69	61.80	85.65	59.53	45.24	93.82	68.20	50.43	92.34	68.35	52.46	83.25	57.13	42.84	92.08	66.46	48.69	90.87	66.88	50.99
5	5	39.92	34.02	30.86	43.37	37.97	31.72	40.48	36.53	31.89	27.37	21.52	18.32	34.47	29.07	22.82	33.06	29.11	24.47	25.41	19.56	16.36	33.08	27.68	21.43	31.90	27.95	23.31
	10	43.41	37.21	33.85	47.16	41.45	34.79	44.05	39.88	34.97	29.52	23.33	19.95	37.18	31.47	24.81	35.72	31.55	26.64	27.35	21.16	17.78	35.62	29.91	23.25	34.42	30.25	25.34
	20	47.16	40.66	37.03	51.14	45.10	38.03	47.84	43.43	38.24	31.81	25.26	21.68	39.98	33.94	26.87	38.50	34.09	28.90	29.41	22.86	19.28	38.24	32.20	25.13	37.03	32.62	27.43
10	5	23.82	23.82	23.82	27.78	27.73	24.68	24.39	26.29	24.85	11.28	11.28	11.28	18.38	18.83	15.78	16.97	18.87	17.43	9.32	9.32	9.32	16.99	11.99	14.39	15.81	17.71	16.27
	10	26.41	26.41	26.41	30.15	30.63	27.35	27.04	29.06	27.53	12.51	12.51	12.51	20.17	20.65	17.37	18.71	20.73	19.20	10.34	10.34	10.34	18.61	13.14	15.81	17.41	19.43	17.90
	20	29.16	29.16	29.16	33.04	33.64	30.16	29.84	31.97	30.37	13.81	13.81	13.81	21.98	22.48	19.00	20.50	22.63	21.03	11.41	11.41	11.41	20.24	14.34	17.26	19.03	21.16	19.56

Figure 3. The total thicknesses of the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10⁶)	Roadbed (ksi)																											
1	5	23.82	23.82	23.82	16.90	16.90	16.90	14.10	14.10	14.10	11.28	11.28	11.20	8.00	8.00	8.00	6.68	6.68	6.68	9.32	9.32	9.32	6.61	6.61	6.61	5.52	5.52	5.52
	10	26.41	26.41	26.41	18.95	18.95	18.95	15.82	15.82	15.82	12.51	12.51	12.51	8.97	8.97	8.97	7.49	7.49	7.49	10.34	10.34	10.34	7.41	7.41	7.41	6.19	6.19	6.19
	20	29.16	29.16	29.16	21.10	21.10	21.10	17.75	17.75	17.75	13.80	13.80	13.80	10.04	10.04	10.04	8.41	8.41	8.41	11.41	11.41	11.41	8.30	8.30	8.30	6.94	6.94	6.94
5	5	23.82	23.82	23.82	16.90	16.90	16.90	14.10	14.10	14.10	11.28	11.20	11.20	8.00	8.00	8.00	6.68	6.68	6.68	9.32	9.32	9.32	6.61	6.61	6.61	5.52	5.52	5.52
	10	26.41	26.41	26.41	18.95	18.95	18.95	15.82	15.82	15.82	12.51	12.51	12.51	8.97	8.97	8.97	7.49	7.49	7.49	10.34	10.34	10.34	7.41	7.41	7.41	6.19	6.19	6.19
	20	29.16	29.16	29.16	21.10	21.10	21.10	17.75	17.75	17.75	13.80	13.80	13.80	10.04	10.04	10.04	8.41	8.41	8.41	11.41	11.41	11.41	8.30	8.30	8.30	6.94	6.94	6.94
10	5	23.82	23.82	23.82	16.90	16.90	16.90	14.10	14.10	14.10	11.28	11.28	11.28	8.00	8.00	8.00	6.68	6.68	6.68	9.32	9.32	9.32	6.61	6.61	6.61	5.52	5.52	5.52
	10	26.41	26.41	26.41	18.95	18.95	18.95	15.82	15.82	15.82	12.51	12.51	12.51	8.97	8.97	8.97	7.49	7.49	7.49	10.34	10.34	10.34	7.41	7.41	7.41	6.19	6.19	6.19
	20	29.16	29.16	29.16	21.10	21.10	21.10	17.75	17.75	17.75	13.80	13.80	13.80	10.04	10.04	10.04	8.41	8.41	8.41	11.41	11.41	11.41	8.30	8.30	8.30	6.94	6.94	6.94

Figure 4. The AASHTO produced thicknesses of the asphalt layer for the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	Roadbed (ksi)																											
1	5	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97
	10	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31
	20	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66
5	5	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97
	10	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31
	20	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66
10	5	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97	0.00	0.00	0.00	10.38	5.45	0.00	10.29	6.81	2.97
	10	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31	0.00	0.00	0.00	11.20	5.95	0.00	11.22	7.51	3.31
	20	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66	0.00	0.00	0.00	11.94	6.40	0.00	12.09	8.18	3.66

Figure 5. The AASHTO produced thicknesses of the base layer for the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	Roadbed (ksi)																											
1	5	63.20	40.20	27.70	63.20	45.60	35.40	63.20	45.60	35.40	63.20	40.20	27.70	63.20	45.60	35.40	63.20	45.60	35.40	63.20	40.20	27.70	63.20	45.60	35.40	63.20	45.60	35.40
	10	67.30	42.80	29.50	67.30	48.60	37.90	67.30	48.60	37.90	67.30	42.80	29.50	67.30	48.60	37.90	67.30	48.60	37.90	67.30	42.80	29.50	67.30	48.60	37.90	67.30	48.60	37.90
	20	71.80	45.70	31.40	71.80	51.80	40.40	71.80	51.80	40.40	71.80	45.70	31.40	71.80	51.80	40.40	71.80	51.80	40.40	71.80	45.70	31.40	71.80	51.80	40.40	71.80	51.80	40.40
5	5	16.10	10.20	7.04	16.10	15.60	14.80	16.10	15.60	14.80	16.10	10.20	7.04	16.10	15.60	14.80	16.10	15.60	14.80	16.10	10.20	7.04	16.10	15.60	14.80	16.10	15.60	14.80
	10	17.00	10.80	7.44	17.00	16.60	15.80	17.00	16.60	15.80	17.00	10.80	7.44	17.00	16.60	15.80	17.00	16.60	15.80	17.00	10.80	7.44	17.00	16.60	15.80	17.00	16.60	15.80
	20	18.00	11.50	7.87	18.00	17.50	16.80	18.00	17.50	16.80	18.00	11.50	7.87	18.00	17.50	16.80	18.00	17.50	16.80	18.00	11.50	7.87	18.00	17.50	16.80	18.00	17.50	16.80
10	5	0.00	0.00	0.00	0.00	5.38	7.78	0.00	5.38	7.78	0.00	0.00	0.00	0.00	5.38	7.78	0.00	5.38	7.78	0.00	0.00	0.00	0.00	5.38	7.78	0.00	5.38	7.78
	10	0.00	0.00	0.00	0.00	5.73	8.40	0.00	5.73	8.40	0.00	0.00	0.00	0.00	5.73	8.40	0.00	5.73	8.40	0.00	0.00	0.00	0.00	5.73	8.40	0.00	5.73	8.40
	20	0.00	0.00	0.00	0.00	6.04	8.96	0.00	6.04	8.96	0.00	0.00	0.00	0.00	6.04	8.96	0.00	6.04	8.96	0.00	0.00	0.00	0.00	6.04	8.96	0.00	6.04	8.96

Figure 6. The AASHTO produced thicknesses of the subbase layer for the 243 pavement sections of figure 1.

and base layers. It is dependent on the resilient modulus of the roadbed soil. That is low values of the resilient modulus of the roadbed soil give thicker subbase layer but they do not affect the thicknesses of the other pavement layers.

3.2 PHASE 2 - MECHANISTIC ANALYSIS

Given the material properties listed in figure 1 and the layer thicknesses obtained from the AASHTO design procedure for the 243 pavement sections (see figures 4, 5, and 6), a mechanistic analysis of each section was conducted by using the linear option of the MICHPAVE computer program. Some of the results of the mechanistic analysis were also verified by using the CHEVRON5 computer program. It should be noted that for all mechanistic analysis, the following values of Poisson's ratios were assumed:

1. A value of Poisson's ratio of 0.3 was assumed for all AC layers regardless of their resilient moduli values.
2. A value of Poisson's ratio of 0.35 was assumed for all base material regardless of their resilient moduli values.
3. A value of Poisson's ratio of 0.4 was assumed for all subbase materials regardless of their resilient moduli values.
4. A value of Poisson's ratio of 0.45 was assumed for all roadbed soils regardless of their types or resilient moduli values.

Results of the mechanistic analysis (the mechanistic responses) of all 243 pavement sections are provided in the matrices shown in figures 7 through 14. These figures provide, respectively, the calculated compressive vertical stresses at the top of the base and subbase layers and at the top of the roadbed soil, the tensile stress at the bottom of the AC layer, and the peak deflections at the top of the AC surface, base and subbase layers as well as at the top of the roadbed soil.

3.3 PHASE 3 - MECHANISTIC EVALUATION OF THE AASHTO DESIGN EQUATIONS

3.3.1 Performance Period and Service Life of a Pavement Structure

Recall that the 243 pavement sections were assumed to have an initial (after construction) serviceability index of 4.2 and a terminal serviceability index of 2.5 as shown in figure 15. This implies that the minimum allowable serviceability index is 2.5. A pavement with a serviceability index of less than 2.5 is considered to be a substandard pavement (not a failed pavement). Further, in the AASHTO design process of all 243 pavement sections, a pavement design life (period) equal to its performance period of 20 years was used. Once again, any pavement designed for a 20 years performance period (also

	AC (ksi)	100									300									500								
	Base (ksi)	10			25			40			10			25			40			10			25			40		
ESAL (10^6)	Subbase (ksi) / Roadbed (ksi)	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
1	5	1.94	2.58	3.50	6.98	6.80	7.83	11.63	11.22	11.37	7.60	8.46	9.92	16.15	15.20	18.23	25.00	23.74	23.54	9.24	10.01	11.41	17.61	16.28	20.23	26.54	25.00	24.71
	10	1.69	2.18	2.91	5.18	5.07	5.84	9.37	9.03	9.06	6.03	6.81	8.09	13.77	12.89	15.66	21.88	20.73	19.63	7.23	7.95	9.23	15.37	14.09	17.85	22.84	21.63	20.36
	20	1.48	1.84	2.38	4.58	4.45	5.13	7.58	7.36	7.40	1.37	2.03	2.88	11.27	10.63	12.74	18.07	17.43	15.34	6.24	6.83	7.91	12.52	11.61	14.36	19.68	18.93	17.65
5	5	1.47	1.80	2.15	6.71	6.31	6.74	11.33	10.70	10.40	6.23	6.60	6.93	15.83	14.55	16.08	24.68	23.17	22.44	7.42	7.70	7.91	17.30	15.64	17.65	26.24	24.45	23.62
	10	1.29	1.55	1.81	4.96	4.66	4.92	9.14	8.64	8.37	5.01	5.35	5.68	13.51	12.37	13.69	21.63	20.28	18.71	5.91	6.20	6.46	15.12	13.57	15.41	22.60	21.18	19.43
	20	1.12	1.33	1.53	4.37	4.11	4.37	7.24	7.03	6.80	0.0	2.48	2.92	9.39	10.18	11.16	15.91	15.25	14.71	5.07	5.31	5.51	12.30	11.16	12.48	16.27	18.54	16.84
10	5	1.71	1.71	1.71	6.84	6.30	6.37	11.49	10.65	10.06	7.28	7.28	7.28	16.04	14.49	15.00	24.89	23.08	21.95	8.92	8.92	8.92	17.52	13.22	16.31	26.45	24.35	23.12
	10	1.46	1.46	1.46	5.03	4.60	4.57	9.24	8.59	8.12	5.72	5.72	5.72	13.66	12.29	12.72	21.78	20.18	18.28	6.90	6.90	6.90	15.28	11.37	14.16	22.75	21.08	18.99
	20	1.25	1.25	1.25	4.11	4.11	4.11	7.44	6.97	6.59	0.95	0.95	0.95	11.16	10.11	10.39	17.96	16.94	14.38	5.90	5.90	5.90	12.42	9.18	11.53	19.58	18.44	16.45

Figure 7. The compressive vertical stresses at the top of the base layer for the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10⁶)	Roadbed (ksi)																											
1	5	1.94	2.58	3.50	1.19	1.91	7.83	3.07	2.03	7.71	7.60	8.46	9.92	4.16	3.34	18.23	4.94	3.23	14.06	9.24	10.01	11.41	4.27	7.38	20.23	4.58	7.82	14.36
	10	1.69	2.18	2.91	1.06	1.60	5.84	2.55	1.70	3.04	6.03	6.81	8.09	3.45	2.75	15.66	1.48	2.67	5.46	7.23	7.95	9.23	3.55	6.10	17.85	4.23	5.56	11.76
	20	1.48	1.84	2.38	0.94	1.32	5.13	1.00	3.05	2.50	1.37	2.03	2.88	1.29	4.71	12.74	3.35	5.24	9.44	6.24	6.83	7.91	2.97	5.07	14.36	3.14	5.42	9.74
5	5	1.47	1.80	2.15	1.56	2.34	6.74	2.58	2.64	6.70	6.23	6.60	6.93	3.58	4.30	16.08	4.24	4.50	12.61	7.42	7.70	7.91	3.70	6.53	17.65	3.82	6.81	12.88
	10	1.29	1.55	1.81	1.33	1.91	4.92	2.14	2.14	3.58	5.01	5.35	5.68	2.95	3.49	13.69	2.37	3.66	6.78	5.91	6.20	6.46	3.04	5.36	15.41	3.63	5.75	10.59
	20	1.12	1.33	1.53	1.10	1.54	4.37	1.71	2.57	2.89	3.20	2.48	2.92	2.52	4.09	11.16	2.88	4.58	8.59	5.07	5.31	5.51	2.53	4.43	12.48	3.02	4.71	8.70
10	5	1.71	1.71	1.71	2.37	2.89	6.37	2.86	3.29	6.38	7.28	7.28	7.28	3.98	5.25	15.00	4.27	5.59	11.99	8.92	8.92	8.92	4.11	13.22	16.31	4.31	6.67	12.24
	10	1.46	1.46	1.46	1.95	2.33	4.57	2.33	2.65	3.93	5.72	5.72	5.72	3.26	4.26	12.72	3.46	4.54	7.39	6.90	6.90	6.90	3.37	11.37	14.16	4.01	5.61	10.07
	20	1.25	1.25	1.25	1.63	1.91	4.11	1.73	2.51	3.16	0.95	0.95	0.95	2.76	4.03	10.39	3.13	4.42	8.23	5.90	5.90	5.90	2.78	9.18	11.53	2.88	4.58	8.25

Figure 8. The compressive vertical stresses at the top of the subbase layers of the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	**Roadbed (ksi)**																											
1	5	0.53	0.43	0.42	0.43	0.43	0.43	0.53	0.55	0.43	0.54	0.45	0.45	0.44	0.44	0.65	0.44	0.57	0.45	0.54	0.45	0.66	0.53	0.57	0.65	0.54	0.44	0.64
	10	0.42	0.52	0.40	0.41	0.52	0.40	0.41	0.52	0.40	0.52	0.41	0.41	0.41	0.41	0.42	0.41	0.41	0.59	0.42	0.42	0.60	0.52	0.41	0.61	0.51	0.41	0.42
	20	0.40	0.39	0.44	0.45	0.39	0.40	0.41	0.40	0.53	0.52	0.41	0.41	0.51	0.40	0.41	0.52	0.41	0.2	0.41	0.41	0.41	0.51	0.41	0.58	0.52	0.41	0.57
5	5	0.90	0.60	0.53	0.67	1.05	0.66	0.70	1.13	0.68	0.84	0.76	2.08	1.26	0.81	0.79	0.78	0.78	0.77	0.87	0.80	2.13	1.30	0.82	2.22	0.79	0.78	0.78
	10	0.64	0.58	0.53	0.63	0.91	1.13	0.86	0.67	0.66	1.29	1.53	1.75	1.09	1.35	0.75	1.14	1.37	1.72	0.79	1.57	0.61	1.12	0.77	0.77	0.75	0.75	0.74
	20	0.60	0.81	0.88	0.70	0.62	0.96	0.61	0.85	0.63	1.12	0.65	0.54	0.97	1.15	0.70	1.01	1.21	1.46	0.73	0.68	0.57	0.97	1.20	0.72	1.05	1.22	0.71
10	5	0.87	0.87	0.87	0.94	0.96	0.93	2.86	0.98	0.95	7.28	7.28	7.28	3.98	3.78	1.40	4.72	3.96	1.24	8.92	8.92	8.92	4.11	2.46	1.54	1.12	1.31	1.31
	10	0.82	0.82	0.82	0.88	0.89	0.86	2.33	0.90	2.25	5.72	5.72	5.72	3.26	1.23	1.23	1.00	1.13	1.12	6.90	6.90	6.90	3.37	4.81	1.34	4.01	1.17	1.18
	20	0.77	0.77	0.77	0.82	1.50	1.79	0.83	1.67	0.83	0.95	0.95	0.95	1.04	1.09	3.21	3.13	2.68	3.25	5.90	5.90	5.90	2.78	1.74	3.32	0.97	1.06	1.07

Figure 9. The compressive vertical stresses at the top of the roadbed soil for the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	**Roadbed (ksi)**																											
1	5	10.71	9.30	7.08	14.11	14.46	12.66	13.00	13.87	14.01	59.76	54.59	46.77	79.46	80.39	72.93	76.32	79.15	78.99	92.61	85.86	75.78	125.23	126.17	115.76	124.39	128.24	127.18
	10	8.47	7.39	5.65	11.77	12.11	10.59	10.68	11.32	11.48	50.10	46.02	39.69	67.73	68.54	62.46	66.98	69.26	69.37	78.18	72.91	64.81	107.46	108.26	99.83	110.62	113.79	113.27
	20	6.67	5.84	4.49	9.15	9.41	8.34	8.78	9.25	9.42	44.28	40.89	35.36	57.84	58.54	53.53	58.68	60.36	64.05	65.31	61.23	54.75	92.50	93.23	86.28	96.78	99.09	98.72
5	5	11.51	10.42	9.07	14.37	15.07	14.35	13.23	14.38	15.21	63.38	60.05	55.71	80.82	83.40	80.79	77.34	81.33	83.73	97.43	93.58	88.58	127.46	130.97	127.36	126.18	131.93	134.85
	10	9.06	8.19	7.13	11.93	12.52	11.95	10.81	11.64	12.29	52.86	50.14	46.56	68.70	70.75	68.73	67.74	70.91	73.10	81.89	78.75	74.62	109.10	111.85	109.08	111.95	116.60	119.36
	20	7.12	6.42	5.59	9.27	9.72	9.27	10.30	9.47	10.01	52.04	44.29	41.03	64.54	60.22	58.61	64.10	66.58	68.47	68.13	65.59	62.22	93.78	95.96	93.76	105.5	101.31	103.60
10	5	11.15	11.15	11.15	14.25	15.28	15.27	13.12	14.60	15.93	60.42	60.42	60.42	79.92	83.88	83.87	76.78	81.99	86.19	93.26	93.26	93.26	125.94	149.90	131.42	124.98	132.80	138.43
	10	8.85	8.85	8.85	11.88	12.73	12.73	10.76	11.83	12.84	50.84	50.84	50.84	68.11	71.24	71.30	67.29	71.50	75.11	79.02	79.02	79.02	108.08	127.52	112.49	111.12	117.40	122.32
	20	7.00	7.00	7.00	9.61	9.85	9.86	8.85	9.63	10.43	45.18	45.18	45.18	58.20	60.69	60.78	58.99	62.16	69.81	66.19	66.19	66.19	93.10	108.95	96.95	97.30	102.03	106.03

Figure 10. The tensile stresses at the bottom of the AC layers for the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10⁶)	Roadbed (ksi)																											
1	5	76.31	74.7	73.8	77.5	76.1	74.9	77.6	76.4	75.4	74.5	72.5	71.5	76.9	75.4	73.5	77.3	76.0	74.7	73.9	72.0	71.5	76.0	74.4	72.7	76.8	75.6	74.2
	10	76.1	74.4	73.6	77.3	75.7	74.7	77.2	75.9	75.0	73.3	71.4	70.2	75.8	74.3	72.7	76.2	74.9	73.6	74.0	72.0	70.9	75.6	74.0	72.4	75.3	74.0	72.7
	20	73.5	71.8	70.2	74.4	72.8	74.1	76.8	75.4	74.4	73.1	71.2	70.0	74.2	72.7	71.2	75.6	74.2	35.19	71.6	69.8	68.7	74.5	72.9	71.4	75.0	73.7	72.5
5	5	23.3	23.1	22.9	24.6	24.5	24.4	24.9	25.0	25.0	22.4	22.1	21.9	24.5	24.8	24.5	24.9	25.3	25.3	21.8	21.5	21.3	24.2	24.4	24.1	24.7	25.1	25.1
	10	22.6	22.5	22.4	23.9	23.7	23.5	24.1	24.0	24.1	21.1	20.8	20.6	23.0	23.1	22.9	23.4	23.7	23.7	20.5	20.3	20.1	22.6	22.7	22.5	23.1	23.4	23.4
	20	22.1	22.0	21.9	23.0	22.7	22.8	21.14	23.4	23.3	19.64	19.9	19.7	20.87	21.8	21.6	21.26	21.70	21.83	19.4	19.2	19.0	21.2	21.3	21.1	21.14	22.0	22.0
10	5	16.4	16.4	16.4	17.7	18.0	17.9	18.0	18.4	18.6	14.9	14.9	14.9	17.3	17.9	17.8	17.6	18.5	18.8	14.3	14.3	14.3	16.9	18.7	17.4	17.4	18.3	18.5
	10	15.9	15.9	15.9	17.0	17.2	17.1	17.2	17.6	17.7	13.9	13.9	13.9	15.9	16.4	16.3	16.3	17.0	17.2	13.2	13.2	13.2	15.5	17.0	15.9	16.0	16.7	16.9
	20	15.5	15.5	15.5	16.4	16.5	16.5	16.6	16.9	16.9	13.0	13.0	13.0	14.8	15.1	15.1	15.1	15.7	16.93	12.2	12.2	12.2	14.3	15.5	14.6	14.8	15.4	15.5

Figure 11. The vertical deflections at the top of the AC layers of the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	**Roadbed (ksi)**																											
1	5	69.9	68.2	67.3	70.4	71.7	69.2	72.3	71.1	70.0	73.1	71.1	70.1	75.8	74.3	72.5	76.3	75.1	73.7	73.1	71.2	70.7	75.5	73.8	72.2	76.4	75.2	73.8
	10	69.4	67.8	66.9	69.7	71.3	68.6	71.6	70.3	69.4	71.8	69.8	68.6	74.6	73.1	71.5	75.1	73.8	72.5	73.2	71.2	70.1	75.0	73.4	71.8	74.8	73.5	72.1
	20	66.7	64.9	63.4	66.7	68.2	67.8	70.8	69.5	68.5	71.4	69.5	68.4	72.9	71.4	69.9	74.4	73.1	34.07	70.8	68.9	67.8	73.8	72.2	70.7	74.4	73.1	72.0
5	5	16.9	16.7	16.6	18.9	18.9	18.7	19.6	19.8	19.8	21.0	20.7	20.4	23.5	23.7	23.4	24.0	24.4	24.4	21.1	20.8	20.6	23.7	23.9	23.6	24.3	24.7	24.7
	10	16.0	15.9	15.8	17.7	17.9	17.6	18.5	18.5	18.5	19.6	19.3	19.1	21.8	21.9	21.7	22.4	22.7	22.7	19.7	19.5	19.3	22.0	22.1	21.9	22.6	22.9	22.9
	20	15.3	15.2	15.2	16.5	16.8	16.6	15.31	17.5	17.5	0.0	18.2	18.1	19.57	20.4	20.2	20.13	20.58	20.71	18.6	18.3	18.2	20.6	20.6	20.5	17.51	21.4	21.4
10	5	10.0	10.0	10.0	12.3	12.0	12.2	12.7	13.2	13.3	13.5	13.5	13.5	16.2	16.8	16.7	16.7	17.6	17.8	14.3	14.3	14.3	16.4	18.2	16.9	17.0	17.8	18.1
	10	9.30	9.30	9.30	11.2	11.2	11.2	11.6	12.0	12.1	12.3	12.3	12.3	14.7	15.2	15.2	15.3	16.0	16.2	13.2	13.2	13.2	14.9	16.4	15.3	15.5	16.2	16.5
	20	8.80	8.80	8.80	10.3	10.3	10.3	10.7	11.0	11.1	11.4	11.4	11.4	13.4	13.8	13.8	14.0	14.6	15.79	12.2	12.2	12.2	13.6	14.8	13.9	14.2	14.8	15.0

Figure 12. The vertical deflection at the top of the base layers of the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	Roadbed (ksi)																											
1	5	69.9	68.2	67.3	69.7	69.1	69.2	70.3	69.6	69.2	73.1	71.1	70.1	72.2	72.0	72.5	72.9	72.4	72.3	73.1	71.2	70.7	71.9	71.6	72.2	72.9	72.5	72.4
	10	69.4	67.8	66.9	69.5	68.6	68.6	69.9	68.9	68.6	71.8	69.8	68.6	71.4	71.0	71.5	72.0	71.4	71.2	73.2	71.2	70.1	71.8	71.4	71.8	71.6	71.0	70.8
	20	66.7	64.9	63.4	66.7	65.6	67.8	69.3	68.3	67.8	71.4	69.5	68.4	70.1	69.5	69.9	71.6	70.8	32.79	70.8	68.9	67.8	71.0	70.4	70.7	71.6	70.8	70.7
5	5	16.9	16.7	16.6	17.0	17.6	18.7	17.7	18.3	19.0	21.0	20.7	20.4	19.9	21.4	23.4	20.6	21.8	23.0	21.1	20.8	20.6	20.2	21.7	23.6	20.9	22.1	23.3
	10	16.0	15.9	15.8	16.2	16.6	17.6	16.8	17.1	17.8	19.6	19.3	19.1	18.6	19.9	21.7	19.2	20.2	21.4	19.7	19.5	19.3	18.9	20.1	21.9	19.5	20.5	21.6
	20	15.3	15.2	15.2	15.3	15.6	16.6	13.58	16.3	16.8	18.03	18.2	18.1	16.54	18.6	20.2	17.1	18.22	19.43	18.6	18.3	18.2	17.8	18.9	20.5	17.51	19.2	20.2
10	5	10.0	10.0	10.0	10.0	11.0	12.2	10.7	11.7	12.5	13.5	13.5	13.5	16.2	14.5	16.7	16.7	14.9	16.4	13.5	13.5	13.5	12.9	18.2	16.9	13.5	15.2	16.7
	10	9.30	9.30	9.30	9.30	10.1	11.2	9.90	10.6	11.4	12.3	12.3	12.3	11.6	13.2	15.2	15.3	13.5	14.9	12.4	12.4	12.4	11.7	16.4	15.3	12.3	13.8	15.1
	20	8.80	8.80	8.80	8.80	9.40	10.3	9.20	9.80	10.5	11.4	11.4	11.4	10.6	12.0	13.8	14.0	12.3	14.52	11.4	11.4	11.4	10.8	14.8	13.9	11.4	12.6	13.8

Figure 13. The vertical deflections at the top of the subbase layers of the 243 pavement sections of figure 1.

AC (ksi)		100									300									500								
Base (ksi)		10			25			40			10			25			40			10			25			40		
Subbase (ksi)		10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
ESAL (10^6)	Roadbed (ksi)																											
1	5	65.4	65.5	65.5	65.3	65.3	65.7	65.2	65.4	65.6	65.6	66.1	66.8	65.5	65.9	66.5	65.5	65.9	66.5	65.4	65.5	65.5	65.5	65.3	65.7	65.2	65.4	65.6
	10	65.4	65.4	65.4	65.5	65.4	65.6	65.3	65.3	65.5	65.2	65.5	65.7	65.5	65.7	66.2	65.5	65.7	66.1	65.4	65.4	65.4	65.4	65.4	65.6	65.3	65.3	65.5
	20	63.2	62.9	62.1	63.2	62.9	65.2	65.2	65.2	65.1	65.5	65.7	65.9	64.8	64.9	65.2	65.7	65.9.	27.00	63.2	62.9	62.1	62.1	62.9	65.2	65.2	65.2	65.1
5	5	14.9	15.4	15.8	14.9	15.4	16.3	15.2	15.8	16.5	17.1	18.2	18.9	16.5	17.6	19.1	16.7	17.6	18.8	14.9	15.4	15.8	15.8	15.4	16.3	15.2	15.8	16.5
	10	14.3	14.8	15.1	14.5	14.8	15.5	14.7	15.0	15.7	16.3	17.2	17.7	15.7	16.7	17.9	15.9	16.7	17.7	14.3	14.8	15.1	15.1	14.8	15.5	14.7	15.0	15.7
	20	13.9	14.3	14.5	13.9	14.1	14.9	11.05	14.6	15.0	14.3	16.4	16.9	13.02	15.9	17.0	17.1	14.37	15.66	13.9	14.3	14.5	14.5	14.1	14.9	13.5	14.6	15.0
10	5	10.0	10.0	10.0	10.0	9.90	10.6	10.7	10.4	10.8	13.5	13.5	13.5	12.7	12.6	13.8	13.3	12.9	13.6	10.0	10.0	10.0	10.0	9.90	10.6	10.7	10.4	10.8
	10	9.30	9.30	9.30	9.30	9.20	9.70	9.90	9.60	9.90	12.3	12.3	12.3	11.6	11.5	12.5	12.1	11.7	12.3	9.40	9.40	9.40	9.30	9.20	9.80	9.90	9.60	9.90
	20	8.80	8.80	8.80	8.80	8.60	9.10	9.20	8.90	9.20	11.4	11.4	11.4	10.6	10.6	11.5	11.2	10.8	12.03	8.80	8.80	8.80	8.70	8.60	9.00	9.20	8.90	9.20

Figure 14. The vertical deflections at the top of the roadbed soils of the 243 pavement sections of figure 1.

called the Design Life "DL") is expected to serve the traveling public for a period of 20 years during which the serviceability index of the pavement is higher than the minimum allowable standard of 2.5. In general, some pavements may perform more than the assumed 20 year performance period, others less than the 20 year period, and still others, may have an actual performance period equal to the assumed one.

In order to better differentiate between the assumed performance period (assumed during the design process) and the actual performance period, the term "Service Life (SL)" is introduced herein. Hence, the service life of a pavement structure relative to its pavement serviceability index (PSI) can be defined as follows:

The Service Life of a pavement structure relative to its PSI is the actual time period in years between construction and/or rehabilitation and the present time.

Given the definition of the service life of the pavement, a second term "the Remaining Service Life (RSL)" can be defined as follows:

The Remaining Service Life (RSL) of a pavement structure relative to its PSI is the number of years between any time "t" where PSI data is collected and the expected time (based on the pavement rate of deterioration) at which the PSI reaches its terminal value (e.g., 2.5).

Given the above definitions, the SL of any pavement structure may be lower than, higher than, or equal to its assumed performance period (DL) as shown in figure 16.

Using the service life and the remaining service life as defined above, two aspects that are very important to State Highway Agencies are noted below:

1. Comparison of the SL of a pavement structure with the DL assumed during the design process will determine whether or not the design process and perhaps the construction practices need to be modified. That is the SL of a pavement can be used as feedback data to assess the design process and the construction practices used by the State Highway Agency.

2. Using the distress data (data collected periodically as a part of the pavement management process), the remaining service life (RSL) of each pavement section in question or the weighted average remaining service life of a part or the entire pavement network can be calculated as shown in figure 17. The RSL data can be used by various people within and outside the State Highway Agencies including:

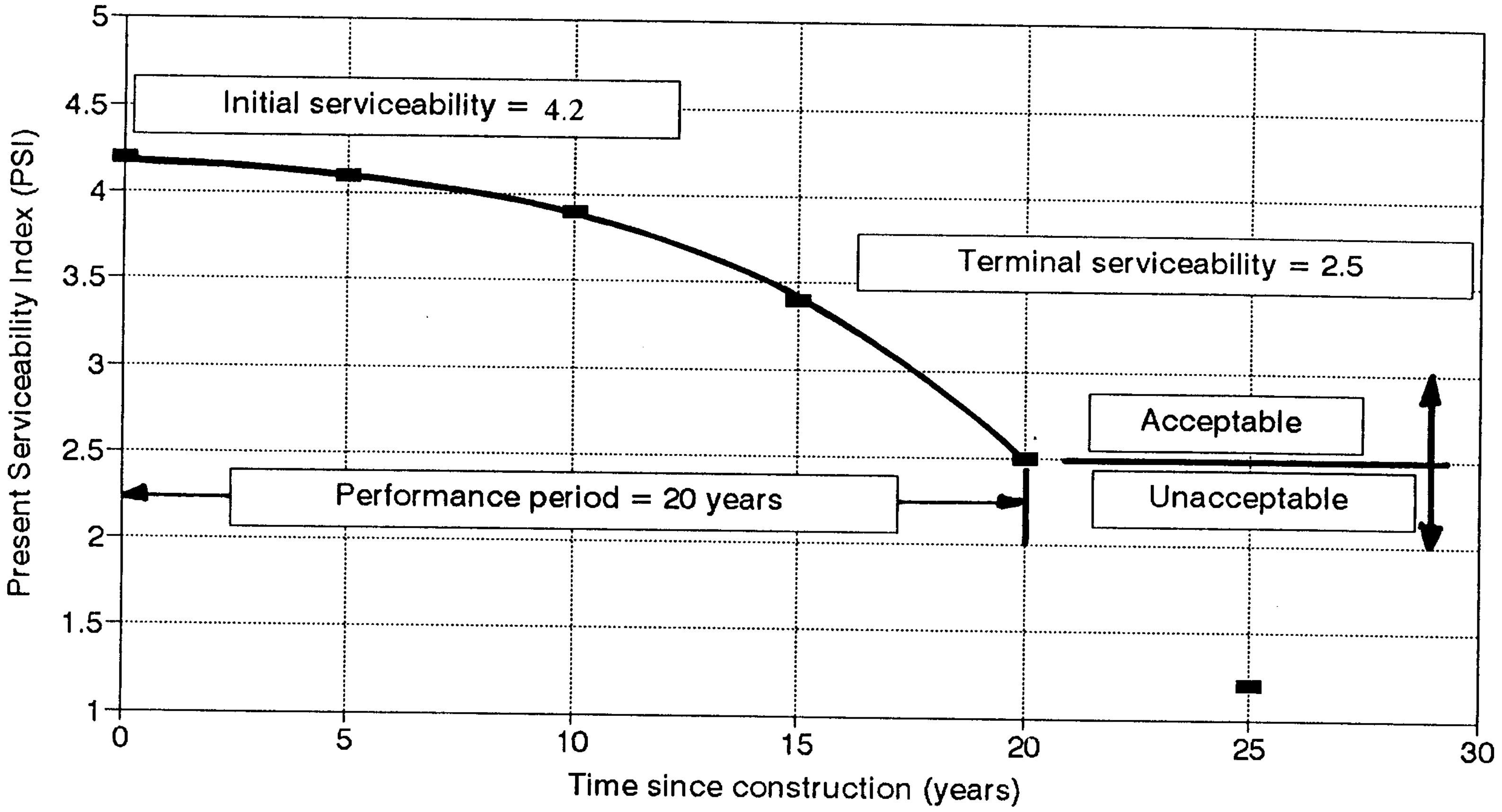

Figure 15. The initial and terminal PSI values and the performance period used in the AASHTO design of all 243 pavement sections of figure 1.

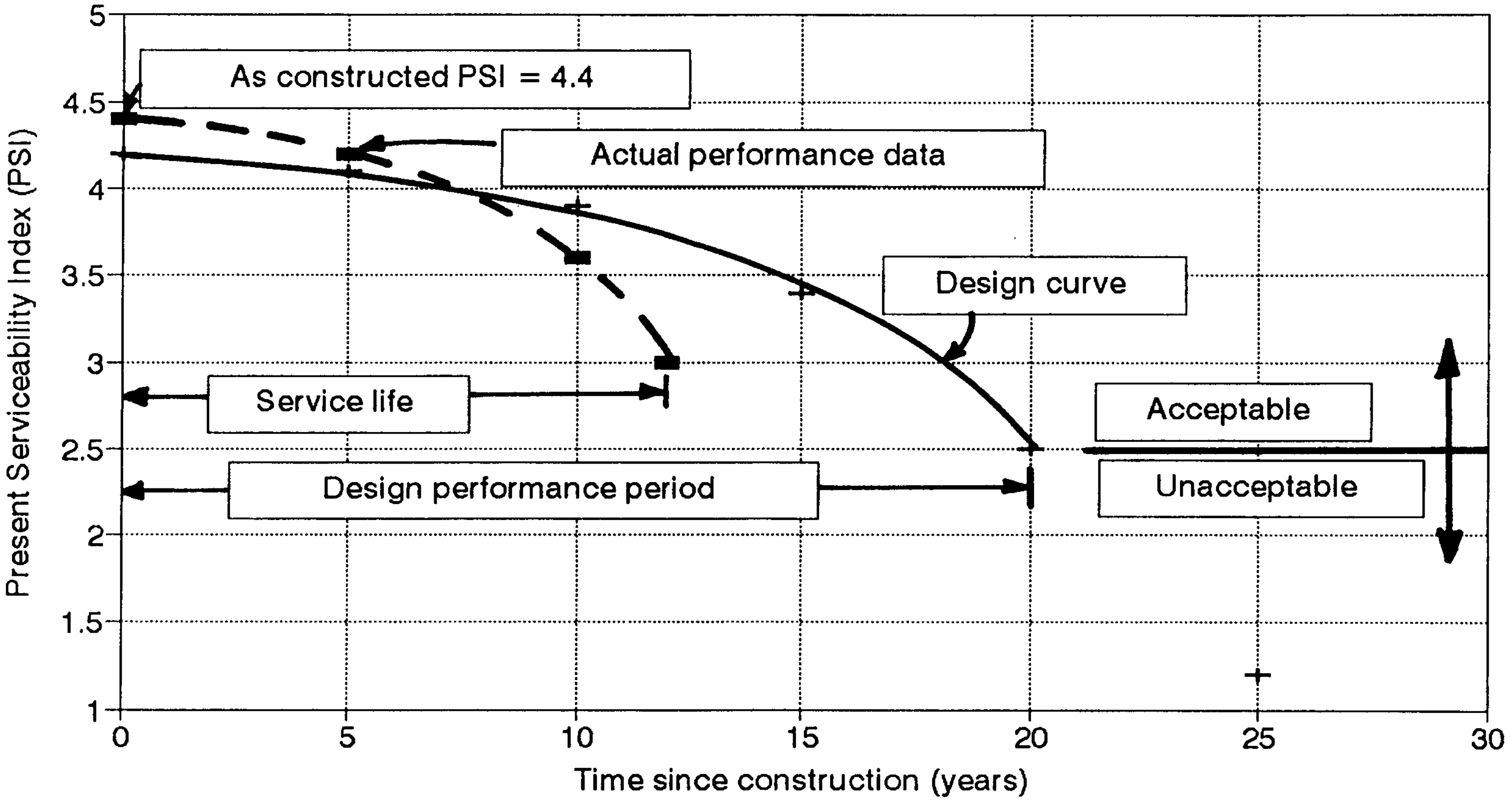

Figure 16. Comparison of service life and performance period of a pavement structure.

a) Engineers to determine the optimum rehabilitation time of the pavement in question, to assess the impacts of various rehabilitation strategies on the health of the pavement network, and the optimum strategy that will produce an even pavement distribution in the various values of the RSL which produces a constant yearly work load for the State highway Agency.
b) Managers to assess the state of the pavement network (the percentages of the network with 2, 5, 10, and 20 years of RSL), the percent of the users that are traveling on substandard roads, and future budgetary needs to maintain and/or improve the health of the system.
c) Legislators to assess the impacts of the budget appropriation and future budgetary needs.
d) Planners to determine present and future planning needs.

3.3.2 Engineering Criteria for the Mechanistic Evaluation of the AASHTO Design Equations

Recall that all 243 pavement sections were designed by using the AASHTO design procedure and that the total loss of serviceability during the performance period is 1.7 PSI (an initial PSI of 4.2 was assumed and a terminal PSI of 2.5 was used). Further, the results of the AASHTO design procedure (see figures 1 through 6) indicated that:

For a given value of the resilient modulus of the roadbed soil and for a constant traffic volume, the AASHTO design procedure produces pavement sections with a constant SN which provides an equal level of protection against traffic loading to all pavement layers regardless of the type and quality of the AC, base, and subbase layers.

For example, the three pavement sections of cells 141, 114, and 87 of figure 1 were designed by the AASHTO design procedure to have 20 years of service life (performance period) and to carry 20,000,000 ESAL during its service life. All three sections were made of the same materials except that the resilient modulus of the base layer varies from 40 to 25 and to 10 ksi for sections 141, 114, and 87, respectively. The AASHTO produced layer thicknesses and the layers resilient moduli of the three pavement-sections are listed in table 3. Since all three pavements were designed to serve the same number of 18-kips ESAL during the 20 years performance period, the amount of damage received by all three sections at the end of their design performance period is the same. This implies that the three pavement sections are designed to have the same level of protection against damage due to traffic load.

Similarly, the pavement-sections of cells 141, 150 and 159 (the only difference is the resilient modulus of the subbase layer, it varies from 10 to 15 and to 25 ksi) and of cells 141, 60, and 222 (the only difference is the resilient modulus of the AC layer, it varies from

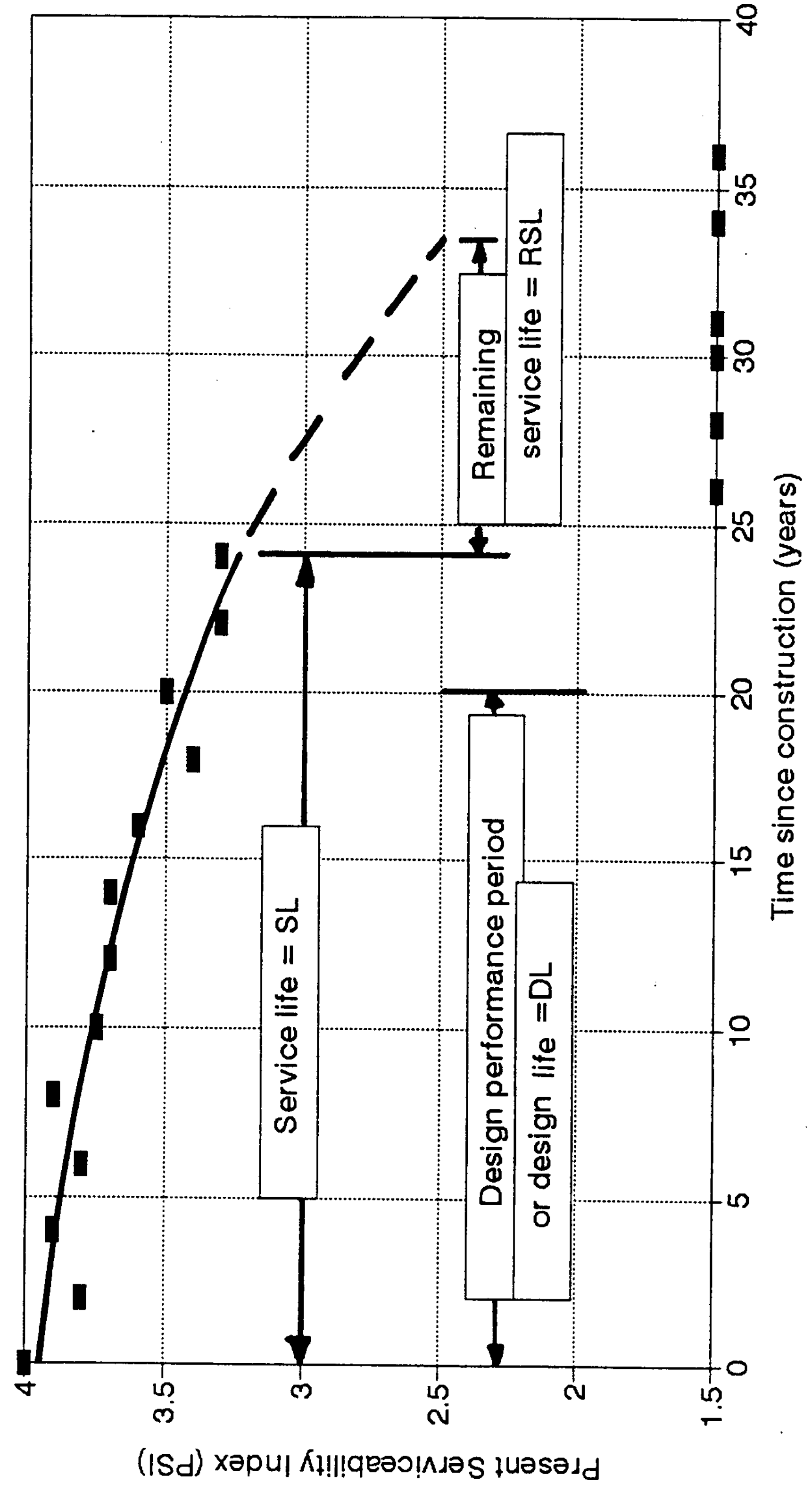

Figure 17. The remaining service life of a pavement structure calculated by using the distress data and the rate of deterioration of that pavement.

Table 3. Layer thicknesses and moduli of the pavement sections of cells 141, 114, and 87 of figure 1 (effective resilient modulus of the roadbed soil of 5 ksi, performance period of 20 years, and 20,000,000 18-kips ESAL).

Cell Number	Structural Number	Total Thickness (inch)	Layer Thicknesses (inches)			Layer Modulus (ksi)		
			AC	Base	Subbase	AC	Base	Subbase
141	6.51	38.5	8.41	12.09	18.0	300	40	10
114	6.51	39.98	10.04	11.94	18.0	300	25	10
87	6.51	31.80	13.80	0.0	18.0	300	10	10

300, to 100, to 500 ksi, respectively) are shown in tables 4 and 5. According to the AASHTO design procedure, all these seven pavements-sections are suppose to carry the same amount of traffic of 20,000,000 18-kips ESAL, all supported by the same roadbed soil, and all should have a performance period of 20 years. Hence, the amount of damage delivered to each pavement-section during the performance period is the same and the three pavements receive the same level of protection.

Based upon the above observation, an engineering evaluation criterion was formulated. The criterion can be summarized as follows:

Since for the same roadbed soil and traffic volume, the AASHTO design procedure produces pavement sections that receive the same level of protection against damage due to traffic, then the magnitudes of the deflections, stresses, and strains induced in these pavement-sections due to an 18-kips ESAL must be the same. Otherwise, the level of protection is different and the three pavements will not have an equal performance period of 20 years.

The above criterion assumes that the induced levels of deflection, stresses, and strains induced in a pavement section due to traffic load are indicators of the damage received by that pavement. This assumption is reasonable because of several reasons including:

1. The shape of the pavement deflection basin is a function of the pavement peak deflection and the ability of the pavement section to spread the load to the lower layers. Higher peak deflections and steeper deflection basins imply that the delivered energy is concentrated under the wheel load and thus, more damage is delivered to that area.

2. For a given modulus value, higher stresses and strains induced in a pavement section cause higher damage. This should not be interpreted as the modulus of a material is a measure of its strength. Rather, it simply means that higher stress cause higher total strains. If the strain is totally recoverable (elastic), then no strain energy will be available to do the damage. Unfortunately, for most pavement materials, higher total strain causes higher plastic (permanent strain) which manifest itself as rutting and/or fatigue cracking.

3.3.3 Evaluation of the AASHTO Design Equations

As stated in chapter 2 of this report, the 243 pavement sections were analyzed by using the linear option of the MICHPAVE computer program. It should be noted that, although the MICHPAVE program is a finite element-based program, the accuracy of the outputs (stresses, strains, and deflections) of its linear option is better than 99.5 percent when

Table 4. Layer thicknesses and moduli of the pavement sections of cells 141, 150, and 159 of figure 1 (effective resilient modulus of the roadbed soil of 5 ksi, performance period of 20 years, and 20,000,000 18-kips ESAL).

Cell Number	Structural Number	Total Thickness (inch)	Layer Thicknesses (inches)			Layer Modulus (ksi)		
			AC	Base	Subbase	AC	Base	Subbase
141	6.51	38.5	8.41	12.09	18.0	300	40	10
150	6.51	34.09	8.41	8.18	17.50	300	40	15
159	6.51	28.87	8.41	3.66	16.80	300	40	25

Table 5. Layer thicknesses and moduli of the pavement sections of cells 141, 60, and 222 of figure 1 (effective resilient modulus of the roadbed soil of 5 ksi, performance period of 20 years, and 20,000,000 18-kips ESAL).

Cell Number	Structural Number	Total Thickness (inch)	Layer Thicknesses (inches)			Layer Modulus (ksi)		
			AC	Base	Subbase	AC	Base	Subbase
141	6.51	38.5	8.41	12.09	18.0	300	40	10
60	6.51	47.84	17.75	12.09	18.0	100	40	10
222	6.51	37.03	6.94	12.09	18.0	500	40	10

compared with the outputs of a closed form solution. Nevertheless, the mechanistic responses of the 243 pavement sections are provided in the matrices of figures 7 through 14. Tables 6, 7, and 8 summarize the mechanistic responses of the pavement sections of cells 141, 114, 87, 150, 159, 60 and 222 due to an 18-kip ESAL. These pavement sections are the same as those of tables 3, 4, and 5. Examination of these mechanical responses indicate that the magnitudes of deflections, stresses, and strains (amount of damage) delivered to each pavement section due to one 18-kip ESAL are different. Hence, the service lives of these sections are not the same. The implication of this is that the results of the mechanistic analysis do not support the AASHTO design premises that the three pavements are designed to receive an equal amount of damage during their service lives.

In reference to pavement sections 141, 114, and 87, examination of the values of layer moduli and thicknesses (see table 3) indicates that:

1. The only difference in the material properties between the three sections is the resilient modulus of the base material, it decreases from 40 to 25 and to 10 ksi for sections 141, 114, and 87, respectively.

2. The AASHTO produced structural number for the three pavement sections is the same and is equal to 6.51.

3. The AASHTO produced subbase thickness for the three pavement sections is the same and is equal to 18 inches.

4. The thickness of the AC layer increases from 8.41 to 10.04 and to 13.80 inches as the modulus of the base material decreases from 40 to 25 and to 10 ksi.

5. The thickness of the base decreases from 12.09 to 11.94 and to 0.0 inches as the modulus of the base decreases from 40 to 25 and to 10 ksi. Note that, for the case of 10 ksi base material where its modulus is the same as the subbase material, the AASHTO design procedure eliminates the base layer and provides much thicker AC course which is reasonable.

Examination of the mechanistic responses of the same three pavement sections (see table 6) and the AASHTO produced layer thicknesses (see table 3) indicates that decreasing the modulus value of the base material causes an increase in the thickness of the AC layer and a decrease in the thickness of the base material. These AASHTO resulting changes in the layer thicknesses precipitate the following changes in the mechanistic responses:

1. As the modulus of the base material increases from 10 to 25 and to 40 psi, the pavement peak surface deflection (see figure 18) increases. This implies that the total damage delivered to the three pavement sections due to an 18-kip ESAL is not the same or their levels of protection are different.

Table 6. Mechanistic responses of the pavement sections of cells 141, 114, and 87 of figure 1 due to an 18-kips ESAL.

Cell Number	Deflection at the Top of (mills)				Vertical Compressive Stress at the Top of (psi)			Vertical strain at top/bottom of layers (10^{-4} inch/inch)				Tensile Stress at the Bottom of the AC layer (psi)
	AC	Base	Subbase	Roadbed	Base	Subbase	Roadbed	AC	Base	Subbase	Roadbed	
141	21.26	20.13	17.10	13.25	15.91	2.88	1.01	0.30/0.81	4.26/1.98	3.24/1.67	2.01	64.10
114	20.87	19.57	16.54	13.02	9.39	2.52	0.97	0.42/1.60	4.06/1.95	2.82/1.59	1.91	64.54
87	19.64	N/A	18.03	14.30	N/A	3.20	1.12	0.68/1.15	N/A	3.15/1.68	2.01	52.04

N/A = Not applicable, the AASHTO design produced zero thickness for this layer.

Table 7. Mechanistic responses of the pavement sections of cells 141, 150, and 159 of figure 1 due to an 18-kips ESAL.

Cell Number	Deflection at the Top of (mills)				Vertical Compressive Stress at the Top of (psi)			Vertical strain at top/bottom of layers (10^{-4} inch/inch)				Tensile Stress at the Bottom of the AC layer (psi)
	AC	Base	Subbase	Roadbed	Base	Subbase	Roadbed	AC	Base	Subbase	Roadbed	
141	21.26	20.13	17.10	13.25	15.91	2.88	1.02	0.30/1.81	4.26/1.98	3.24/1.67	2.01	64.10
150	21.70	20.58	18.22	14.37	15.25	4.58	1.21	0.26/1.84	4.21/2.38	3.48/1.81	2.40	66.58
159	21.83	20.71	19.43	15.66	14.84	8.59	1.46	0.25/1.86	4.17/3.09	3.77/1.95	2.83	68.47

Table 8. Mechanistic responses of the pavement sections of cells 141, 60, and 222 of figure 1 due to an 18-kips ESAL.

Cell Number	Deflection at the Top of (mills)				Vertical Compressive Stress at the Top of (psi)			Vertical strain at top/bottom of layers (10^{-4} inch/inch)				Tensile Stress at the Bottom of the AC layer (psi)
	AC	Base	Subbase	Roadbed	Base	Subbase	Roadbed	AC	Base	Subbase	Roadbed	
141	21.26	20.13	17.10	13.25	15.91	2.88	1.01	0.30/1.81	4.26/1.98	3.24/1.67	2.01	64.10
60	21.14	15.31	13.58	11.05	7.24	1.71	0.70	3.63/1.34	2.14/1.23	1.99/1.15	1.38	10.30
222	21.14	20.60	17.51	13.50	16.27	3.02	1.05	0.28/1.59	4.23/2.06	3.37/1.75	2.09	105.50

2. The peak deflections (see figure 18)and the vertical compressive stress at the top of the base, subbase, and roadbed soil vary from one pavement section to another. These variations are, for some pavement sections, favorable (provide better protection of the layer in question) and unfavorable for other sections.

3. The tensile stress (see the last column of table 6) at the bottom of the AC decreases from 64.10 to 52.04 psi which implies (since the modulus of the AC is constant) the tensile strain decreases and the level of protection against fatigue cracking of the AC increases.

4. The vertical compressive strain at the top of each pavement layer and at the top of the subgrade varies from one pavement section to another (see figure 19). Again, this implies that the three pavement sections have various levels of protection against traffic load.

In reference to pavement sections 141, 150, and 159, examination of the values of layer moduli and thicknesses (see table 4) indicates that:

1. The only difference in the material properties between the three sections is the resilient modulus of the subbase material, it increases from 10 to 15 and to 25 ksi for sections 141, 150, and 159, respectively.

2. The AASHTO design procedure produced structural number for the three pavement sections is the same and is equal to 6.51.

3. The AASHTO design method produced AC thickness for the three pavement sections is the same and is equal to 8.41 inches.

4. The thickness of the base layer decreases from 12.09 to 8.18 and to 3.66 inches as the modulus of the subbase material increases from 10 to 15 and to 25 ksi, respectively.

5. The thickness of the subbase layer decreases from 18.0 to 17.5 and to 16.8 inches as the modulus of the subbase layer increases from 10 to 15 and to 25 ksi, respectively.

Examination of the mechanistic responses of the same three pavement sections (see table 7) and the AASHTO design method produced layer thicknesses (see table 3) indicates that decreasing the modulus value of the subbase material causes a decrease in the thickness of the base and subbase layers. These AASHTO design method resulting changes in the layer thicknesses precipitate the following changes in the mechanistic responses:

1. The pavement peak surface deflection is almost constant which imply that the level of the overall damage delivered to the three pavements is almost the same. However, the amount of compression in the base (the difference between the peak deflections at the top of the base and subbase layers of figure 20) vary from one pavement section to another. These variations, for some pavement sections, are favorable (provide a better protection of the layer in question from damages such as rutting) and unfavorable for other sections.

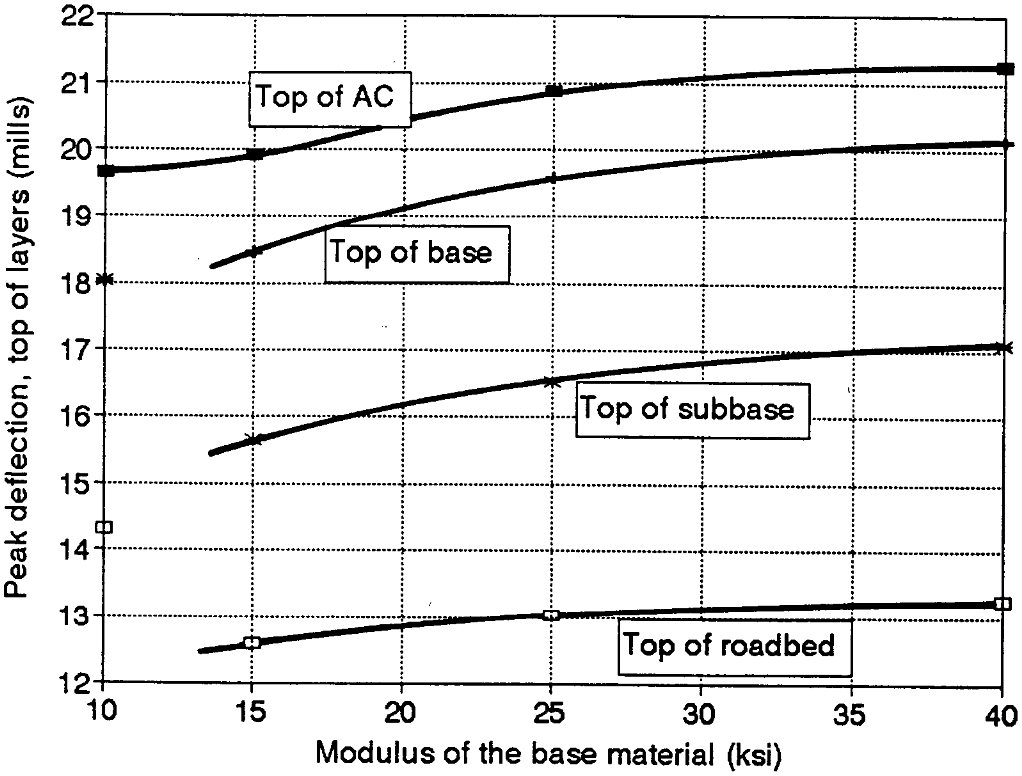

Figure 18. Peak deflections at the top of each pavement layer of sections 141, 114, and 87.

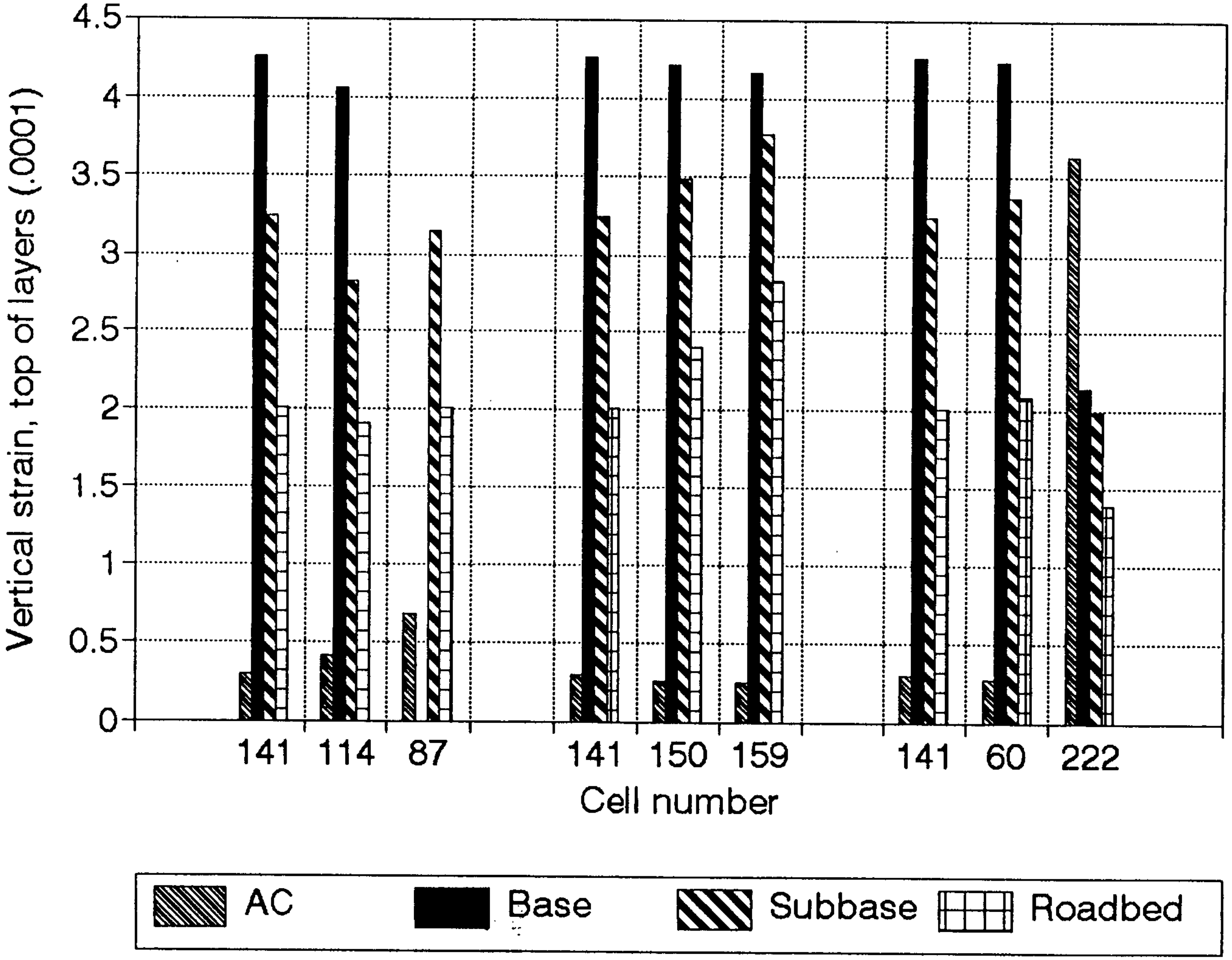

Figure 19. Vertical compressive strains at the top of each pavement laye and at the top of the roadbed soil for sections 60, 87, 114, 141, 150, 159, and 222.

2. As shown in figure 20, the peak deflections at the top of the base, subbase, and roadbed soil increase as the subbase modulus increases from 10 to 25 ksi.

3. The tensile stress (see the last column of table 7) at the bottom of the AC increases from 64.10 to 68.47 psi which implies that (since the modulus of the AC is constant) the level of protection against fatigue cracking of the AC decreases. That is the AC surface of pavement section 159 is more prone to fatigue cracking than that of section 141.

4. The vertical compressive strain at the top of each pavement layer and at the top of the subgrade varies from one pavement section to another (see figure 18). Again, this implies that the three pavement sections have various levels of protection against traffic load.

Similarly, table 4 summarizes the values of the moduli, the AASHTO design method produced layer thicknesses, the total thickness, and the structural numbers of pavement sections 141, 60, and 222. Examination of these values indicates that:

1. The only difference in the material properties between the three sections is the resilient modulus of the AC, it varies from 100 to 300 and to 500 ksi for sections 60, 141, and 222, respectively.

2. The AASHTO produced structural number for the three pavement sections is the same and is equal to 6.51.

3. The AASHTO produced AC thicknesses for sections 60, 141, and 222 are 17.75, 8.41, and 6.94 inches, respectively.

Examination of the mechanistic responses of the same three pavement sections (see table 8) and the AASHTO produced layer thicknesses (see table 5) indicates that decreasing the modulus value of the AC causes a decrease in the AC thickness. This change precipitated the following changes in the mechanistic responses of the three sections:

1. The pavement peak surface deflection remains almost constant at about 21.26 mil. This may imply that the damage delivered to the pavement system due to an 18-kips ESAL is the same. Stated differently, the AASHTO thickness design procedure provides an equal protection against traffic to all three sections.

2. As shown in figure 21, the peak deflections at the top of the base, subbase, and roadbed soil increase as the AC modulus increases and the AC thickness decreases. Further, the amount of compression (the difference between the peak deflections at the top of the base and subbase layers) in the base layer increases from 1.73 mil for section 60 to 3.09 mil for section 222 (an increase of about 79%). Once again, this implies that the three sections do not have the same level of protection against damage.

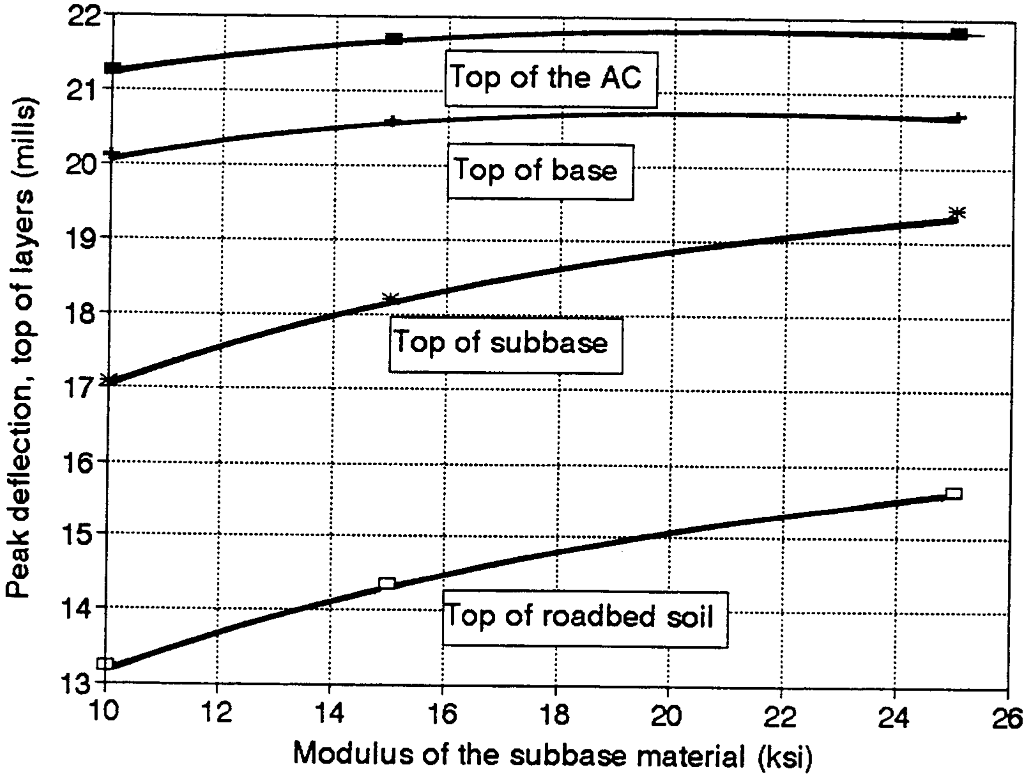

Figure 20. Peak deflections at the top of each pavement layer of sections 141, 150, and 159.

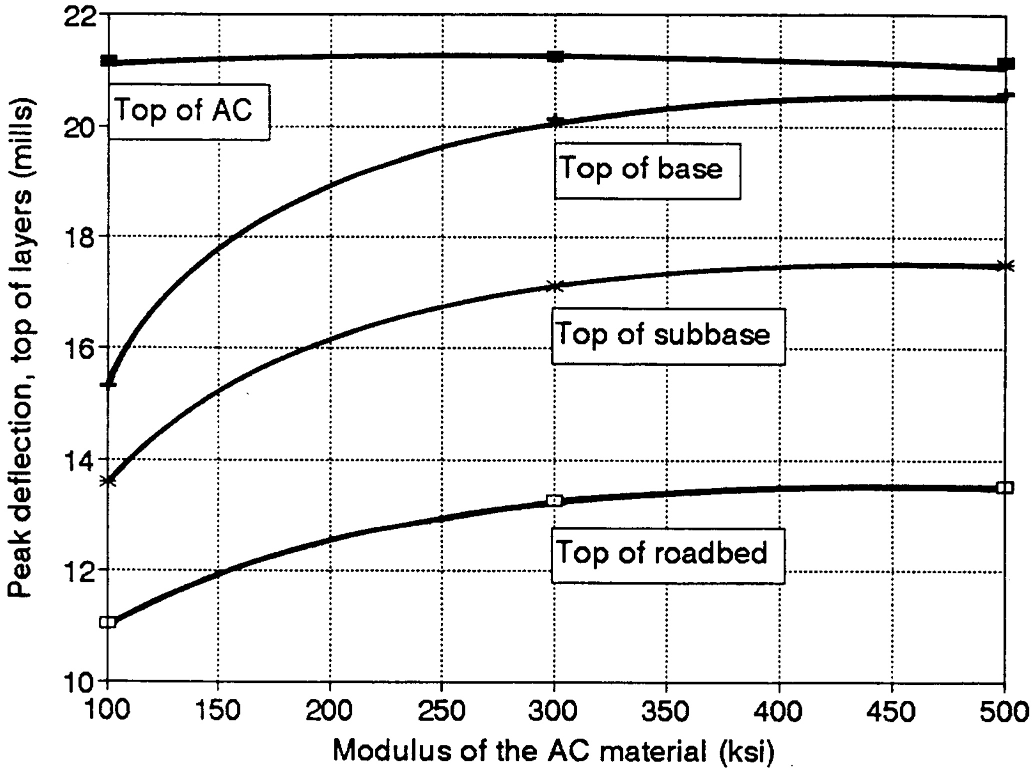

Figure 21. Peak deflections at the top of each pavement layer of sections 60, 141, and 222.

3. The amount of deflection (see figure 21) at the top of the roadbed soil increases from 11.05 mil for section 60 to 13.5 mil for section 222. The implication of this is that the rut potential of the roadbed soil of section 60 is lower than that of section 222.

4. The vertical compressive strain at the top of each pavement layer and at the top of the subgrade varies from one pavement section to another (see figure 18). Again, this implies that the three pavement sections have various levels of protection against traffic load.

5. The tensile stress at the bottom of the AC increases from 10.30 to 64.10 and to 105.5 psi for sections 60, 141, and 222, respectively. Although, the modulus of the AC increases from 100 ksi for section 60 to 500 ksi for section 222 (an increase of 5 fold), the corresponding tensile strength increases by a factor of about 10. One can also use equation 1.3 (repeated herein for convenience) to calculate the tensile strength of the AC mix as follows:

   $$\ln(MR) = 7.3667 + 1.08335[\ln(INTS)] + 0.14(AV) + 0.00034(L) \qquad \text{(Eq. 1.3)}$$

   The use of the above equation requires that the values of the percent air voids and the applied effective average load (at the middle of the AC layer) be assumed, since such data are not available in the databank. However, the equation can be used to assess the relative increase and decrease of the indirect tensile strength (INTS) due to an increase or decrease in the value of the resilient modulus (MR). Hence, rearranging the above equation yields:

   $$(INTS)^{1.08335} = [e^{-7.3667}][MR][e^{-0.14(AV)}][e^{0.00034(L)}]$$

   As it can be seen, the value of the INTS can be calculated as the product of four terms. For pavement section numbers 60 and 141 with the respective resilient moduli of the AC of 100,000 and 500,000 psi, the resilient modulus term of the last equation is equal to 100,000 and 500,000, respectively. That is, if one assumes that the indirect tensile strength of the 500,000 psi AC material (section 222) represents a unit strength, then the indirect tensile strength of the 100,000 psi AC material (section 60) is equal to 0.2 unit strength. Likewise, the unit strength of the 300,000 psi material (section 141) is 0.6 unit strength. Further, assuming that the unit tensile strength is equal to 300 psi (a reasonable value for the 500,000 psi material), it yields that the tensile strengths for the 300,000 and 100,000 psi materials are 180, and 60 psi, respectively. These tensile strength values, the section number, the resilient moduli, the tensile stresses at the bottom of the AC, and the tensile stress-tensile strength ratio are tabulated below for the three pavement sections. It can be seen that the AC layer in section 60 is subjected to the lowest stress/strength ratio. Since fatigue life is proportional to this ratio (the higher the stress ratio, the lower the fatigue life), it implies that the fatigue cracking potentials of the three pavement sections are not the same.

Section number	Resilient modulus (psi)	Tensile strength (psi)	Tensile stress (psi)	Stress ratio (%)
60	100,000	60	10.3	17.17
141	300,000	180	64.1	35.61
222	500,000	300	105.5	35.17

3.4 Conclusions of the Mechanistic Evaluation of the AASHTO Design Equations

Table 9 summarizes the AASHTO and the mechanistic response outputs of the seven pavement sections discussed in the previous section. Based on the data presented in the table, and an the range of the material properties used in this study, the following conclusions are drawn:

1. Based on the pavement surface peak deflection data listed in table 9 and shown in figure 22 and on the assumption that the peak surface deflection can be used as a measure of the level of damage delivered to a pavement section (higher deflection causes higher compression and higher rut and/or fatigue cracking potential), one can conclude that:

For a constant traffic level and one type of roadbed soil, the AASHTO design procedure produces pavement sections (layer thicknesses) such that the peak surface deflection is constant. Hence, the amount of the overall damage delivered to the pavement section (or the overall protection level) is constant and independent of the material properties.

2. Based on the amount of vertical compression (the difference between the peak deflections at the top of any two consecutive layers) experienced by each pavement layer (see figures 23 through 26, and the resulting vertical strains at the top and bottom of each pavement layer (see figures 27 and 28), the following conclusion is drawn:

For a constant traffic level and one type of roadbed soil, the AASHTO design procedure produces pavement sections (layer thicknesses) such that the amount of compression and the resulting compressive strain experienced by any one layer vary from one section to another. Hence, the amount of damage delivered to each layer of the pavement sections (or the level of protection) varies. This implies that while the AASHTO design procedure insures that the overall damage of the pavement sections is the same, the relative damage delivered to each layer is not.

Table 9. The outputs of the AASHTO design method and the mechanistic responses of pavement sections 60, 87, 141, 114, 150, 159, and 222.

Section Number	Layer thicknesses (in)			Layer moduli (ksi)				Deflection (mills) at top of				Amount of compression (mill			
	AC	Base	Subbas	AC	Base	Subba	Roadbed	AC	Base	Subba	Roadb	AC	Base	Subba	Roadbe
60	17.75	12.09	18.00	100	40	10	5	21.14	15.31	13.58	11.05	5.83	1.73	2.53	11.05
141	8.41	12.09	18.00	300	40	10	5	21.26	20.13	17.10	13.25	1.13	3.03	3.85	13.25
222	6.94	12.09	18.00	500	40	10	5	21.14	20.60	17.51	13.50	0.54	3.09	4.01	13.5
87	13.80	0.00	18.00	300	10	10	5	19.64	18.03	18.03	14.30	1.61	0.00	3.73	14.3
114	10.04	11.94	18.00	300	25	10	5	20.87	19.57	16.54	13.02	1.3	3.03	3.52	13.02
141	8.41	12.09	18.00	300	40	10	5	21.26	20.13	17.10	13.25	1.13	3.03	3.85	13.25
141	8.41	12.09	18.00	300	40	10	5	21.26	20.13	17.10	13.25	1.13	3.03	3.85	13.25
150	8.41	8.18	17.50	300	40	15	5	21.70	20.58	18.22	14.37	1.12	2.36	3.85	14.37
159	8.41	3.66	16.8	300	40	25	5	21.83	20.71	19.43	15.66	1.12	1.28	3.77	15.66
156	8.41	3.66	40.40	300	40	25	1	35.19	34.07	32.79	27.00	1.12	1.28	5.79	27.00
159	8.41	3.66	16.80	300	40	25	5	21.83	20.71	19.43	15.66	1.12	1.28	3.77	15.66
162	8.41	3.66	8.96	300	40	25	10	16.93	15.79	14.52	12.03	1.14	1.27	2.49	12.03

Section Number	Layer thicknesses, inch			Vertical stress (psi) at top of			Tensile stress bottom of AC		Vertical strain top and bottom (0.0001 in/in)						
							Stress	Stress	AC		Base		Subbase		Roadbe
	AC	Base	Subbas	Base	Subbas	Roadb	(psi)	ratio*	Top	Bottom	Top	Bottom	Top	Bottom	Top
60	17.75	12.09	18.00	7.24	1.71	0.70	10.30	0.10	3.63	1.34	2.14	1.23	1.99	1.15	1.38
141	8.41	12.09	18.00	15.91	2.88	1.01	64.10	0.21	0.30	1.81	4.26	1.98	3.24	1.67	2.01
222	6.94	12.09	18.00	16.27	3.02	1.05	105.50	0.21	0.28	1.59	4.23	2.06	3.37	1.75	2.09
87	13.80	0.00	18.00	3.20	3.20	1.12	52.04	0.17	0.68	1.15	-	-	3.15	1.68	2.01
114	10.04	11.94	18.00	9.39	2.52	0.97	64.54	0.22	0.42	1.60	4.06	1.95	2.82	1.59	1.91
141	8.41	12.09	18.00	15.91	2 88	1.01	64.10	0.21	0.30	1.81	4.26	1.98	3.24	1.67	2.01
141	8.41	12.09	18.00	15.91	2.88	1.01	64.10	0.21	0.30	1.81	4.26	1.98	3.24	1.67	2.01
150	8.41	8.18	17.50	15.25	4.58	1.21	66.58	0.22	0.26	1.84	4.21	2.38	3.48	1.81	2.40
159	8.41	3.66	16.8	14.71	8.59	1.46	68.47	0.23	0.25	1.86	4.17	3.09	3.77	1.95	2.83
156	8.41	3.66	40.40	15.34	9.44	0.20	64.05	0.21	0.31	1.79	4.16	3.11	3.79	1.09	1.82
159	8.41	3.66	16.80	14.71	8.59	1.46	68.47	0.23	0.25	1.86	4.17	3.09	3.77	1.95	2.83
162	8.41	3.66	8.96	14.38	8.23	3.25	69.81	0.23	0.27	1.88	4.15	3.07	3.75	2.46	3.14

* Ratio of tensile stress to modulus

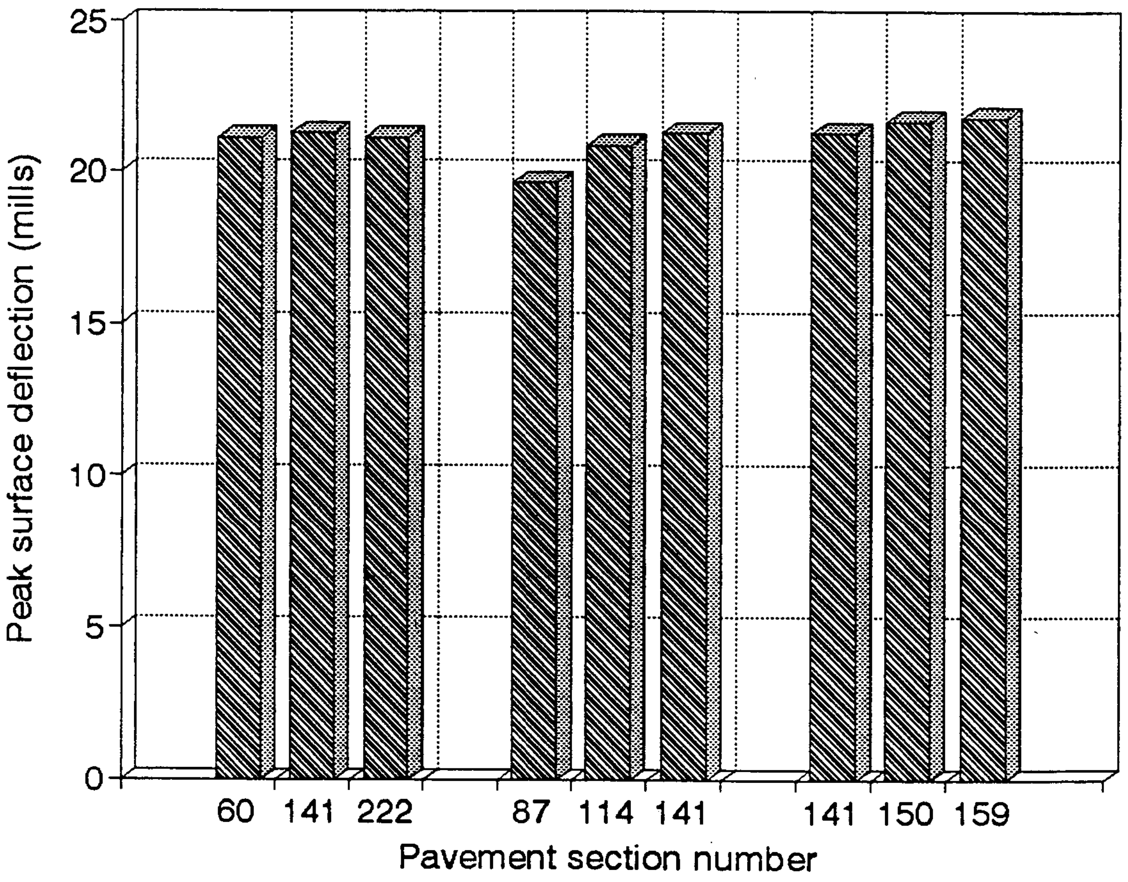

Figure 22. Peak pavement surface deflections of the seven indicated pavement sections.

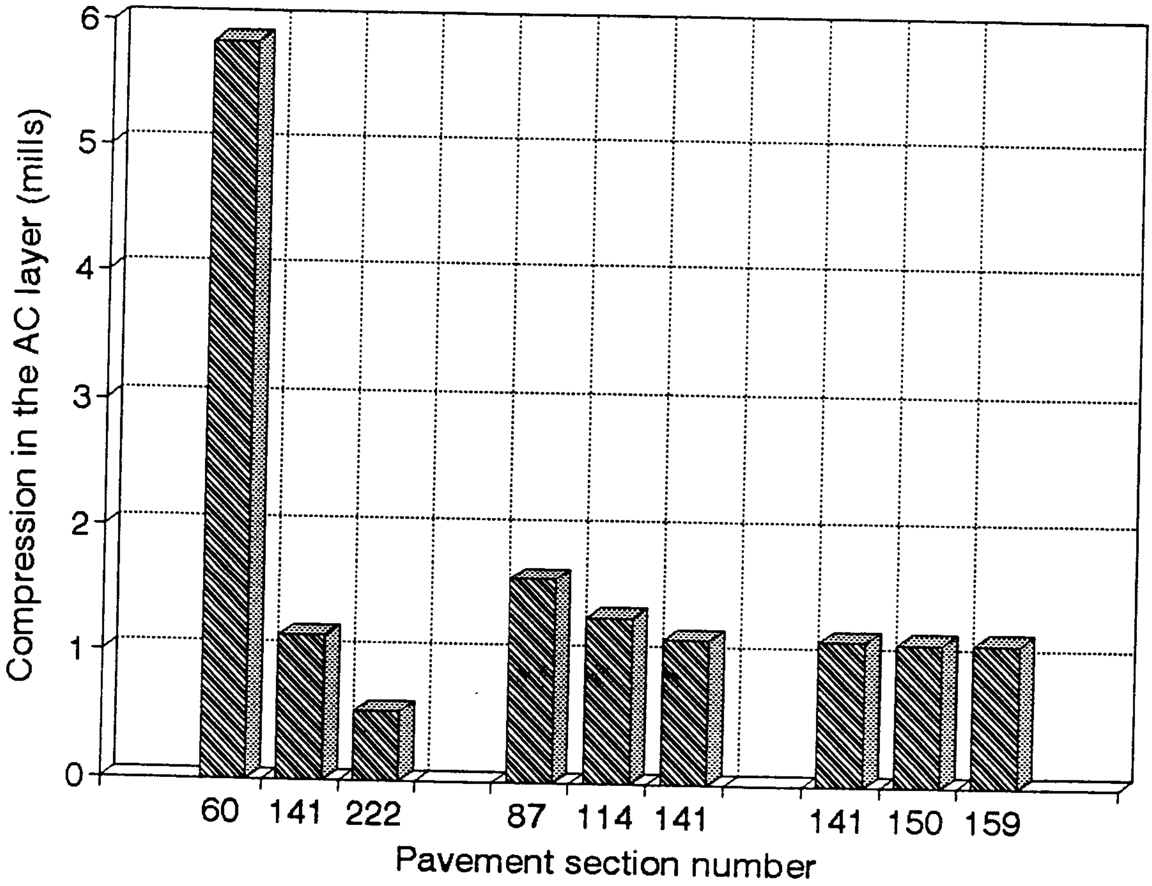

Figure 23. The amount of compression in the AC layer of the seven indicated pavement sections.

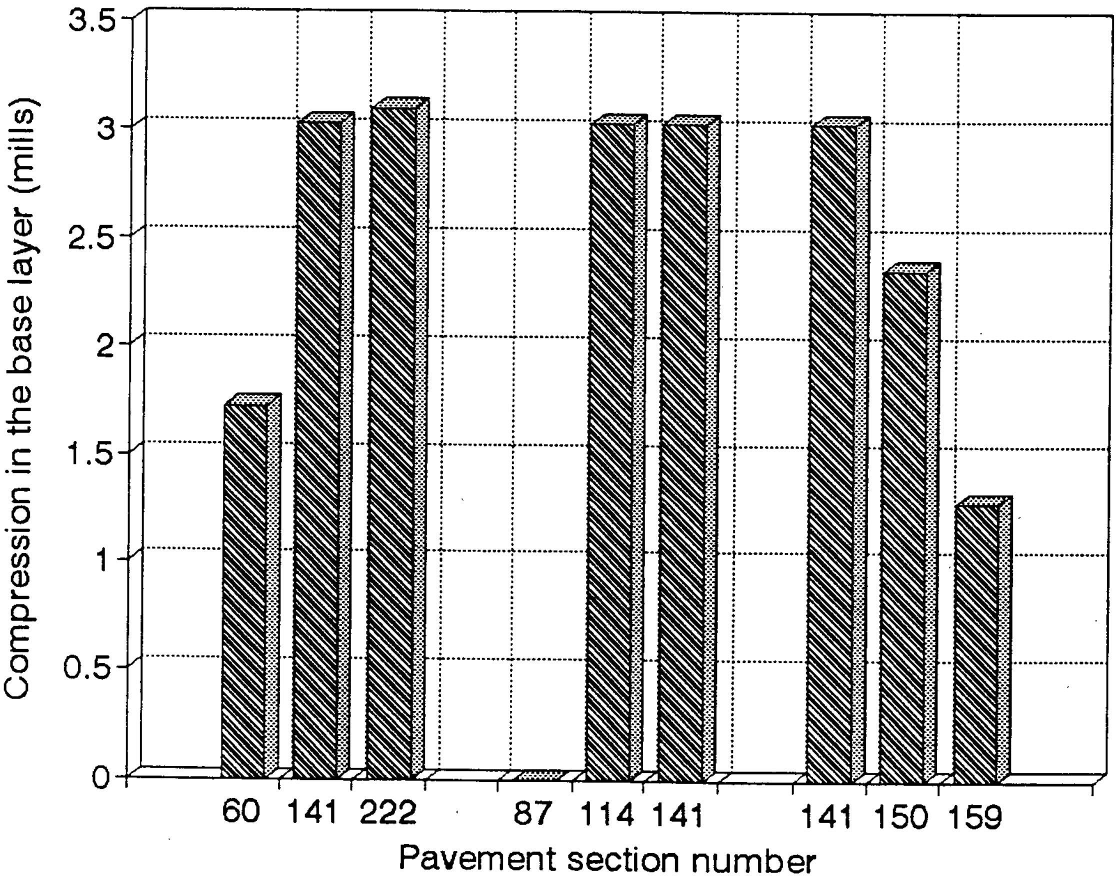

Figure 24. The amount of compression in the base layer of the seven indicated pavement sections.

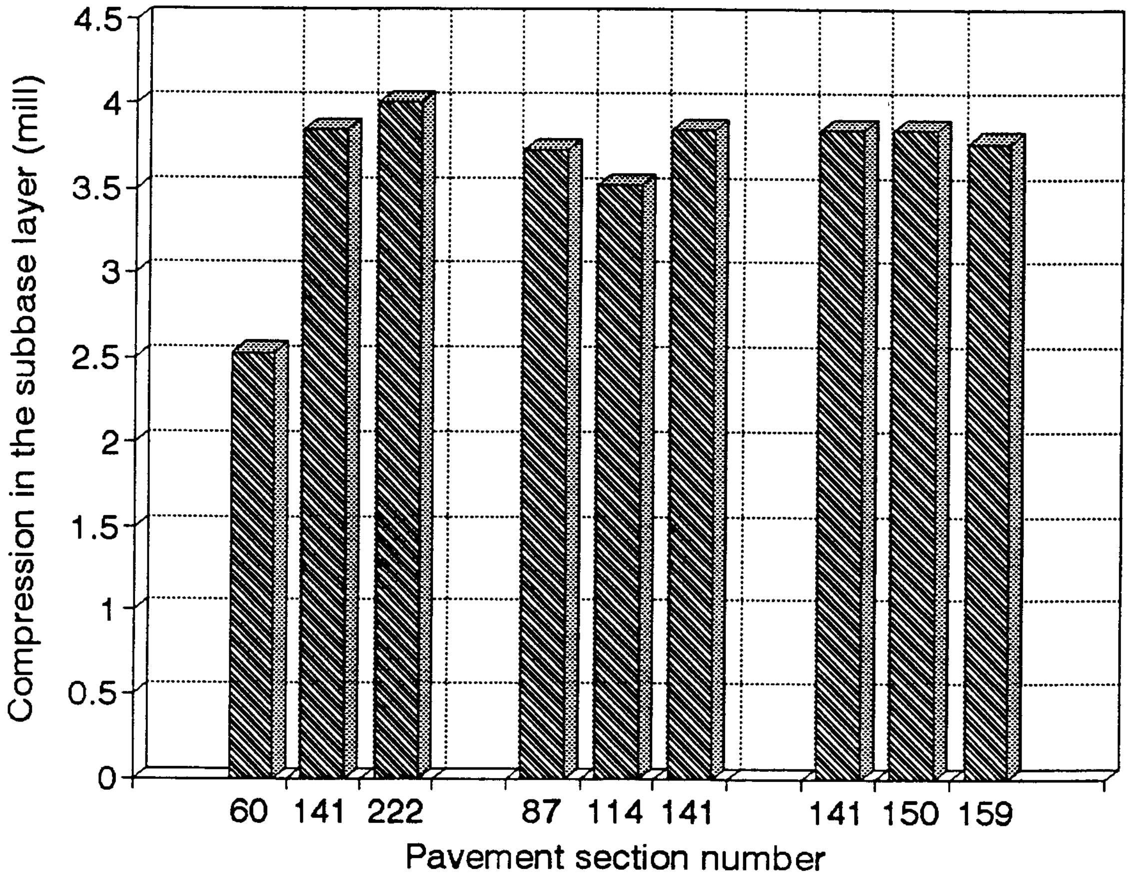

Figure 25. The amount of compression in the subbase layer of the seven indicated pavement sections.

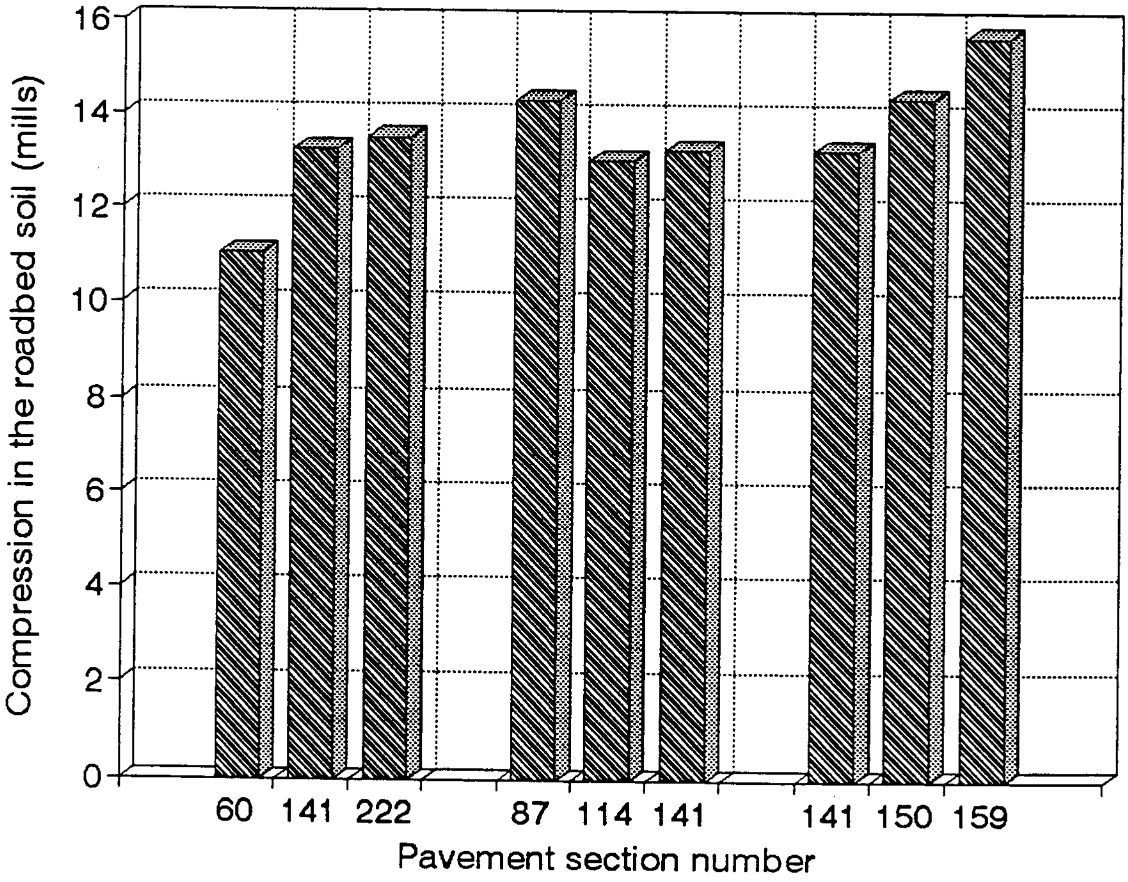

Figure 26. The amount of compression in the roadbed soil of the seven indicated pavement sections.

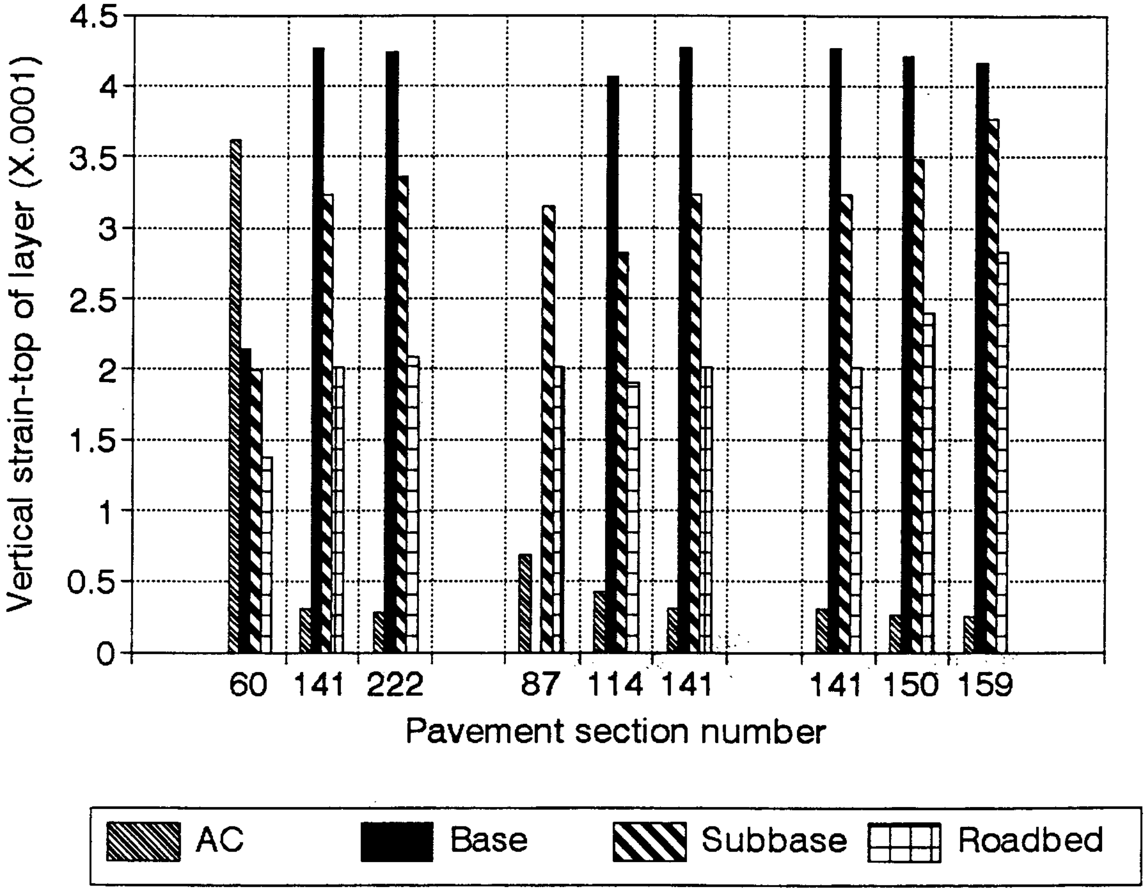

Figure 27. The vertical strains induced at the top of each pavement layer for the indicated pavement sections.

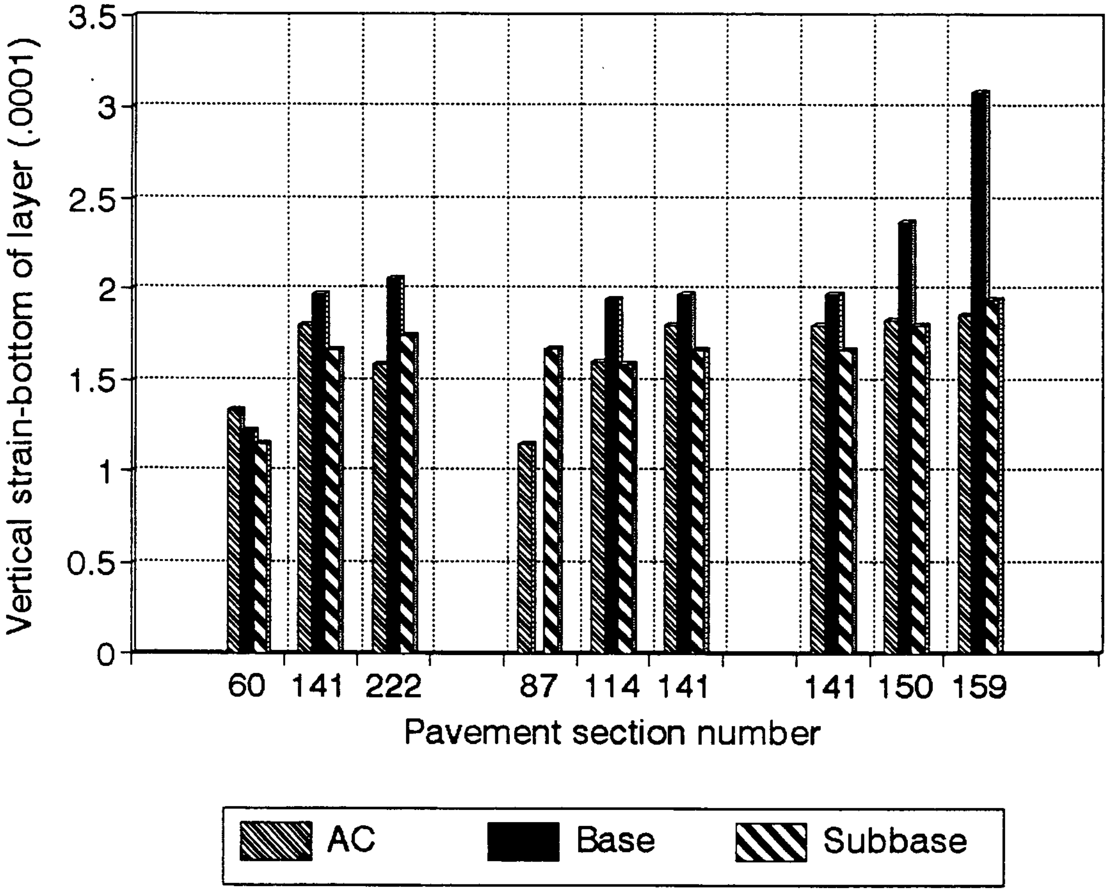

Figure 28. The vertical strain induced at the bottom of each pavement layer for the indicated pavement sections.

3. Based on the magnitude of the tensile stress induced at the bottom of the AC layer (of seven pavement sections) due to an 18-kips ESAL and the ratio of that tensile stress to the value of the AC modulus (see table 9 and figures 29 and 30), the following conclusion is drawn:

For a constant traffic level and one type of roadbed soil, the AASHTO design procedure produces pavement sections (layer thicknesses) such that the tensile stress induced at the bottom of the AC layer vary from one section to another. Hence, the amount of damage delivered to the AC layer of the pavement sections (or the level of protection) varies. This implies that while the AASHTO design procedure insures that the overall damage of the pavement sections is the same, the relative damage delivered to each layer is not.

It should be noted that the three conclusions stated above are strictly based upon the outputs (layer thicknesses) of the AASHTO flexible pavement design procedure and the outputs of the mechanistic analysis of the AASHTO designed pavement sections. Recall that the premises of the above analyses are:

1. The outputs of the mechanistic analysis of a pavement section reflect the true stresses and strains induced in that section.

2. The magnitudes of the stresses, strains, and deflections induced in a pavement section are measures of the amount of damage delivered to a pavement section.

Based upon these premises and the results of the analyses which led to the three conclusions stated above, several important aspects relative to the calibration of the AASHTO flexible design equations can be made. These are presented in the next sections.

3.5 Important Concepts Relative to the Calibration of the AASHTO Flexible Design Equations

Several important concepts related to the calibration of the AASHTO flexible design equations can be inferred from the mechanistic analysis of those equations. These concepts can be divided (according to the type of the AASHTO equation) into two categories: the concepts of the structural number, and the concept of the resilient modulus of the roadbed soil in the AASHTO main design equation. These two categories are presented in the next subsections.

3.5.1 The Concept of the AASHTO Structural Number

The AASHTO AN equation (note that the drainage coefficient is not included yet) can be written as follows:

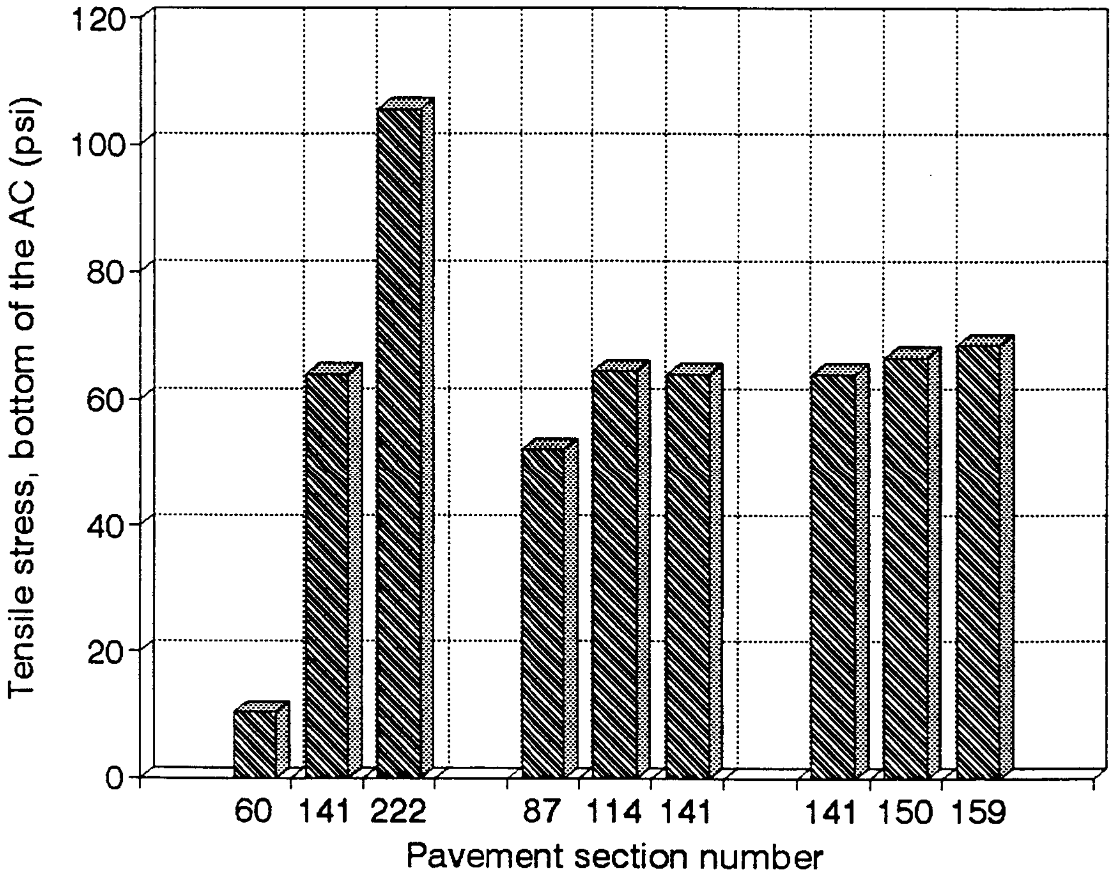

Figure 29. Tensile stress at the bottom of the AC layer of the seven indicated pavement sections.

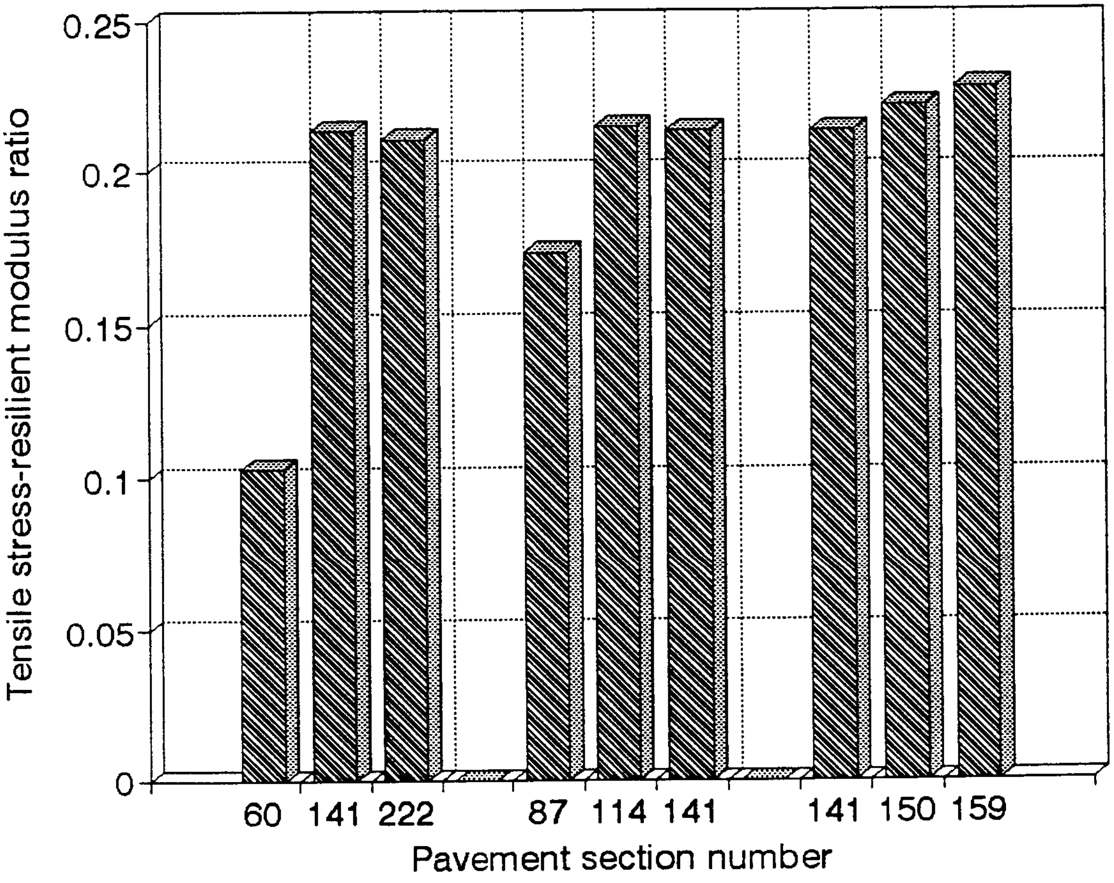

Figure 30. The ratio of the tensile stress at the bottom of the AC layer to its resilient modulus for the seven indicated pavement sections.

$SN = a_1D_1 + a_2D_2 + a_3D_3$ which can also be written as:

$SN = SN_1 + SN_2 + SN_3$

That is the structural number of a pavement section is the linear sum of the structural numbers of its layers. The following conclusions are made relative to this AASHTO concept.

STRUCTURAL NUMBER -AASHTO CONCEPT 1

The total structural number of any flexible pavement section is the sum of the structural numbers of its layers. The findings of the mechanistic analysis support this AASHTO concept.

The concept of the role of the layer coefficients as a function of the layers resilient moduli (see figure 31 for the AC resilient modulus values between 100,000 and 450,000 psi at 68 °, and the following base (a_2) and subbase (a_3) layer coefficient equations):

$a_2 = 0.249[\mathrm{Log}(E_{BS})] - 0.977$; and $a_3 = 0.227[\mathrm{Log}(E_{SB})] - 0.839$

STRUCTURAL NUMBER - AASHTO CONCEPT 2

The structural number of any flexible pavement layer is the product of its thickness and its layer coefficient. For any layer, its coefficient can be obtained from the appropriate equation or chart based on the modulus value of that layer. The results of the mechanistic analysis do not support this AASHTO concept.

One of the reason of the above findings could be related to the nature of the AASHTO method and the nature of the analysis. That is the AASHTO method is based mainly on one type of distress, ride quality in terms of the PSI. The results of the mechanistic analyses are mainly based on rutting and fatigue cracking (load related distress). Hence, the calibration of the layer coefficient equations and/or chart depends upon two facets as follows:

1. The type of distress (damage) that is being considered. Stated differently, for any pavement layer, the value or values of its layer coefficients could be distress mode dependent. That is, as indicated by the results of the mechanistic analysis, the layer coefficient values to insure equal roughness (ride quality) are not necessarily the same as those to insure equal rutting and/or fatigue cracking.

2. For load related distress, the properties (layer coefficients) of all pavement layers and their interactions influence the mechanistic response of the pavement structure. The AASHTO procedure is based on equalizing the overall response of the pavement section in question.

5.3.2 The Concept of the AASHTO Main Design Equation.

The number of 18-kips ESAL (W_{18}) is a function of the design reliability (Z_R), the overall standard deviation (S_o) of the materials and traffic data, the structural number (SN) of the pavement section, the resilient modulus (M_R) of the roadbed soil, and the serviceability loss (ΔPSI) expected during the performance period. In practice, however, the number of 18-kips ESAL is used as an input to the equation and the required structural number is obtained.

$$\mathrm{Log}(W_{18}) = (Z_R)(S_0) + 9.36[\mathrm{Log}(SN + 1)] - 0.20 + \frac{\mathrm{Log}[(\Delta PSI)/(4.2 - 1.5)]}{[0.4+1094/(SN+1)^{5.19}]} + 2.32[\mathrm{Log}(MR)] - 8.07$$

THE CONCEPT OF THE AASHTO MAIN DESIGN EQUATION

The structural number of a pavement section is a function of only one material property, the resilient modulus of the roadbed soil. Pavement sections with different types of roadbed soil will have different structural numbers such that each section will receive the same amount of damage. The results of the mechanistic analysis do not support this AASHTO concept.

In reference to figure 1, pavement sections 156, 159, and 162 were designed by using the AASHTO flexible pavement design procedure. The material properties of the AC, base, and subbase layers for all three sections are the same. All sections were designed to carry 20,000,000 ESAL. The only difference between the three sections is the resilient modulus of the roadbed soil. It varies from 1 ksi for section 156 to 10 ksi for section 162. The outputs (layer thicknesses) of the AASHTO design procedure are listed in figures 2 through 6 and summarized, for convenience, in table 10. The mechanistic responses of the three sections are summarized in table 11. Examination of the mechanistic responses of sections 156, 159, and 162 listed in table 11 indicates that:

1. The peak pavement surface deflection varies from 35.19 mil for pavement section 156 to 16.93 mil for pavement section 162. Figure 32 depicts the peak deflection at the top of each pavement layer. It can be seen that the peak deflection at the top of each layer varies from one section to another which indicates that the amount of the overall damage received by one pavement section is different than that received by the other section. It should be noted that the variation in the peak deflection at the top of each layer is due mainly to the deflection at the top of the

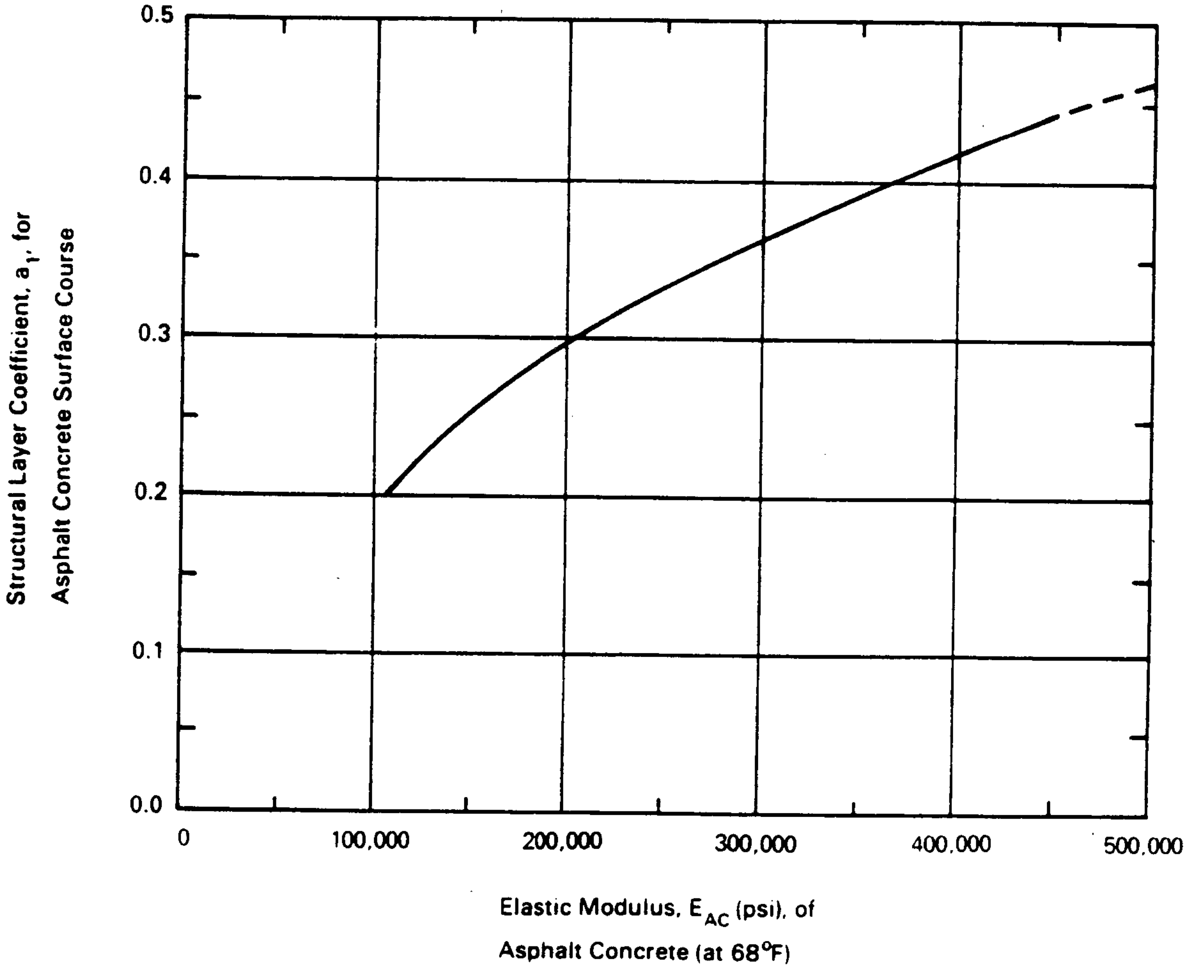

Figure 31. The AASHTO chart for estimating the structural layer coefficient of dense-graded asphalt concrete based on the elastic (resilient) modulus.

Table 10. Layer thicknesses and moduli of the pavement sections of cells 156, 159, and 162 of figure 1 (performance period = 20 years, 18-kips ESAL = 20,000,000).

Cell Number	Structural Number	Total Thickness (inch)	Layer Thicknesses (inch)			Layer Moduli (ksi)			
			AC	Base	Subbase	AC	Base	Subbase	Roadbed Soil
156	10.3	52.46	8.41	3.66	40.40	300	40	25	1
159	6.51	28.90	8.41	3.66	16.80	300	40	25	5
162	5.25	21.03	8.41	3.66	8.96	300	40	25	10

Table 11. Mechanistic responses of the pavement sections of cells 156, 159, and 162 of figure 1.

Cell Number	Deflection at the top of (mills)				Vertical compressive stress at the top of (psi)			Vertical strain at top/bottom of layers (10^{-4} inch/inch)				Tensile stress at the bottom of the AC layer (psi)
	AC	Base	Subbase	Roadbed	Base	Subbase	Roadbed	AC	Base	Subbase	Roadbed	
156	35.19	34.07	32.79	27.00	15.34	9.44	0.2	0.31/1.79	4.16/3.11	3.79/1.09	1.82	64.05
159	21.83	20.71	19.43	15.66	14.71	8.59	1.46	0.46/1.86	4.17/3.09	3.77/1.95	2.83	68.47
162	16.93	15.79	14.52	12.03	14.38	8.23	3.25	0.27/1.88	4.15/3.07	3.75/2.46	3.14	69.81

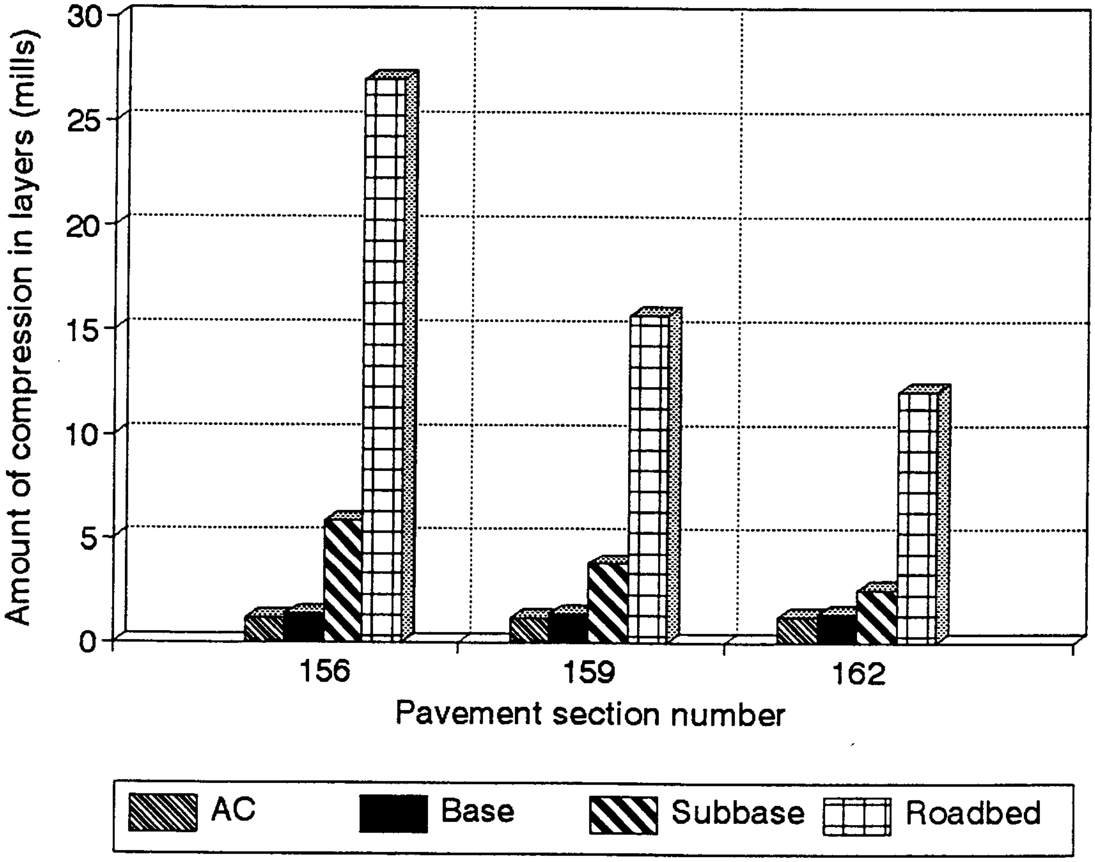

Figure 32. Peak deflection at the top of each pavement layer and roadbed soil for the indicated pavement sections.

roadbed soil. This is illustrated in figure 33 which shows the amounts of compression (the difference between the peak deflection of one layer and that of the layer beneath it) in the AC and base layers are more or less constant for all three pavement sections. The amount of compression in the subbase, however, decreases from about 5 mil for section 156 to about 2 mil for section 162. Since the resilient modulus of the subbase of the three sections is the same (25 ksi), this observation indicates that the subbase of section 156 would experience more damage than that of section 162.

Previously, it was stated that for the same type of roadbed soil and traffic level, the AASHTO design procedure produces pavement sections (based on the structural number) such that the peak pavement deflection is almost constant. However, this finding is not true when the roadbed soil is changed from one type to another. For example, the AASHTO design process produces thicker pavement sections for softer roadbed soils. The consolidation of the softer soils due to the weight of the pavement alone could be substantially higher than that of stiffer soils. The implication herein is that for the same traffic level and pavement layer properties, the AASHTO produced structural numbers for various types of roadbed soil do not provide the same protection level to that soil. Since, for these three sections, the only factor affecting the calculation of the required SN is the resilient modulus of the roadbed soil, one can conclude that:

The AASHTO main design equation for flexible pavements does not properly account for the effects of the resilient modulus of the roadbed soil on the structural capacity of the pavement.

2. Figures 34 and 35 depict the vertical compressive strains induced in the three pavement sections at the top and bottom of each pavement layer. It can be seen that (see figure 34) the vertical strains at the top of the AC, base, and subbase layers are almost constant for the three pavement sections. The vertical strain at the top of the roadbed soil, however, varies and it increases from about 180 microstrain for section 156 to about 320 microstrain for section 162 (an increase of about 100 percent) as the respective resilient modulus of the roadbed soil increases from 1000 to 10,000 psi (1000 percent increase). Once again, this implies that higher damage is being delivered to the roadbed soil of section 156 than that for section 162. The resulting vertical strains at the bottom of the AC, base, and subbase layers shows slightly different pattern (see figure 35). Like the vertical strain at the top of the layers, the vertical strains at the bottom of the AC and base layers are almost constant for all three sections. However, unlike the vertical strain at the top of the subbase layer, the strain at the bottom of the subbase varies and it increases from about 100 microstrain for section 156 to about 250 microstrain for section 162. Given that the modulus of the subbase material is the same for all three sections and it is equal to 25,000 psi, one can

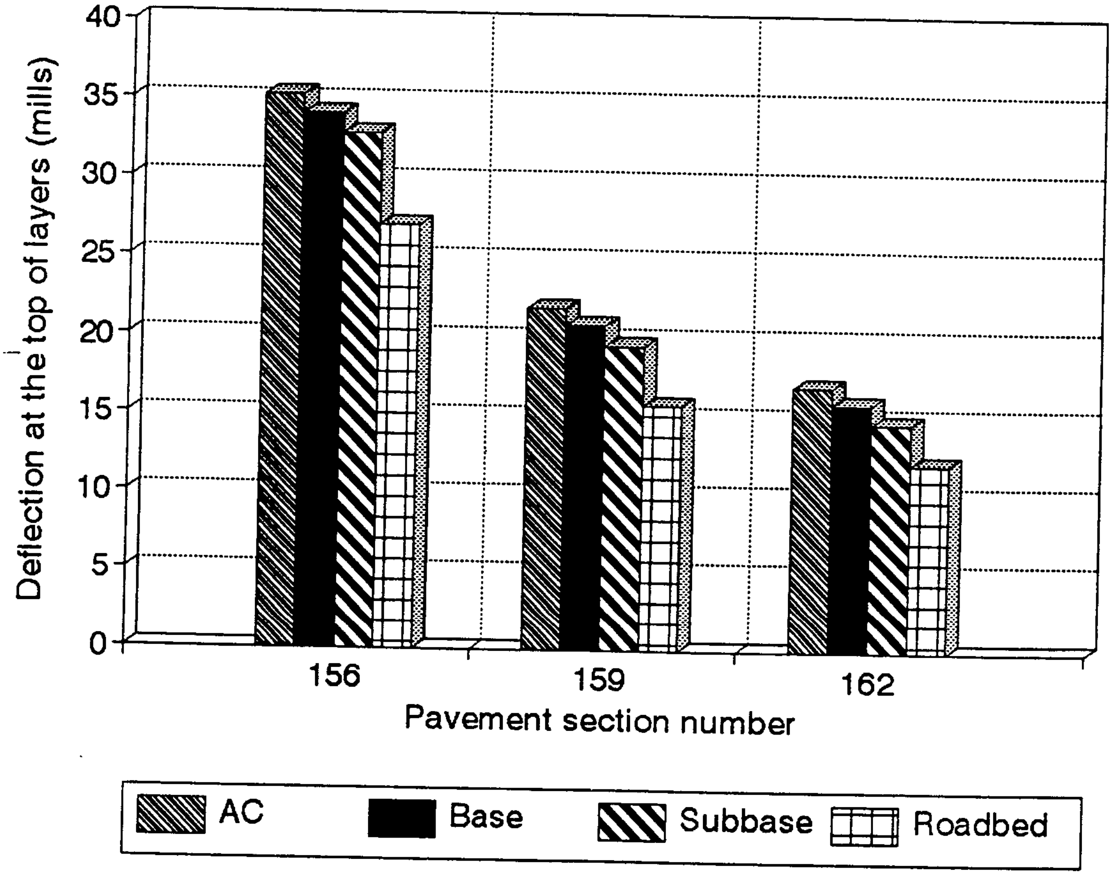

Figure 33. The amount of compression in each pavement layer and in the roadbed soil of the indicated pavement sections.

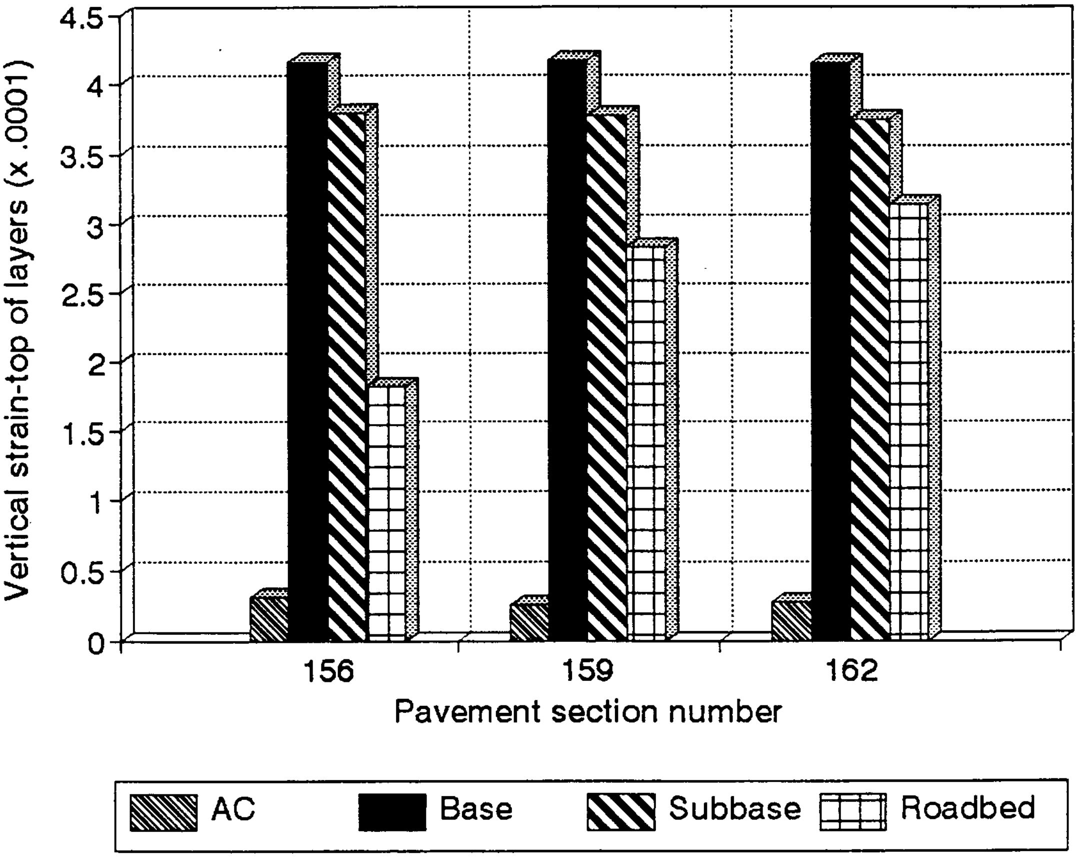

Figure 34. The vertical strains at the top of the layers of the indicated pavement sections.

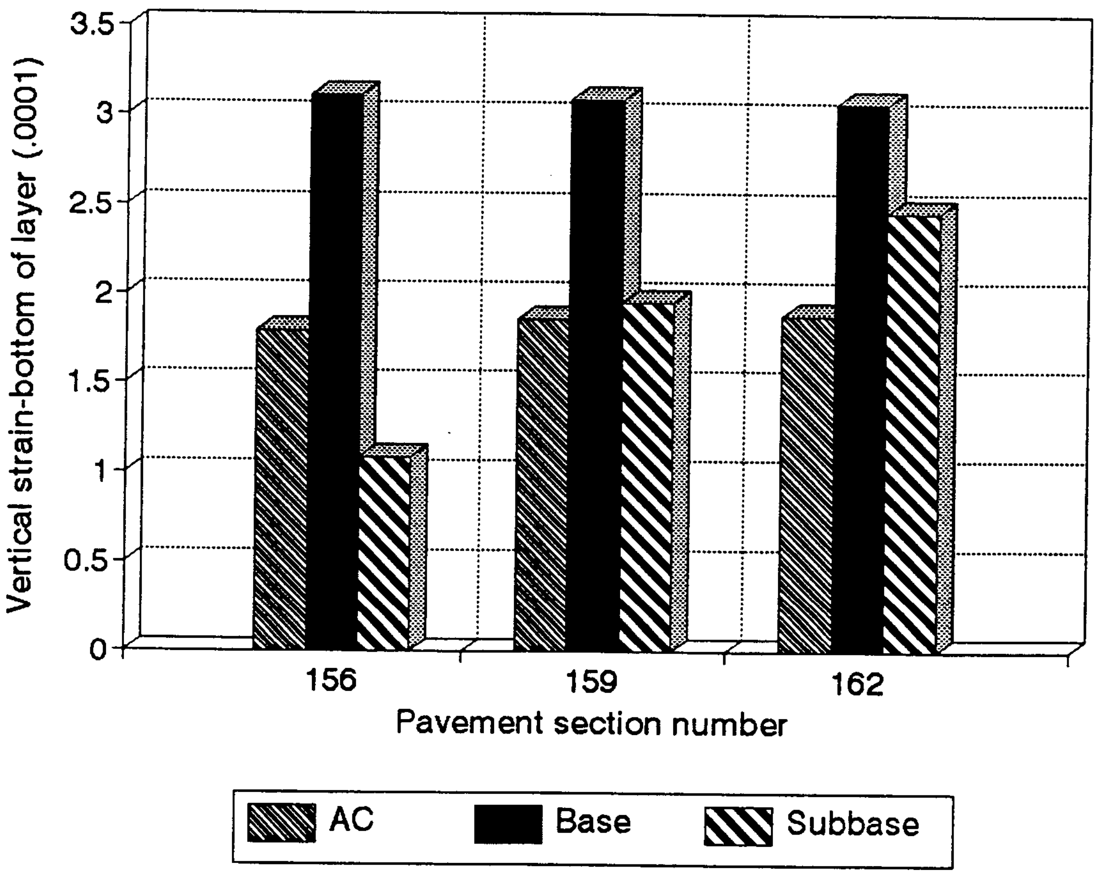

Figure 35. The vertical strains at the bottom of the layers of the indicated pavement sections.

conclude that the subbase material of section 162 receives relatively higher damage than the subbase material of section 156.

3. Finally, examination of the values of the tensile stress induced at the bottom of the AC layer indicates that the tensile stress increases from 64.05 psi for section 156 to 69.81 psi for section 162 (about ten percent increase). Since the resilient modulus of the AC layer is the same for all three sections, the fatigue cracking potential of section 162 is higher than that of section 156.

Given the three observations stated above, one can conclude that:

The role of the resilient modulus of the roadbed soil in the AASHTO main design equation appear to be inadequate. Such a role could not be calibrated because of the lack of field data.

CHAPTER 4

MECHANISTIC EVALUATION OF THE AASHTO DRAINAGE COEFFICIENTS

4.1 PHASE 4 - MECHANISTIC EVALUATION OF THE CONCEPT OF THE AASHTO DRAINAGE COEFFICIENT

4.1.1 The AASHTO Drainage Coefficients

The 1986 AASHTO design methods included descriptions of the selection of input parameters to treat the effects of certain levels of drainage on the predicted pavement performance. However, the AASHTO design guide provided no criteria relative to the ability of various drainage methods to remove moisture from the pavement section. Rather, the AASHTO design guide provides general definitions corresponding to the quality of different drainage levels and recommended drainage coefficients. These are listed in table 12.

Relative to the drainage coefficient, the 1986 AASHTO Design Guide states that (see page II-26 of the guide):

> "The treatment for the expected level of drainage for a flexible pavement is through the use of modified layer coefficient (e.g., a higher effective layer coefficient would be used for improved drainage conditions). The factor for modifying the layer coefficient is referred to as an m_i value and has been integrated into the Structural Number (SN) equation along with layer coefficient (a_i) and thickness (D_i); thus:

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

Relative to the above SN equation, one points that is very important to this study must be noted. The SN equation should not be interpreted as "the required SN of a pavement structure is a function of the drainage coefficients and layer thicknesses and coefficients". Indeed, the AASHTO procedure determines the required SN by using the main design equation (presented in the previous chapter) which is a function of the number of 18-kip ESAL, design reliability, standard deviation, serviceability loss during the performance period, and the effective roadbed resilient modulus. After determining the required SN, the layer thicknesses are adjusted as to yield the required SN. Hence, the following statement is absolutely true:

The AASHTO design method determines the required SN of a pavement structure independent of the layer thicknesses, layer coefficients, and drainage coefficients. The layer thicknesses, on the other hand, are a function of the required SN and the given layer and drainage coefficients.

Examination of the structural number equation indicates that the user of the guide may interpret the equation in two different ways as follows:

Table 12. The AASHTO Design Guide definitions of quality of drainage and the recommended drainage coefficients.

Quality of drainage	Water removed within
Excellent	2 hours
Good	1 day
Fair	1 week
Poor	1 month
Very poor	Water will not drain

Quality of drainage	Percent of time structure is exposed to moisture levels approaching saturation			
	Less than 1 percent	1 - 5 percent	5 - 25 percent	Greater than 25 percent
Excellent	1.40 - 1.35	1.35 - 1.30	1.30 - 1.20	1.20
Good	1.35 - 1.25	1.25 - 1.15	1.15 - 1.00	1.00
Fair	1.25 - 1.15	1.15 - 1.05	1.00 - 0.80	0.80
Poor	1.15 - 1.05	1.05 - 0.80	0.80 - 0.60	0.60
Very poor	1.05 - 0.95	0.95 - 0.75	0.60 - 0.40	0.40

1. The user of the AASHTO Guide may obtain the layer thicknesses for a unit value of m_2 and m_3 (i.e., $m_2 = m_3 = 1$), and then either reduce or increase the thickness of each layer according to the actual value of the drainage coefficients as illustrated in example 1 below. In this interpretation, the layer coefficients of the base and subbase materials are not modified. Rather, the thickness of the appropriate layer is either reduced or increased depending on the value of the drainage coefficient. This interpretation (since the layer coefficients are not modified) produces a constant thickness of the AC layer.

   It should be noted that the AASHTO DNPS86 program uses this interpretation. For convenience, this interpretation is called herein "the thickness modification method".

2. The user of the AASHTO Guide modify the values of the layer coefficient of the base and subbase materials by multiplying the actual layer coefficient by the drainage coefficient. Hence, the AASHTO design method produces layer thicknesses that are compatible with the modified values of the layer coefficients. Examples for this interpretation are given in the next subsection. Nevertheless, for convenience, this interpretation is called herein "the layer coefficient modification method".

Example 1 - Layer Coefficient Modification Method

Assumes that:

1. the layer coefficients of the base and subbase materials are 1.3 and 1.1, respectively.
2. for drainage coefficients of the base and subbase materials of 1, the AASHTO design procedure produces a base thickness of 6 inches and a subbase thickness of 9 inch.

The actual values of the drainage coefficients of the base and subbase materials are 1.2 and 0.8. The adjusted thicknesses of the base and subbase are:

Adjusted base thickness = 6/1.2 = 5 inches
Adjusted thickness of the subbase = 9/0.8 = 11.25 inch

Once again, it is very important to note that regardless of the user interpretation, the AASHTO main design equation produces a constant SN and independent of the values of the drainage coefficients. After determining the required SN, the layer thicknesses are adjusted.

4.1.2 Mechanistic Evaluation of the AASHTO Drainage Coefficients

The mechanistic evaluation of the AASHTO drainage coefficients was conducted by using the data of pavement section 162 of figure 1 of Chapter 1. During the evaluation, Five values of the drainage coefficients were used (0.6, 0.8, 1.0, 1.2, and 1.4). Further, two evaluation methods were used: the layer thickness modification method, and the layer coefficient modification method. The results of both methods are presented in the next subsections.

4.1.2.1 Layer Thickness Modification Method

As stated above, pavement section number 162 and the corresponding material properties (see figure 1 of chapter 1) were used in this analysis. Using the 1986 AASHTO design procedure, the pavement section was designed five times, once for each of the following values of drainage coefficients (0.6, 0.8, 1.0, 1.2, and 1.4). In each design, the same value of the drainage coefficient was assumed for both the base and the subbase materials. The outputs (layer thicknesses, and structural number) of the AASHTO design procedure, and the values of the drainage coefficients are listed in the first six columns of table 13.

The layer thicknesses obtained from the AASHTO design procedure and the layer moduli (calculated by using the values of the layer coefficients and the proper AASHTO equations) were then used to conduct mechanistic analysis of each design alternatives of section 162. The mechanistic responses are also listed in table 13.

Examination of the values of the various output parameters listed in table 13 indicates that:

1. As it was expected, the structural number is constant and it is independent of the drainage coefficient (also, see figure 36). This implies that the quality of drainage does not affect the structural capacity of the pavement structures (since the AASHTO design procedure uses the structural number to represent the structural capacity of the pavement).

2. Figure 37 depicts the layer thicknesses of the pavement as a function of the drainage coefficient. It can be seen that the AASHTO 1986 design methods produces:

   a) Constant AC thickness, that is the thickness of the AC layer is not affected by the drainage quality of the various layers.
   b) Increasing the value of the drainage coefficient (i.e., a better quality drainage) causes the thickness of the base material to decrease.
   c) Increasing the value of the drainage coefficient causes the thickness of the subbase material to increase.

3. Figure 38 displays the peak deflection calculated at the top of each layer as a function of the drainage coefficient. It can be seen that the deflection of each layer and the total pavement deflection (the deflection at the top of the AC layer) varies with variation in the drainage quality. However, by the AASHTO premises, the performance period and the cumulative 18-kip ESAL expected to travel the pavements are the same.

Table 13. Layer thicknesses and moduli, structural number, and mechanistic responses for various drainage coefficients of pavement section 162 (the 1986 AASHTO procedure, thickness modification method.

Results of the analysis	Drainage coefficient pavement section 162 of figure 1				
	0.60	0.80	1.00	1.20	1.40
Layer thicknesses (inches)					
AC	8.41	8.41	8.41	8.41	8.41
Base	6.10	4.57	3.66	3.05	2.61
Subbase	14.93	11.19	8.95	7.45	6.40
Structural number	5.25	5.25	5.25	5.25	5.25
Layer moduli (ksi)					
AC	300.00	300.00	300.00	300.00	300.00
Base	21.50	29.50	40.00	55.33	75.77
Subbase	13.15	18.19	25.00	34.82	48.17
Roadbed	10.00	10.00	10.00	10.00	10.00
Deflection at top of layer (mills)					
AC	18.37	17.51	16.93	16.42	16.00
Base	17.25	16.36	15.79	15.26	14.56
Subbase	14.63	14.60	14.52	14.36	14.18
Roadbed	10.31	11.37	12.03	12.42	12.64
Amount of compression in layers (mills)					
AC	1.12	1.13	1.14	1.14	1.14
Base	2.82	1.78	1.27	0.92	0.56
Subbase	4.32	3.23	2.49	1.94	1.54
Roadbed	10.31	11.37	12.03	12.42	12.64
Vertical stress at the top of layer (psi)					
Base	11.43	12.92	14.38	15.97	17.48
Subbase	5.76	7.07	8.23	9.32	10.33
Roadbed	2.30	2.55	3.25	3.52	3.68
Tensile stress at the bottom of the AC (psi)	86.32	77.93	69.81	60.94	52.20
Vertical strain at top of layer (in/in)					
AC	0.09	0.19	0.27	0.35	0.42
Base	5.61	4.83	4.15	3.50	2.94
Subbase	4.38	4.12	3.75	3.32	2.91
Roadbed	2.18	2.73	3.14	3.40	3.54
Vertical strain at bottom of layer (in/in)					
AC	2.11	1.99	1.88	1.75	1.83
Base	3.56	3.36	3.07	2.72	2.39
Subbase	2.09	2.34	2.46	2.49	2.45

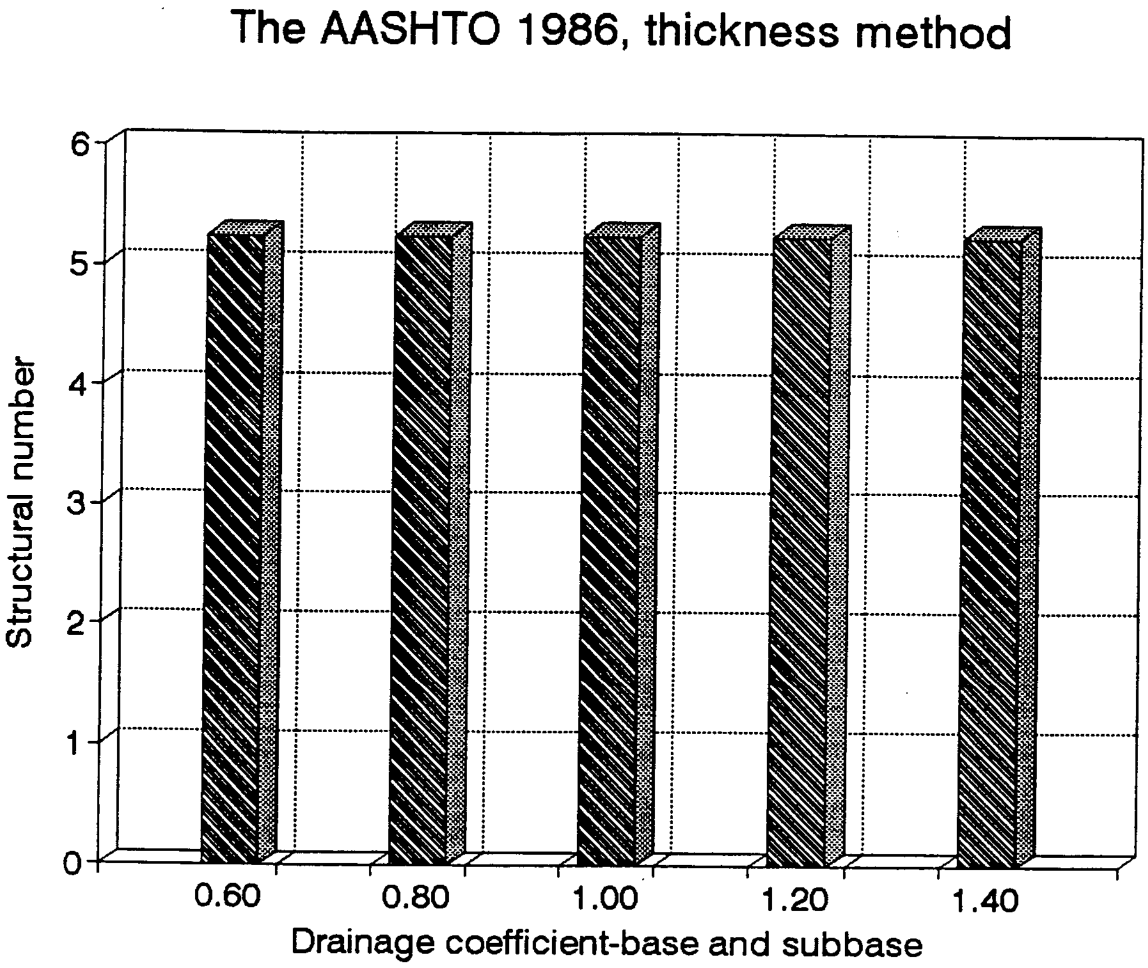

Figure 36. Structural number versus drainage coefficient (AASHTO 1986, thickness modification method).

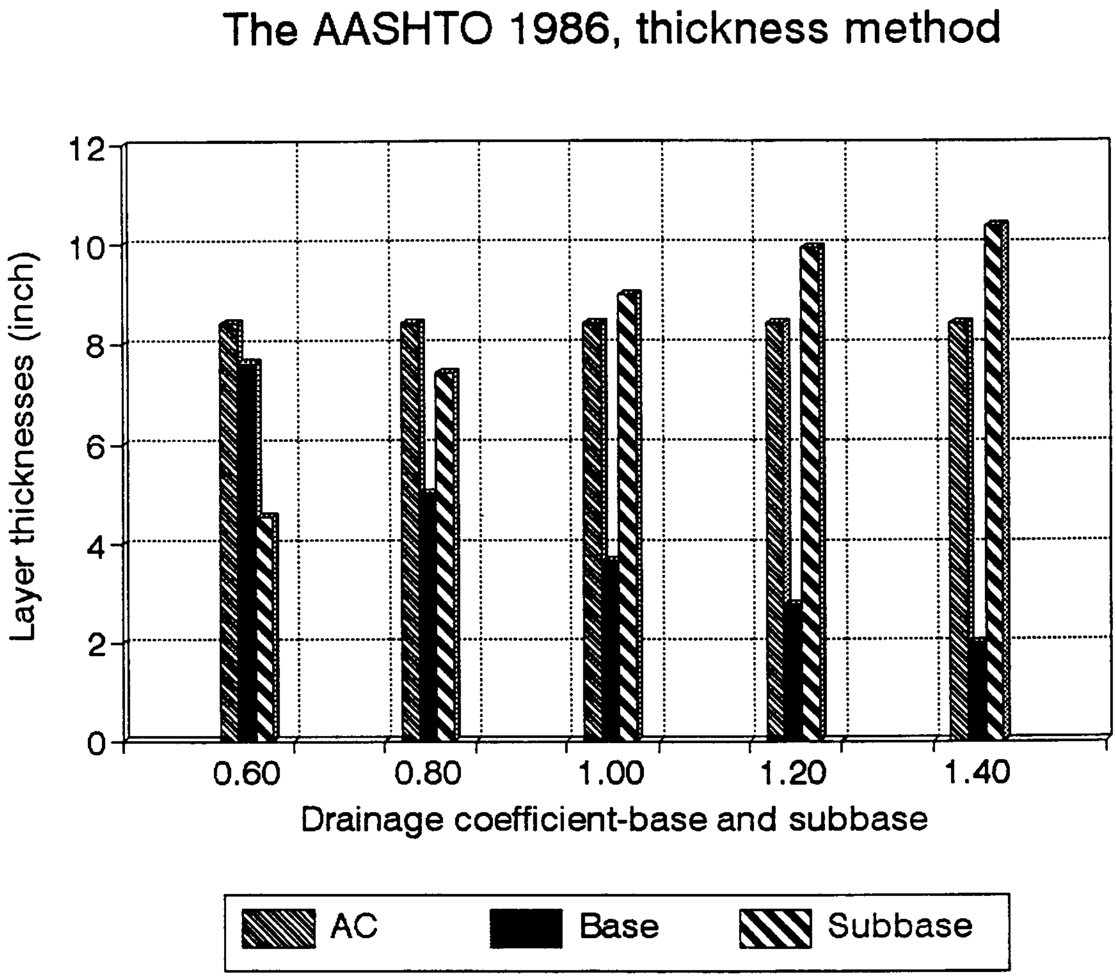

Figure 37. Layer thicknesses versus drainage coefficient (AASHTO 1986, thickness modification method).

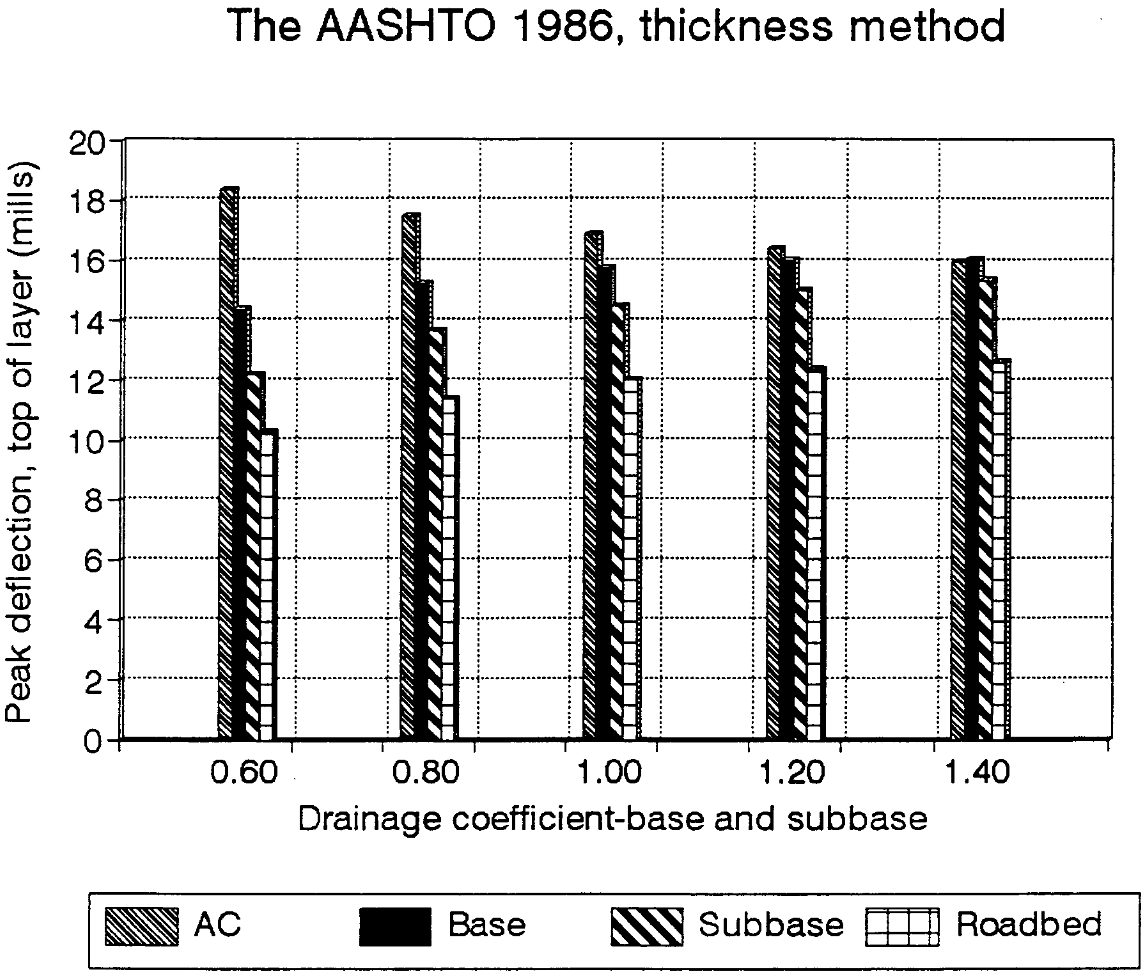

Figure 38. Peak deflection at top of layers versus drainage coefficient (AASHTO 1986, thickness modification method).

4. Figure 39 shows the amount of compression experienced by each pavement layer as a function of the drainage quality. Once again, the damage (measured in terms of compression) delivered to each layer is affected by the quality of drainage. Hence, the five design alternatives (one alternative per one value of the drainage coefficient) should not be expected (as per AASHTO design method) to have the same performance level.

5. Figure 40 depicts the vertical strains calculated at the top of each pavement layer due to an 18-kip ESAL. It can be seen that the vertical strains at the top of the base and subbase layers increases as the quality of drainage deteriorate (the coefficient of drainage decreases). Once again, this implies that higher level of damage is being delivered to those layers with poor drainage quality.

6. Figure 41 depicts the tensile stress induced at the bottom of the AC layer due to an 18-kip ESAL as a function of the drainage coefficient. It can be seen that as the drainage coefficient decreases from 1.4 to 0.6, the magnitude of the tensile stress increases by about 70 percent. Thus, pavement sections constructed by using a poorly drainable material would have a shorter fatigue life than those constructed of well drainable material. Although, the AASHTO design method is suppose to produce pavements with equal performance period.

4.1.2.2 Layer Coefficient Modification Method

In this method, the layer coefficient of the base (a_1) and subbase (a_2) are modified by multiplying it by the value of the drainage coefficient (a_i x m_i). The modified layer coefficient values are then used to estimate the modified layer moduli (using the appropriate AASHTO layer coefficient equations) and as inputs to the AASHTO design method. Unlike the thickness modification method, this procedure produces different thicknesses of all layers including the AC layer. Like the thickness modification method however, the procedure produces a constant structural number.

Pavement section number 162 and the corresponding material properties (see figure 1) were used in this analysis. Like the thickness method, the 1986 AASHTO design procedure was used to design pavement section 162 five times, once for each of the following values of drainage coefficients (0.6, 0.8, 1.0, 1.2, and 1.4). In each design, the same value of the drainage coefficient was assumed for both the base and the subbase materials. The outputs (layer thicknesses, and structural number) of the AASHTO design procedure, and the values of the drainage coefficients are listed in the first six columns of table 14.

The layer thicknesses obtained from the AASHTO designed procedure and the layer moduli (calculated by using the modified values of the layer coefficients and the proper AASHTO equations) were then used to conduct mechanistic analysis of each design alternative of section 162. The mechanistic responses are also listed in table 14.

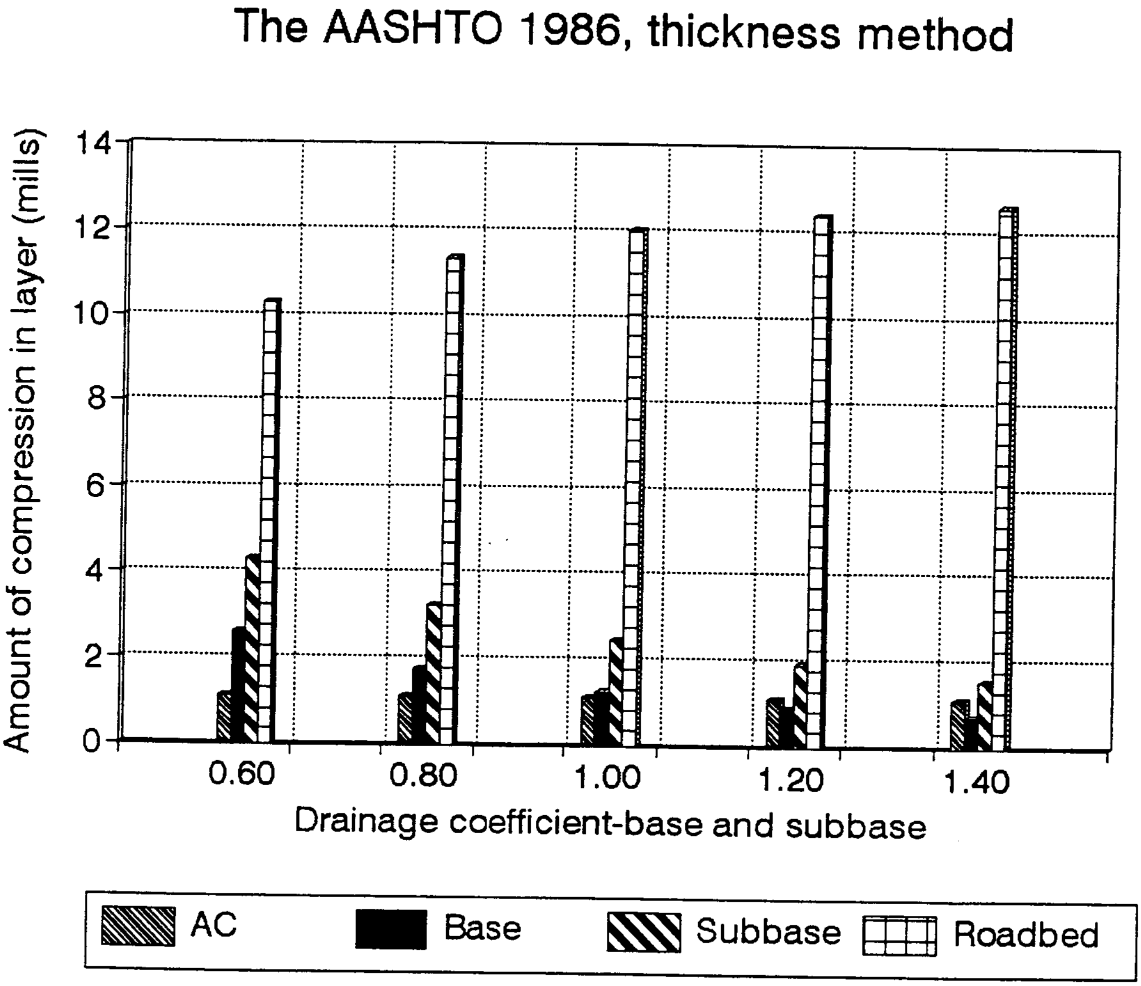

Figure 39. The amount of compression in each layer versus drainage coefficient (AASHTO 1986, thickness modification method).

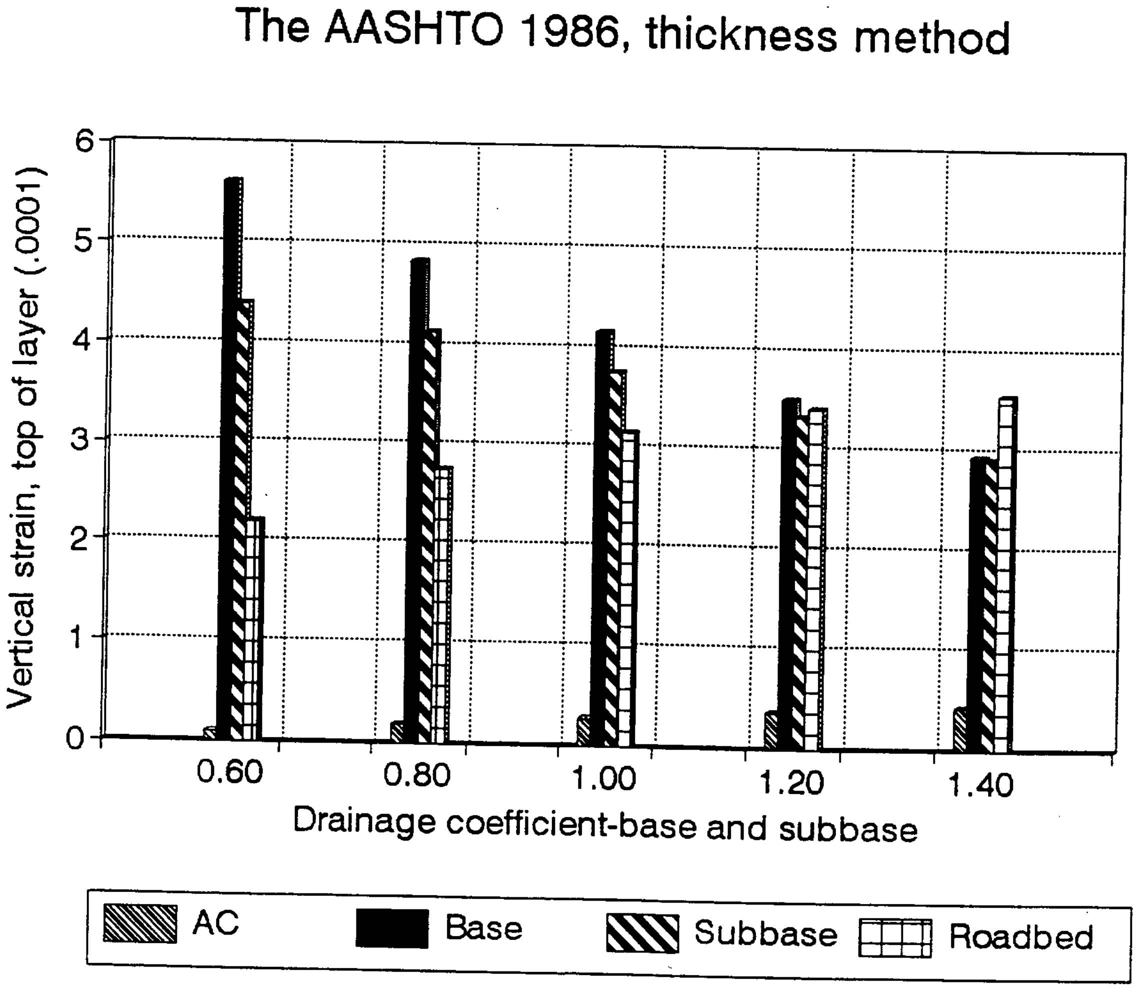

Figure 40. The vertical strain at the top of each layer versus drainage coefficient (AASHTO 1986, thickness modification method).

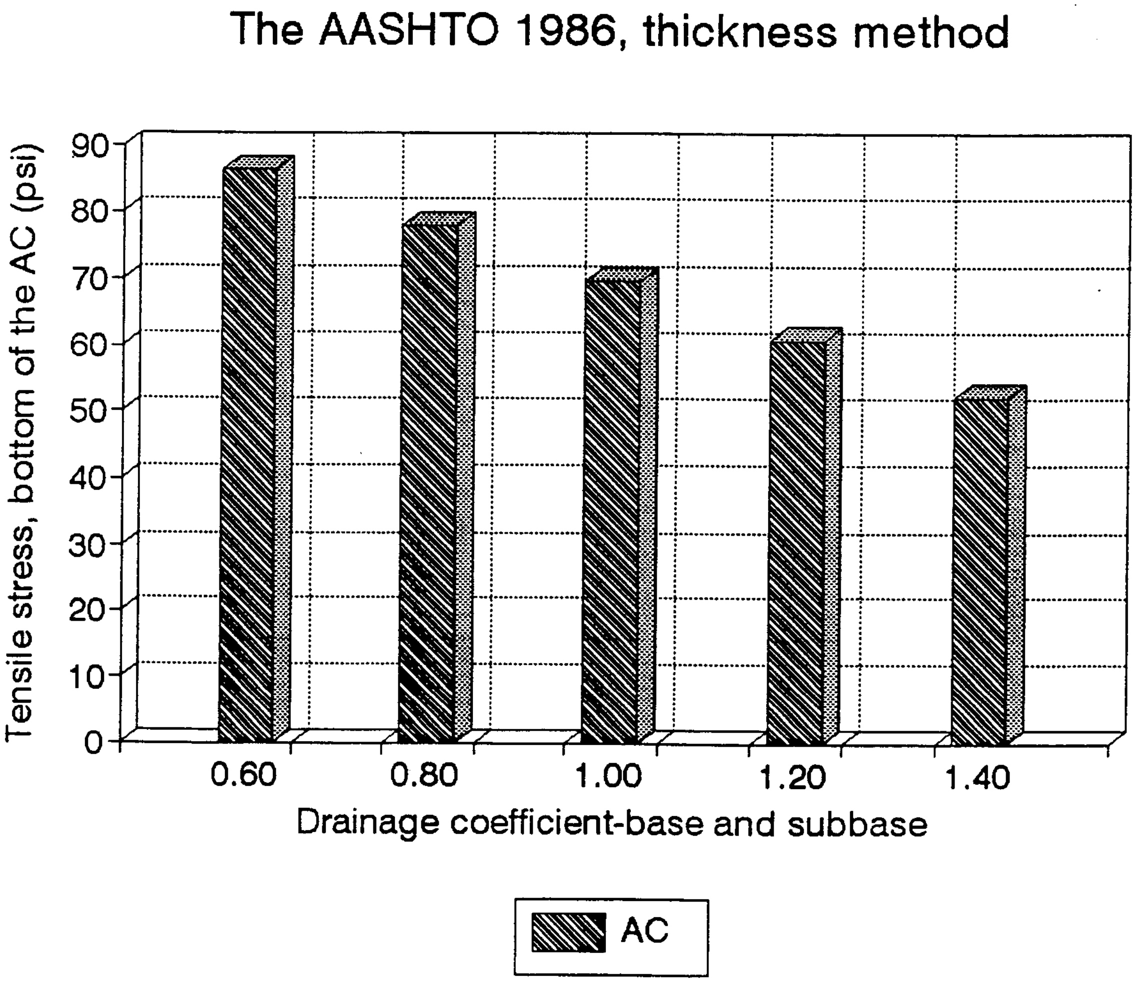

Figure 41. The tensile stress at the bottom of the AC layer versus drainage coefficient (AASHTO 1986, thickness modification method).

Table 14. Layer thicknesses and moduli, structural number, and mechanistic responses for various drainage coefficients of pavement section 162 (the 1986 AASHTO procedure, layer coefficient modification method.

Results of the analysis	Drainage coefficient pavement section 162 of figure 1				
	0.60	0.80	1.00	1.20	1.40
Layer thicknesses (inches)					
AC	10.82	9.44	8.41	7.42	6.57
Base	7.61	4.99	3.66	2.75	1.99
Subbase	4.54	7.41	8.95	9.90	10.34
Structural number	5.25	5.25	5.25	5.25	5.25
Layer moduli (ksi)					
AC	300.00	300.00	300.00	300.00	300.00
Base	21.50	29.50	40.00	55.33	75.77
Subbase	13.15	18.19	25.00	34.82	48.17
Roadbed	10.00	10.00	10.00	10.00	10.00
Deflection at top of layer (mills)					
AC	15.78	16.52	16.93	17.07	17.01
Base	14.41	15.28	15.79	16.05	16.10
Subbase	12.22	13.66	14.52	15.08	15.38
Roadbed	11.04	11.63	12.03	12.33	12.59
Amount of compression in layers (mills)					
AC	1.37	1.24	1.14	1.02	0.91
Base	2.19	1.82	1.27	0.99	0.72
Subbase	1.18	2.03	2.49	2.73	2.79
Roadbed	11.04	11.63	12.03	12.33	12.59
Vertical stress at the top of layer (psi)					
Base	7.70	10.55	14.38	19.76	26.12
Subbase	3.52	5.49	8.23	12.40	16.29
Roadbed	2.67	2.98	3.25	3.49	3.72
Tensile stress at the bottom of the AC (psi)	63.22	68.23	69.81	67.14	60.14
Vertical strain at top of layer (in/in)					
AC	0.50	0.37	0.27	0.19	0.15
Base	3.90	4.06	4.15	4.13	3.94
Subbase	2.90	3.40	3.75	4.00	4.12
Roadbed	2.40	2.85	3.14	3.38	3.57
Vertical strain at bottom of layer (in/in)					
AC	1.52	1.72	1.88	2.00	2.07
Base	2.35	2.78	3.07	3.29	3.40
Subbase	2.43	2.44	2.46	2.47	2.47

Examination of the values of the various output parameters listed in table 14 indicates that:

1. Like the thickness modification method, the structural number of all design alternatives is constant and it is independent of the drainage coefficient (also, see figure 42). This implies that the quality of drainage does not affect the structural capacity of the pavement structures (the AASHTO design procedure uses the structural number to represent the required structural capacity of the pavement).

2. Figure 43 depicts the layer thicknesses of the pavement as a function of the drainage coefficient. It can be seen that the AASHTO method produces:

    a) Higher AC thickness for lower values of drainage coefficients. That is the thickness of the AC layer is affected by the drainage quality of the various layers. Since the effective layer coefficient of the base is affected by the drainage coefficient, the required thickness of the AC layer to protect the base material should be different. Hence, this method (the layer modification method) produces more reasonable results than that of the thickness modification method.
    b) Higher base thickness for lower values of drainage coefficients. This result is compatible to that of the thickness modification method.
    c) Higher subbase thickness for higher values of drainage coefficients. This result is also compatible to that of the thickness modification method.

3. Figure 44 displays the peak deflection calculated at the top of each layer as a function of the drainage coefficient. It can be seen that the deflection of each layer and the total pavement deflection (the deflection at the top of the AC layer) varies with variation in the drainage quality. These variations however, are less than those produced by the thickness modification method (see figure 38). In this regard, the peak pavement deflection (the deflection at the top of the AC layer slightly decreases as the quality of drainage deteriorates which is exactly the opposite to that produced from the thickness modification method. Thus, the layer modification method seems to produce more consistent pavement sections than the thickness modification method.

4. Figure 45 shows the amount of compression delivered to each pavement layer as a function of the drainage quality. The variations however, are less than those observed in figure 39 (the thickness modification method). Hence, this method produces more consistent layer thickness designs than the other method.

5. Figure 46 depicts the vertical strains calculated at the top of each pavement layer due to an 18-kip ESAL. It can be seen that the vertical strains at the top of the base and subbase layers and at the top of the roadbed soil increases as the quality of drainage improves (the coefficient of drainage increases). Once again, this

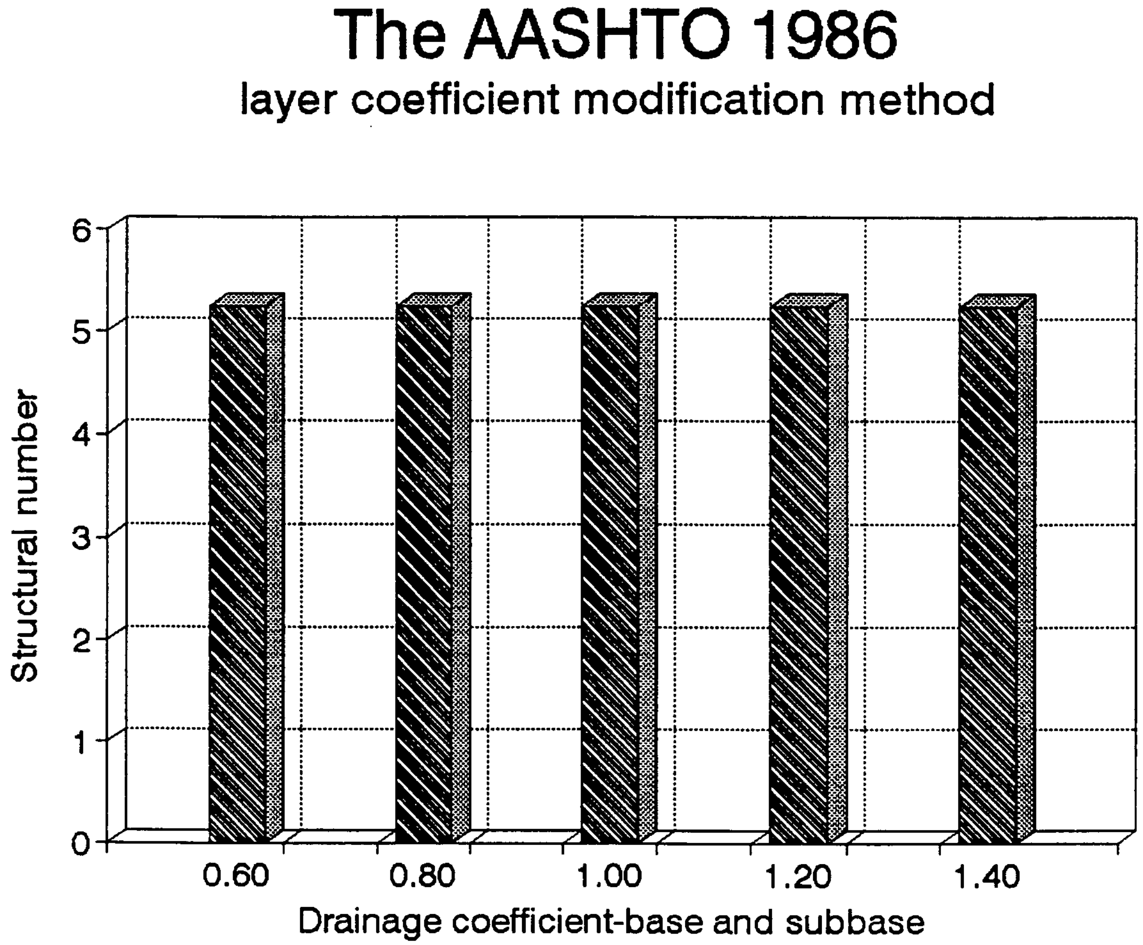

Figure 42. Structural number versus drainage coefficient (AASHTO 1986, layer coefficient modification method).

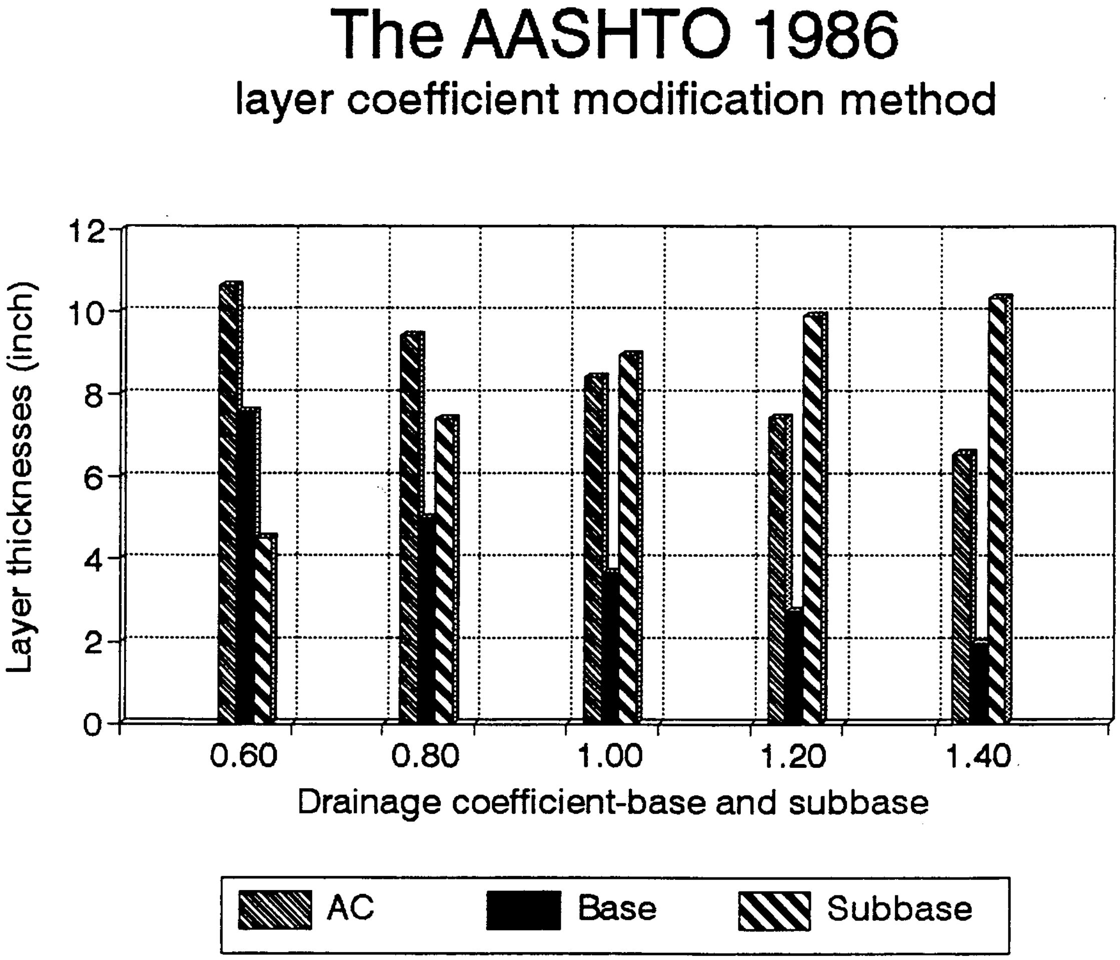

Figure 43. Layer thicknesses versus drainage coefficient (AASHTO 1986, layer coefficient modification method).

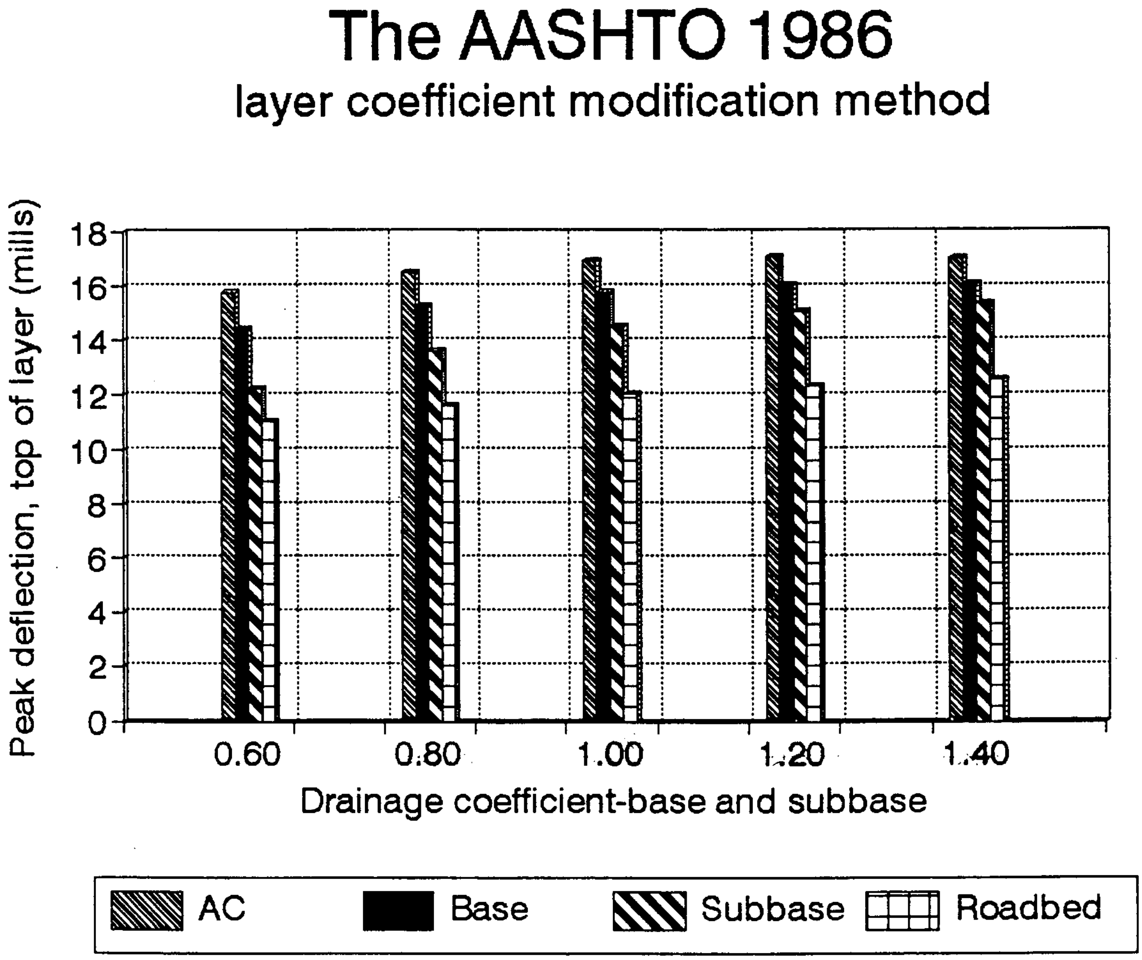

Figure 44. Peak deflection at top of layers versus drainage coefficient (AASHTO 1986, layer coefficient modification method).

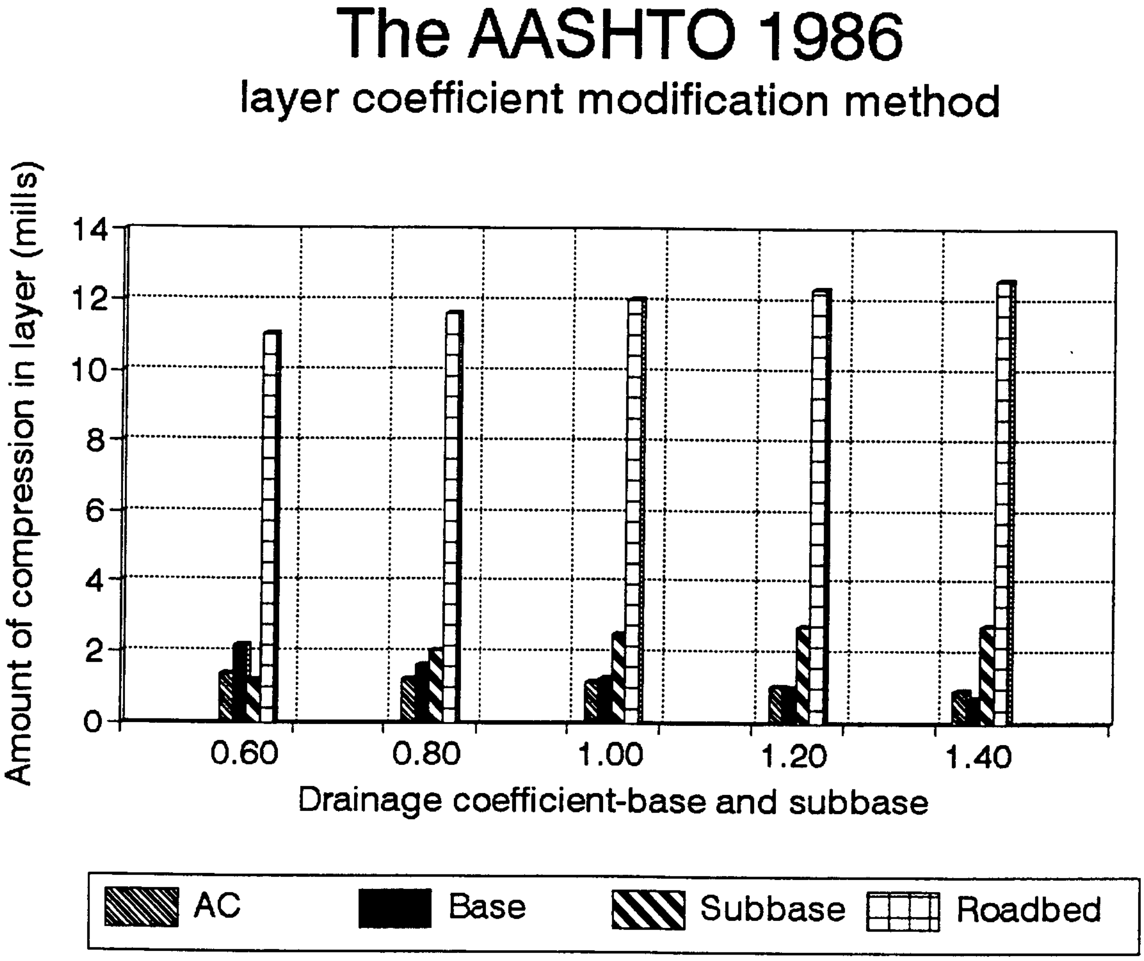

Figure 45. The amount of compression in each layer versus drainage coefficient (AASHTO 1986, layer coefficient modification method).

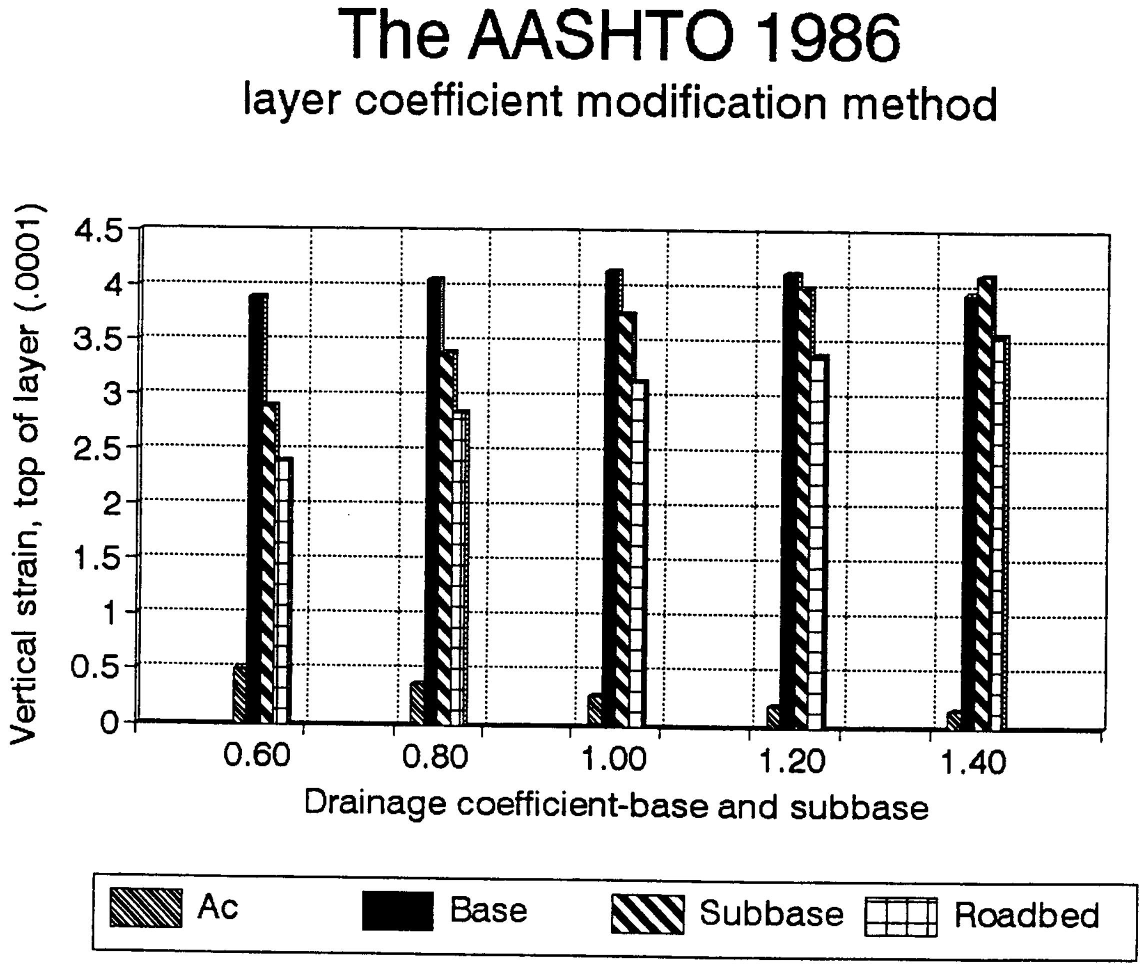

Figure 46. The vertical strain at the top of each layer versus drainage coefficient (AASHTO 1986, layer coefficient modification method).

observation is the opposite to that shown in figure 39 (the thickness modification method). Based on this observation, one can conclude that the layer coefficient modification method seems to produce more consistent results than those of the thickness modification method.

6. Figure 47 depicts the tensile stress induced at the bottom of the AC layer due to an 18-kip ESAL as a function of the drainage coefficient. It can be seen that the maximum variation in the magnitude of the tensile stress from one section to another is about 17 percent. For the thickness modification method, this variation was about 70 percent (see figure 41). Again, the layer coefficient modification method tends to produce better thickness design than the thickness modification method.

4.1.2.3 Mechanistic-Based Modification of the AASHTO Drainage Coefficient Procedure

Once again, the intent of the 1986 AASHTO design procedure is that, for the same effective modulus of the roadbed soil, traffic level, serviceability loss, performance period, design reliability, and an overall standard deviation, is to produce pavement sections with equal performance. That is regardless of the material used in the various pavement layers or their drainage coefficients, the AASHTO methods produces combinations of layer thicknesses as to insure equal pavement damage during the design performance period. Results of the mechanistic analyses showed that the level of damage induced in a pavement section in terms of deflections, stresses, and strains vary significantly with drainage coefficients. To this end, a mechanistic-based calibration of the AASHTO method was developed to account for the effects of drainage quality on the pavement performance. During the development, various forms of the AASHTO SN equation were employed. The one that produced the most promising results (minimum variations in the pavement deflections, stresses, and strains) is presented below. In this mechanistic modified method, the values of the drainage coefficients recommended in the 1986 AASHTO Design Guide were used. The method consists of several steps as follows:

1. Calculate the effective values of the layer coefficients of the base and subbase materials using the following equation:

$$a_{ci} = (a_i)(m_i)^{0.5}$$

where a_{ci} = the effective layer coefficient of layer "i";
a_i = the layer coefficient of layer "i"; and
m_i = the drainage coefficient of layer "i".

2. Calculate the design value of the resilient modulus using the following equation:

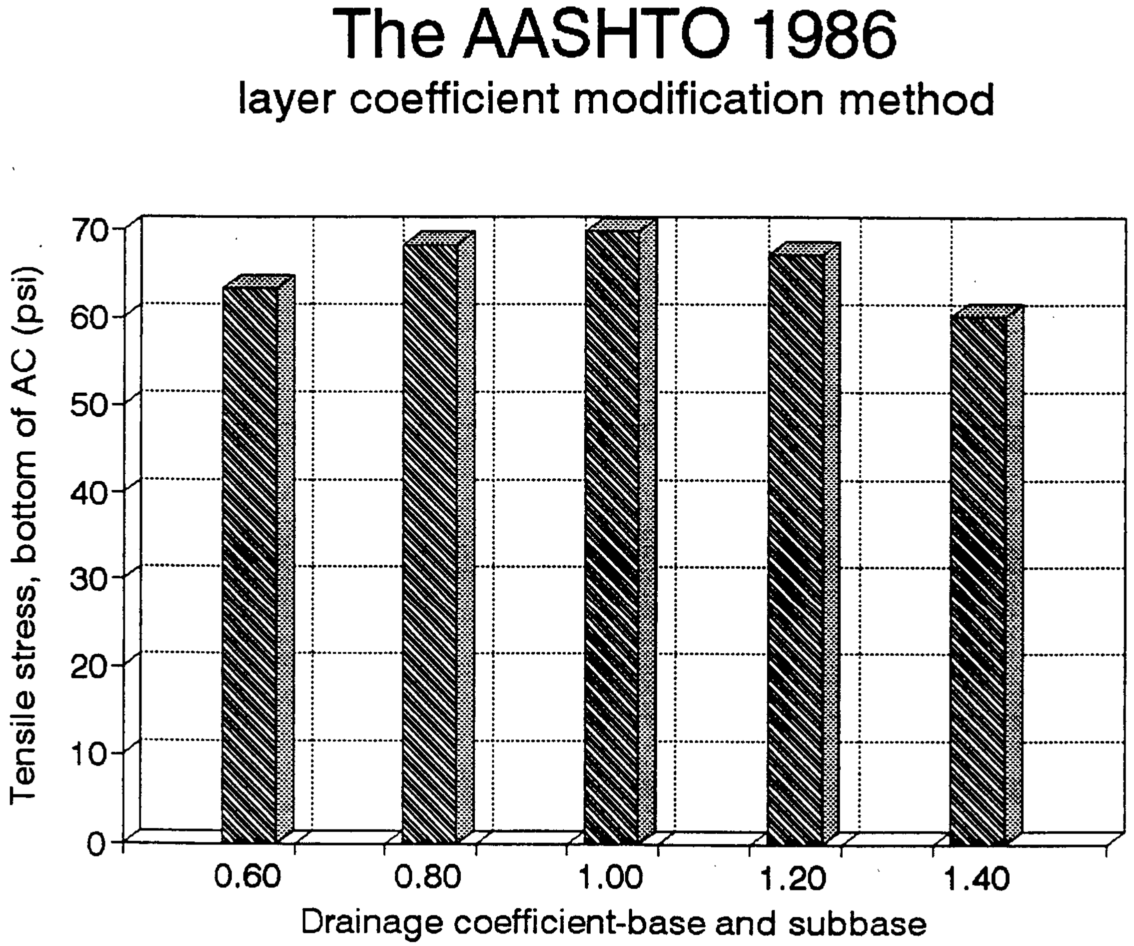

Figure 47. The tensile stress at the bottom of the AC layer versus drainage coefficient (AASHTO 1986, layer coefficient modification method).

$$MR_{RBd} = (MR_{EFF})(m_3)^{0.5}$$

where MR_{RBd} = the design value of the resilient modulus of the roadbed soil (psi);

MR_{EFF} = the AASHTO defined effective resilient modulus of the roadbed soil (psi); and

m_3 = the drainage coefficient of the subbase material or of the layer immediately above the roadbed soil.

3. Use the values calculated in steps 1 and 2 above as inputs to the AASHTO design procedure to obtain the required SN and layer thicknesses.

As in the previous two methods, pavement section number 162 and the corresponding material properties (see figure 1 of chapter 1) were used in this analysis. Like the other two methods of the previous two subsections, the 1986 AASHTO design procedure was used to design pavement section 162 five times, once for each of the following values of drainage coefficients (0.6, 0.8, 1.0, 1.2, and 1.4). In each design, the same value of the drainage coefficient was assumed for both the base and the subbase materials. The outputs (layer thicknesses, and structural number) of the AASHTO design procedure, and the values of the drainage coefficients are listed in the first six columns of table 15.

The layer thicknesses obtained from the AASHTO designed procedure, the layer moduli (calculated by using the effective values of the layer coefficients and the proper AASHTO equations), and the design value of the resilient modulus of the roadbed soil were then used to conduct mechanistic analysis of each design alternatives of section 162. The mechanistic responses are also listed in table 15.

Figures 48 through 53 show, respectively, the required structural number and layer thicknesses produced by using the AASHTO method, and the mechanistic outputs (the peak deflection at the top of each pavement layer and roadbed soil, the amount of compression in each layer, the vertical strains at the top of each layer, and the tensile stress at the bottom of the AC layer) plotted as functions of the values of the drainage coefficients. Discussion of the results and their comparison with those obtained from the other two methods (thickness modification and layer coefficient modification methods) are presented in the next subsection.

4.1.2.4 Comparison of the Results of the Three Methods

Each of the mechanistic responses obtained from the mechanistic analyses of the various AASHTO design alternatives of pavement section 162 were compared. Results of this comparison are presented and discussed below.

Table 15. Layer thicknesses and moduli, structural number, and mechanistic responses for various layer coefficients of pavement section 162 (mechanistic-based modification of the 1986 AASHTO procedure).

Results of the analysis	Drainage coefficient pavement section 162 of figure 1				
	0.60	0.80	1.00	1.20	1.40
Layer thicknesses (inches)					
AC	9.64	8.99	8.41	7.80	7.53
Base	5.75	4.26	3.66	2.97	2.67
Subbase	10.70	9.90	8.95	8.70	8.28
Structural number	5.69	5.44	5.25	5.09	4.97
Layer moduli (ksi)					
AC	300.00	300.00	300.00	300.00	300.00
Base	27.91	33.58	40.00	48.61	53.32
Subbase	16.78	21.21	25.00	30.83	34.12
Roadbed	7.75	8.94	10.00	10.95	11.83
Deflection at top of layer (mills)					
AC	18.19	17.44	16.93	16.48	16.03
Base	16.93	16.24	15.79	15.41	14.99
Subbase	15.13	14.81	14.52	14.35	14.02
Roadbed	12.52	12.22	12.03	11.85	11.60
Amount of compression in layers (mills)					
AC	1.26	1.20	1.14	1.07	1.04
Base	1.80	1.43	1.27	1.06	0.97
Subbase	2.61	2.59	2.49	2.50	2.42
Roadbed	12.52	12.22	12.03	11.85	11.60
Vertical stress at the top of layer (psi)					
Base	10.04	12.10	14.38	17.37	18.90
Subbase	4.84	6.66	8.23	10.67	12.03
Roadbed	2.10	2.68	3.25	3.81	4.25
Tensile stress at the bottom of the AC (psi)	67.52	69.15	69.81	69.13	68.32
Vertical strain at top of layer (in/in)					
AC	0.37	0.32	0.27	0.22	0.20
Base	4.05	4.11	4.15	4.15	4.13
Subbase	3.25	3.54	3.75	3.93	4.00
Roadbed	2.61	2.88	3.14	3.36	3.47
Vertical strain at bottom of layer (in/in)					
AC	1.69	1.79	1.88	1.96	2.00
Base	2.62	2.91	3.07	3.24	3.31
Subbase	2.13	2.29	2.46	2.56	2.64

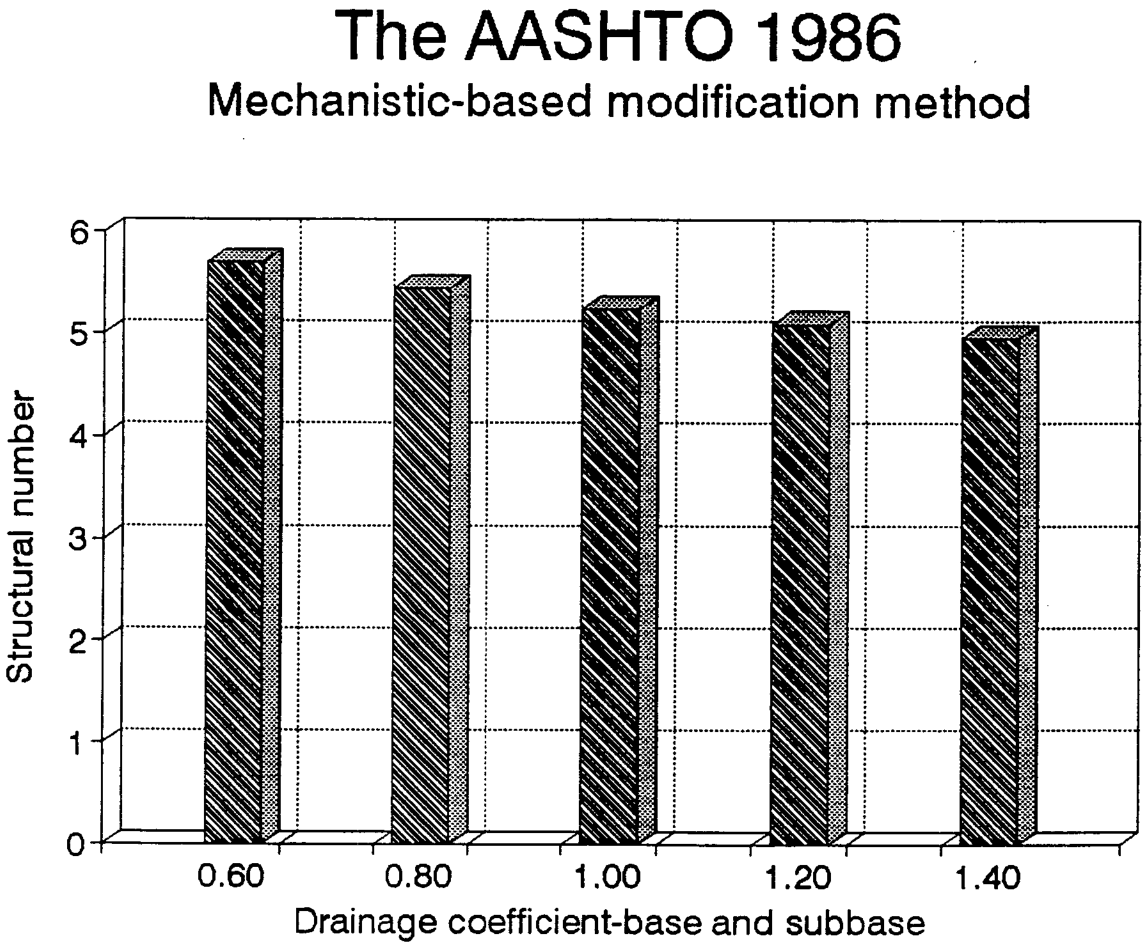

Figure 48. Structural number versus drainage coefficient (AASHTO 1986, mechanistic-based modification method).

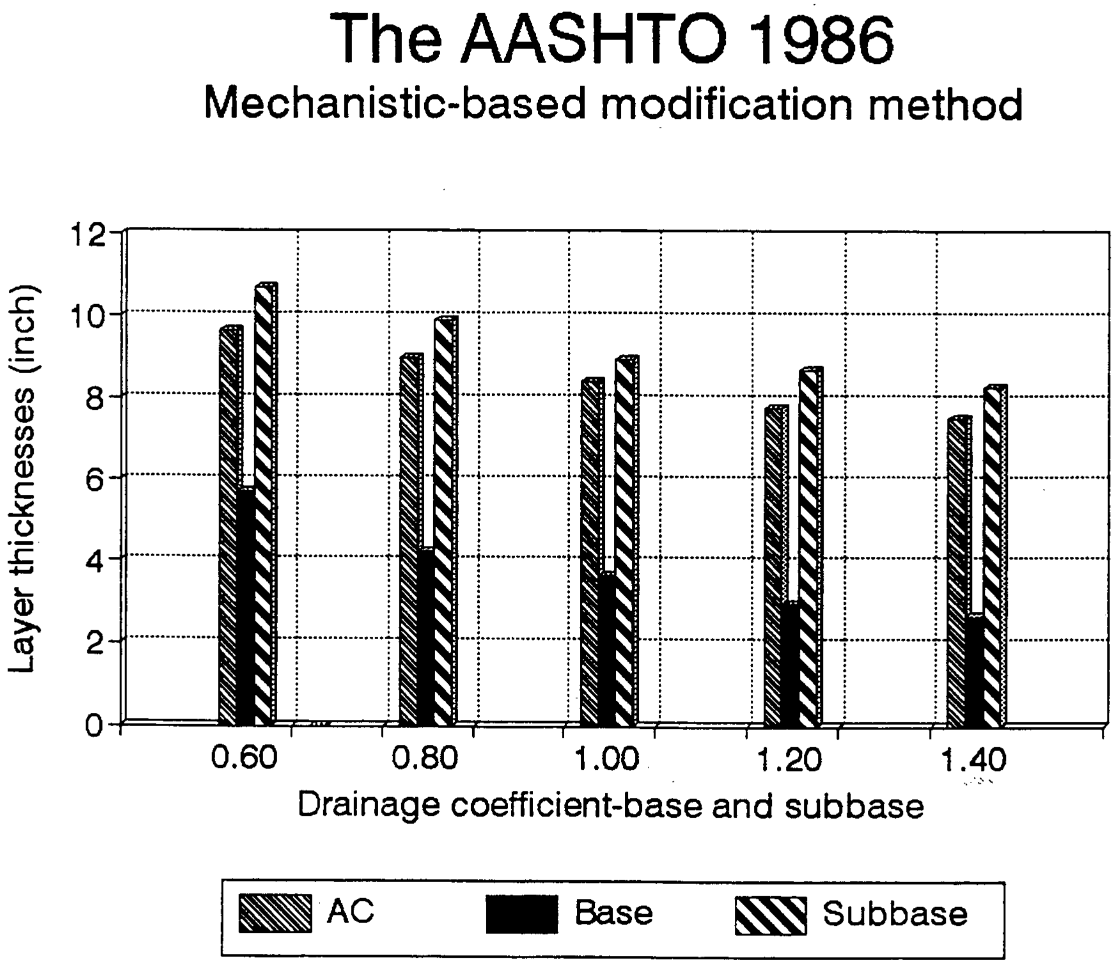

Figure 49. Layer thicknesses versus drainage coefficient (AASHTO 1986, mechanistic-based modification method).

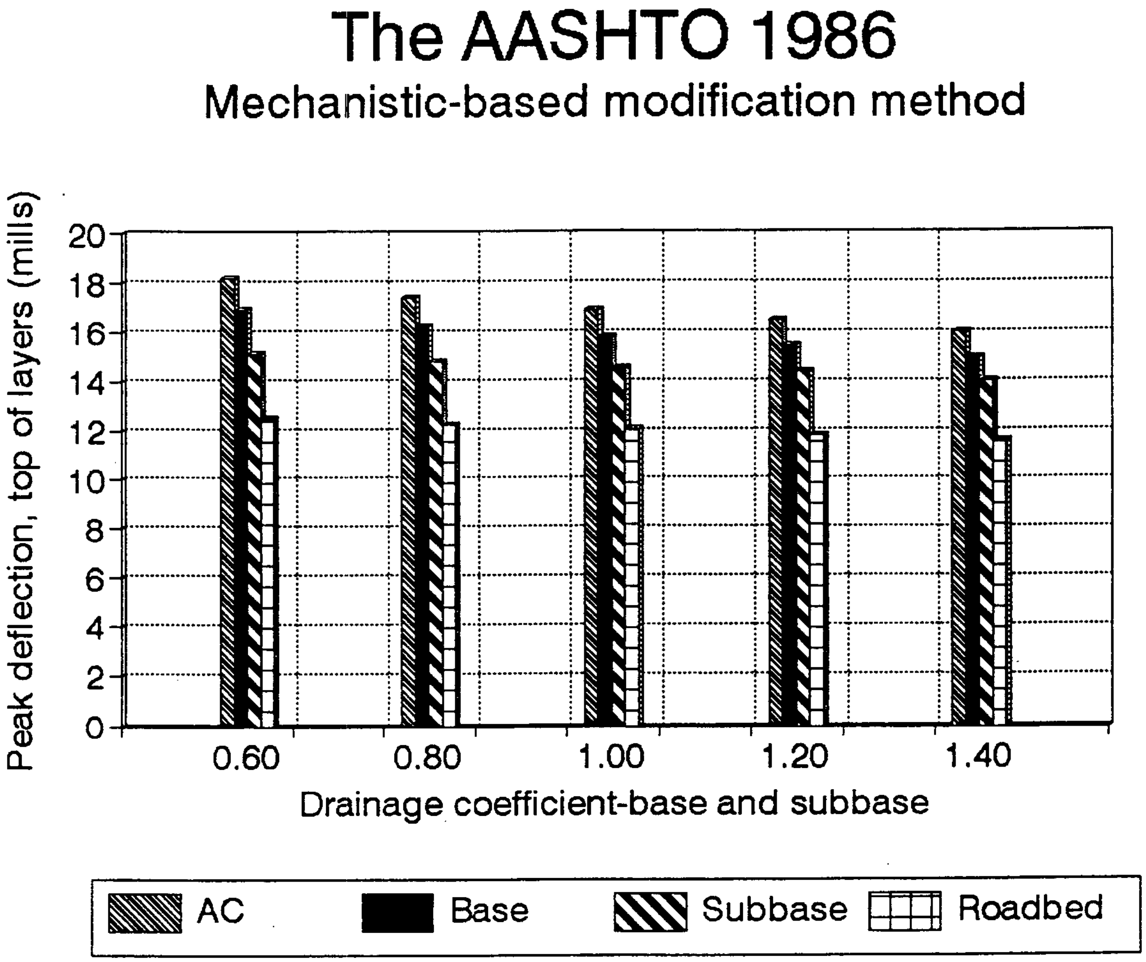

Figure 50. Peak deflection at top of layers versus drainage coefficient (AASHTO 1986, mechanistic-based modification method).

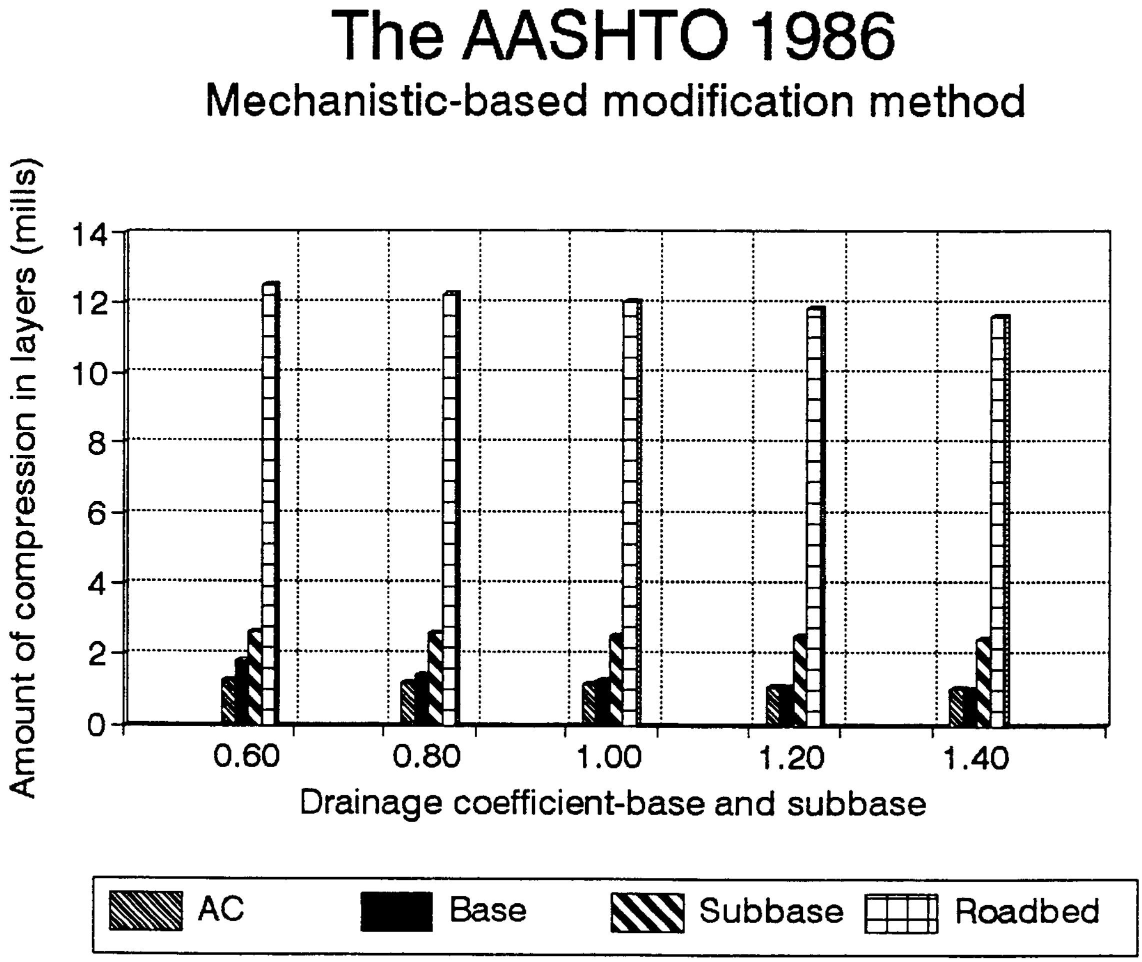

Figure 51. The amount of compression in each layer versus drainage coefficient (AASHTO 1986, mechanistic-based modification method).

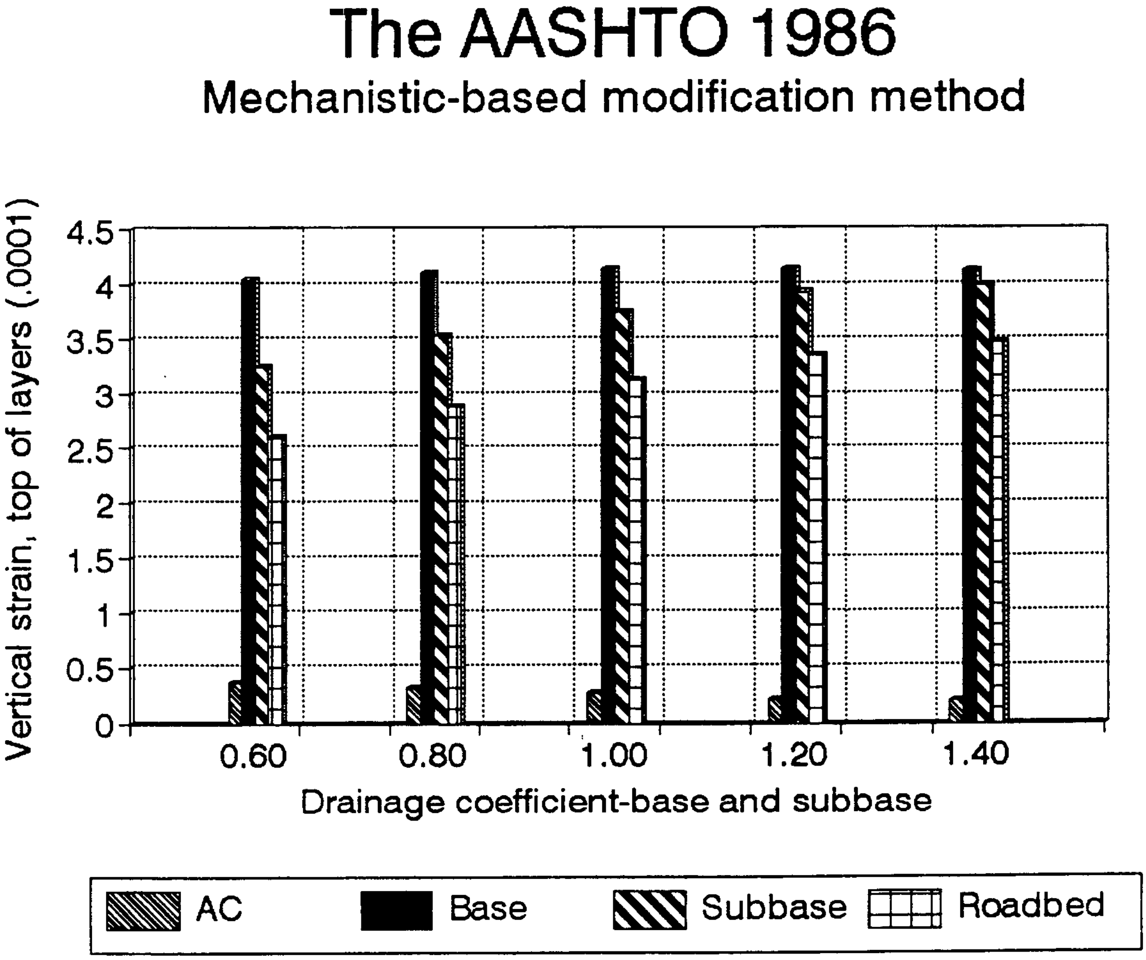

Figure 52. The vertical strain at the top of each layer versus drainage coefficient (AASHTO 1986, mechanistic-based modification method).

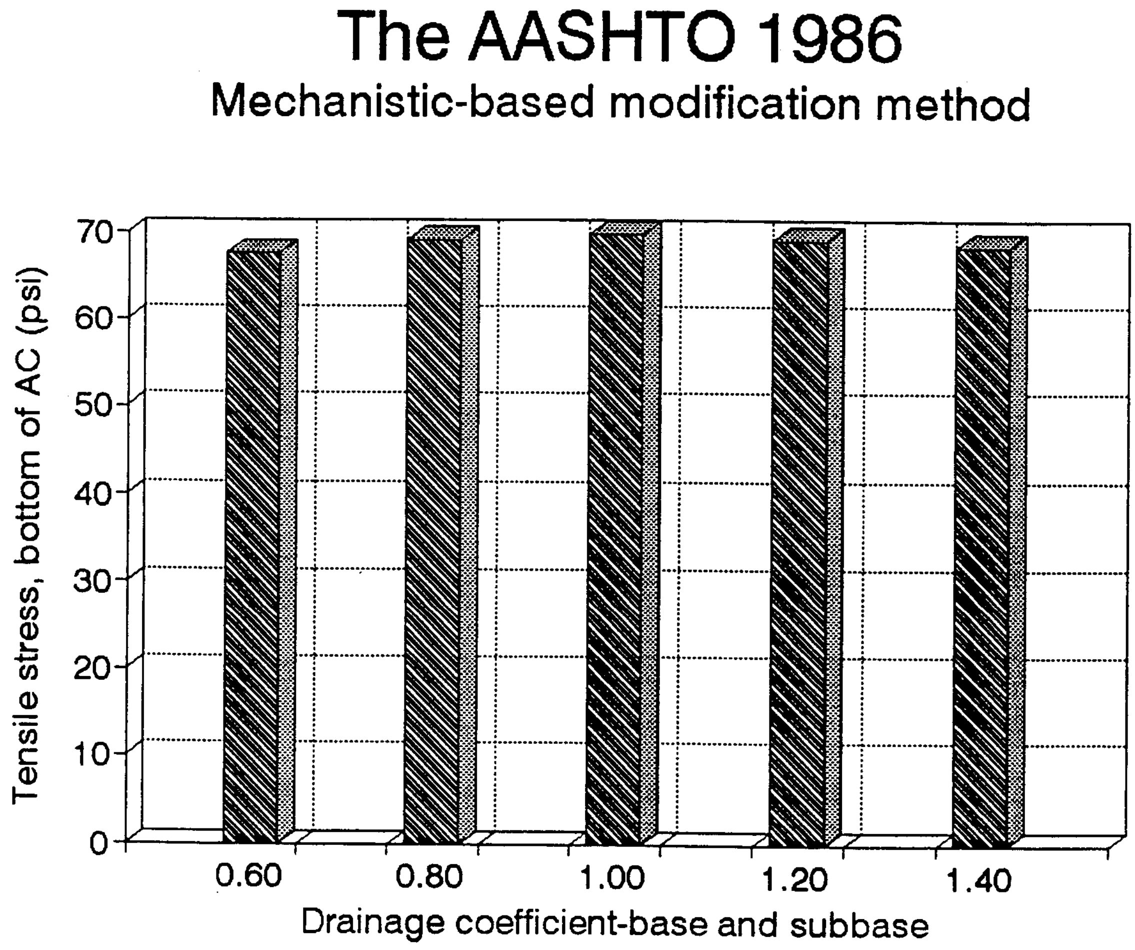
The AASHTO 1986
Mechanistic-based modification method

Figure 53. The tensile stress at the bottom of the AC layer versus drainage coefficient (AASHTO 1986, mechanistic-based modification method).

1. **Structural Number** - Figure 54 depicts the structural numbers produced by the 1986 AASHTO design procedure for the three methods (thickness modification, layer coefficient modification, and mechanistic-based modification methods) used to account for the effects of drainage. It can be seen from the figure that while the first two methods produced a constant structural number (required structural capacity) that is independent of the values of the drainage coefficients, the mechanistic-based method produces higher structural number for lower drainage coefficients. That is, as the quality of drainage deteriorates, the required structural capacity of the pavement (expressed in terms of the structural number) increases. The results of the mechanistic-based modification method are reasonable and are expected. From the engineering point of view, lower quality material requires higher structural capacity to accommodate the same traffic level. Hence, based on the structural number values, the mechanistic-based modification of the effects of drainage coefficients represents an improvement over the present AASHTO methods.

2. **Thickness of the AC Layer** - Figure 55 depicts the thicknesses of the AC layer as a function of the values of the drainage coefficients. It can be seen from the figure that:

    a) The thickness modification method produces a constant AC thickness implying that the level of protection of the base layer is not affected by its drainage quality.
    b) The AASHTO layer modification and the mechanistic-based modification methods produce variable AC thickness. Higher drainage quality of the base material requires less protection in terms of the asphalt thickness. This is a very reasonable result (lower drainage coefficient values yield lower layer coefficient and hence thicker AC is required to protect the base material). Hence, based on the values of the mechanistic outputs, both drainage modification methods produce more consistent results than the thickness modification method.

3. **Thickness of the Base Layer** - Figure 56 shows the thicknesses of the base layers produced by the 1986 AASHTO thickness design procedure for the three methods accounting for the effects of drainage coefficients. It can be seen from the figure that:

    a) As is the case for the AC and subbase layers, for a value of the drainage coefficient of 1.0, the three methods lead to the same base thickness.
    b) The thickness of the base layer decreases as the value of the drainage coefficient increases. Modification of the layer coefficient method causes the largest variation while the mechanistic-based drainage coefficient modification method leads to the smallest variation.

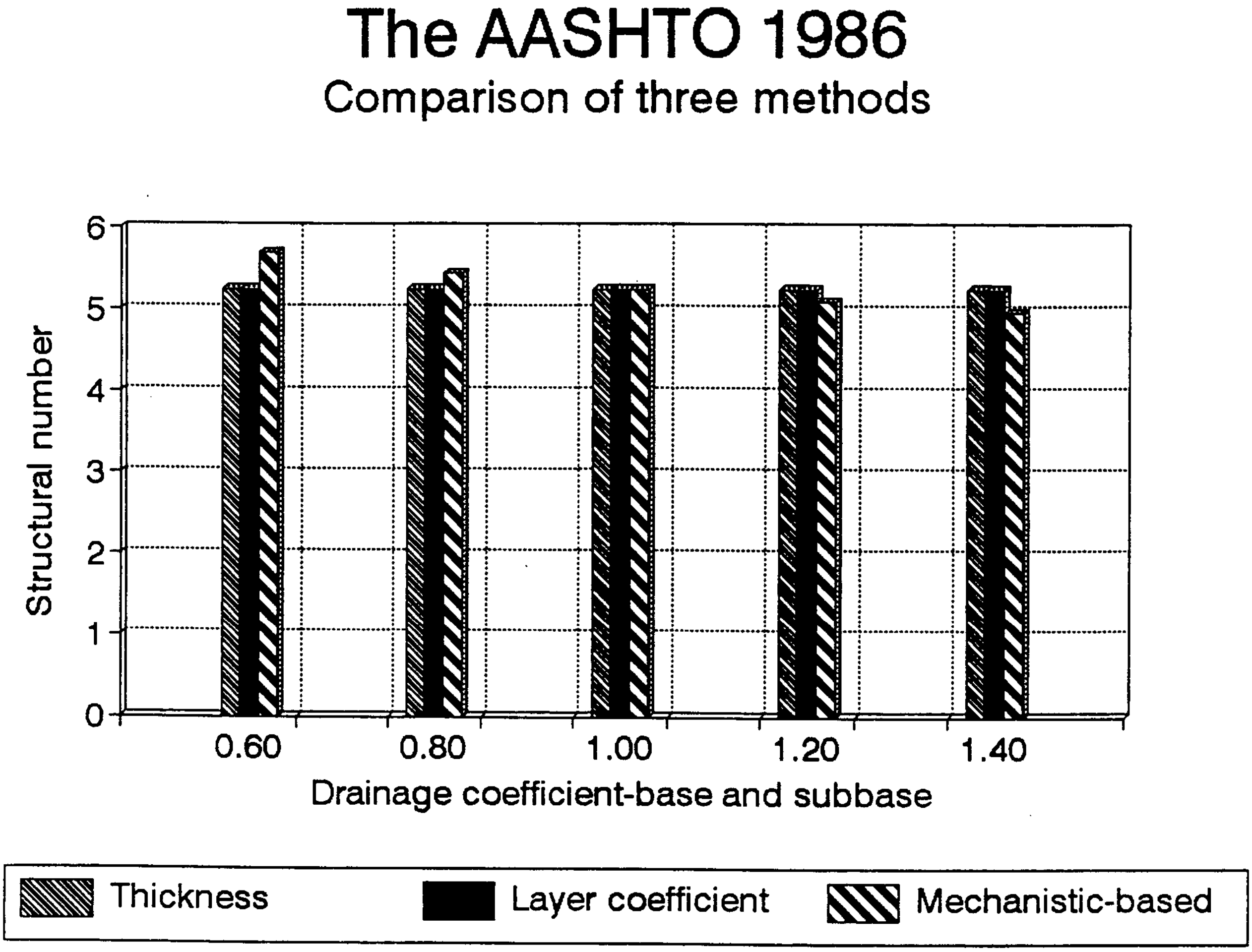

Figure 54. Comparison of the structural number versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

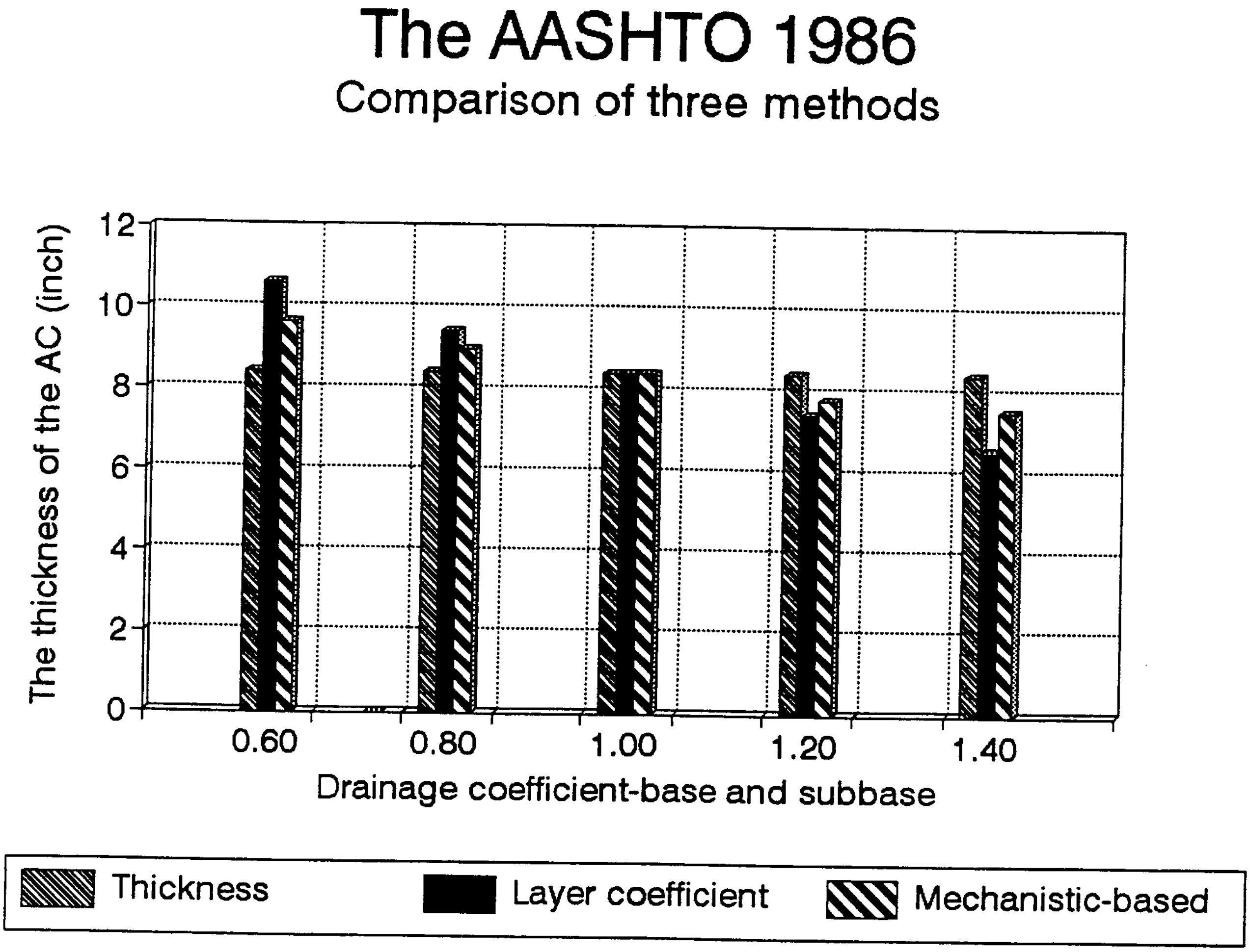

Figure 55. Comparison of the AC layer thicknesses versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

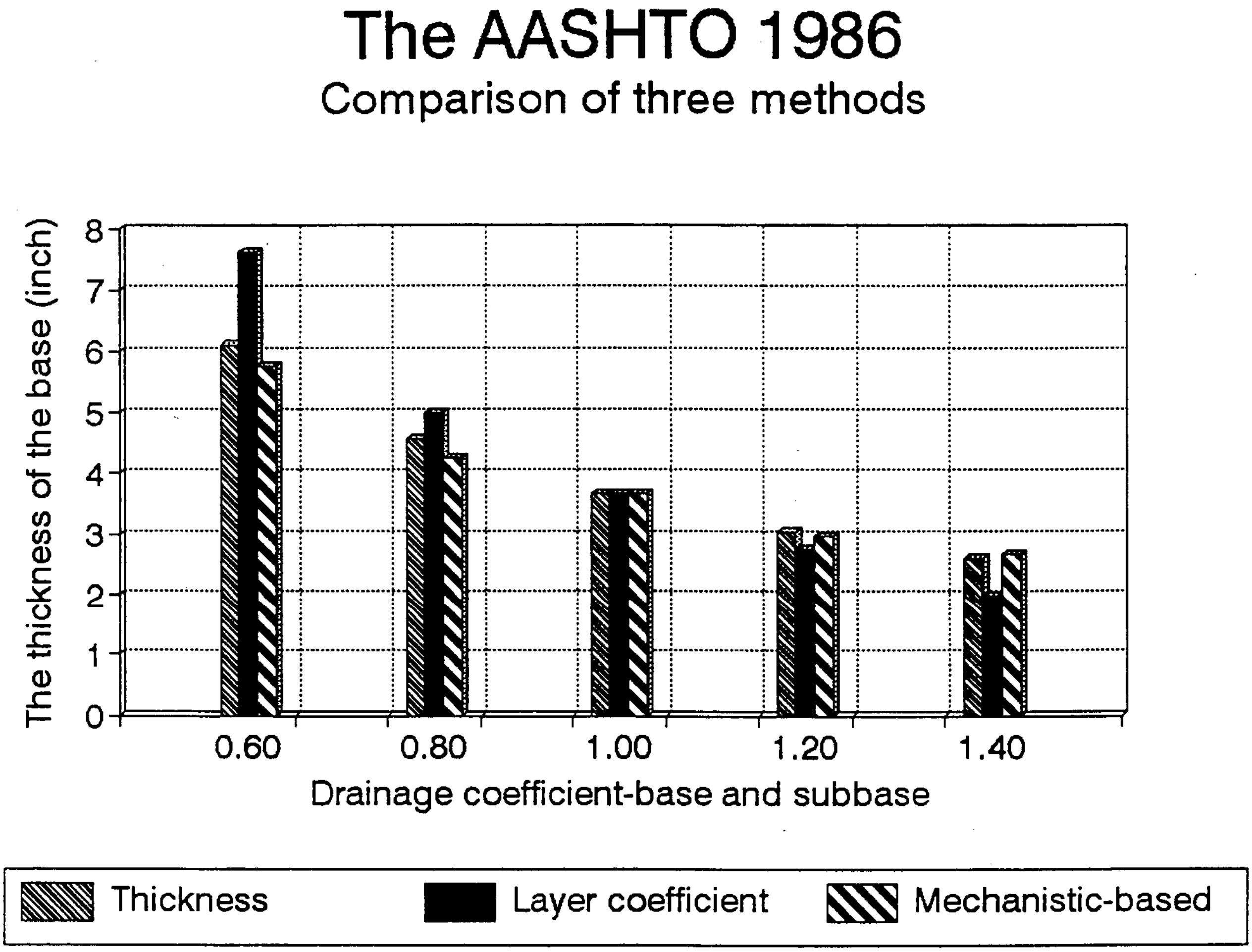

Figure 56. Comparison of the base layer thicknesses versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

The validity and engineering interpretations of these observations are discussed below along with the mechanistic responses of the pavement sections.

4. **Thickness of the Subbase Layer** - Figure 57 displays the thicknesses of the subbase layers produced by the 1986 AASHTO thickness design procedure for the three methods accounting for the effects of drainage coefficients. It can be seen from the figure that the thickness modification and the mechanistic-based methods cause the thickness of the subbase layer to decrease as the value of the drainage coefficient increases with the thickness modification method leading to the maximum variations in the thickness of the subbase layer. On the other hand, the layer modification method causes the thickness of the subbase to increase as the value of the drainage coefficient increases.

   Once again, the validity and engineering interpretations of these observations are discussed below along with the mechanistic responses of the pavement sections.

5. **Amount of Compression in the Base and Subbase layers and in the Roadbed Soil** - Figures 58, 59, and 60 depict, respectively, the amount of compression in the base, subbase, and roadbed soil as functions of the values of the drainage coefficients. Examination of the figures indicate that after accounting for the effects of drainage coefficients by using the three methods (the thickness modification, the layer coefficient modification, and the mechanistic-based methods), the 1986 AASHTO design procedure produces pavement sections such that:

   a) The amount of compression in the base layer (see figure 58) decreases as the value of the drainage coefficient increases. The thickness modification method causes the largest variation in the amount of compression in the base, while the mechanistic-based method causes the smallest variations. Since the objective of the design is to produce pavement sections that will be exposed to the same level of damage (or the same level of protection), it implies that the mechanistic-based method produces more consistent results relative to the effects of drainage coefficients.
   b) For the thickness modification method, the amount of compression in the subbase layer (see figure 59) decreases as the value of the drainage coefficient increases. On the contrary, the layer coefficient modification method causes the amount of compression in the subbase layer to increase as the value of the drainage coefficient increases. Finally, the mechanistic modified method leads to pavement cross sections whereby the amount of compression in the subbase is almost constant and independent of the drainage coefficient. This implies that the mechanistic-based method influences the 1986 AASHTO design procedure appropriately to produce more consistent results.

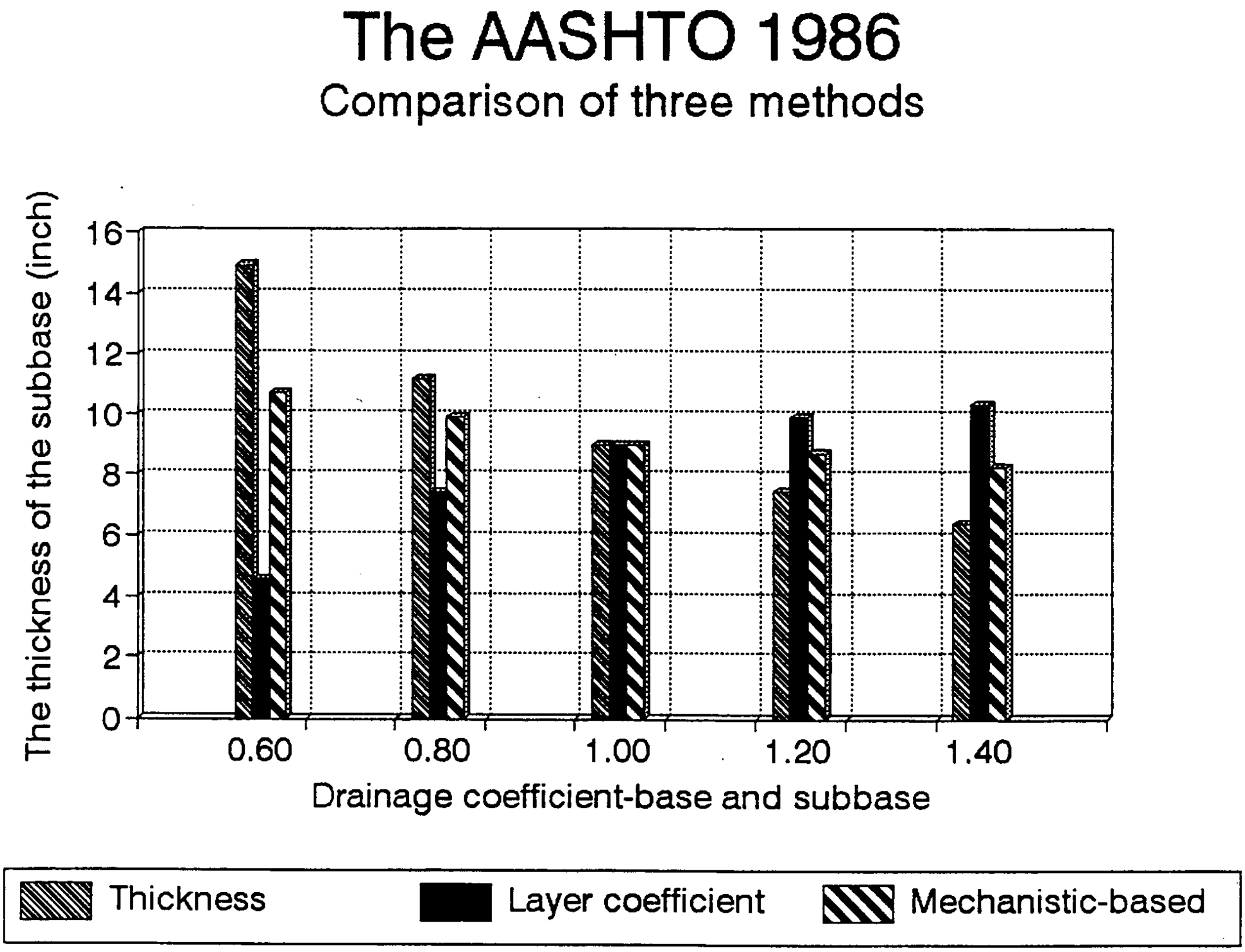

Figure 57. Comparison of the subbase layer thicknesses versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

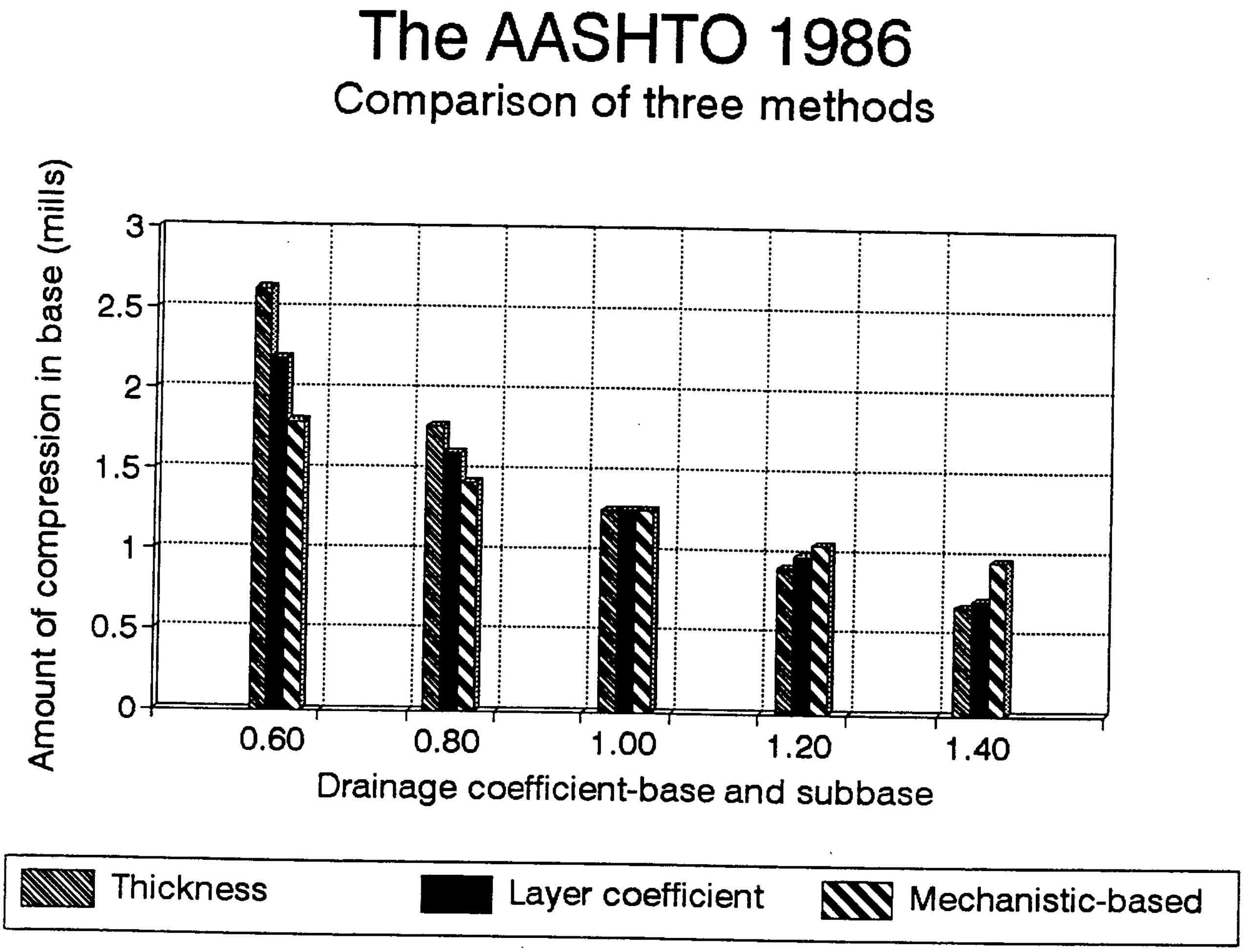

Figure 58. Comparison of the amount of compression in the base layer versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

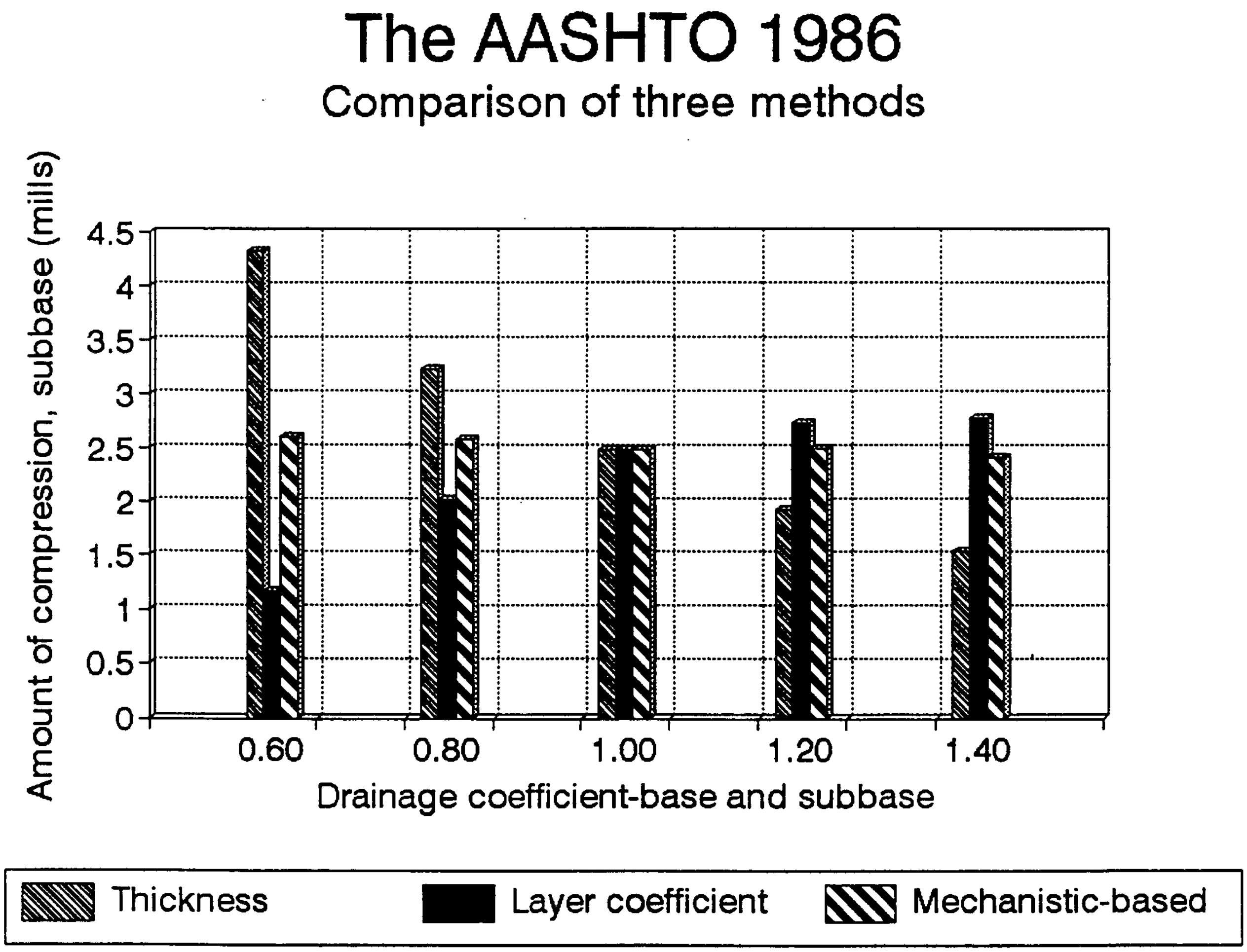

Figure 59. Comparison of the amount of compression in the subbase layer versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

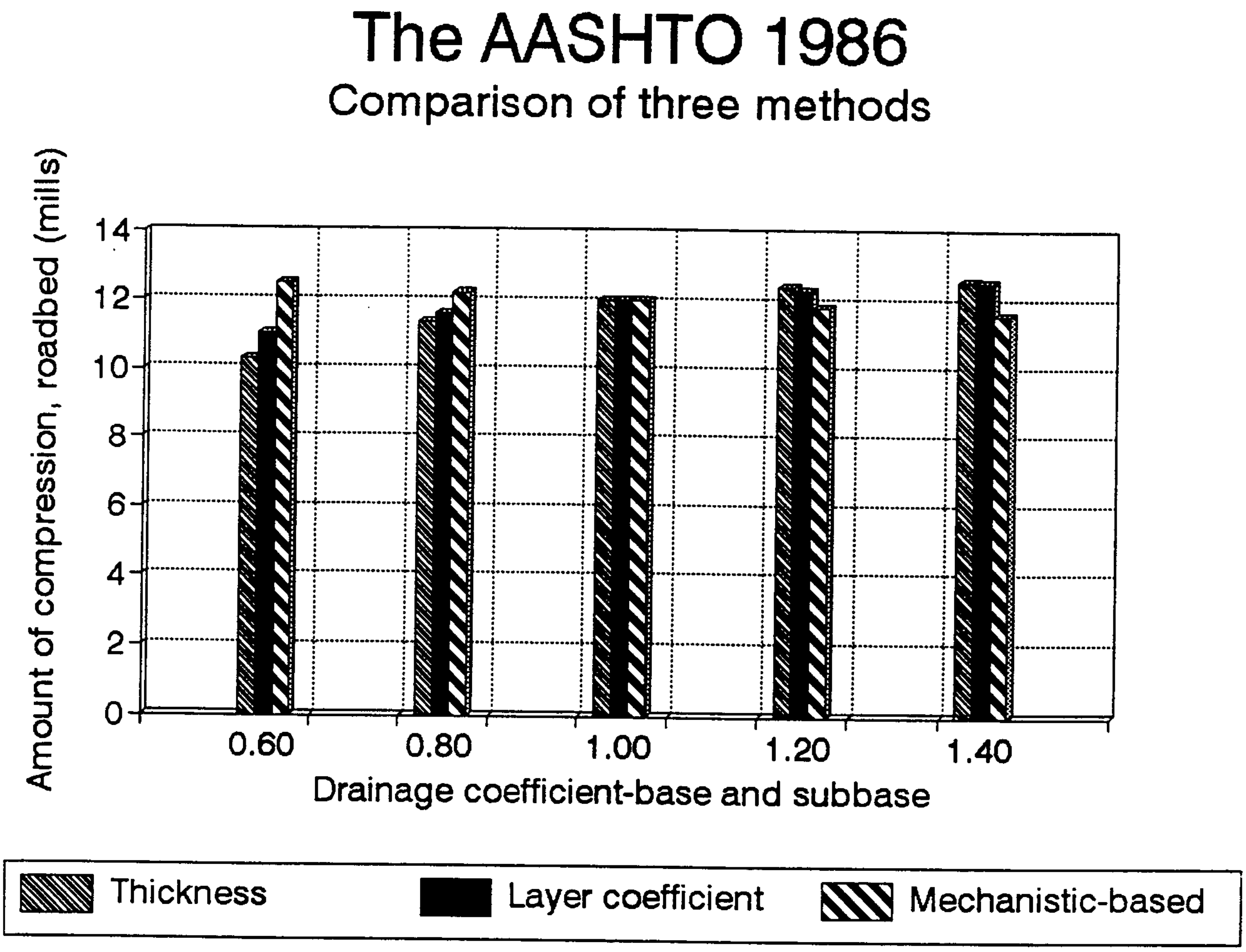

Figure 60. Comparison of the amount of compression in the roadbed versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

c) The three modification methods lead the 1986 AASHTO design procedure to yield pavement cross-sections with almost equal amount of compression (equal damage) in the roadbed soil (see figure 60). Although, the mechanistic-based method causes slightly less variations in the roadbed compression than the other two methods.

6. **Vertical Strain at the Top of the AC, Base, and Subbase Layers, and at the Top of the Roadbed Soil** - Figures 61, 62, and 63 show, respectively, the amount of the vertical strain induced at the top of the AC, base, and subbase layers, and at the top of the roadbed soil as functions of the values of the drainage coefficients. Examination of the figures indicate that after accounting for the effects of drainage coefficients by using the three methods (the thickness modification, the layer coefficient modification, and the mechanistic-based methods), the 1986 AASHTO design procedure produces pavement sections such that:

a) For the thickness modification method, the vertical strain at the top of the AC (see figure 61) increases as the drainage coefficient increases. On the contrary, the other two methods cause a decrease in the vertical strain with increasing values of the drainage coefficient. Recall that, for all design alternatives, the modulus of the AC is constant and it is equal to 300,000 psi. Thus, different vertical strain levels imply that the pavement will receive different levels of damage. Presumably, the five pavement alternatives were designed to carry the same amount of traffic and to have the same performance period. The above scenario hints that the three methods used to account for the effects of drainage quality are not absolutely accurate. Further examination of figure 61 indicates that, as the maximum variation in the vertical strains from one pavement section to another is about 425 percent for the modified thickness method, about 230 percent for the layer modification method, and about 85 percent for the mechanistic-based method. Consequently, the latter method produces more consistent results.

b) The vertical strains at the top of the base layer (see figure 62) is almost constant for the layer coefficient modification and the mechanistic-based modification methods. Hence, the two methods are more consistent than the thickness modification method.

c) For all three methods, the vertical strains at the top of the subbase layer and top of the roadbed soil (see figures 63 and 64) vary with the values of the drainage coefficient. It can be seen that, the thickness modification method produces the largest variation (about 57 percent) while the mechanistic-based method produces the least (about 21 percent).

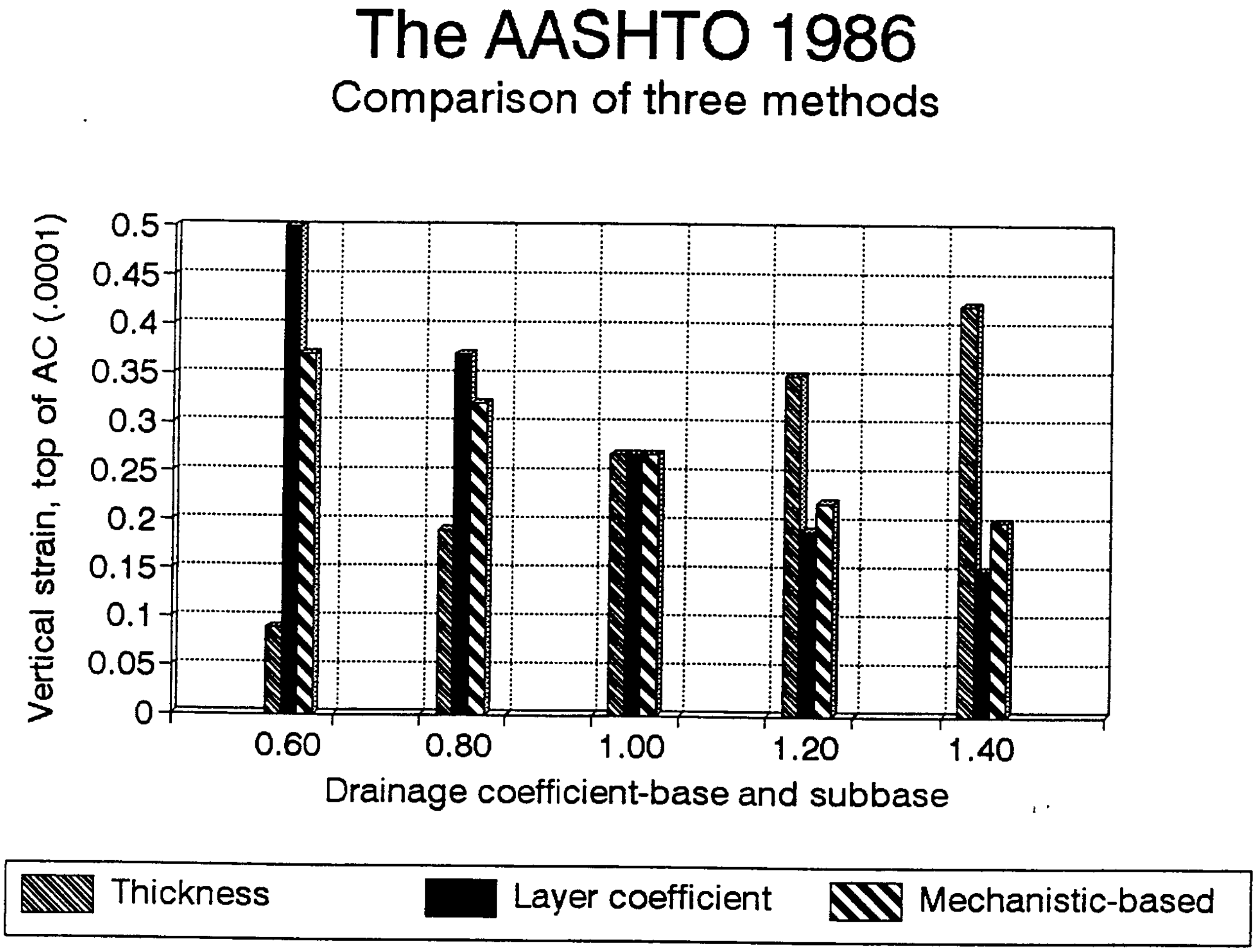

Figure 61. Comparison of the vertical strain at the top of the AC layer versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

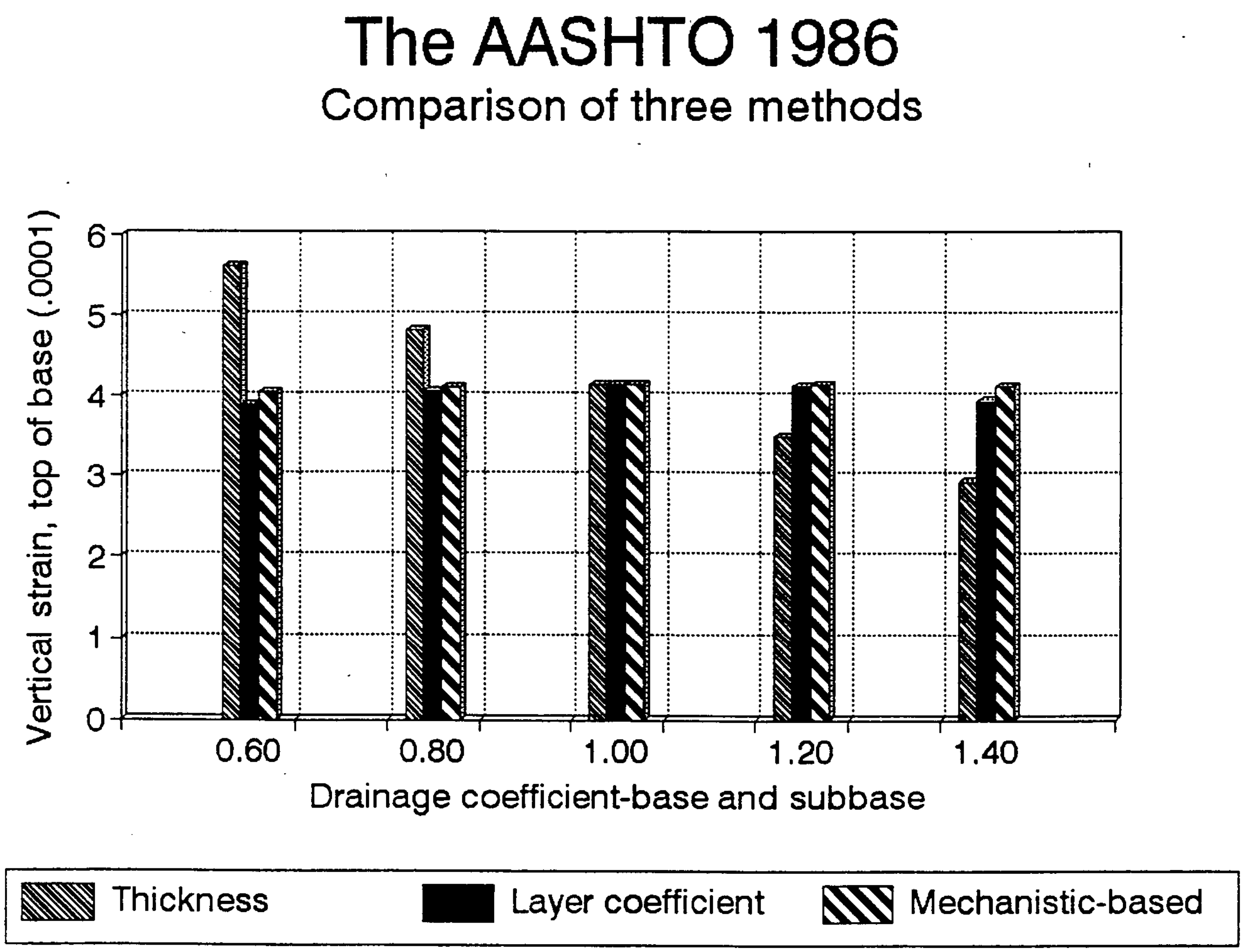

Figure 62. Comparison of the vertical strain at the top of the base layer versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

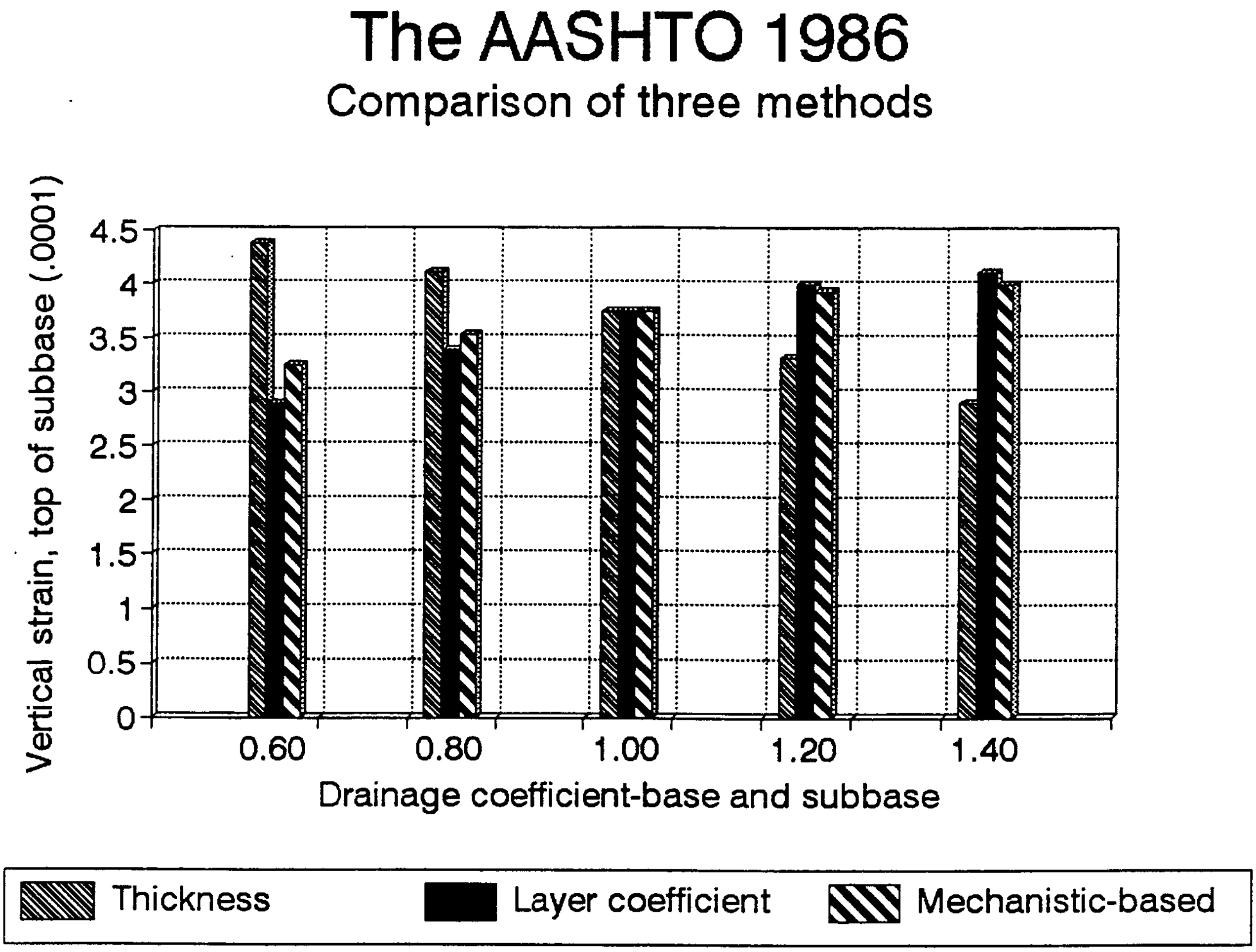

Figure 63. Comparison of the vertical strain at the top of the subbase layer versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

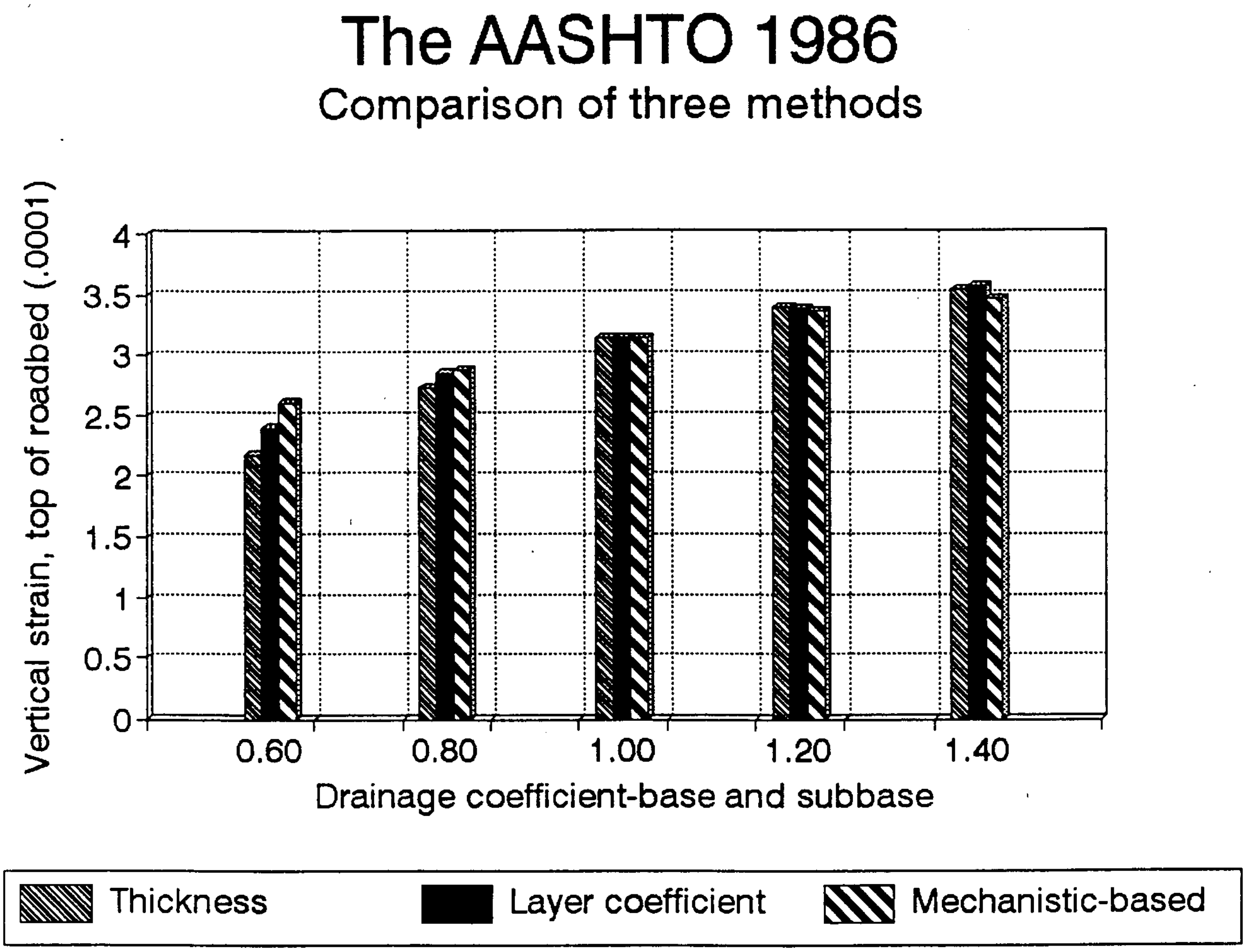

Figure 64. Comparison of the vertical strain at the top of the roadbed soil versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

7. **Tensile Stress at the Bottom of the AC Layer** - Figure 65 shows the tensile stresses induced at the bottom of the AC layers for the five pavement alternatives and for the three methods that account for the effects of the drainage coefficient in the AASHTO design procedure. It can be seen that the layer coefficient modification and the mechanistic-based modification methods lead to very similar results and minimum variations in the tensile stress (about 10 percent). The other method causes a variation in the tensile stress of the order of about 70 percent. Thus, the former methods produce more consistent results.

4.1.3 Alternative Perspective of the AASHTO Drainage Coefficient

The above discussion indicates that the effects of the drainage coefficient on the 1986 AASHTO design procedure varies from one method to another. Further, the mechanistic-based method provides more consistent results than the other two methods. Hence, the existing 1986-AASHTO Design Guide should be modifies and it should be made clear that modifying the layer thicknesses is **NOT** the true intention of the guide. In addition, the DNPS86 computer program and perhaps DARWIN program should be modified. The layer coefficient modification method represents no change to the existing guide, rather, the guide needs some clarification relative to that section. The mechanistic-based method requires minimum changes to the existing guide.

Another perspective relative to the effects of the drainage coefficients on the pavement design procedure is that, the effects of the drainage quality can be presented in terms of reduction in the pavement Service Life (SL). Figure 66 depicts the AASHTO structural number as a function of the design 18-kip ESAL for three roadbed soils (1, 5 and 10 ksi moduli values). The three curves were obtained for a design period of 20 years, a design reliability of 95 percent, an overall standard deviation of 0.45, and a serviceability loss of 1.7 points. Figure 67 depicts the percent gain or loss in the pavement service life as a function of the drainage coefficients. The data for figure 67 were obtained from figure 66. The use of the two figures is illustrated in example 2 below.

EXAMPLE 2 - Pavement section 162 of figure 1 is designed by using the AASHTO method, the material properties listed below, a design reliability of 95 percent, an overall standard deviation of 0.45, a performance period of 20 years, a total 18-kip ESAL of 20,000,000, and a total loss of serviceability of 1.7 PSI.

Layer	Modulus (ksi)	Layer Coefficient	Drainage Coefficient
AC	300	0.38	1.0
Base	40	0.17	1.0
Subbase	25	0.16	1.0
Roadbed	10	N/A	N/A

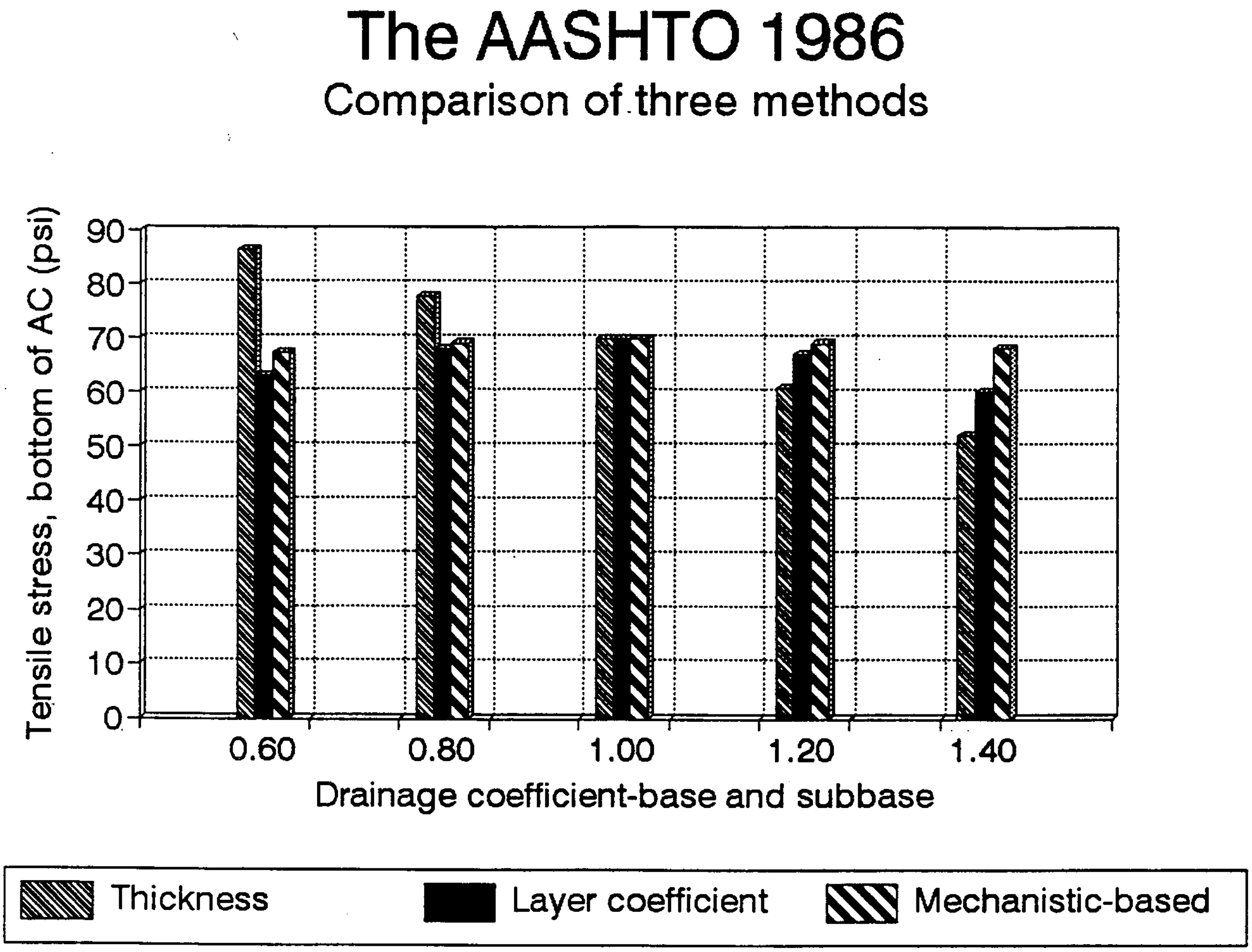

Figure 65. Comparison of the tensile stress at the bottom of the AC layer versus drainage coefficient produced by the 1986 AASHTO design procedure and the three drainage coefficient modification methods.

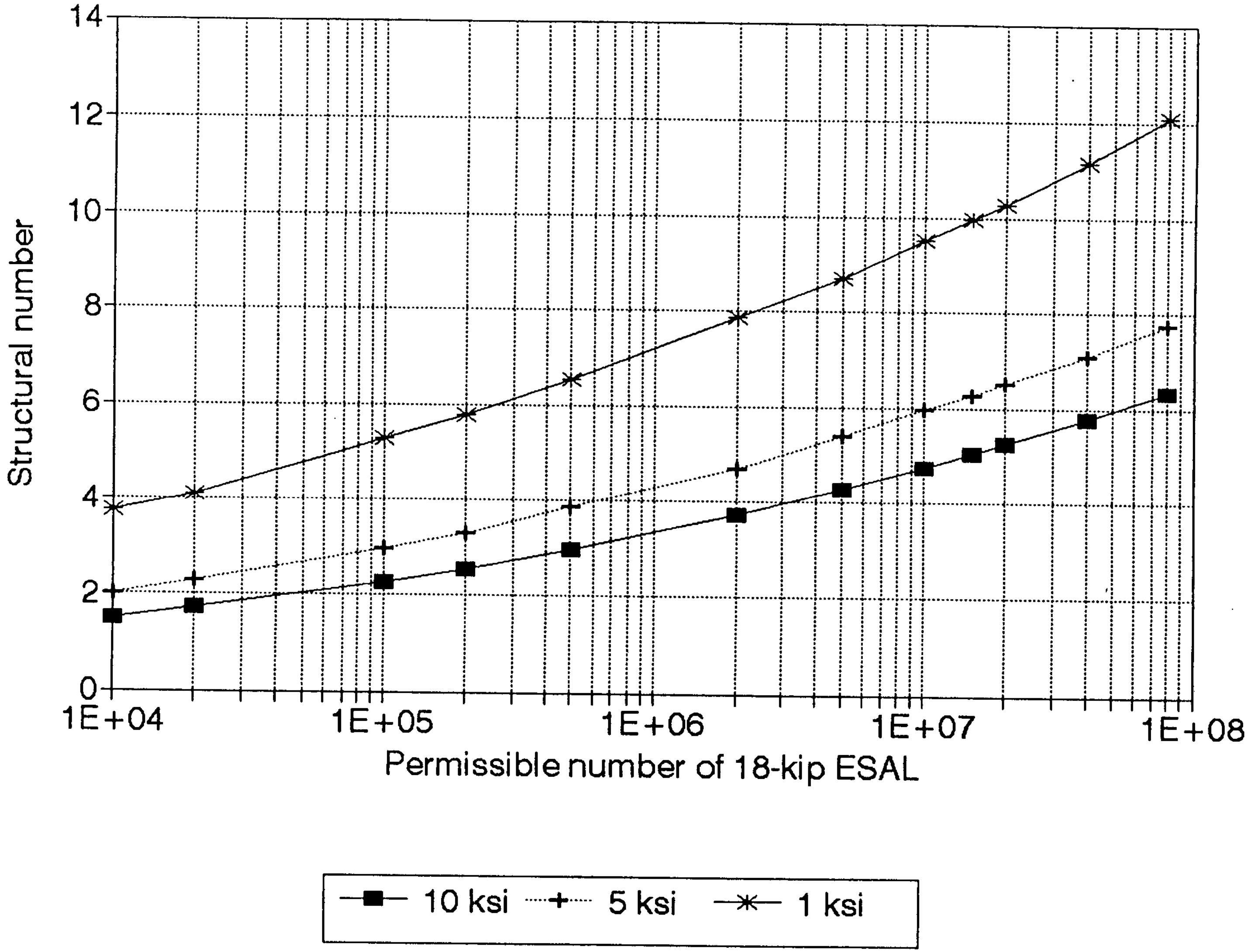

Figure 66. Effective structural number versus the permissible number of 18-kip ESAL.

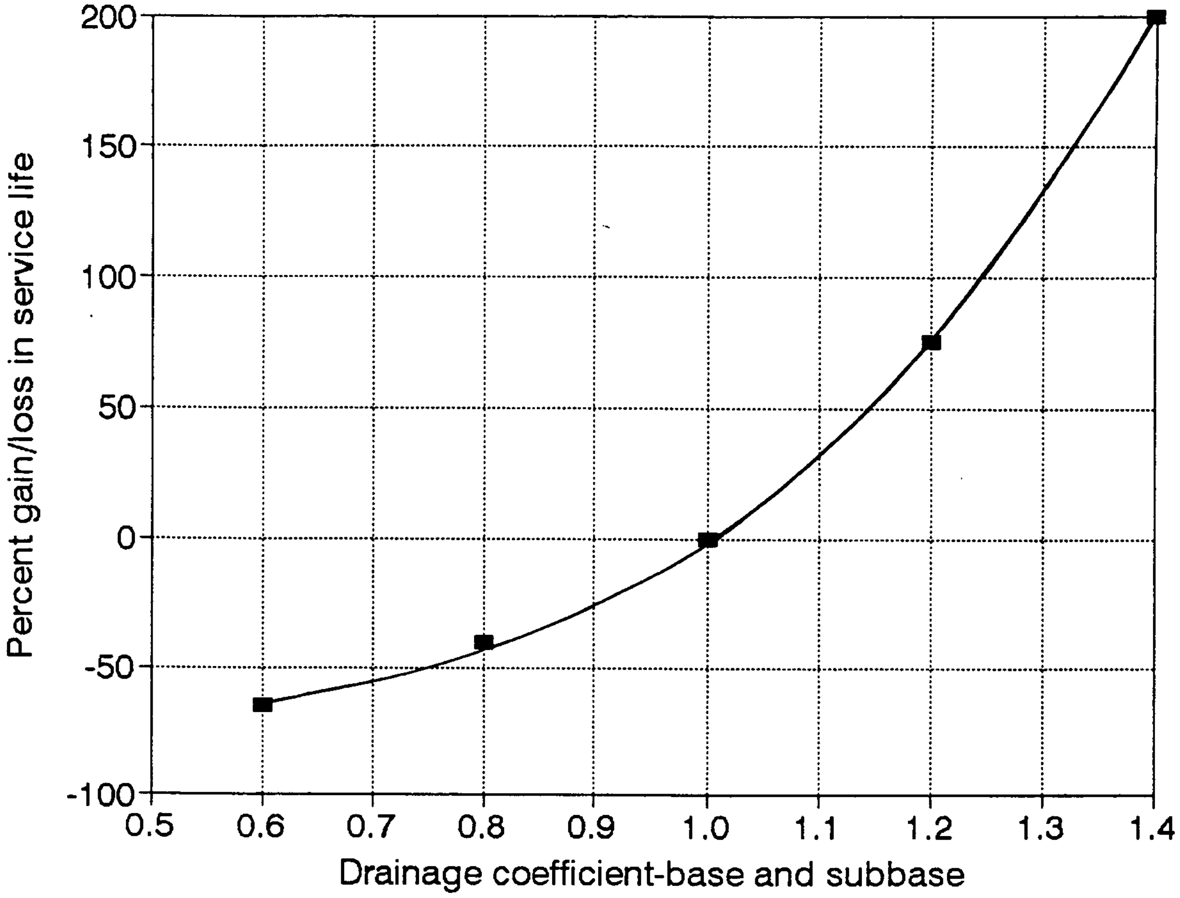

Figure 67. Percent gain and loss in pavement service life versus drainage coefficient.

The AASHTO output for layer thicknesses is tabulated below.

Layer type	Layer thickness (inch)
AC	8.41
Base	3.66
Subbase	8.96

Calculate the percent gain or loss in the pavement service life due to drainage quality and for drainage coefficients of the base and subbase layers of 0.6, 0.8, 1.2, and 1.4.

SOLUTION - After designing the pavement section by using the 1986 AASHTO Design Guide and drainage coefficient of the base and subbase layers of 1.0, the effective structural number of the pavement for the various values of the drainage coefficients can be calculated by using the following equation:

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

The values of the structural number for the various drainage coefficients are tabulated below.

Drainage Coefficient	Calculation	Effective SN
0.6	(8.41)(0.38) + (3.66)(0.17)(0.6) + (8.96)(0.16)(0.6) =	4.43
0.8	(8.41)(0.38) + (3.66)(0.17)(0.8) + (8.96)(0.16)(0.8) =	4.84
1.0	(8.41)(0.38) + (3.66)(0.17)(1.0) + (8.96)(0.16)(1.0) =	5.25
1.2	(8.41)(0.38) + (3.66)(0.17)(1.2) + (8.96)(0.16)(1.2) =	5.66
1.4	(8.41)(0.38) + (3.66)(0.17)(1.4) + (8.96)(0.16)(1.4) =	6.07

For each value of the drainage coefficient, the permissible number of 18-kip ESAL can be obtained from figure 66. To obtain the permissible number of 18-kip ESAL for a drainage coefficient of 0.6 and a structural number of 4.43, simply enter the vertical axis (the structural number axis) of figure 66 at the SN value of 4.43, draw a horizontal line to intersect the curve labeled 10 ksi roadbed soil modulus, draw a vertical line to intersect the horizontal axis and read the permissible number of 18-kip ESAL as 7,000,000. Likewise, the permissible number of 18-kip ESAL for an SN of 4.84 is 12,000,000. The permissible numbers of 18-kip ESAL for the other SN values of example 2 are tabulated below along with the calculation of the percent gain and loss of the pavement service life.

Drainage Coefficient	Effective Structural Number	Number of Permissible 18-kip ESAL	Percent gain and loss in the pavement service life in terms of ESAL and relative to the service life for a drainage coefficient of 1.0	
			Percent gain	Percent loss
0.6	4.43	7,000,000	-	65.0
0.8	4.84	12,000,000	-	40.0
1.0	5.25	20,000,000	0.0	0.0
1.2	5.66	30,000,000	75.0	-
1.4	6.07	60,000,000	200.0	-

It should be noted that, the percentages of gain and loss in service life of the previous example were calculated relative to the pavement section designed with drainage coefficient of 1.0. Further, a drainage coefficient of 1.0 implies that the quality of drainage is fair and the pavement is expected to be exposed 5 percent of the time to moisture levels approaching saturation.

This new perspective implies that, regardless of the actual values of the drainage coefficient) the 1986 AASHTO Design Guide would produce layer thicknesses for a unit value of the drainage coefficient. The Guide will also advise the user that if the actual drainage coefficient is improved then the pavement is expected to gain certain percentages of its service life.

CHAPTER 5

EVALUATION OF THE AASHTO CONCEPT OF LOSS OF SERVICEABILITY DUE TO SWELLING SOILS AND FROST ACTION

5.1 PHASE 5 - THE AASHTO CONCEPT OF LOSS OF SERVICEABILITY DUE TO ENVIRONMENTAL FACTORS

5.1.1 Serviceability Loss

In general, the performance of asphalt surfaced pavements is affected by various factors. These factors can be divided into several categories as follows:

1. Material factors including the engineering and physical properties and characteristics of the various materials in a pavement structure.
2. Design factors including traffic volume and load, design reliability, accuracy of the material properties, design serviceability loss, drainage design, type of roadbed soil, and the type of pavement analysis and/or design model used.
3. Construction factors including construction practices and procedures, existing standards, and quality control.
4. Environmental factors including low and high temperatures, freezing index, number of freeze-thaw cycles, moisture (rainfall intensity and duration), and solar radiation.

The 1986 AASHTO Design Guide accounts for the effects of the environmental factors in several ways. These include:

1. Drainage coefficient for the presence or absence of moisture in the base and subbase materials.
2. Effective modulus of the roadbed soil where the soil should be tested under various moisture conditions (simulating the moisture in the field for every month of the year). The effective resilient modulus of the roadbed soil is the weighted average (based on a damage factor) of all test values.
3. Serviceability loss due to swelling soil and frost and heave.

In this chapter, the 1986 AASHTO concept relative to serviceability loss due to swelling soil and frost and heave is addressed.

The 1986 AASHTO concept of pavement serviceability and pavement performance is that, for any performance period, the total loss in pavement serviceability is the sum of the losses due to traffic and due to environmental factors (swelling soil and frost heave). Hence, the total serviceability loss due to environmental factors is the sum of the losses due to swelling soil and frost heave. Figure 68 depicts the AASHTO concept of the environmental serviceability loss as a function of time. It should be noted that the AASHTO methods for predicting the serviceability loss due to swelling and due to frost heave are based on their effects on the longitudinal profile of the pavement surface.

5.1.2 Roadbed Swelling

Expansive roadbed soils may be found in soil deposits of fine material that contain appreciable amount of clay minerals such as montmorillonite and/or illite. Expansive soils adsorb water when they are decompressed, such as in excavation and/or when they come in contact with a source of water. These conditions cause the soil to expand appreciably in volume.

The compressibility characteristics and swell potential of expanding soils have a practical importance to the pavement engineer. Pavement constructed over expansive roadbed soils are likely to experience serviceability losses due to pavement roughness and other types of distress caused by the swelling soils.

The swell potential and the compressibility of expansive soils can be evaluated in the laboratory by performing odometer tests. The tests should be conducted on soil specimens having at least two limiting water contents: 100 percent saturation and the minimum possible water content that will be experienced in the field. The tests will yield the limiting values of the compression and expansion properties of the soils.

The rate and magnitude of serviceability loss due to swelling soil is affected by three variables: swell rate constant, potential vertical rise of the soil, and the probability of swelling. Fine materials such as clays and silts have higher swelling potential than coarser soils. The amount and rate of swell are functions of the availability of moisture and the types of mineral in the soil. Good drainage and/or a cut-off drainage blanket will minimize the swell potential.

5.1.3 Frost and Heave

The term "frost-susceptibility" implies the tendency of a soil to hold water and undergo volume changes when it is subjected to freezing temperatures. Hence, a frost-susceptible soil is any roadbed or base course soil that has a relatively low permeability and a high water holding capacity. The term "frost heave" refers to the raising of a portion of a pavement as a direct result of the formation of ice crystals and ice lenses in the underlying frost-susceptible soil.

Frost susceptible soils include all inorganic soils that contain more than 12 percent of fine materials (less than 0.02 mm). The degree of frost susceptibility of a soil is a function of its fine content, permeability, and water holding capacity expressed in terms of the soil void ratio

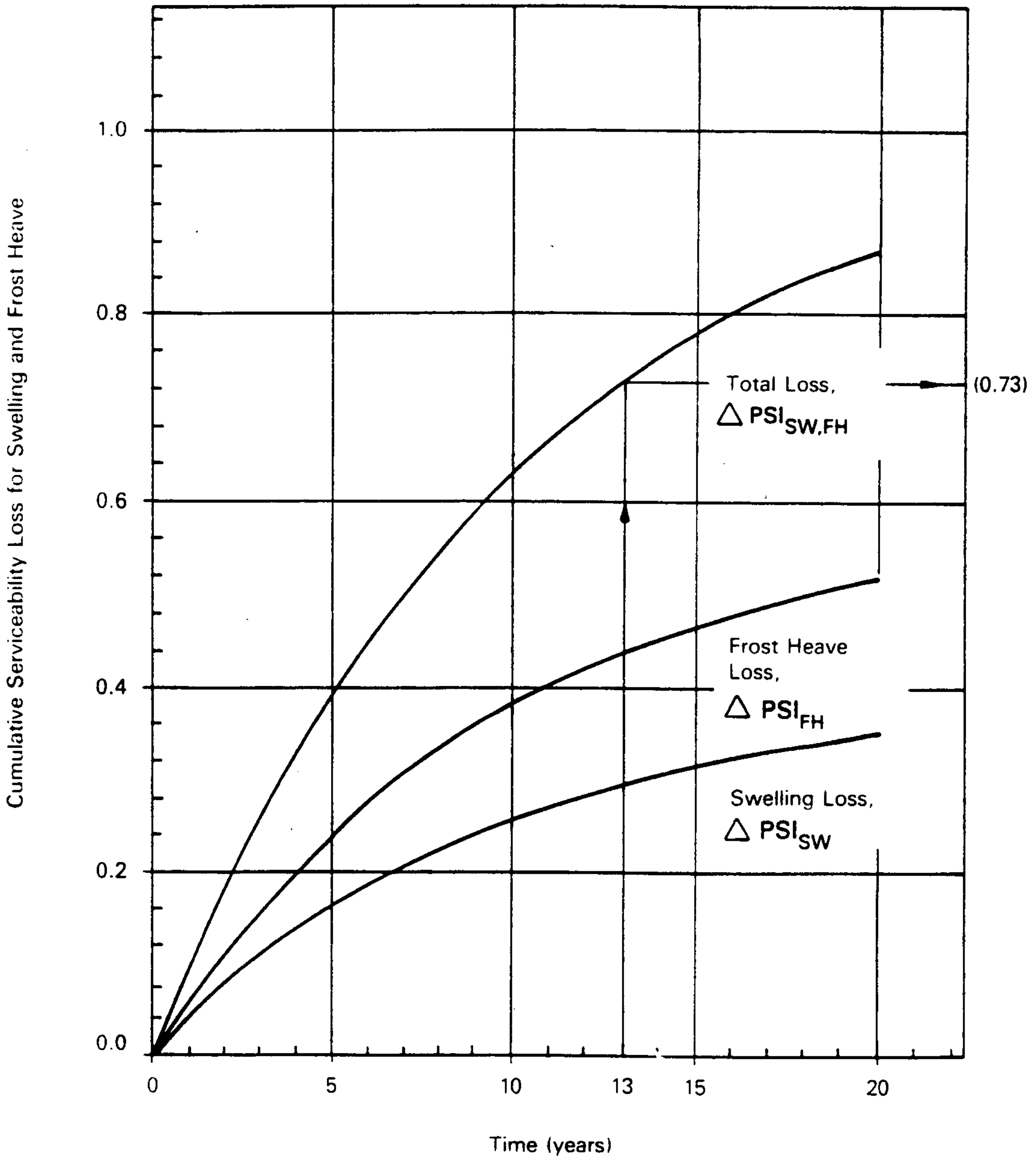

Figure 68. A conceptual example of the environmental serviceability loss versus time graph that may be developed for specific location (8).

or porosity. The amount of frost heave experienced by a pavement system is affected by the presence or absence of drainage systems and their quality. Frost heave adversely affects pavement serviceability and service life. In general, deeper frost penetrations cause higher serviceability loss.

Frost heave of roadbed soils or any other pavement layer affects the pavement structure in two phases as follows:

1. As the temperature drops below freezing during the late Fall and early Winter seasons, water under the pavements (in the base or subbase layers and/or in the roadbed soil) expands by about 9 percent in volume as it freezes in the form of ice lenses. This cause an uneven heave in the pavement surface which results in a higher pavement roughness. During the Winter season, if temperature stayed below freezing, water from the ground water table will travel upward by means of capillary action or in the form of vapor, will coat the ice lenses, and it will freeze causing growth in the ice lenses and more uneven pavement heave.

2. During the Spring season (thaw period), ice will start to melt at the top of the ice lenses due to above freezing temperatures causing uneven settlement in the pavement surface, and at the bottom of the ice lenses due to the interior heat of the earth. The melted water at the top of the ice lenses, since it is underlained by impermeable ice, will accumulate beneath the pavement surface and often will drain to the surface through pavement cracks. Thus, the pavement surface which is practically supported by a soft soupy layer (mainly water), may break-up under traffic causing frost boils and potholes. In addition, this melted water may refreeze at night-time causing new additional heave and, perhaps, lifting the pavement off its foundation.

Nevertheless, as is the case for roadbed swelling, the rate and magnitude of serviceability loss due to frost heave is affected by three variables: frost heave rate, probability of frost heave, and the maximum potential of serviceability loss due to frost heave. Once again, fine materials such as clay and silt have higher frost-heave potential than coarser soils. The amount and rate of frost heave are functions of the availability of moisture, freezing temperatures, and the types of mineral in the soil. Good drainage system decreases frost heave potential.

5.2 EVALUATION OF THE AASHTO CONCEPT OF LOSS OF SERVICEABILITY

As stated early, the 1986 AASHTO design procedure accounts for the effects of swelling soils and frost heave by dividing the total loss of serviceability (loss during the pavement performance period) in term of the Pavement Serviceability Index (PSI) into two components as follows:

1. Loss of serviceability due to traffic.

2. Loss of serviceability due to swelling and frost heave.

In addition, the 1986 AASHTO Design Guide provides nomograph and charts for the estimation of the serviceability loss due to swelling and frost heave.

The proper evaluation of the AASHTO loss of serviceability concept due to swelling and frost heave requires two sets of data as follows:

1. Laboratory data concerning the soil swelling and frost heave properties and their effects on the elastic and plastic properties of the soils.
2. Field data concerning the behavior and performance of pavement structures supported on roadbed soils having swell and frost heave potentials.

Unfortunately, such data are not available in the SHRP data base. Consequently, the loss of serviceability concept is evaluated herein by assuming several values of the loss of serviceability due to swelling and frost heave.

Table 16 provides a list of two pavement sections (section 162 and 160, see figure 1) that were used in the evaluation. For each section, the material properties and the design parameters used in this evaluation are provided in table 16.

Nevertheless, for each pavement section, the material properties and the design parameters were used as inputs to the 1986 AASHTO design procedure to arrive at the layer thicknesses and the required pavement structural numbers for five values of the loss of serviceability due to swelling and frost heave. These values of PSI loss are listed in column 2 of table 17. The output of the AASHTO design procedure in terms of the required structural number (SN) for each design alternative is listed in column 3 of the table. Column 4 provides a list of the percent increase of the SN relative to the SN value of the pavement with no swelling and frost heave potential.

Figure 69 depicts the required structural number of the pavements of sections 162 and 160 as a function of the serviceability loss due to swelling and frost heave. It can be seen that higher serviceability losses due to environmental factors yield higher required pavement structural number (thicker pavements). Figure 70 shows the incremental percent increases of the SN as a function of the PSI loss due to environmental factors for pavement sections 162 and 160. It can be seen that the incremental percent increase is a function of the PSI loss and they are different from one section to another. Since the only difference between pavement sections 160 and 162 is the number of 18-kips ESAL (20,000,000 ESAL for section 162 and 5,000,000 ESAL for section 160), one can conclude that the incremental increase in the SN is traffic volume dependent. This implies that, the level of required protection (the amount of increase in the pavement thickness) for pavements having the same swell and frost heave potentials depends on the number of 18-kip ESAL expected to traffic that pavement. That is the environmental damage is traffic dependent. This may be true because of the interaction between the two damages (that due to environment and that due to traffic). However, the AASHTO loss of serviceability concept is a linear concept, the total loss of pavement serviceability is the sum

Table 16. The required pavement structural numbers for various values of loss of serviceability due to swelling and frost heave conditions.

Pavement Section Number	PSI Loss Due to Swelling and Frost-Heave	Required Pavement Structural Number	Percent Increase in Structural Number	Equivalent Roadbed Modulus (psi)	Percent Decrease in Roadbed Modulus
162	0.00	5.25	0.00	10000.00	0.00
	0.30	5.56	5.90	8400.00	16.00
	0.60	5.91	12.57	6855.00	31.45
	0.90	6.64	26.48	4675.00	53.25
	1.20	7.71	46.86	2800.00	72.00
160	0.00	4.29	0.00	10000.00	0.00
	0.30	4.52	5.36	8600.00	14.00
	0.60	4.87	13.52	6910.00	30.90
	0.90	5.41	26.11	5020.00	49.80
	1.20	6.36	48.25	2975.00	70.25

Table 17. Material properties and design parameters of pavement sections 160 and 162.

Pavement Section Number	Pavement Layer	Layer Modulus (ksi)	Initial (Terminal) PSI	Traffic Volume (10^6) ESAL	Design Reliability	Overall Standard Deviation	Design Alternatives for Various Loss of PSI Due to Swelling and Frost Heave		
							Loss of PSI due to Traffic	Loss of PSI due to Swelling & frost heave	Layer Structural Number
162	AC	300	4.2 (2.5)	20	0.95	0.45	1.7	0.0	5.25
	Base	40					1.4	0.3	5.56
	Subbase	25					1.1	0.6	5.91
	Roadbed	10					0.8	0.9	6.64
							0.5	1.2	7.71
	AC	300	4.2 (2.5)	5	0.95	0.45	1.7	0.0	4.29
	Base	40					1.4	0.3	4.52
	Subbase	25					1.1	0.6	4.87
	Roadbed	10					0.8	0.9	5.41
							0.5	1.2	6.36

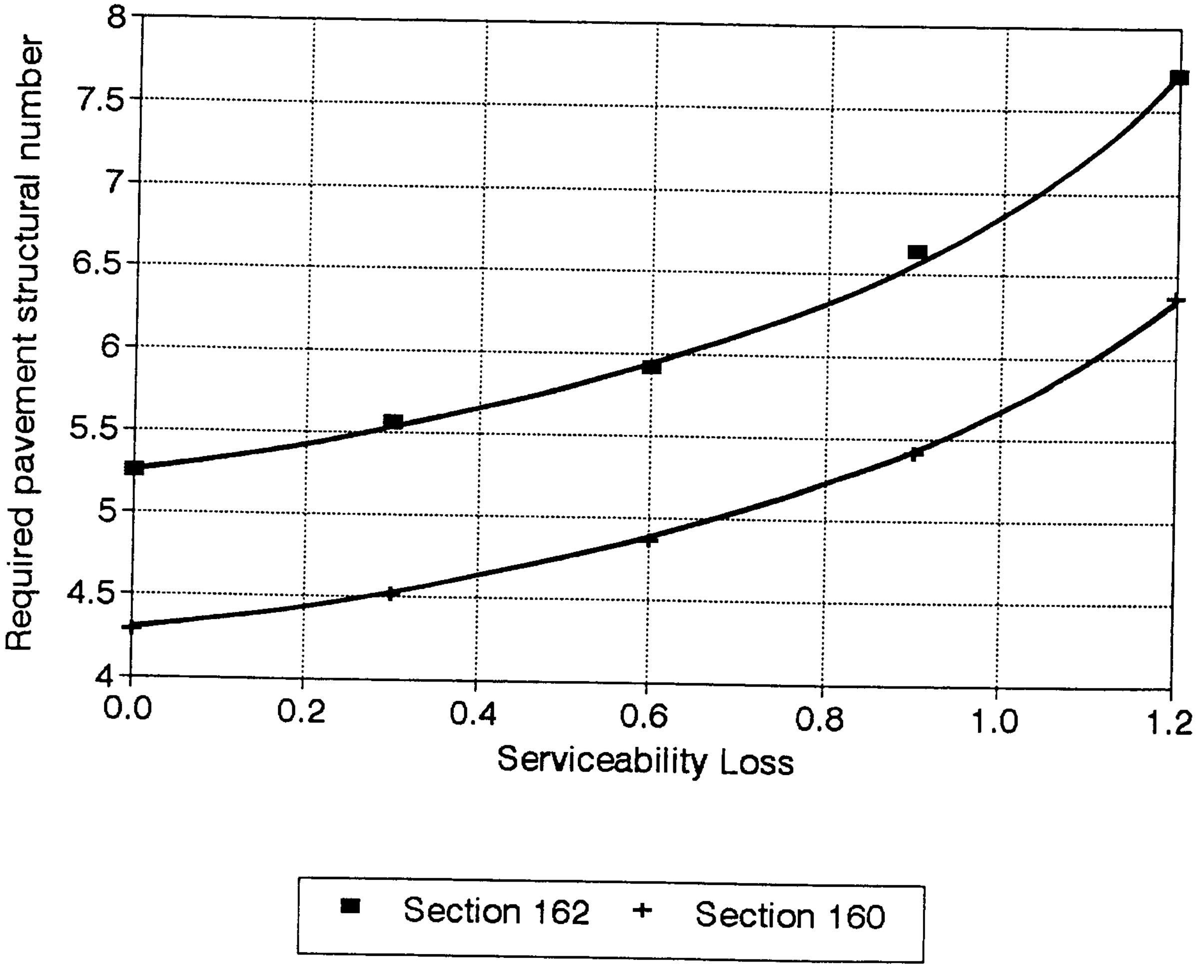

Figure 69. The required pavement structural number versus the serviceability loss due to environmental conditions.

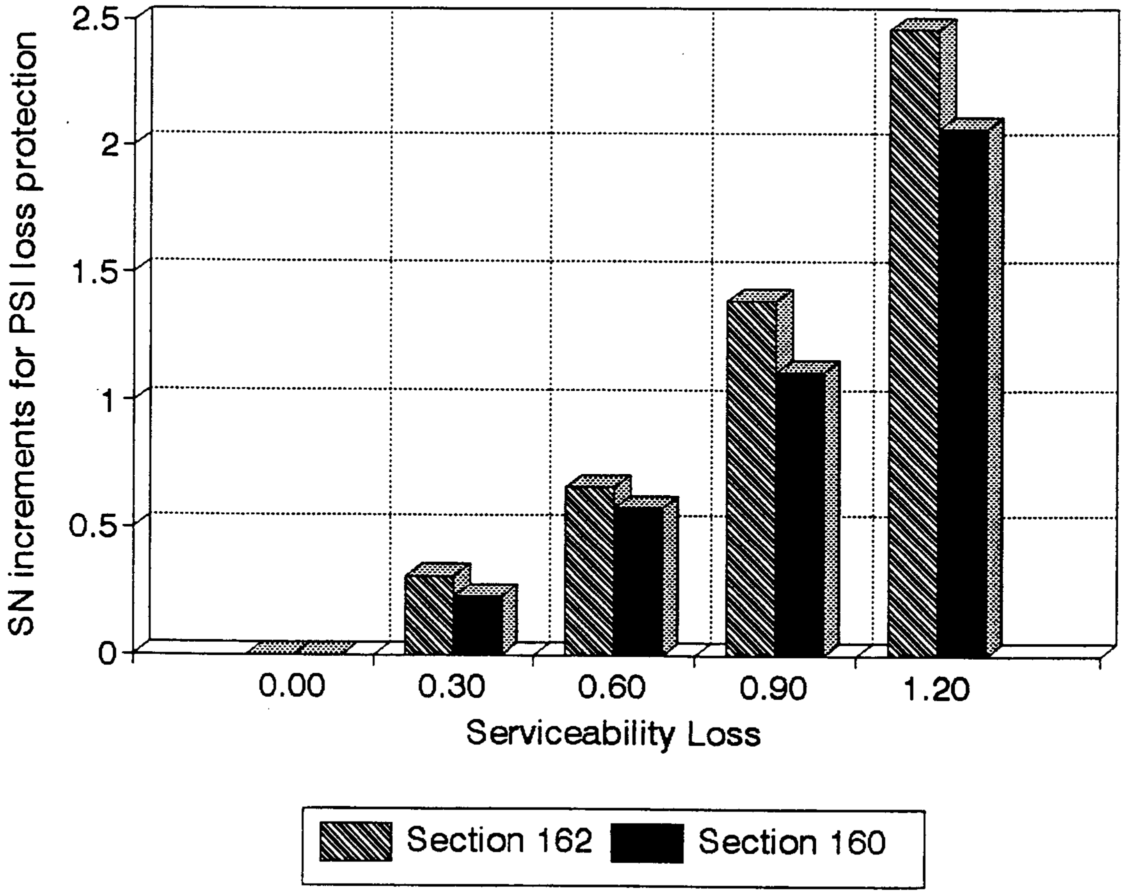

Figure 70. The incremental increase in the structural number versus the serviceability loss due to environmental conditions.

of the loss of serviceability due to traffic and the losses due to swelling and frost heave potentials. The concept (or the procedure in calculating the various losses) do not allow any interaction between the various losses. Consequently, the AASHTO concept seems to be incompatible with the outputs of the AASHTO design procedure.

The AASHTO concept of loss of serviceability due to environmental conditions was also evaluated in term of the effective resilient modulus of the roadbed soil. In this evaluation, the AASHTO design procedure was used to determine the value of the effective resilient modulus of the roadbed soil that will cause the same increase in the structural number as that due to environmental serviceability loss. Since the AASHTO design procedure is typically used to determine the required SN of the pavements for a given set of parameters, a trial and error procedure was used to determine the resilient modulus of the roadbed soil that will yield a given structural number. The results of the evaluation are listed in column 5 and 6 of table 16. Figure 71 displays the required value of the effective resilient modulus of the roadbed soil as a function of the serviceability loss. It can be seen that, higher environmental serviceability loss produces lower effective resilient modulus values. Increasing the environmental PSI loss from none to 1.2 will have the same effect on the required structural number of the pavement as that for decreasing the effective roadbed modulus from 10,000 to about 2,800 psi. Although, these findings tend to suggest that the AASHTO concept for environmental serviceability loss is reasonable, the findings cannot be supported by field data at this time.

One important point should be noted is that, regardless how reasonable the loss of serviceability concept is, the role of proper drainage design, good construction practices, and well thought standard specifications in extending the service life of pavements cannot be overemphasized.

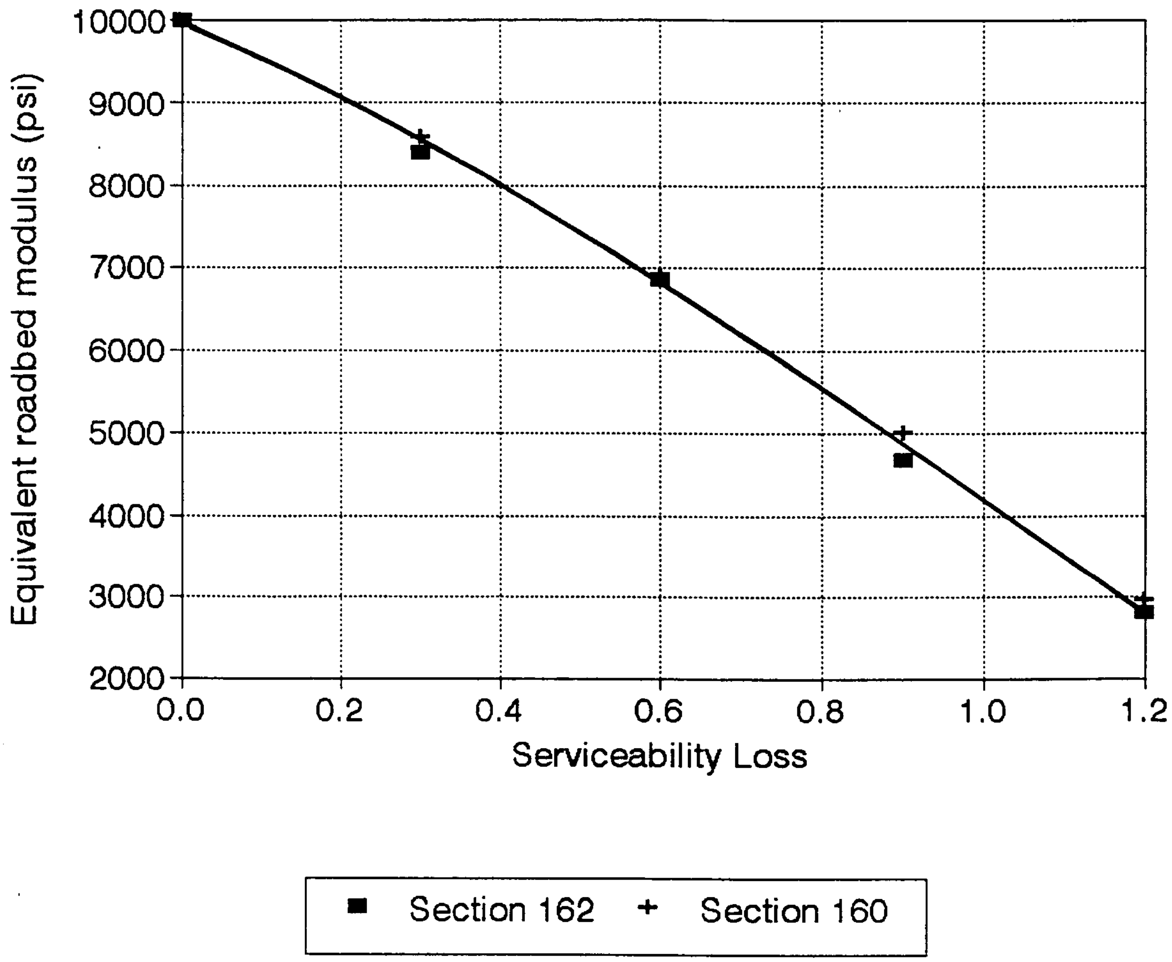

Figure 71. Equivalent roadbed resilient modulus that produces the same increases in the required pavement structural number as those required for environmental serviceability loss.

CHAPTER 6

MECHANISTIC ANALYSIS OF THE SHRP ASPHALT SURFACED PAVEMENT SECTIONS

6.1 GENERAL

This chapter presents the results of the mechanistic evaluation of the SHRP asphalt surfaced pavement sections. Due to the lack of appropriate material data in the National Pavement Performance Databank (NPPD), the values of the layer moduli backcalculated by using computer program MODULUS and the layer thicknesses found in the NPPD were used in the evaluation.

Because of various reasons including the calibration of the MODULUS program, the back- calculated layer moduli were made available to this project during the first month of 1993. Due to time constraint, the results of the mechanistic evaluation are reported herein with no substantive discussion. Although, several theoretical models concerning the cluster of variables were established for the purpose of developing mechanistic-based rut and fatigue cracking models, the data elements were not available on a timely fashion. Therefore, no mechanistic-based rut and/or fatigue models are reported.

During the course of this study, several important points were learned relative to the software (MODULUS program) and the backcalculated modulus values. These are presented in the next section.

6.2 IMPORTANT ISSUES RELATIVE TO THE MODULUS COMPUTER PROGRAM AND THE BACKCALCULATED LAYER MODULUS VALUES

The backcalculation of layer moduli of the various asphalt surfaced SHRP sections have been accomplished by the SHRP contractors of the four SHRP regions and by using the approved version of MODULUS software. Prior to the backcalculation, the MODULUS program was modified as to minimize the dependency of the outputs (the backcalculated layer moduli) on the user inputs of seed modulus. Several rules and tests were developed and approved by the SHRP office and they were implemented as parts of MODULUS program.

During this investigation, a new backcalculation computer program was under development as a part of a parallel project sponsored by the Michigan DOT and directed by the first author (Dr. Gilbert Baladi). The program was developed such that the final backcalculated layer moduli are independent of the user inputs of the values of the seed moduli. The new computer program "named MICHBACK" was written by using a new technique that was originally suggested by Dr. Robert Raab of the SHRP and later modified and implemented by the research team of MDOT project. Given the critical timing on such a program, the efforts scheduled for the MDOT contract were accelerated so that the new program could be used to randomly check the accuracy of the MODULUS backcalculated layer modulus values.

As a part of the MICHBACK development process and in order to test the accuracy of the MICHBACK calculated layer moduli, three different exercises were designed and they were undertaken by the authors. Two of the exercises concerned the backcalculation of layer moduli for several SHRP pavement sections listed in tables 18 and 19 and several MDOT pavement sections using measured deflection data. These two exercises do not have direct impacts on this study because they did not involve MODULUS program. The third exercise, however, has substantial impacts on the decisions regarding the SHRP LTPP program and its continuity by the Federal Highway Administration (FHWA). Therefore, it is included as a part of this report.

The third exercise was designed and conducted in cooperation with Rauhut Engineering Inc. (the contractor of the SHRP P-020A contract) to check the accuracy of the outputs of both MICHBACK and MODULUS programs. The exercise was accomplished in two steps as follows:

1. A deflection and layer thicknesses file concerning thirty pavement sections (10 artificial sections that were randomly mixed with 20 SHRP sections) was constructed by Peter Jordahl of Rauhut Engineering. For the twenty SHRP sections, the measured field deflection data and the layer thicknesses were included in the data file and were used for the backcalculation of the pavement layer moduli. The ten artificial sections were selected by Rauhut Engineering and the pavement deflections were mechanistically calculated (using the Waterways Experiment Station Layer Analysis Program, WESLAY) based on known sets of layer moduli, bedrock moduli, and various depths to bedrock. For all thirty sections, the modulus of, and depth to, bedrock were not included in the data file and therefore, were not known to the authors at the time of the exercise. Upon receiving the data file from Rauhut Engineering, the first author of this contract along with other members of the MDOT research team at Michigan State University (MSU) conducted backcalculation of layer moduli and depths to bedrock using the MICHBACK computer program. At the same time, the staff of Rauhut Engineering performed backcalculation of the layer moduli of all the thirty sections by using the modified and updated version of MODULUS program.

2. The results obtained from MICHBACK were further examined by the first author and other faculty at MSU, it was found that the version of the CHEVRON computer program used in MICHBACK was incorrect. A corrected version of the CHEVRON program was then obtained from Dr. Lynn Irwin at Cornell University. After replacing the incorrect version of the CHEVRON program by the corrected version, the ten analytical pavement sections were analyzed once again and the values of the backcalculated moduli were obtained. After the completion of this exercise and faxing the results to Rauhut Engineering Inc., the authors received a list of the true values of the layer moduli used by Rauhut Engineering to calculate the deflection basins. These values along with those backcalculated by Rauhut Engineering by using the MODULUS program are listed in table 20. The results are listed in the table in the following order:

1. Column 1 provides a list of the section designation number (a number that was originally assigned by the staff of Rauhut Engineering).

Table 18. Pavement cross-sections (data supplied by the SHRP office).

Section ID	Layer Number	Material Type	Thickness (inch)
A	1	asphalt concrete surface	4.95
	2	crushed limestone base	13.40
	3	soil/aggregate (fine) subbase	12.00
	4	sand subgrade	
B	1	asphalt concrete surface	4.20
	2	gravel (uncrushed) base	5.00
	3	sand subgrade	
C	1	asphalt concrete surface	7.92
	2	soil cement base	8.36
	3	silty sand subgrade	
D	1	asphalt concrete surface	7.25
	2	cement aggregate mix base	5.50
	3	silty subgrade	
E	1	AC surface with overlay	7.45
	2	asphalt treated base	6.41
	3	crushed stone base	7.00
	4	silty clay/clayey silt subgrade	
F	1	AC surface with overlay	7.65
	2	crushed limestone base	14.47
	3	silty sand subgrade	49.88
	4	pieces of shale grey at 6’ below surface dark gray at 16.5’ below surface	126.00
G	1	AC surface overlay	5.33
	2	jointed plain PCC base	9.60
	3	sand subbase	4.00
	4	silty sand subgrade	
H	1	AC surface overlay	2.54
	2	jointed plain PCC base	6.89
	3	sandy clay subgrade	

Table 19. The average deflection basins and loads (data supplied by the SHRP office).

Sec. ID	Load ID	Deflection in mils at a lateral distance in inch							
		Load (lbs)	0	8	12	16	24	36	60
A	1	7246	6.78	5.21	4.39	3.35	2.60	1.66	0.84
	2	10006	9.47	7.43	6.31	4.90	3.82	2.48	1.24
	3	12644	12.48	9.80	8.38	6.56	5.19	3.37	1.67
	4	17054	15.05	11.87	10.12	7.92	6.36	4.14	2.06
B	1	6460	8.50	6.63	5.34	3.94	2.93	1.78	0.99
	2	9596	12.21	9.43	7.65	5.72	4.32	2.62	1.36
	3	12700	15.16	11.83	9.66	7.31	5.55	3.40	1.79
	4	16362	18.87	14.69	12.06	9.21	7.04	4.34	2.33
C	1	6616	3.39	2.72	2.37	2.03	1.77	1.38	0.89
	2	9522	4.87	3.89	3.40	2.95	2.57	2.03	1.31
	3	12958	6.64	5.30	4.69	4.07	3.57	2.83	1.79
	4	16696	8.12	6.48	5.73	4.98	4.39	3.47	2.21
D	1	6264	3.30	3.17	2.98	2.70	2.45	2.04	1.38
	2	9474	5.67	5.27	4.97	4.50	4.10	3.42	2.38
	3	12914	7.97	7.48	7.06	6.51	5.96	5.01	3.48
	4	17474	10.41	9.68	9.17	8.47	7.78	6.58	4.62
E	1	7608	2.78	2.16	1.95	1.67	1.50	0.95	0.48
	2	9752	3.67	2.88	2.60	2.23	1.95	1.29	0.65
	3	12714	4.92	3.98	3.54	3.05	2.63	1.76	0.92
	4	17764	6.70	5.44	4.83	4.17	3.62	2.44	1.40
F	1	6534	3.28	2.69	2.33	1.88	1.56	1.09	0.68
	2	9512	5.07	4.32	3.67	2.99	2.40	1.69	1.01
	3	12662	7.28	5.97	5.17	4.26	3.49	2.37	1.33
	4	16812	9.71	8.17	7.11	5.88	4.81	3.29	1.83
G	1	6424	1.72	1.56	1.57	1.49	1.44	1.21	0.88
	2	9398	2.81	2.41	2.33	2.24	2.14	1.90	1.40
	3	12256	3.90	3.40	3.32	3.17	3.02	2.67	1.96
	4	16350	5.03	4.37	4.22	4.04	3.84	3.38	2.45
H	1	7734	4.55	3.74	3.60	3.26	2.88	2.16	1.15
	2	9704	5.77	4.79	4.66	4.26	3.75	2.80	1.49
	3	12504	7.99	6.72	6.53	5.92	5.27	4.03	2.17
	4	17706	10.90	9.25	8.99	8.27	7.34	5.63	3.10

** MICHBACK program did not converge for this deflection basin.

Table 20. Comparison of layer moduli of ten analytical pavement sections backcalculated by using MODULUS and MICHBACK computer programs (after correcting the CHEVRON program in MICHBACK).

SECTION	LAYER THICKNESSES (inch) AND MODULI (ksi)					ITEM	CUM. ABS. PERCENT ERROR	MOST ACCURATE PROGRAM
	AC	BASE	SUBBASE	ROADBED	BEDROCK			
4131	1.5	7.5	11.3	297.7	1000	Thickness		
	300	60	30	20	1000	T.M.*		
	207	62	30	20	1000	MODULUS	34	
	307.4	61.4	30.6	20.5	1000	MICHBACK	9	MICHBACK
1305	2.4	10.4	6	581.2	1000	Thickness		
	600	30	20	30	1000	T.M.*		
	516	32	27	18	1000	MODULUS	87	
	598	30.3	19.9	30.5	1000	MICHBACK	4	MICHBACK
1047	3	4.2	0	142.8	1000	Thickness		
	900	40	1	40	1000	T.M.*		
	621	79	1	31	1000	MODULUS	151	
	901.2	40	1	40	999	MICHBACK	0	MICHBACK
2109	3.7	12.1	0	584.2	1000	Thickness		
	600	60	1	30	1000	T.M.*		
	524	67	1	27	1000	MODULUS	34	
	602.4	59	1	29.2	998	MICHBACK	5	MICHBACK
4003	4.2	9.1	6	580.7	1000	Thickness		
	900	120	50	20	1000	T.M.*		
	866	107	134	13	1000	MODULUS	112	
	896.7	119.6	48.9	20	1000	MICHBACK	3	MICHBACK
3301	4.9	6.4	13.7	575	1000	Thickness		
	400	240	75	50	1000	T.M.*		
	627	199	22	23	1000	MODULUS	369	
	399.8	239.7	74	49	998	MICHBACK	4	MICHBACK
1099	5.7	8.9	36	249.4	1000	Thickness		
	900	1500	15	40	1000	T.M.*		
	886	1723	9.7	73	1000	MODULUS	154	
	910	1490	14.5	39.9	995	MICHBACK	5	MICHBACK
1111	6.6	4.2	14	275.2	1000	Thickness		
	600	75	25	35	1000	T.M.*		
	556	68	42	15	1000	MODULUS	114	
	600.6	75.3	24.6	34.8	1000	MICHBACK	3	MICHBACK
1035	8.3	14	0	577.7	1000	Thickness		
	300	600	1	25	1000	T.M.*		
	294	723	1	21	1000	MODULUS	39	
	300.6	599	1	25.3	1002	MICHBACK	2	MICHBACK
3801	10.3	6.6	12	121.1	1000	Thickness		
	600	150	50	30	1000	T.M.*		
	616	76	141	15	1000	MODULUS	167	
	601.5	148.6	49.8	29.4	1100	MICHBACK	4	MICHBACK

* = The true moduli (T.M.) of the pavement layers used in the forward calculations of the deflection basins.
1 = Indicates the absence of that layer.

2. For each designation number, columns 2 through 6 of table 19 provides the following data by row:

   a) Row 1 - Layer thicknesses in inches.
   b) Row 2 - The true values of the resilient modulus of each pavement layer, roadbed soil, and bedrock.
   c) Row 3 - The values of the layer moduli backcalculated by the staff of Rauhut Engineering using the modified version of MODULUS program. Note that, bedrock modulus was not backcalculated by MODULUS program. The true value was used as input (fixed seed modulus).
   d) Row 4 - The values of the layer moduli and the modulus of the bedrock backcalculated by the author using MICHBACK computer program.

3. Column 7 provides a title for each row of data.

4. Column 8 provides the values of the calculated cumulative absolute error between the backcalculated layer modulus values and the true values.

5. Column 9 provides a list of the most accurate program for the designated pavement section based on the value of the cumulative absolute error (the sum of the errors between the calculated and the measured deflections). Note that the term "tie" was used to indicates that both MICHBACK and MODULUS produced similar results. The results were considered the same when the difference between the cumulative absolute errors of both program is less than 20 percent.

It should be noted that the bedrock depths and moduli were not known to the author and hence, they were backcalculated using MICHBACK and that the bedrock moduli were known to the users of MODULUS program (they used them as inputs to MODULUS program in the form of fixed seed moduli). Therefore, one more unknown was calculated by the MICHBACK program. Nevertheless, examination of the results of the backcalculated layer moduli (for the ten analytical pavement sections) provided in table 20 indicates that:

1. For all pavement sections, the MICHBACK program produced more accurate results than those obtained from MODULUS program.

2. The maximum cumulative percent error obtained by MODULUS program is 369 percent (see pavement section 3301). This maximum is only 9 percent for the MICHBACK program (see section 3801). This maximum error for the MICHBACK program was found to be related to other issue as stated in the last paragraph of this section.

Figures 72 through 75 depict the absolute percent error in the backcalculated moduli (using the MODULUS program) for the AC, base, and subbase layers, and for the roadbed soil, respectively. Using the 20 percent error level in each material modulus as a criterion for accepting or rejecting the backcalculated values, it can be seen from the figures that:

1. For three of the ten analytical pavement sections, the error in the backcalculated AC moduli (see figure 72) is larger than 20 percent.

2. For two of the ten analytical pavement sections, the error in the backcalculated base

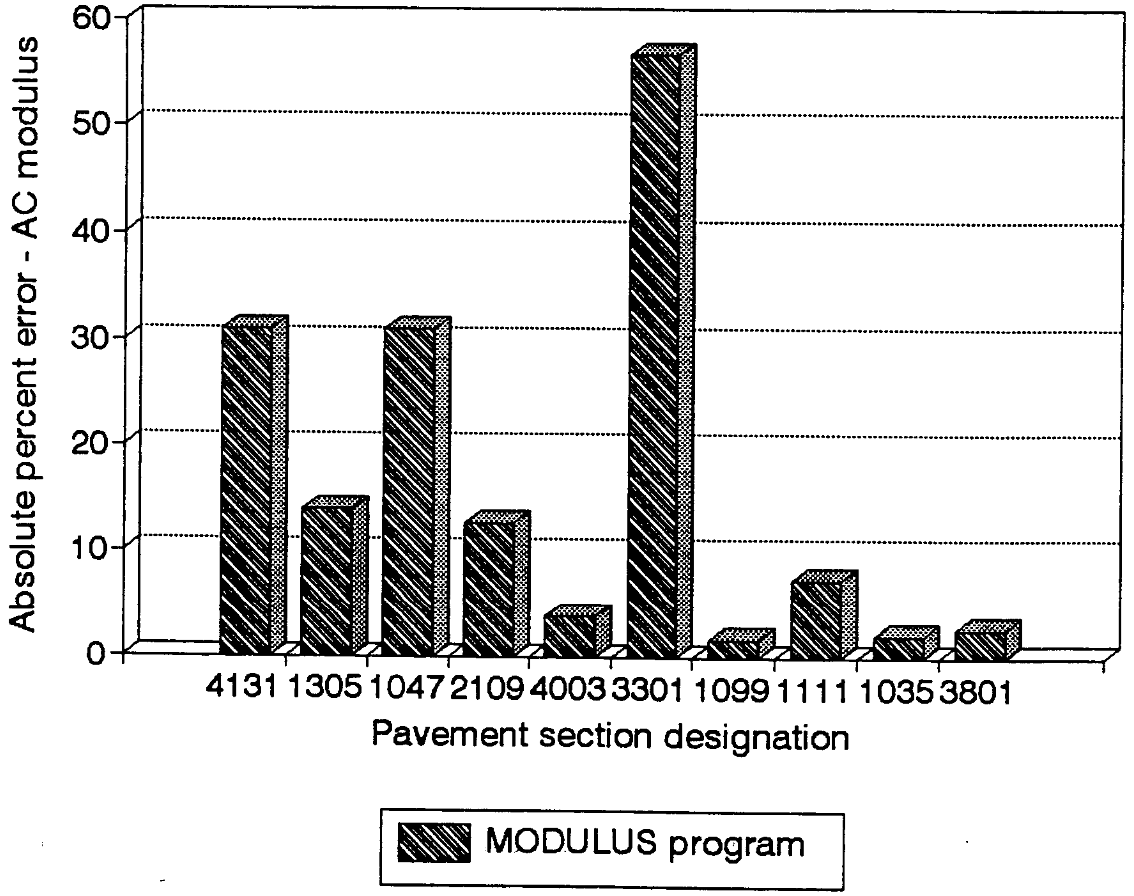

Figure 72. Absolute percent error in the AC modulus for ten analytical pavement sections backcalculated by using the SHRP modified MODULUS program.

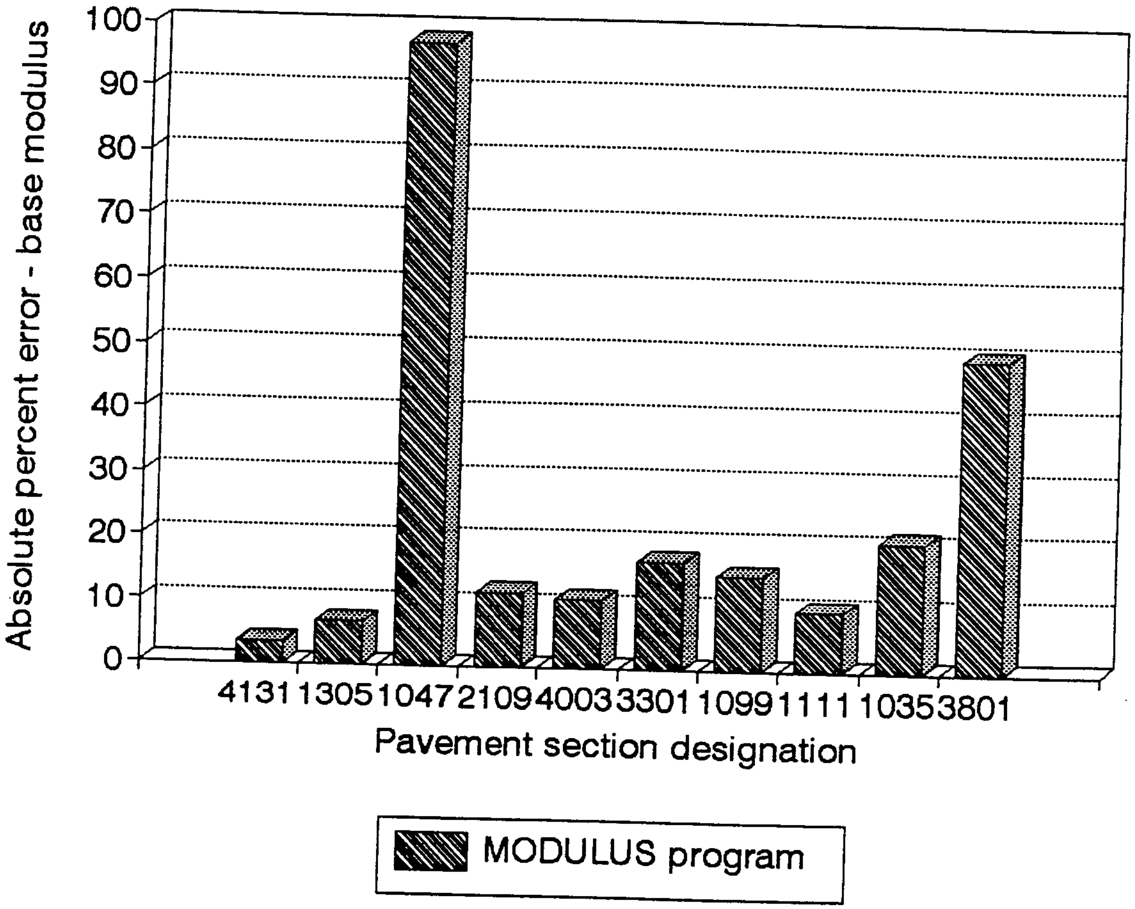

Figure 73. Absolute percent error in the base modulus for ten analytical pavement sections backcalculated by using the SHRP modified MODULUS program.

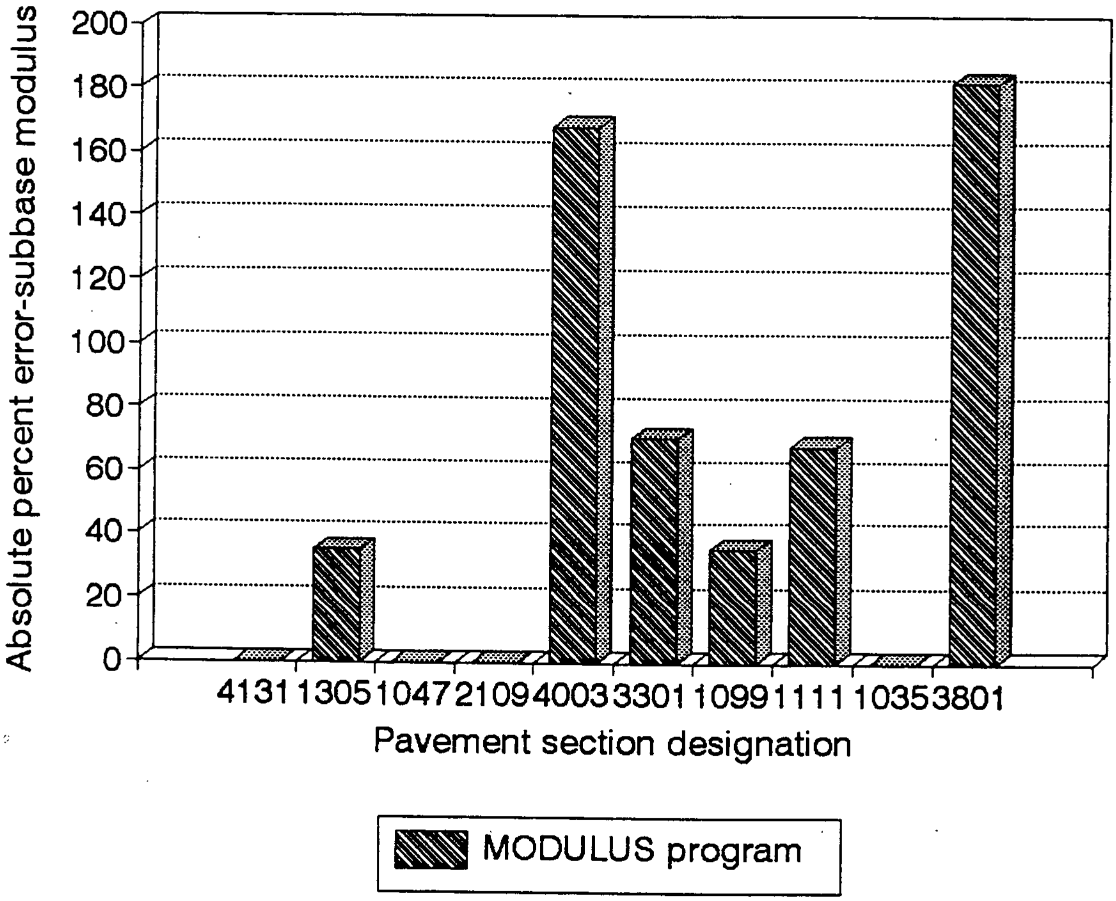

Figure 74. Absolute percent error in the subbase modulus for ten analytical pavement sections backcalculated by using the SHRP modified MODULUS program.

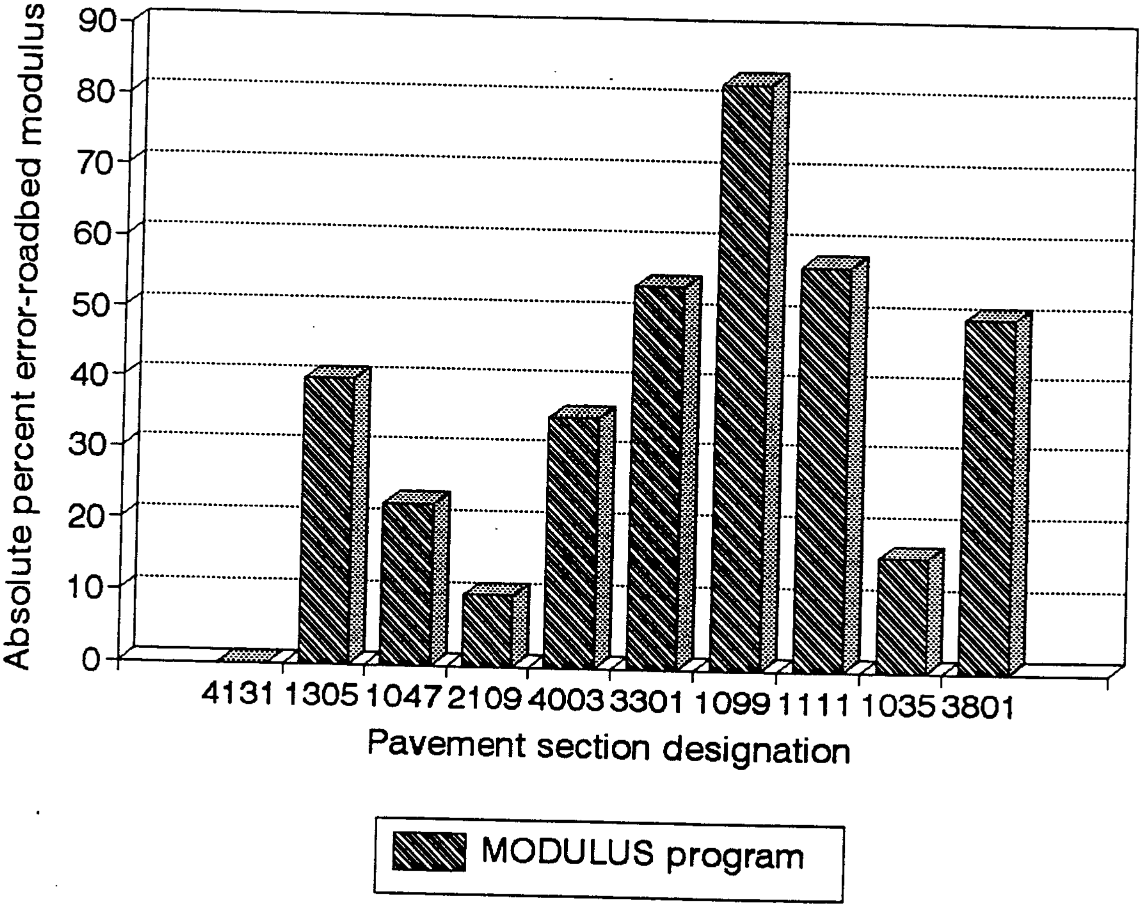

Figure 75. Absolute percent error in the roadbed modulus for ten analytical pavement sections backcalculated by using the SHRP modified MODULUS program.

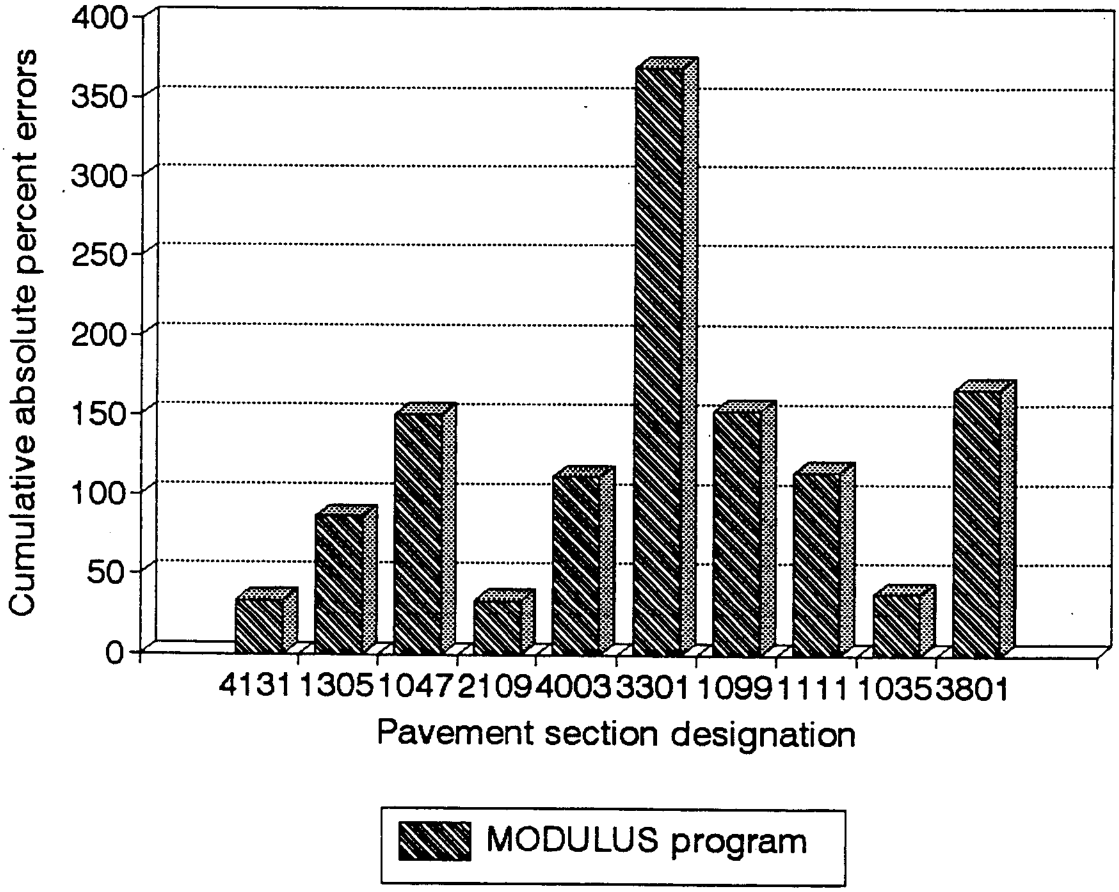

Figure 76. Cumulative absolute percent errors in all layer moduli for ten analytical pavement sections backcalculated by using the SHRP modified MODULUS program.

moduli (see figure 73) is larger than 20 percent.

3. For six of the ten analytical pavement sections, the error in the backcalculated subbase moduli (see figure 74) is larger than 20 percent.

4. For seven of the ten analytical pavement sections, the error in the backcalculated subbase moduli (see figure 75) is larger than 20 percent.

Finally, figure 76 shows the cumulative absolute percent errors in all backcalculated moduli produced by using the MODULUS program. It can be seen that the cumulative absolute percent errors for seven of the ten analytical sections is larger than 50 percent.

The analysis of the ten pavement sections presented above indicates that the results of the MODULUS program can be described as poor at best. Hence, extreme care should be taken when analyzing the backcalculated layer moduli of the SHRP pavement sections using measured deflection data. Stated differently, the MODULUS program must be substantially modified before the backcalculated modulus values can be accepted at face values.

6.3 MECHANISTIC ANALYSIS OF THE SHRP ASPHALT SURFACED PAVEMENT SECTIONS

As stated earlier, the MODULUS computer program was modified and several SHRP designed checks and tests and quality control statements were incorporated into the program. The modified program was then mailed to all SHRP regions to perform backcalculation on the SHRP asphalt surfaced pavement sections located in those regions. The backcalculated layer moduli along with the layer thicknesses were then tabulated in ASCII computer files and they were mailed to Michigan State University for mechanistic analysis of the pavement sections.

Upon receiving the backcalculated moduli data files from the various regions, each file was examined. For each pavement site and for each nondestructive deflection test location, the backcalculated layer moduli were not accepted for analytical analysis when the letter "N" was found in the quality control column of the file. The letter "N" indicated that the backcalculated layer moduli are not acceptable according to the SHRP acceptance criteria. On the other hand, all data entries with the letter "Y" in the quality control column indicates that the values of the backcalculated layer moduli have passed the SHRP quality control criteria. Nevertheless, about 40 percent of all tests have an "N" designate in the quality control column and hence, they were unacceptable. The data for all other deflection locations (with designate "Y" in the quality control column) were then accepted and they were transformed to other data files that are compatible with the MICHPAVE computer program (MICHPAVE is a linear and nonlinear finite element program that was developed at MSU).

It should be noted that the backcalculated layer moduli of numerous pavement sections can be considered unreasonable, although they have passed the SHRP quality check criteria (i.e., the letter "Y" is placed in the quality control column). For example, the value of the backcalculated asphalt modulus of the SHRP ID 893015 pavement section (see page A-3 of Appendix A) is 5,738,700 psi. This value is quite high and it can be considered unreasonable. Similarly, the backcalculated modulus value of the base layer of the SHRP ID 101450 (see page A-4 of Appendix A) can be considered unreasonable.

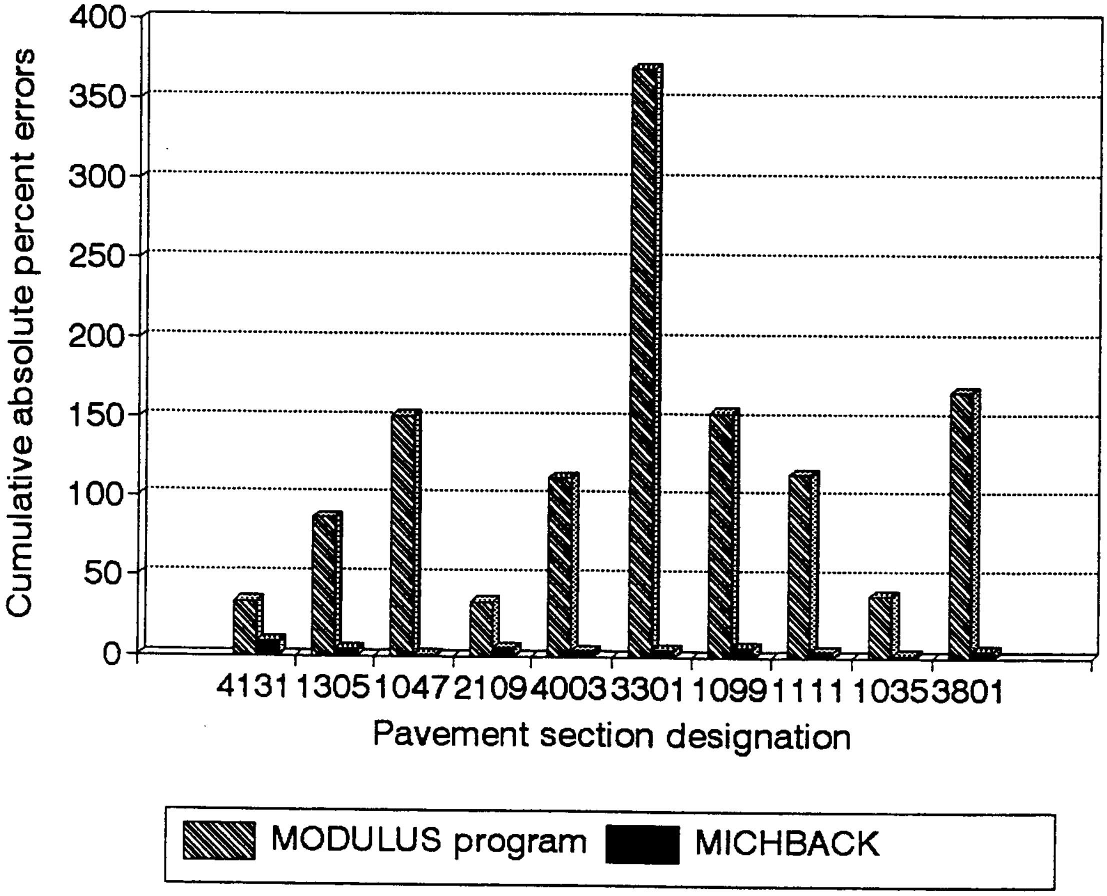

Figure 77. Cumulative absolute percent errors in all layer moduli for ten analytical pavement sections backcalculated by using the SHRP modified MODULUS program and the MICHBACK computer program.

For all of the SHRP asphalt surfaced pavement sections where the backcalculated layer moduli were accepted, the mechanistic responses (stresses, strains, and deflections) due to an 18-kip single axle load (one side of the axle or 9000 pounds was used in the analysis) were then calculated. The results are tabulated in Appendix A.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1 SUMMARY

Mechanistic evaluations of the AASHTO design equations, the AASHTO concept of drainage coefficient, and the AASHTO concept relative to the loss of serviceability due to swelling and frost heave are presented and discussed. An artificial experiment design matrix consists of 243 pavement sections was designed. For each pavement section, a typical range of pavement material properties, traffic volume in term of 18-kip ESAL, and a typical range of roadbed soil were assigned. Each section was designed by using the 1986 AASHTO design procedure. The layer thicknesses obtained from the AASHTO design procedure and the material properties were then used and mechanistic analyses of all 243 pavement sections were conducted. Details of the research plan used for the evaluation of the AASHTO design procedure can be found in chapter 2 of this report.

From the 243 pavement sections, several sets of pavement sections (three pavement sections per set) that were designed by the AASHTO design procedure to have equal performance period, equal traffic, and equal level of protection were then chosen and their mechanistic responses (stresses, strains, and deflections) were compared. Based on this comparison, the 1986 AASHTO design procedure was evaluated. The results of the evaluation can be found in Chapter 3 of this report.

The AASHTO concept for drainage coefficient was evaluated by assigning five different values for the drainage coefficients of the base and subbase layers of a pavement section. For each value of the drainage coefficient, the pavement section was redesigned and the layer thicknesses were determined by using the 1986 AASHTO design procedure. These thicknesses along with the appropriate material properties were then used to calculate the mechanistic responses of the pavement due to a 9000 pound load. The evaluation of the AASHTO concept for drainage coefficient was evaluated by comparing the mechanistic responses. The results of the evaluation are presented in chapter 4 of this report.

Similarly, the AASHTO concept for loss of serviceability due to environmental factor was evaluated by using five values of the loss of serviceability due to soil swelling and frost heave. Chapter 5 of this report presents the results and discussion of this evaluation.

Finally, all of the SHRP asphalt surfaced pavement sections where the backcalculated layer moduli were accepted by the SHRP established quality control criteria were evaluated using MICHPAVE computer program. The mechanistic responses can be found in Appendix A.

During the course of the investigation, the backcalculation computer program MODULUS (which was accepted by the SHRP) was also evaluated. Ten forward calculated deflection basins were used in this evaluation. The results are presented in Chapter 6.

7.2 CONCLUSIONS

Based on the research plan, the mechanistic evaluation of the 1986 AASHTO design procedure which includes the concepts of drainage coefficients and loss of serviceability due to environmental conditions, and on the basis of the range of variables used in this study, several conclusions are drawn. These conclusions are divided into several categories that are relevant to the topic and are summarized below.

7.2.1 The AASHTO Design Procedure

7.2.1.1 Observations

For a given value of the resilient modulus of the roadbed soil, a constant traffic volume, a constant design reliability level, and a constant overall standard deviation, the AASHTO design procedure produces:

1. Pavement sections with a constant SN which presumably provides an equal level of protection against traffic loading to all pavement layers regardless of the type and quality of the AC, base, and subbase layers.

2. An AC layer thickness that is independent of the properties (modulus or layer coefficient) of the subbase material and roadbed soil. It depends on the layer coefficients of the AC and base materials.

3. A base layer thickness that is independent of the resilient moduli of the AC layer and roadbed soil. It depends on the layer coefficient of the base and subbase materials.

4. A subbase thickness that is independent of the resilient moduli of the AC and base layers. It depends on the layer coefficient of the subbase material and on the modulus of the roadbed soil.

7.2.1.2 Conclusions

Relative to the AASHTO design procedure and the above general observations, and based on the results of the mechanistic evaluation of the AASHTO design procedure and the range of material properties used in this study, the following conclusions are drawn:

1. **Results of the mechanistic evaluation support observation "1" of the AASHTO design procedure.** The reason is that, for a constant traffic level and one type of roadbed soil, and for the range of the AC, base, and subbase properties used in this study, the AASHTO design procedure produces pavement sections (layer thicknesses) such that the peak surface deflection is constant.

Hence, the amount of the overall damage delivered to the pavement section (or the overall protection level) is constant and independent of the material properties.

2. **Results of the mechanistic evaluation do not support observations "2, 3, and 4" of the AASHTO design procedure.** The reasons are that for a constant traffic level and one type of roadbed soil, the AASHTO design procedure produces:

   a) pavement sections (layer thicknesses) such that the amount of compression and the resulting tensile strain experienced by any one layer vary from section to section. Hence, the amount of damage delivered to each layer of the pavement sections (or the level of protection) varies. This implies that while the AASHTO design procedure insures that the overall damage of the pavement sections is the same, the relative damage delivered to each layer is not.

   b) pavement sections (layer thicknesses) such that the tensile stress and the ratio of the tensile stress to the AC modulus induced at the bottom of the AC layer vary from section to section. Hence, the amount of damage delivered to each layer of the pavement sections (or the level of protection) varies.

Based on the mechanistic evaluation of the AASHTO design equations (the structural number equation, the layer coefficient equations or nomographs, and the AASHTO main design or performance equation), the following conclusions are drawn:

1. **Results of the mechanistic evaluation support the AASHTO structural number equation** (the structural number of any flexible pavement section is the sum of the structural numbers of its layers).

2. **Results of the mechanistic evaluation do not support the AASHTO structural number concept of any one flexible pavement layer** (the structural number of any flexible pavement layer is the product of its thickness and its layer coefficient, and the layer coefficient of any pavement layer can be obtained from the appropriate equation or nomograph based on the modulus value of that layer).

3. **Results of the mechanistic evaluation do not support the role of the roadbed soil resilient modulus in the AASHTO main design/performance equation** (the equation does not properly account for the effects of the resilient modulus of the roadbed soil on the structural capacity of the pavement).

7.2.2 The AASHTO Drainage Coefficient Concept

7.2.2.1 Observations

The AASHTO concept relative to drainage coefficient allows the user to either modify the thicknesses of each layer (Higher layer thicknesses for lower values of the drainage coefficients).

7.2.2.2 Conclusions

Based on the results of the mechanistic evaluation of the AASHTO drainage concept, the following conclusions are drawn:

1. The layer thicknesses modification option produces pavement sections with variable mechanistic responses.
2. The layer coefficient modification option tends to produce better pavement cross-section than the thickness modification option.
3. The DNPS86 and Darwin programs are both based on the thickness modification option.
4. The mechanistic-based modification of the effects of the AASHTO drainage coefficients on the pavement design produces better pavement cross-sections than either the thickness or the layer coefficient modification options.
5. Accounting for the quality of drainage in terms of percent gain or loss in the pavement service life is a viable option.

7.2.3 Loss of Serviceability Due to Environmental Factors

7.2.3.1 Observations

The AASHTO loss of serviceability concept is a linear concept, the total loss of pavement serviceability is the sum of the loss of serviceability due to traffic and the losses due to swelling and frost heave potentials. The concept (or the procedure in calculating the various losses) do not allow any interaction between the various serviceability losses.

7.2.3.2 Conclusions

Based on the results of the evaluation of the AASHTO concept of loss of serviceability due to environmental factors, the following conclusions are drawn:

1. The AASHTO concept of loss of serviceability (a linear concept) seems to be incompatible with the outputs of the AASHTO design procedure (the outputs, the layer thicknesses, are based on the interaction between the damages contributed by traffic and those by swelling and frost heave).

2. The loss of serviceability due to environmental conditions can also ne expressed in term of the effective roadbed resilient modulus.

3. The AASHTO concept for loss of serviceability due to environmental factors seems to be reasonable.

7.2.4 Backcalculation of Layer Moduli

7.2.4.1 Observations

MODULUS computer program for the backcalculation of layer moduli using nondestructive deflection test data was modified according to several SHRP specifications and rules. The accuracy of the backcalculated moduli values using the modified version of MODULUS program was evaluated by using ten analytical pavement sections (ten analytical deflection basins where the exact values of the layer moduli are known).

7.2.4.2 Conclusions

Based on the results of the evaluation of the modified version of MODULUS computer program, the following conclusions are drawn:

1. The modified version of MODULUS program produces inaccurate backcalculated layer moduli values.

2. The degree of confidence in the backcalculated layer modulus values is poor at best.

7.2.5 Mechanistic Evaluation of the Asphalt Surface Pavement Sections

7.2.5.1 Observations

The mechanistic evaluation of the asphalt surfaced pavement sections was conducted on the basis of the values of the layer moduli backcalculated by using the MODULUS program and the layer thicknesses found in the NPPD. The evaluation was limited to those pavement sections and deflection test locations where the backcalculated layer modulus values have passed the SHRP quality control check.

7.2.5.2 Conclusions

Based on the examination of the backcalculated layer modulus values that have passed the SHRP quality control checks and were reported by the various SHRP regions, the following conclusions were drawn:

1. The values of the backcalculated layer moduli for some pavement sections at some test locations are not reasonable.

2. The MODULUS program needs to be evaluated once again prior to any further backcalculation of layer moduli.

CHAPTER 8

RECOMMENDATIONS

8.1 RECOMMENDATIONS

Based on the analyses and evaluations presented in chapter 1 through 6 and on the conclusions presented in chapter 7, several recommendations are made. These recommendations are divided into several topics and presented below.

8.1.1 The AASHTO Design Equations

Relative to the AASHTO design equations and the AASHTO design procedure, the following recommendations are made:

1. It is highly recommended that the layer coefficients nomographs and equations be calibrated on the basis of mechanistic analyses. The calibration should address two important issues:
   - a) The layer coefficient of any one pavement layer material is a function of all other layer coefficients, hence, the calibration process should address this relationship.
   - b) The layer coefficients should lead to pavement cross-sections whereby the damage delivered to the pavement structure and to each layer is constant for the same design parameters (traffic, serviceability loss, design reliability, and the over all standard deviation).
2. It is recommended that the effects of the resilient modulus of the roadbed soil in the AASHTO main design/performance equation be calibrated on the basis of the mechanistic outputs and the damage delivered to the pavement section.

8.1.2 The AASHTO Concept for Drainage Coefficient

Relative to the AASHTO drainage coefficient concept, the following recommendations are made:

1. It is highly recommended that the existing option to modify the layer thicknesses to account for the effects of drainage coefficients be eliminated from the 1986 AASHTO Design Guide.
2. It is highly recommended that the AASHTO procedure to account for the effects of layer coefficients be modified. Two alternatives are recommended and are listed below in their order of accuracy.

a) **Alternative 1 - Mechanistic-Based Modification Method**. It is highly recommended that the 1986 AASHTO Design Guide be modified and a mechanistic-based method to account for the effects of drainage coefficients on the pavement design process be included as a substitute to the existing procedure. The new method should be based on the results of the mechanistic evaluation of various pavement sections having several values of drainage coefficients.

b) **Alternative 2 - Layer Coefficient Modification Method**. It is recommended that the 1986 AASHTO Design Guide be modified as to clarify the procedure that accounts for the effects of drainage quality on the pavement design process and to restrict the process to one option (the layer coefficient modification option). Examples should be included.

3. It is recommended that the AASHTO design computer programs be modified according to the above recommendations.

8.1.3 AASHTO Concept for Loss of Serviceability Due to Environmental Factors

Based on the analysis of the AASHTO concept for loss of serviceability due to swelling and frost heave, the following recommendation is made:

1. It is recommended that an explanation of the interaction and nonlinearity of the AASHTO concept be included in any future modification of the AASHTO Design Guide.

8.1.4 Backcalculation of Layer Moduli

Based on the evaluation of the SHRP adopted and then modified MODULUS computer program for the backcalculation of layer moduli, the following recommendations are made:

1. It is recommended that MODULUS program be further modified and retested for the accuracy of the backcalculated layer moduli.

2. It is highly recommended that for future LTPP data analysis, another backcalculation computer program be adopted and that the new program should be capable of:

    a) Calculating to within a reasonable accuracy the depth to a stiff layer.

    b) Calculating to within a reasonable accuracy the modulus values of all pavement layers.

    c) Producing backcalculated layer modulus values that are independent of the user inputs of the seed moduli, the user designation of the material type, and the user input of the depth to stiff layer.

8.1.5 Future LTPP Data Analysis

Based on the availability and evaluation of the data elements in the NPPD and on the mechanistic evaluation of the asphalt surfaced pavement sections, the following recommendations are made:

1. It is recommended that monitoring of all GPS sections to continue and that distress data (such as fatigue cracking, rut, roughness, and temperature cracking) be collected separately. This should allow the development of mechanistic based performance models.

2. It is recommended that nondestructive testing data be collected at a regular interval (such as every other year) so that the effects of time and traffic volume on the structural capacity of the pavements can be assessed.

3. It is recommended that traffic data be collected in terms of volume and weight (e.g., weigh in motion).

4. It is recommended that additional asphalt surfaced pavement sections be added to the existing GPS pool. The new sections could be selected on the basis of the lack of pavement sections with certain distress characteristics (e.g., fatigue cracking) in the existing GPS pool and on data availability in the State Highway Agency.

5. It is recommended that the SPS experiment be extended to include pavement sections constructed with polymer modified asphalts, stone mastic asphalt, and rubber additives.

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APPENDIX A

RESULTS OF THE MECHANISTIC ANALYSIS OF THE ASPHALT SURFACED PAVEMENT SECTIONS

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RESULTS OF THE MECHANISTIC ANALYSIS OF THE ASPHALT SURFACED PAVEMENT SECTIONS

The results (mechanistic responses) in terms of stresses, strains, and deflections of the SHRP asphalt surfaced pavement sections located in the four regions (North Atlantic, Western, South West, and North Central) are tabulated in this appendix.

In reference to page A-3, for each SHRP section and deflection test location, the data elements in the table are listed in order in 19 columns (column 1 is the left-hand side column) and 7 rows. The tables should be used as follows:

1. Column 1 - Provides the SHRP Identification (ID) number.

2. Column 2 - Provides the total number of layers in that pavement section.

3. Columns 3 through 7 - Provides, respectively, the layer number in question (1 = AC, 2 = base, 3 = subbase, and 4 = roadbed soil); layer type; layer thicknesses; the backcalculated layer moduli; and the layer Poisson's ratio used in the analysis.

4. Column 8 - Provides the depth information (at the surface and at the interfaces between layers) at which the stresses, strains and deflections are calculated under the center of the loaded area. Hence the depth information should be used along with the mechanistic responses listed in columns 9 through 14 only.

5. Column 9 through 14 - Provides, respectively, the following information:

   Column 9 - deflection (mills).
   Column 10 - Radial stresses (psi).
   Column 11 - Vertical stresses (psi).
   Column 12 - Shear stresses (psi).
   Column 13 - Radial strain (inch/inch).
   Column 14 - Vertical strain (inch/inch).

6. Column 15 - Provides a list of the radial distances at which the mechanistic responses at the pavement surface are calculated. Hence, the information in this column should be used along with the information in columns 16 through 19 as follows:

   Column 16 - Radial displacement (mills).
   Column 17 - Vertical deflection (mills).
   Column 18 - Radial stresses (psi).
   Column 19 - Radial strains (inch/inch).

For example, the deflection data provided in column 17 represents the deflection basin at the radial distances listed in column 15.

It should be noted that for all stresses, a negative sign implies compression while a negative sign implies tension.

EXAMPLE What is the tensile (radial) stress at the bottom of the AC and at the top of the base layers of the pavement section with SHRP ID = 893002 on page A-3.

From column 8, at a depth of 9.5 inches (the thickness of the AC layer in column 5), the radial (tensile) stress at the bottom of the AC is 85.4 psi.

From column 8, at a depth of 9.5 inches (the thickness of the AC layer in column 5), the radial (tensile) stress at the top of the base is 0.6 psi.

Mechanistic responses - North Atlantic Region.

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULUS	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
893002	4	1	AC	9.5	1941100	0.15	0	6.62	-115.7	-79.6	0	-0.004301	-0.0002148	0	0	6.62	-113.45	-0.004301
		2	BASE	8.6	56300	0.35	9.5	6.41	85.4	-6	-5.3	0.003670	-0.00171	8	0.2414	6.1409	-27.2	-0.000839
		3	SUBBASE	14.2	18700	0.35	9.5	6.41	0.6	-6	-5.3	0.003670	-0.0094	12	0.2651	5.8465	-8.84	-0.000255
		4	ROADBED	27.7	19100	0.35	18.1	5.838	1.7	-2	-0.1	0.003137	-0.005622	18	0.2614	5.4762	1.72	0.000269
							18.1	5.838	-0.2	-2	-0.1	0.003137	-0.01002	24	0.2353	5.1415	8.31	0.00057
							32.3	4.852	-0.3	-1.1	0	0.000977	-0.004858	36	0.1489	4.6411	15.58	0.000744
							32.3	4.852	-0.3	-1.1	0	0.000977	-0.00479	60	0.0237	4.2718	11.79	0.000595
893015	4	1	AC	8.1	5738700	0.15	0	6.656	-159.3	-79.6	0	-0.002105	-0.000492	0	0	6.656	-157.86	-0.002105
		2	BASE	13	23800	0.35	8.1	6.596	139	-3.6	-10.9	0.002025	-0.000819	8	0.1225	6.4251	-48.37	-0.000566
		3	SUBBASE	36	15600	0.35	8.1	6.596	-0.4	-3.6	-10.9	0.002025	-0.007911	12	0.1394	6.2643	-20.22	-0.00022
		4	ROADBED	20	18600	0.35	21.1	5.858	-0.2	-1.2	0	0.001162	-0.004455	18	0.1401	6.0347	1.63	0.000123
							21.1	5.858	-0.4	-1.2	0	0.001162	-0.006144	24	0.1266	5.8233	13.29	0.000307
							57.1	4.408	-0.4	-0.7	0	-0.000133	-0.002755	36	0.0788	5.5036	25.98	0.000409
							57.1	4.408	-0.4	-0.7	0	-0.000133	-0.002279	60	0.0126	5.2693	18.48	0.000315
893015	4	1	AC	8.4	2821300	0.15	0	6.235	-141.4	-79.6	0	-0.003743	-0.001197	0	0	6.235	-139.76	-0.003743
		2	BASE	13.6	35500	0.35	8.4	6.107	117.3	-5.3	-9.3	0.003478	-0.001491	8	0.214	5.8212	-38.39	-0.000874
		3	SUBBASE	36	14200	0.35	8.4	6.107	-0.2	-5.3	-9.3	0.003478	-0.01074	12	0.2392	5.5445	-13.94	-0.000286
		4	ROADBED	20	26400	0.35	22	5.175	0.5	-1.5	0	0.002343	-0.005225	18	0.2362	5.1694	3.05	0.000262
							22	5.175	-0.3	-1.5	0	0.002343	-0.009233	24	0.2111	4.8318	11.64	0.000539
							58	3.196	-0.5	-0.8	0	-7.3E-05	-0.003406	36	0.1303	4.3268	21.11	0.00068
							58	3.196	-0.5	-0.8	0	-7.3E-05	-0.001798	60	0.0206	3.96	14.91	0.000518
91803	3	1	AC	7	673200	0.3	0	11.5	-137.2	-79.6	0	-0.01039	0.001156	0	0	11.5	-144.27	-0.01039
		2	BASE	9.6	94000	0.35	7	11.07	78.9	-21.7	-6.9	0.008951	-0.01052	8	0.5597	10.0913	-34.5	-0.001854
		3	ROADBED	43.4	13600	0.35	7	11.07	2.4	-21.7	-6.9	0.008951	-0.02291	12	0.5997	9.256	-7.05	7.4E-05
							16.6	9.712	11.2	-3.4	-0.5	0.008894	-0.01206	18	0.5474	8.3016	2.75	0.001175
							16.6	9.712	0.2	-3.4	-0.5	0.008894	-0.0251	24	0.469	7.5229	5.71	0.001416
														36	0.2836	6.4446	10.97	0.001477
91803	3	1	AC	7.2	812800	0.3	0	12.76	-152.4	-79.6	0	-0.009865	0.002167	0	0	12.76	-160.44	-0.009865
		2	BASE	14.4	51500	0.35	7.2	12.4	107	-16.1	-8.2	0.009562	-0.01016	8	0.5407	11.4577	-42.67	-0.002054
		3	ROADBED	38.4	11100	0.35	7.2	12.4	0.3	-16.1	-8.2	0.009562	-0.02692	12	0.5875	10.645	-10.45	-4.5E-05
							21.6	10.34	4.2	-2.3	-0.2	0.006732	-0.01017	18	0.5364	9.6628	3.99	0.001227
							21.6	10.34	0	-2.3	-0.2	0.006732	-0.02017	24	0.4535	8.8564	7.88	0.001484
														36	0.2642	7.757	13.28	0.00145
														60	0.0407	7.0108	9.41	0.001024

Mechanistic responses - North Atlantic Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULUS	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
95001	4	1	AC	8.3	2973100	0.15	0	5.275	-133.6	-79.6	0	-0.003331	-0.001218	0	0	5.275	-131.92	-0.003331
		2	BASE	15.6	64600	0.35	8.3	5.153	107.3	-7.2	-9.4	0.003028	-0.001376	8	0.1868	4.9001	-32.19	-0.000659
		3	SUBBASE	36	25400	0.35	8.3	5.153	-0.2	-7.2	-9.4	0.003028	-0.009078	12	0.2045	4.6575	-9.05	-0.000143
		4	ROADBED	20	26700	0.35	23.9	4.339	0.9	-1.8	-0.1	0.001778	-0.00363	18	0.1963	4.3414	5.36	0.000299
							23.9	4.339	-0.2	-1.8	-0.1	0.001778	-0.006238	24	0.172	4.0638	11.39	0.000488
							59.9	3.113	-0.4	-0.8	0	3.7E-05	-0.001932	36	0.103	3.6628	18.22	0.000558
							59.9	3.113	-0.4	-0.8	0	3.7E-05	-0.001837	60	0.016	3.3793	12.22	0.000403
101450	4	1	AC	9.3	1326600	0.3	0	4.665	-88.7	-79.6	0	-0.002763	-0.001794	0	0	4.665	-92.64	-0.002763
		2	BASE	6.8	1264100	0.2	9.3	4.374	6.3	-23.1	-3.1	0.000815	-0.002076	8	0.148	4.2344	-17.37	-0.000405
		3	SUBBASE	36	11700	0.35	9.3	4.374	7.2	-23.1	-3.1	0.000815	-0.002034	12	0.1596	4.0365	-4.71	-0.000164
		4	ROADBED	20	40000	0.35	16.1	4.285	34.1	-1.5	-2	0.002153	-0.001224	18	0.1641	3.8608	-4.27	0
							16.1	4.285	-0.3	-1.5	-2	0.002153	-0.009728	24	0.1574	3.6987	0.11	0.000226
							52.1	2.128	-0.5	-0.8	0	-0.000145	-0.004115	36	0.1128	3.4438	6.2	0.000463
							52.1	2.128	-0.5	-0.8	0	-0.000145	-0.001098	60	0.0191	3.2413	7	0.000475
111400	3	1	AC	13.1	1423400	0.33	0	4.6	-100.2	-79.6	0	-0.002762	-0.000742	0	0	4.6	-107.6	-0.002762
		2	BASE	36	47300	0.45	13.1	4.275	50.5	-4	-2.8	0.002427	-0.002673	8	0.1532	4.1718	-24.99	-0.000639
		3	ROADBED	20	20900	0.45	13.1	4.275	-0.7	-4	-2.8	0.002427	-0.005988	12	0.1717	3.9588	-8.14	-0.000248
							49.1	3.433	-0.3	-0.8	0	0.000319	-0.000944	18	0.1754	3.7438	-4.39	6.6E-05
							49.1	3.433	-0.5	-0.8	0	0.000319	-0.001479	24	0.1636	3.5509	1.13	0.000309
														36	0.111	3.2586	7.46	0.000495
														60	0.0181	3.037	7.43	0.000453
231009	4	1	AC	5.5	1003800	0.31	0	15.28	-218.9	-79.6	0	-0.01296	0.005469	0	0	15.28	-248.95	-0.01296
		2	BASE	3.6	23100	0.35	5.5	15.06	185.5	-15.5	-7	0.0136	-0.0126	8	0.6879	13.4801	-67.36	-0.002339
		3	SUBBASE	25.2	27800	0.35	5.5	15.06	-2.3	-15.5	-7	0.0136	-0.05048	12	0.7278	12.2525	-10.43	0.000701
		4	ROADBED	25.7	10200	0.35	9.1	13.52	-1.9	-9.5	-0.3	0.009113	-0.03533	18	0.6107	10.7167	16.76	0.002296
							9.1	13.52	-1.2	-9.5	-0.3	0.009113	-0.0311	24	0.4769	9.5473	16.35	0.002163
							34.3	9.745	1	-1.6	0	0.004128	-0.008001	36	0.2339	8.0885	19.76	0.001612
							34.3	9.745	-0.2	-1.6	0	0.004128	-0.01387	60	0.0329	7.2332	9.8	0.000836
231026	3	1	AC	6.4	797400	0.31	0	11.62	-190.2	-79.6	0	-0.01308	0.005723	0	0	11.62	-203.7	-0.01308
		2	BASE	19.2	23100	0.35	6.4	11.3	155	-14.6	-13.6	0.01372	-0.01433	8	0.711	9.8858	-55.71	-0.002648
		3	ROADBED	34.4	18900	0.35	6.4	11.3	-1.2	-14.6	-13.6	0.01372	-0.04566	12	0.7656	8.7165	-11.83	0.000291
							25.6	6.744	0.1	-2.8	-0.1	0.004587	-0.01254	18	0.6686	7.2624	10.62	0.002116
							25.6	6.744	-0.2	-2.8	-0.1	0.004587	-0.01434	24	0.5359	6.1136	13.34	0.002243
														36	0.2731	4.6416	17.2	0.001804
														60	0.0382	3.749	8.9	0.00097

Mechanistic responses - North Atlantic Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULUS	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
231026	4	1	AC	6.4	528700	0.31	0	8.572	-138.8	-79.6	0	-0.01311	0.002261	0	0	8.572	-147.75	-0.01311
		2	BASE	16	62000	0.35	6.4	8.062	84.6	-25.4	-8.8	0.01228	-0.01511	8	0.668	6.7035	-27.82	-0.001301
		3	SUBBASE	36	15300	0.35	6.4	8.062	-0.7	-25.4	-8.8	0.01228	-0.03673	12	0.6746	5.6285	1.39	0.001212
		4	ROADBED	20	49100	0.35	22.4	5.265	5	-3.1	-0.2	0.006895	-0.01069	18	0.5526	4.5114	8.32	0.002114
							22.4	5.265	0	-3.1	-0.2	0.006895	-0.02013	24	0.4373	3.6953	6.57	0.001788
							58.4	1.835	-0.5	-1	0	0.000133	-0.00425	36	0.2396	2.6895	8.19	0.001388
							58.4	1.835	-0.5	-1	0	0.000133	-0.00145	60	0.0362	2.0575	5.49	0.000914
231028	4	1	AC	6.6	565600	0.3	0	10.6	-153.6	-79.6	0	-0.01438	0.003315	0	0	10.6	-162.22	-0.01438
		2	BASE	18.7	30100	0.35	6.6	10.1	115.1	-18.6	-10.6	0.01489	-0.01595	8	0.7423	8.6098	-33.15	-0.001653
		3	SUBBASE	36	49700	0.35	6.6	10.1	-1.6	-18.6	-10.6	0.01489	-0.04907	12	0.753	7.3988	1.64	0.001463
		4	ROADBED	20	20900	0.35	25.3	5.448	-1.1	-4.2	-0.1	0.002531	-0.01127	18	0.5941	6.0675	14.11	0.002893
							25.3	5.448	-0.3	-4.2	-0.1	0.002531	-0.008047	24	0.4335	5.1215	11.59	0.002452
							61.3	4.073	0	-0.9	0	0.00063	-0.001838	36	0.1833	4.0712	10.05	0.001496
							61.3	4.073	-0.3	-0.9	0	0.00063	-0.003364	60	0.0213	3.5483	3.57	0.000556
231028	4	1	AC	6.3	390200	0.3	0	13.39	-136.4	-79.6	0	-0.01786	0.001985	0	0	13.39	-143.93	-0.01786
		2	BASE	20.4	39400	0.35	6.3	12.68	88.8	-25.3	-9.9	0.01751	-0.02068	8	0.8802	10.807	-22.11	-0.000815
		3	SUBBASE	36	33000	0.35	6.3	12.68	-1.6	-25.3	-9.9	0.01751	-0.05559	12	0.8495	9.3462	7.24	0.00267
		4	ROADBED	20	14100	0.35	26.7	7.757	0.4	-3.8	-0.1	0.003893	-0.009997	18	0.6286	7.9137	12.92	0.003593
							26.7	7.757	0	-3.8	-0.1	0.003893	-0.01138	24	0.4459	6.9643	8.21	0.00261
							62.7	5.926	-0.1	-0.8	0	0.000691	-0.002336	36	0.1958	5.9573	6.53	0.001474
							62.7	5.926	-0.3	-0.8	0	0.000691	-0.004416	60	0.0253	5.4473	2.86	0.00065
237023	4	1	AC	6.3	394500	0.35	0	8.482	-74.4	-79.6	0	-0.005034	-0.006628	0	0	8.482	-81.11	-0.005034
		2	BASE	7.8	1267100	0.15	6.3	7.79	-33.4	-51.6	-4.6	-0.000675	-0.007081	8	0.2887	7.391	-14.4	-0.001264
		3	SUBBASE	9.6	14800	0.35	6.3	7.79	-19.9	-51.6	-4.6	-0.000675	-0.00357	12	0.335	6.9663	-5.33	-0.001029
		4	ROADBED	36.3	15500	0.35	14.1	7.629	58.3	-3	-3.2	0.003856	-0.001666	18	0.3821	6.6448	-5.74	-0.000412
							14.1	7.629	-0.4	-3	-3.2	0.003856	-0.01419	24	0.3787	6.3114	-0.46	0.000455
							23.7	6.591	-0.4	-1.5	0	0.001809	-0.008302	36	0.2714	5.7766	4.57	0.001125
							23.7	6.591	-0.4	-1.5	0	0.001809	-0.008059	60	0.0449	5.358	5.13	0.001122
245807	4	1	AC	8.9	1839100	0.15	0	4.966	-100	-79.6	0	-0.003843	-0.002544	0	0	4.966	-98.23	-0.003843
		2	BASE	4.8	286300	0.2	8.9	4.741	56.9	-13.3	-3.7	0.002653	-0.001723	8	0.2062	4.5156	-16.32	-0.000409
		3	SUBBASE	21.6	62800	0.35	8.9	4.741	6.4	-13.3	-3.7	0.002653	-0.005331	12	0.215	4.263	-1.49	3.3E-05
		4	ROADBED	24.7	24400	0.35	13.7	4.557	10.5	-4.9	-0.7	0.003253	-0.003184	18	0.201	3.9783	4.04	0.000347
							13.7	4.557	0.6	-4.9	-0.7	0.003253	-0.008414	24	0.1754	3.7342	7.02	0.000494
							35.3	3.706	0.4	-1.1	0	0.000989	-0.002182	36	0.1073	3.3867	10.96	0.000556
							35.3	3.706	-0.2	-1.1	0	0.000989	-0.003928	60	0.0168	3.1397	7.89	0.000421

Mechanistic responses - North Atlantic Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULUS	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
251002	4	1	AC	7.6	591700	0.31	0	11.91	-151	-79.6	0	-0.01299	0.003305	0	0	11.91	-160.28	-0.01299
		2	BASE	4.1	69000	0.35	7.6	11.41	101.6	-12.8	-4.1	0.01223	-0.01332	8	0.7314	10.2117	-47.45	-0.003319
		3	SUBBASE	8.4	8800	0.35	7.6	11.41	6.8	-12.8	-4.1	0.01223	-0.02368	12	0.817	9.125	-15.53	-0.000612
		4	ROADBED	39.9	18600	0.35	11.7	10.55	14.3	-5.1	-0.6	0.01601	-0.02209	18	0.7729	7.7697	1.13	0.001425
							11.7	10.55	-0.5	-5.1	-0.6	0.01601	-0.05226	24	0.663	6.6191	8.11	0.002105
							20.1	7.321	-1.1	-3.2	0	0.004249	-0.02669	36	0.3828	5.0122	14.74	0.002161
							20.1	7.321	-0.5	-3.2	0	0.004249	-0.01517	60	0.0568	3.9253	9.75	0.001433
251003	4	1	AC	6.7	1299900	0.3	0	12.28	-203.7	-79.6	0	-0.008919	0.003851	0	0	12.28	-216.12	-0.008919
		2	BASE	12.1	13500	0.35	6.7	12.07	176.7	-9.7	-11.7	0.009545	-0.009189	8	0.5019	11.1267	-68.01	-0.002274
		3	SUBBASE	36	39200	0.35	6.7	12.07	-1.5	-9.7	-11.7	0.009545	-0.04031	12	0.5583	10.3375	-21.69	-0.000262
		4	ROADBED	20	11900	0.35	18.8	8.541	-1.6	-3.7	0	0.001791	-0.0188	18	0.513	9.2607	7.2	0.001242
							18.8	8.541	-0.9	-3.7	0	0.001791	-0.007746	24	0.4252	8.3718	15.08	0.001597
							54.8	7.028	0.1	-0.9	0	0.00091	-0.002383	36	0.2245	7.1738	22.42	0.001441
							54.8	7.028	-0.3	-0.9	0	0.00091	-0.005379	60	0.0316	6.4188	11.91	0.000803
331001	4	1	AC	8.2	800500	0.3	0	8.702	-144.2	-79.6	0	-0.009418	0.001387	0	0	8.702	-151.98	-0.009418
		2	BASE	19.3	29400	0.35	8.2	8.29	106.1	-10.3	-7.9	0.009439	-0.009456	8	0.5293	7.4836	-42.47	-0.002233
		3	SUBBASE	14.4	8700	0.35	8.2	8.29	-0.2	-10.3	-7.9	0.009439	-0.02821	12	0.5868	6.7235	-13.52	-0.0004
		4	ROADBED	20	27200	0.35	27.5	5.521	1.3	-1.9	0	0.00494	-0.00933	18	0.5554	5.7829	1.53	0.00101
							27.5	5.521	-0.3	-1.9	0	0.00494	-0.01855	24	0.478	4.9853	7.68	0.001477
							41.9	3.507	-0.6	-1.3	0	0.000576	-0.009746	36	0.2804	3.8699	13.91	0.001541
							41.9	3.507	-0.5	-1.3	0	0.000576	-0.003543	60	0.0425	3.1067	9.65	0.001071
331001	4	1	AC	8.5	866000	0.3	0	8.218	-141.1	-79.6	0	-0.00844	0.001056	0	0	8.218	-148.56	-0.00844
		2	BASE	19.3	29700	0.35	8.5	7.825	102.9	-9.4	-7.3	0.008431	-0.008415	8	0.4773	7.13	-42.39	-0.002094
		3	SUBBASE	14.4	8800	0.35	8.5	7.825	-0.2	-9.4	-7.3	0.008431	-0.02514	12	0.533	6.454	-14.41	-0.000473
		4	ROADBED	20	27200	0.35	27.8	5.33	1.1	-1.8	0	0.004431	-0.008511	18	0.5114	5.6154	0.25	0.000816
							27.8	5.33	-0.3	-1.8	0	0.004431	-0.01711	24	0.4452	4.8948	7.04	0.001302
							42.2	3.46	-0.6	-1.2	0	0.000496	-0.009156	36	0.2663	3.873	13.85	0.001427
							42.2	3.46	-0.5	-1.2	0	0.000496	-0.003327	60	0.0408	3.161	10	0.001026
341034	3	1	AC	12.3	1621700	0.3	0	5.257	-108.3	-79.6	0	-0.003109	-0.000725	0	0	5.257	-113.38	-0.003109
		2	BASE	36	18000	0.35	12.3	4.98	65	-2.6	-3.8	0.002809	-0.002631	8	0.1771	4.8364	-29.71	-0.000778
		3	ROADBED	20	27700	0.35	12.3	4.98	-0.3	-2.6	-3.8	0.002809	-0.01041	12	0.2009	4.6095	-12.38	-0.00036
							48.3	3.068	-0.4	-0.8	0	4.2E-05	-0.002919	18	0.2088	4.3533	-5.77	3.9E-05
							48.3	3.068	-0.4	-0.8	0	4.2E-05	-0.00193	24	0.1964	4.1162	1.63	0.000347
														36	0.1345	3.7468	10.1	0.000594
														60	0.0222	3.46	10.03	0.000554

Mechanistic responses - North Atlantic Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULUS	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
341034	3	1	AC	11.7	1202000	0.3	0	5.779	-110.6	-79.6	0	-0.004291	-0.000839	0	0	5.779	-115.66	-0.004291
		2	BASE	36	21000	0.35	11.7	5.417	67.7	-3.7	-4.1	0.003944	-0.003818	8	0.2439	5.198	-31.19	-0.0011
		3	ROADBED	20	26900	0.35	11.7	5.417	-0.3	-3.7	-4.1	0.003944	-0.01326	12	0.2766	4.88	-12.32	-0.000455
							47.7	3.217	-0.4	-0.9	0	0.000231	-0.002921	18	0.2834	4.5174	-4.85	0.000122
							47.7	3.217	-0.4	-0.9	0	0.000231	-0.002366	24	0.263	4.1871	2.4	0.000522
														36	0.1757	3.6808	10.28	0.000804
														60	0.0285	3.296	9.6	0.000713
341638	4	1	AC	9.2	1161800	0.3	0	4.631	-87.4	-79.6	0	-0.00308	-0.002121	0	0	4.631	-91.28	-0.00308
		2	BASE	6.3	1306700	0.2	9.2	4.3	3.3	-24	-3.4	0.000778	-0.002282	8	0.1643	4.1464	-16.6	-0.000426
		3	SUBBASE	36	19500	0.35	9.2	4.3	6.7	-24	-3.4	0.000778	-0.002022	12	0.1766	3.926	-4.3	-0.00017
		4	ROADBED	20	32400	0.35	15.5	4.214	37.8	-1.9	-2.4	0.002317	-0.001341	18	0.1812	3.7335	-4.05	7E-06
							15.5	4.214	-0.3	-1.9	-2.4	0.002317	-0.008542	24	0.1733	3.5565	0.25	0.000259
							51.5	2.609	-0.4	-0.8	0	-1.8E-05	-0.002552	36	0.1231	3.2792	6.04	0.000512
							51.5	2.609	-0.5	-0.8	0	-1.8E-05	-0.001541	60	0.0206	3.0625	6.64	0.000515
341638	4	1	AC	9	1251000	0.3	0	4.247	-88.7	-79.6	0	-0.002934	-0.001898	0	0	4.247	-92.71	-0.002934
		2	BASE	8.5	771100	0.2	9	3.938	12.7	-24.4	-3	0.001244	-0.002614	8	0.1533	3.7807	-15.41	-0.000309
		3	SUBBASE	36	29300	0.35	9	3.938	6.1	-24.4	-3	0.001244	-0.003425	12	0.1606	3.5672	-2.37	-3.7E-05
		4	ROADBED	20	32300	0.35	17.5	3.779	21.2	-2.3	-1.1	0.002218	-0.001412	18	0.1579	3.3834	-2.36	9.8E-05
							17.5	3.779	-0.1	-2.3	-1.1	0.002218	-0.007067	24	0.1473	3.2211	0.76	0.000262
							53.5	2.585	-0.4	-0.8	0	4.9E-05	-0.001711	36	0.1024	2.9776	5.57	0.000437
							53.5	2.585	-0.4	-0.8	0	4.9E-05	-0.001573	60	0.0171	2.79	5.92	0.000426
361008	4	1	AC	1.1	173000	0.35	0	9.367	-69.6	-79.6	0	-0.01089	-0.01544	0	0	9.367	-73.22	-0.01089
		2	BASE	10.1	518100	0.35	1.1	9.156	-60	-78.6	-2.9	-0.006827	-0.0204	8	0.6313	7.7606	-14.25	-0.003736
		3	SUBBASE	12	7700	0.35	1.1	9.156	-100.8	-78.6	-2.9	-0.006827	-0.000855	12	0.7413	6.949	-4.37	-0.001478
		4	ROADBED	36.8	26400	0.35	11.2	8.409	80.4	-5.7	-3.1	0.009982	-0.0125	18	0.7542	6.0264	-1.43	0.000574
							11.2	8.409	-0.9	-5.7	-3.1	0.009982	-0.04151	24	0.6839	5.1838	1.28	0.001615
							23.2	4.686	-1.1	-2.4	0	0.001558	-0.02113	36	0.4343	3.9295	4.11	0.002153
							23.2	4.686	-0.7	-2.4	0	0.001558	-0.007396	60	0.0678	3.0132	3.34	0.001702
361011	3	1	AC	9.6	335200	0.31	0	10.06	-105.5	-79.6	0	-0.01375	-0.003213	0	0	10.06	-111.25	-0.01375
		2	BASE	15	33800	0.35	9.6	8.89	57.2	-13.3	-3.7	0.01254	-0.01497	8	0.7282	7.9947	-22.36	-0.001991
		3	ROADBED	35.4	22000	0.35	9.6	8.89	0.1	-13.3	-3.7	0.01254	-0.03587	12	0.7655	6.9207	-2.39	0.00037
							24.6	6.009	0.8	-3.2	-0.1	0.004847	-0.01111	18	0.6855	5.8561	2.61	0.001738
							24.6	6.009	0	-3.2	-0.1	0.004847	-0.01434	24	0.5695	5.0134	4.86	0.002046
														36	0.3196	3.921	6.85	0.001833
														60	0.0461	3.2263	4.43	0.001169

Mechanistic responses - North Atlantic Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULUS	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
364017	4	1	AC	8.9	4336000	0.15	0	4.335	-124.1	-79.6	0	-0.002094	-0.000903	0	0	4.335	-122.15	-0.002094
		2	BASE	15	120500	0.35	8.9	4.246	94.6	-6.8	-7.6	0.001827	-0.000846	8	0.1179	4.1017	-30.18	-0.000425
		3	SUBBASE	36	12900	0.35	8.9	4.246	0.4	-6.8	-7.6	0.001827	-0.004885	12	0.1299	3.9545	-9.81	-0.000124
		4	ROADBED	20	40000	0.35	23.9	3.836	2.2	-1.2	-0.1	0.001478	-0.002227	18	0.1275	3.7646	2.54	0.000143
							23.9	3.836	-0.3	-1.2	-0.1	0.001478	-0.007183	24	0.1142	3.5944	9.29	0.000284
							59.9	2.098	-0.5	-0.8	0	-0.000166	-0.003521	36	0.0717	3.3403	17.06	0.000362
							59.9	2.098	-0.5	-0.8	0	-0.000166	-0.001013	60	0.0115	3.1553	12.71	0.000287
371006	4	1	AC	9	1213400	0.3	0	7.788	-139.7	-79.6	0	-0.005925	0.000683	0	0	7.788	-146.95	-0.005925
		2	BASE	9.7	19100	0.35	9	7.493	105.1	-6.9	-5.5	0.006074	-0.005921	8	0.3387	7.0293	-43.81	-0.001588
		3	SUBBASE	36	37000	0.35	9	7.493	-1	-6.9	-5.5	0.006074	-0.02319	12	0.3826	6.5568	-16.2	-0.000445
		4	ROADBED	20	19000	0.35	18.7	5.828	-1.1	-3.1	0	0.001816	-0.01193	18	0.3727	5.9634	-0.94	0.000522
							18.7	5.828	-0.6	-3.1	0	0.001816	-0.007148	24	0.3267	5.4463	7.08	0.000937
							54.7	4.454	-0.2	-0.9	0	0.00051	-0.002036	36	0.1953	4.7043	14.41	0.001054
							54.7	4.454	-0.3	-0.9	0	0.00051	-0.003385	60	0.0295	4.189	10.17	0.000743
371006	4	1	AC	9.3	967300	0.3	0	8.774	-131.3	-79.6	0	-0.006815	0.000317	0	0	8.774	-137.86	-0.006815
		2	BASE	9	24500	0.35	9.3	8.393	93.7	-7.4	-4.6	0.006816	-0.006771	8	0.387	7.8861	-39.41	-0.001747
		3	SUBBASE	36	26600	0.35	9.3	8.393	-0.6	-7.4	-4.6	0.006816	-0.02223	12	0.4347	7.3508	-13.93	-0.000472
		4	ROADBED	20	16900	0.35	18.3	6.953	-0.5	-3.2	-0.1	0.003222	-0.01145	18	0.4231	6.697	-1	0.000582
							18.3	6.953	-0.4	-3.2	-0.1	0.003222	-0.01091	24	0.3719	6.1295	6.17	0.001044
							54.3	5.019	-0.2	-0.9	0	0.000543	-0.002643	36	0.2248	5.3139	12.84	0.00119
							54.3	5.019	-0.3	-0.9	0	0.000543	-0.003799	60	0.0342	4.7445	9.4	0.000862
371040	3	1	AC	5.3	655900	0.31	0	29.46	-265.5	-79.6	0	-0.02483	0.01279	0	0	29.46	-302.38	-0.02483
		2	BASE	14.4	9400	0.35	5.3	29.15	236	-14.5	-20.2	0.02602	-0.02356	8	1.3592	26.0371	-94.78	-0.005698
		3	ROADBED	40.3	6400	0.35	5.3	29.15	-1.5	-14.5	-20.2	0.02602	-0.09252	12	1.4855	23.5375	-26.4	0.000117
							19.7	20.9	0.5	-3.2	-0.1	0.01492	-0.03724	18	1.3183	20.1842	13.88	0.003829
							19.7	20.9	-0.2	-3.2	-0.1	0.01492	-0.04719	24	1.0728	17.4558	19.8	0.004266
														36	0.5528	13.8592	29.77	0.003656
														60	0.0799	11.615	15.56	0.002021
371645	4	1	AC	8.1	775600	0.3	0	5.617	-100.1	-79.6	0	-0.005784	-0.002126	0	0	5.617	-105.03	-0.005784
		2	BASE	8.3	203200	0.2	8.1	5.161	37.6	-23.6	-4	0.004184	-0.00606	8	0.2969	4.7378	-16.61	-0.000445
		3	SUBBASE	36	54600	0.35	8.1	5.161	5.1	-23.6	-4	0.004184	-0.01218	12	0.3004	4.2995	0.51	0.000347
		4	ROADBED	20	26700	0.35	16.4	4.585	8.7	-5.6	-0.6	0.003924	-0.004445	18	0.2639	3.8958	2.59	0.00068
							16.4	4.585	0.5	-5.6	-0.6	0.003924	-0.01063	24	0.2218	3.5818	3.61	0.000729
							52.4	3.176	-0.1	-0.9	0	0.000457	-0.001477	36	0.1314	3.1686	5.84	0.000698
							52.4	3.176	-0.3	-0.9	0	0.000457	-0.002562	60	0.0199	2.8945	4.34	0.000502

Mechanistic responses - North Atlantic Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULUS	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
371803	3	1	AC	5.1	472900	0.31	0	35.59	-200.6	-79.6	0	-0.02468	0.009443	0	0	35.59	-226.15	-0.02468
		2	BASE	13.2	33400	0.35	5.1	35.18	141.8	-26.6	-14.8	0.02299	-0.02321	8	1.2781	32.1296	-54.59	-0.003683
		3	ROADBED	41.7	3900	0.35	5.1	35.18	-0.8	-26.6	-14.8	0.02299	-0.06863	12	1.335	29.8725	-6.71	0.00141
							18.3	30.3	10	-2.6	-0.4	0.02174	-0.02886	18	1.1414	27.1658	10.13	0.003519
							18.3	30.3	0	-2.6	-0.4	0.02174	-0.06394	24	0.9424	25.0717	9.26	0.003281
														36	0.5434	22.2875	16.54	0.003018
														60	0.086	20.41	11.77	0.002158
371817	3	1	AC	4.2	758900	0.3	0	30.48	-269.1	-79.6	0	-0.02219	0.01097	0	0	30.48	-301.09	-0.02219
		2	BASE	12	38100	0.35	4.2	30.28	204.7	-29.1	-27	0.02043	-0.01949	8	1.114	27.1818	-66.01	-0.00252
		3	ROADBED	43.8	5000	0.35	4.2	30.28	-1.9	-29.1	-27	0.02043	-0.06381	12	1.1363	24.9525	-2.91	0.001834
							16.2	25.81	11.7	-3.3	-0.5	0.0223	-0.03027	18	0.94	22.2633	18.44	0.003355
							16.2	25.81	0.1	-3.3	-0.5	0.0223	-0.06389	24	0.7623	20.2142	12.58	0.002845
														36	0.4227	17.5208	22.75	0.002516
														60	0.0662	15.7875	14.37	0.00166
372824	4	1	AC	4.7	565800	0.35	0	10.43	-100.4	-79.6	0	-0.006501	-0.001308	0	0	10.43	-109.71	-0.006501
		2	BASE	5.8	892100	0.2	4.7	10.16	-30.6	-54.5	-7.5	3.1E-05	-0.005702	8	0.3833	9.4181	-28.56	-0.002026
		3	SUBBASE	36	30800	0.35	4.7	10.16	-14	-54.5	-7.5	3.1E-05	-0.005496	12	0.4441	8.8943	-10.76	-0.000848
		4	ROADBED	20	11700	0.35	10.5	9.927	71	-6.6	-6.7	0.006416	-0.004083	18	0.4522	8.3237	-3.4	0.000367
							10.5	9.927	-0.2	-6.6	-6.7	0.006416	-0.01977	24	0.4069	7.812	2.96	0.001025
							46.5	7.263	0.1	-0.9	0	0.001141	-0.00303	36	0.2541	7.0705	8.09	0.001278
							46.5	7.263	-0.3	-0.9	0	0.001141	-0.00599	60	0.0389	6.5447	6.52	0.00098
372825	4	1	AC	4.2	1470700	0.3	0	7.049	-112.6	-79.6	0	-0.003721	-0.0007	0	0	7.049	-119.2	-0.003721
		2	BASE	7.7	1128000	0.2	4.2	6.942	-13.9	-56.3	-7.7	0.000552	-0.003193	8	0.2054	6.5401	-27.14	-0.000703
		3	SUBBASE	36	38300	0.35	4.2	6.942	-7	-56.3	-7.7	0.000552	-0.004769	12	0.2251	6.263	-9.08	-0.000215
		4	ROADBED	20	15800	0.35	11.9	6.727	50	-4.5	-3.7	0.003542	-0.002246	18	0.2233	5.9584	-2.85	0.000188
							11.9	6.727	-0.1	-4.5	-3.7	0.003542	-0.01061	24	0.2035	5.6881	3.01	0.000452
							47.9	5.236	-0.1	-0.8	0	0.000492	-0.001814	36	0.1327	5.2849	9.92	0.00063
							47.9	5.236	-0.3	-0.8	0	0.000492	-0.003673	60	0.0212	4.9878	8.69	0.000532
373816	4	1	AC	9.1	8739300	0.15	0	5.098	-125.9	-79.6	0	-0.001057	-0.000442	0	0	5.098	-124.03	-0.001057
		2	BASE	4.1	848900	0.2	9.1	5.054	89.5	-5.9	-4	0.000858	-0.000394	8	0.061	4.9839	-34.88	-0.000258
		3	SUBBASE	36	8700	0.35	9.1	5.054	7.9	-5.9	-4	0.000858	-0.00098	12	0.0689	4.91	-15.21	-0.000114
		4	ROADBED	20	30300	0.35	13.2	5.022	13.6	-1	-0.8	0.001304	-0.000777	18	0.0706	4.8102	-1.8	3.2E-05
							13.2	5.022	-0.4	-1	-0.8	0.001304	-0.008678	24	0.0654	4.717	7.98	0.000131
							49.2	2.76	-0.4	-0.8	0	-0.000277	-0.005074	36	0.0433	4.5713	19.26	0.000204
							49.2	2.76	-0.5	-0.8	0	-0.000277	-0.001241	60	0.0071	4.4583	15.85	0.000178

Mechanistic responses - North Atlantic Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULUS	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
373816	4	1	AC	9.5	8120900	0.15	0	5.596	-119.5	-79.6	0	-0.001069	-0.0005	0	0	5.596	-117.37	-0.001069
		2	BASE	4.2	791200	0.2	9.5	5.545	82.7	-5.5	-3.5	0.000851	-0.000395	8	0.0613	5.4789	-31.98	-0.000251
		3	SUBBASE	36	7900	0.35	9.5	5.545	7.2	-5.5	-3.5	0.000851	-0.000981	12	0.069	5.4065	-13.76	-0.000111
		4	ROADBED	20	26900	0.35	13.7	5.513	12.5	-1	-0.7	0.00128	-0.000768	18	0.0708	5.3101	-1.97	2.9E-05
							13.7	5.513	-0.4	-1	-0.7	0.00128	-0.009121	24	0.0658	5.2194	7.2	0.000129
							49.7	3.09	-0.4	-0.7	0	-0.000315	-0.005509	36	0.0438	5.0768	17.77	0.000204
							49.7	3.09	-0.5	-0.7	0	-0.000315	-0.001374	60	0.0072	4.9678	14.96	0.000181
375037	4	1	AC	7.7	4570400	0.15	0	8.277	-175.8	-79.6	0	-0.002904	-0.000462	0	0	8.277	-172.14	-0.002904
		2	BASE	15	9300	0.35	7.7	8.206	156.2	-4.2	-12.4	0.002842	-0.001168	8	0.1697	7.9556	-56.26	-0.000841
		3	SUBBASE	36	15000	0.35	7.7	8.206	-0.6	-4.2	-12.4	0.002842	-0.01506	12	0.1946	7.7248	-23.51	-0.000322
		4	ROADBED	20	16600	0.35	22.7	6.473	-0.5	-1.2	0	0.00083	-0.008856	18	0.1957	7.3887	2.05	0.000177
							22.7	6.473	-0.5	-1.2	0	0.00083	-0.005846	24	0.1762	7.0793	15.21	0.000437
							58.7	4.981	-0.4	-0.7	0	-0.00012	-0.002935	36	0.1086	6.6133	29.25	0.000574
							58.7	4.981	-0.4	-0.7	0	-0.00012	-0.002624	60	0.0173	6.2735	20.22	0.000433
421597	3	1	AC	6.6	833300	0.31	0	13.15	-188.1	-79.6	0	-0.01233	0.005288	0	0	13.15	-201.18	-0.01233
		2	BASE	16	26800	0.35	6.6	12.84	150.2	-14	-12	0.0127	-0.01325	8	0.6825	11.5361	-58.94	-0.002854
		3	ROADBED	37.4	11100	0.45	6.6	12.84	-0.6	-14	-12	0.0127	-0.03921	12	0.7496	10.4425	-16.69	-0.00015
							22.6	9.439	1.8	-2.4	-0.1	0.007344	-0.01364	18	0.6823	9.0502	6.03	0.001668
							22.6	9.439	-0.5	-2.4	-0.1	0.007344	-0.01797	24	0.5695	7.9048	11.36	0.00201
														36	0.317	6.3518	18.23	0.001867
														60	0.0475	5.33	11.48	0.001198
421597	3	1	AC	6.3	740100	0.31	0	15.39	-207.9	-79.6	0	-0.01574	0.007714	0	0	15.39	-223.11	-0.01574
		2	BASE	16.8	16500	0.35	6.3	15.06	174.4	-13.1	-14.5	0.01652	-0.01692	8	0.8715	13.3246	-66.74	-0.003665
		3	ROADBED	36.9	11200	0.45	6.3	15.06	-1	-13.1	-14.5	0.01652	-0.05479	12	0.9569	11.895	-18.97	-0.000135
							23.1	9.9	0.6	-2.7	-0.1	0.00773	-0.01846	18	0.8642	10.0187	8.25	0.002265
							23.1	9.9	-0.6	-2.7	-0.1	0.00773	-0.01912	24	0.713	8.4873	13.89	0.002671
														36	0.3826	6.4372	21.04	0.002379
														60	0.0558	5.1267	12.04	0.001412
421690	4	1	AC	10.5	4081900	0.15	0	3.124	-101.3	-79.6	0	-0.001764	-0.001141	0	0	3.124	-99.79	-0.001764
		2	BASE	12	132400	0.35	10.5	3.015	68.5	-5.5	-5	0.001411	-0.000667	8	0.0973	2.9243	-20	-0.000264
		3	SUBBASE	36	43000	0.35	10.5	3.015	0.3	-5.5	-5	0.001411	-0.003785	12	0.1046	2.81	-5.65	-7.1E-05
		4	ROADBED	20	39800	0.35	22.5	2.729	1.1	-1.6	-0.1	0.000978	-0.001829	18	0.1028	2.6749	1.27	0.000104
							22.5	2.729	-0.2	-1.6	-0.1	0.000978	-0.00344	24	0.0928	2.5533	6.58	0.000218
							58.5	2.062	-0.4	-0.7	0	4E-06	-0.00107	36	0.0594	2.3722	12.66	0.00029
							58.5	2.062	-0.4	-0.7	0	4E-06	-0.001155	60	0.0095	2.2375	9.92	0.000238

Mechanistic responses - North Atlantic Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULUS	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
501683	4	1	AC	2.5	1761700	0.3	0	14.23	-423.1	-79.6	0	-0.01576	0.01043	0	0	14.23	-488.77	-0.01576
		2	BASE	2.8	192100	0.35	2.5	14.21	272.1	-46.5	-37.8	0.01159	-0.01235	8	0.7126	11.2142	-68.86	-6.1E-05
		3	SUBBASE	36	23300	0.35	2.5	14.21	11.3	-46.5	-37.8	0.01159	-0.02714	12	0.6657	9.2447	30.26	0.002689
		4	ROADBED	20	20700	0.35	5.3	13.42	64	-19.8	-6.7	0.02532	-0.03414	18	0.462	7.0751	55.16	0.003082
							5.3	13.42	-0.2	-19.8	-6.7	0.02532	-0.07617	24	0.3238	5.6427	21.19	0.001926
							41.3	4.895	-0.1	-1.6	0	0.002144	-0.00616	36	0.1337	4.0797	25.93	0.001152
							41.3	4.895	-0.2	-1.6	0	0.002144	-0.007223	60	0.0179	3.319	9.34	0.000456
511002	3	1	AC	5.7	462300	0.3	0	31.26	-232.4	-79.6	0	-0.03088	0.01254	0	0	31.26	-261.69	-0.03088
		2	BASE	7.8	6900	0.35	5.7	30.78	204.4	-13.3	-13.2	0.03255	-0.02804	8	1.6958	27.1145	-80.72	-0.007089
		3	ROADBED	46.5	7000	0.35	5.7	30.78	-1.6	-13.3	-13.2	0.03255	-0.1191	12	1.853	24.145	-21.34	0.000172
							13.5	23.75	-0.7	-5.1	-0.1	0.01952	-0.06693	18	1.6409	20.1958	13.06	0.00485
							13.5	23.75	-0.6	-5.1	-0.1	0.01952	-0.06639	24	1.3291	16.9992	18.4	0.005413
														36	0.6762	12.8392	25.62	0.004534
														60	0.0956	10.2775	12.97	0.002424
511419	4	1	AC	9.6	1312900	0.32	0	2.744	-106	-79.6	0	-0.003406	-0.000631	0	0	2.744	-112.95	-0.003406
		2	BASE	5.7	152300	0.2	9.6	2.449	54.9	-13.3	-2.5	0.003062	-0.003817	8	0.1815	2.2239	-23.58	-0.000554
		3	SUBBASE	36	99400	0.45	9.6	2.449	2.8	-13.3	-2.5	0.003062	-0.008794	12	0.193	1.9535	-3.34	4.3E-05
		4	ROADBED	20	58500	0.45	15.3	2.091	2.8	-6	-0.3	0.002261	-0.004653	18	0.1756	1.684	1.75	0.000402
							15.3	2.091	-0.8	-6	-0.3	0.002261	-0.005379	24	0.1477	1.4683	4.48	0.000503
							51.3	1.323	-0.2	-1	0	0.000316	-0.000773	36	0.0846	1.1826	6.97	0.000474
							51.3	1.323	-0.5	-1	0	0.000316	-0.000961	60	0.0123	0.9975	4.7	0.000312
512564	4	1	AC	7.9	2944800	0.15	0	5.855	-133.9	-79.6	0	-0.003322	-0.00118	0	0	5.855	-130.55	-0.003322
		2	BASE	6.1	215000	0.2	7.9	5.734	96.4	-11.2	-6	0.002756	-0.001428	8	0.1865	5.4802	-33.24	-0.000696
		3	SUBBASE	36	24400	0.35	7.9	5.734	5	-11.2	-6	0.002756	-0.005464	12	0.2055	5.236	-9.95	-0.000174
		4	ROADBED	20	21900	0.35	14	5.512	9.3	-2.7	-0.5	0.003683	-0.002997	18	0.1996	4.9177	3.72	0.000256
							14	5.512	0	-2.7	-0.5	0.003683	-0.01084	24	0.1774	4.6348	10.31	0.000461
							50	3.816	-0.4	-0.8	0	0.000185	-0.002228	36	0.1096	4.2153	18.31	0.000568
							50	3.816	-0.4	-0.8	0	0.000185	-0.002493	60	0.0174	3.9107	13.12	0.000436
515010	4	1	AC	9.4	2494300	0.15	0	4.285	-107.2	-79.6	0	-0.003066	-0.001782	0	0	4.285	-105.12	-0.003066
		2	BASE	6.2	249400	0.2	9.4	4.118	67.8	-9.3	-4.1	0.002292	-0.001247	8	0.1699	3.9387	-22.8	-0.000517
		3	SUBBASE	36	24900	0.45	9.4	4.118	5.1	-9.3	-4.1	0.002292	-0.004223	12	0.1844	3.7345	-6.77	-0.000145
		4	ROADBED	20	24900	0.45	15.6	3.945	8.8	-2.2	-0.5	0.002982	-0.002295	18	0.1815	3.4863	1.16	0.000176
							15.6	3.945	-0.4	-2.2	-0.5	0.002982	-0.007306	24	0.1644	3.263	6.85	0.000377
							51.6	2.925	-0.6	-0.8	0	8.5E-05	-0.000924	36	0.1061	2.9231	13.71	0.000513
							51.6	2.925	-0.6	-0.8	0	8.5E-05	-0.000955	60	0.0172	2.67	10.92	0.000429

Mechanistic responses - North Atlantic Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULUS	POIS		DEF (mil)	STRESS (psi)			STRAIN			RADIAL DISPL	DEFLECTI (mil)	RADIAL STRESS	RADIAL STRAIN
									RADIAL	VERT	SHR	RADIAL	VERT					
545007	3	1	AC	8.4	3306400	0.15	0	10.45	-141.7	-79.6	0	-0.003202	-0.001021	0	0	10.45	-140.06	-0.003202
		2	BASE	6	106000	0.2	8.4	10.34	113.1	-5.8	-6.5	0.002868	-0.001253	8	0.1846	10.0984	-40.13	-0.000794
		3	ROADBED	45.6	10200	0.35	8.4	10.34	2.7	-5.8	-6.5	0.002868	-0.005452	12	0.2082	9.8595	-16.31	-0.000307
							14.4	10.11	4.7	-1.5	-0.3	0.003803	-0.003232	18	0.2095	9.5365	0.74	0.000167
							14.4	10.11	-0.2	-1.5	-0.3	0.003803	-0.01346	24	0.1905	9.2383	10.63	0.000437
														36	0.1213	8.7819	21.95	0.000606
														60	0.0196	8.4413	16.57	0.000491
871622	4	1	AC	5.6	687400	0.35	0	14.22	-191.7	-79.6	0	-0.01455	0.007935	0	0	14.22	-229.97	-0.01455
		2	BASE	5	36200	0.35	5.6	13.91	146.7	-20.5	-7.4	0.01538	-0.01741	8	0.7583	12.106	-59.46	-0.00243
		3	SUBBASE	30.7	25800	0.35	5.6	13.91	-1	-20.5	-7.4	0.01538	-0.04711	12	0.7925	10.735	-7.02	0.001097
		4	ROADBED	20	12500	0.35	10.6	12.06	1.6	-9.8	-0.5	0.01216	-0.0299	18	0.6461	9.1271	14.04	0.002713
							10.6	12.06	-0.3	-9.8	-0.5	0.01216	-0.03672	24	0.493	7.9459	12.86	0.002396
							41.3	7.517	0.4	-1.3	0	0.002668	-0.006036	36	0.2361	6.5347	14.39	0.001649
							41.3	7.517	-0.2	-1.3	0	0.002668	-0.00947	60	0.0322	5.735	7.02	0.000821

Mechanistic responses - West Region.

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
21002	4	1	AC	3.5	473500	0.35	0	13.28	-212.5	-79.6	0	-0.02401	0.01569	0	0	13.28	-267.24	-0.02401
		2	BASE	6	40300	0.35	3.5	12.99	147.3	-45.4	-14.3	0.02343	-0.03193	8	1.0066	9.0673	-25.95	0.001891
		3	SUBBASE	7	48500	0.35	3.5	12.99	-8.1	-45.4	-14.3	0.02343	-0.08961	12	0.8529	6.7405	29.15	0.005887
		4	ROADBED	43.5	30400	0.35	9.5	8.975	-2.2	-20	-0.9	0.01381	-0.04589	18	0.4996	4.7843	23.25	0.004409
							9.5	8.975	-0.5	-20	-0.9	0.01381	-0.04065	24	0.3262	3.7319	5.91	0.002111
							16.5	6.9	2.8	-8.9	-0.4	0.01014	-0.02247	36	0.1519	2.7222	5.94	0.001044
							16.5	6.9	0.2	-8.9	-0.4	0.01014	-0.02928	60	0.0224	2.206	3.31	0.000567
47613	3	1	AC	13	2773300	0.15	0	2.98	-82.7	-79.6	0	-0.002026	-0.001889	0	0	2.98	-81	-0.002026
		2	BASE	36	86400	0.45	13	2.795	45	-3.7	-3.6	0.00137	-0.000641	8	0.1071	2.7376	-10.85	-0.000136
		3	ROADBED	20	30300	0.45	13	2.795	-0.7	-3.7	-3.6	0.00137	-0.003371	12	0.1103	2.617	-1.21	-1E-06
							49	2.33	-0.3	-0.7	0	0.000193	-0.000537	18	0.107	2.4948	0.5	0.000101
							49	2.33	-0.5	-0.7	0	0.000193	-0.000942	24	0.0975	2.3862	4.12	0.000213
														36	0.0642	2.2218	8.73	0.0003
														60	0.0104	2.0978	7.33	0.00026
47614	4	1	AC	9.8	5135900	0.15	0	4.834	-111.1	-79.6	0	-0.001549	-0.00084	0	0	4.834	-108.82	-0.001549
		2	BASE	5.1	334600	0.2	9.8	4.752	76.1	-6.2	-3.4	0.001237	-0.000599	8	0.0872	4.6613	-26.34	-0.000308
		3	SUBBASE	36	35900	0.35	9.8	4.752	3.9	-6.2	-3.4	0.001237	-0.002068	12	0.0962	4.5575	-9.47	-0.000112
		4	ROADBED	20	21100	0.35	14.9	4.675	6.3	-1.9	-0.4	0.001614	-0.001336	18	0.0965	4.4269	-0.02	7E-05
							14.9	4.675	-0.1	-1.9	-0.4	0.001614	-0.005091	24	0.0883	4.3083	7.06	0.000191
							50.9	3.832	-0.4	-0.7	0	4.6E-05	-0.001258	36	0.0576	4.1234	15.16	0.000275
							50.9	3.832	-0.4	-0.7	0	4.6E-05	-0.002117	60	0.0094	3.985	12.26	0.000234
47614	4	1	AC	9.6	3641100	0.15	0	4.966	-113.9	-79.6	0	-0.002251	-0.001162	0	0	4.966	-111.66	-0.002251
		2	BASE	5.3	208500	0.2	9.6	4.853	79.9	-6.3	-3.7	0.001834	-0.000877	8	0.127	4.7166	-27.35	-0.000455
		3	SUBBASE	36	25700	0.35	9.6	4.853	3.5	-6.3	-3.7	0.001834	-0.003257	12	0.1401	4.5638	-9.79	-0.000161
		4	ROADBED	20	23700	0.35	14.9	4.728	5.7	-2	-0.3	0.002345	-0.002053	18	0.1401	4.3704	0.36	0.000111
							14.9	4.728	-0.1	-2	-0.3	0.002345	-0.007406	24	0.1278	4.1941	7.52	0.000285
							50.9	3.475	-0.4	-0.8	0	4.2E-05	-0.001851	36	0.0827	3.9235	15.67	0.0004
							50.9	3.475	-0.4	-0.8	0	4.2E-05	-0.002021	60	0.0134	3.72	12.44	0.000335
63005	4	1	AC	7.9	978200	0.15	0	9.589	-96.8	-79.6	0	-0.006911	-0.00487	0	0	9.589	-94.58	-0.006911
		2	BASE	3.9	789800	0.2	7.9	9.191	24.5	-20.9	-5.8	0.002398	-0.002978	8	0.3782	8.7974	-18.43	-0.000987
		3	SUBBASE	36	16500	0.35	7.9	9.191	18.5	-20.9	-5.8	0.002398	-0.00355	12	0.4053	8.3575	-4.96	-0.000263
		4	ROADBED	20	13500	0.35	11.8	9.075	55.4	-3.2	-4.4	0.005663	-0.003298	18	0.3996	7.8528	0.56	0.000354
							11.8	9.075	-0.2	-3.2	-4.4	0.005663	-0.01809	24	0.3636	7.3977	5.72	0.000813
							47.8	6.25	-0.3	-0.9	0	0.000474	-0.003676	36	0.2364	6.7068	11.75	0.00113
							47.8	6.25	-0.4	-0.9	0	0.000474	-0.004427	60	0.038	6.191	9.5	0.000952

Mechanistic responses - West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
63017	4	1	AC	8.4	2527200	0.15	0	4.576	-96.9	-79.6	0	-0.002712	-0.001905	0	0	4.576	-95.66	-0.002712
		2	BASE	3	3001000	0.2	8.4	4.418	23.1	-16.2	-7.2	0.00085	-0.000934	8	0.1505	4.2717	-19.24	-0.000413
		3	SUBBASE	5.8	25800	0.35	8.4	4.418	28.5	-16.2	-7.2	0.00085	-0.000931	12	0.1629	4.1027	-6.76	-0.000161
		4	ROADBED	42.8	26300	0.35	11.4	4.391	76.1	-2.6	-4.4	0.002043	-0.001114	18	0.164	3.905	-0.75	9.5E-05
							11.4	4.391	-0.4	-2.6	-4.4	0.002043	-0.007634	24	0.1515	3.7233	5.36	0.000306
							17.2	4.024	-0.4	-1.7	0	0.001194	-0.005256	36	0.1008	3.4419	12.49	0.000467
							17.2	4.024	-0.4	-1.7	0	0.001194	-0.005199	60	0.0165	3.2268	10.6	0.000412
63030	4	1	AC	8.4	3476700	0.15	0	3.036	-106.7	-79.6	0	-0.002204	-0.001291	0	0	3.036	-105.28	-0.002204
		2	BASE	2.3	1429400	0.3	8.4	2.923	51.8	-14.3	-4.5	0.001295	-0.000885	8	0.1219	2.7858	-21.83	-0.000347
		3	SUBBASE	3.3	400900	0.2	8.4	2.923	20.5	-14.3	-4.5	0.001295	-0.001858	12	0.1316	2.6392	-6.36	-9.4E-05
		4	ROADBED	46	43400	0.35	10.7	2.882	34	-6.2	-1.8	0.001795	-0.001882	18	0.1292	2.4602	1.44	0.000132
							10.7	2.882	7.5	-6.2	-1.8	0.001795	-0.002244	24	0.1167	2.3001	6.92	0.000272
							14	2.82	10.8	-2.7	-0.6	0.002277	-0.001773	36	0.0749	2.0575	13.64	0.000366
							14	2.82	0.2	-2.7	-0.6	0.002277	-0.006426	60	0.0121	1.878	10.7	0.000302
67452	4	1	AC	3.8	380400	0.3	0	5.007	-51.8	-79.6	0	-0.003897	-0.01333	0	0	5.007	-57.99	-0.003897
		2	BASE	7	3517800	0.2	3.8	4.495	-38.3	-71.1	-9.6	-0.001956	-0.01363	8	0.2658	4.169	-13.24	-0.001496
		3	SUBBASE	10.6	9400	0.35	3.8	4.495	-107	-71.1	-9.6	-0.001956	-0.000766	12	0.3204	3.833	-5.78	-0.001105
		4	ROADBED	38.6	32500	0.45	10.8	4.418	132.6	-3.6	-9	0.002961	-0.001692	18	0.3561	3.52	-2.75	-5.7E-05
							10.8	4.418	-0.8	-3.6	-9	0.002961	-0.01779	24	0.3333	3.1885	1.29	0.00068
							21.4	2.837	-0.8	-1.7	0	0.000644	-0.0117	36	0.2163	2.6771	4.24	0.001041
							21.4	2.837	-1	-1.7	0	0.000644	-0.002379	60	0.0338	2.2955	3.6	0.00085
67455	4	1	AC	8.9	1758000	0.15	0	5.63	-92.6	-79.6	0	-0.003672	-0.002801	0	0	5.63	-90.96	-0.003672
		2	BASE	4.7	691200	0.2	8.9	5.388	36.7	-16.4	-3.9	0.001851	-0.001614	8	0.1972	5.1987	-14.59	-0.000368
		3	SUBBASE	35.3	40900	0.35	8.9	5.388	12	-16.4	-3.9	0.001851	-0.003022	12	0.2062	4.967	-2.33	-2.9E-05
		4	ROADBED	20	17400	0.45	13.6	5.285	26.2	-3.5	-1.7	0.003117	-0.002067	18	0.1986	4.7117	1.58	0.000233
							13.6	5.285	0.2	-3.5	-1.7	0.003117	-0.008797	24	0.1786	4.4871	5.38	0.000422
							48.9	4.089	-0.2	-0.7	0	0.000354	-0.001476	36	0.1152	4.1501	10.36	0.000556
							48.9	4.089	-0.5	-0.7	0	0.000354	-0.001697	60	0.0185	3.9015	8.29	0.000463
69049	4	1	AC	15	1700700	0.15	0	4.352	-72.4	-79.6	0	-0.002794	-0.003272	0	0	4.352	-70.74	-0.002794
		2	BASE	3.4	555900	0.2	15	4.018	24.5	-4.1	-1.1	0.001238	-0.000681	8	0.1418	3.9987	-5.36	3E-05
		3	SUBBASE	13.7	28600	0.35	15	4.018	7.6	-4.1	-1.1	0.001238	-0.001262	12	0.1393	3.8405	1.44	0.0001
		4	ROADBED	27.9	21100	0.45	18.4	3.98	11.7	-1.6	-0.6	0.001737	-0.001139	18	0.1341	3.7076	-0.34	9.6E-05
							18.4	3.98	-0.1	-1.6	-0.6	0.001737	-0.00531	24	0.1252	3.5877	2.1	0.000218
							32.1	3.508	-0.3	-0.9	0	0.000478	-0.002399	36	0.0877	3.4015	6.44	0.000371
							32.1	3.508	-0.5	-0.9	0	0.000478	-0.001889	60	0.0147	3.2563	6.36	0.000368

Mechanistic responses - West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
412002	4	1	AC	3.8	416300	0.3	0	10.29	-94.8	-79.6	0	-0.01095	-0.005976	0	0	10.29	-106.21	-0.01095
		2	BASE	8.4	413400	0.2	3.8	9.939	-21.8	-62	-7	0.000153	-0.01261	8	0.6107	8.7496	-25.3	-0.002359
		3	SUBBASE	36	13600	0.45	3.8	9.939	-15.9	-62	-7	0.000153	-0.01359	12	0.6777	7.9492	-8.34	-0.000807
		4	ROADBED	20	13900	0.45	12.2	9.268	50.7	-4.5	-3.7	0.009736	-0.006276	18	0.6796	7.1016	-3.02	0.00049
							12.2	9.268	-0.9	-4.5	-3.7	0.009736	-0.02419	24	0.6211	6.3417	2.63	0.00137
							48.2	5.634	-0.5	-1	0	0.001044	-0.003552	36	0.4053	5.2043	8.51	0.001918
							48.2	5.634	-0.5	-1	0	0.001044	-0.003607	60	0.0644	4.3633	7.52	0.001616
415005	4	1	AC	11.5	7554500	0.15	0	3.816	-99.4	-79.6	0	-0.000928	-0.000623	0	0	3.816	-97.54	-0.000928
		2	BASE	6	267800	0.2	11.5	3.754	64.8	-3.1	-2.7	0.000717	-0.000314	8	0.0519	3.7124	-21.81	-0.000166
		3	SUBBASE	30.3	10000	0.35	11.5	3.754	1.8	-3.1	-2.7	0.000717	-0.001206	12	0.057	3.654	-8.52	-7.3E-05
		4	ROADBED	20	34600	0.45	17.5	3.701	3	-0.9	-0.1	0.000946	-0.0008	18	0.0583	3.5835	-2.02	2E-05
							17.5	3.701	-0.4	-0.9	-0.1	0.000946	-0.006899	24	0.0546	3.5175	4.91	9.9E-05
							47.8	2.117	-0.4	-0.7	0	-0.000238	-0.00435	36	0.0371	3.414	13.25	0.000166
							47.8	2.117	-0.8	-0.7	0	-0.000238	-0.000177	60	0.0062	3.3333	11.87	0.000154
415005	4	1	AC	11.5	8210401	0.15	0	4.737	-95	-79.6	0	-0.000809	-0.00059	0	0	4.737	-93.14	-0.000809
		2	BASE	6.3	674600	0.2	11.5	4.68	55.9	-4.8	-2.7	0.000572	-0.000274	8	0.0447	4.6465	-19.12	-0.000127
		3	SUBBASE	23	6700	0.35	11.5	4.68	3.8	-4.8	-2.7	0.000572	-0.00085	12	0.0486	4.596	-6.88	-5.3E-05
		4	ROADBED	20	24500	0.45	17.8	4.644	6.5	-0.9	-0.3	0.000793	-0.000521	18	0.0494	4.5375	-1.84	1.7E-05
							17.8	4.644	-0.4	-0.9	-0.3	0.000793	-0.008723	24	0.0463	4.4832	4.27	8.2E-05
							40.8	2.98	-0.4	-0.7	0	-0.000364	-0.006368	36	0.0319	4.3967	12.04	0.00014
							40.8	2.98	-0.8	-0.7	0	-0.000364	-0.000191	60	0.0053	4.3285	11.15	0.000133
533011	4	1	AC	10	1643200	0.15	0	9.012	-114.9	-79.6	0	-0.005091	-0.002579	0	0	9.012	-113.61	-0.005091
		2	BASE	13.1	15100	0.35	10	8.758	87.5	-3.6	-6	0.00446	-0.001899	8	0.2884	8.4518	-27.73	-0.001025
		3	SUBBASE	36	14600	0.35	10	8.758	-0.4	-3.6	-6	0.00446	-0.0161	12	0.3188	8.1082	-10.41	-0.000385
		4	ROADBED	20	15200	0.35	23.1	7.29	-0.4	-1.5	0	0.001878	-0.008148	18	0.3195	7.6688	0.48	0.000256
							23.1	7.29	-0.4	-1.5	0	0.001878	-0.008388	24	0.2906	7.2659	8.02	0.000662
							59.1	5.437	-0.4	-0.8	0	-3E-06	-0.003229	36	0.1863	6.6533	16.26	0.000917
							59.1	5.437	-0.4	-0.8	0	-3E-06	-0.003089	60	0.0299	6.197	12.53	0.000748
533812	4	1	AC	8.7	4665000	0.15	0	7.446	-145.6	-79.6	0	-0.002336	-0.000696	0	0	7.446	-143.79	-0.002336
		2	BASE	3.4	12100	0.35	8.7	7.368	123.5	-2.6	-3.8	0.002207	-0.000898	8	0.1359	7.1923	-43.5	-0.000622
		3	SUBBASE	4.2	19600	0.35	8.7	7.368	-0.5	-2.6	-3.8	0.002207	-0.01146	12	0.1548	7.0205	-18.74	-0.000258
		4	ROADBED	43.7	14800	0.35	12.1	7.017	-0.6	-1.5	0	0.001272	-0.009188	18	0.157	6.7784	-0.03	0.00011
							12.1	7.017	-0.4	-1.5	0	0.001272	-0.00621	24	0.1434	6.5551	11.19	0.000325
							16.3	6.775	-0.3	-1.3	0	0.001179	-0.005407	36	0.0912	6.2125	23.36	0.000457
							16.3	6.775	-0.4	-1.3	0	0.001179	-0.006737	60	0.0147	5.9555	17.56	0.000369

Mechanistic responses - West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
536049	4	1	AC	10.4	1528100	0.3	0	6.861	-120.7	-79.6	0	-0.003864	-0.000256	0	0	6.861	-126.67	-0.003864
		2	BASE	3.8	42500	0.35	10.4	6.599	79.4	-5.3	-2	0.003671	-0.003592	8	0.2211	6.3544	-35.41	-0.001009
		3	SUBBASE	15.5	42900	0.35	10.4	6.599	0	-5.3	-2	0.003671	-0.01062	12	0.2507	6.0623	-14.19	-0.000386
		4	ROADBED	30.3	14300	0.45	14.2	6.264	-0.1	-3.2	-0.1	0.002507	-0.007344	18	0.2534	5.7133	-4.12	0.000177
							14.2	6.264	0	-3.2	-0.1	0.002507	-0.007338	24	0.2317	5.398	3.56	0.000507
							29.7	5.55	0.5	-1.1	0	0.001696	-0.003476	36	0.1514	4.9228	11.75	0.000715
							29.7	5.55	-0.5	-1.1	0	0.001696	-0.004887	60	0.0244	4.5688	10.46	0.000611
562017	4	1	AC	2.9	947200	0.3	0	4.481	-83.5	-79.6	0	-0.003827	-0.003198	0	0	4.481	-90.19	-0.003827
		2	BASE	10.4	1290200	0.2	2.9	4.36	-40.8	-70.9	-5.8	-0.000892	-0.005177	8	0.2207	3.9379	-20.13	-0.000846
		3	SUBBASE	36	23400	0.45	2.9	4.36	-34.4	-70.9	-5.8	-0.000892	-0.004478	12	0.2473	3.6728	-7.71	-0.000412
		4	ROADBED	20	26800	0.45	13.3	4.087	51.2	-3.2	-3.2	0.00307	-0.001971	18	0.2562	3.4013	-3.78	6.5E-05
							13.3	4.087	-0.8	-3.2	-3.2	0.00307	-0.008002	24	0.24	3.1463	1.41	0.00044
							49.3	2.808	-0.6	-0.9	0	0.000223	-0.001313	36	0.1634	2.7506	7.15	0.000726
							49.3	2.808	-0.6	-0.9	0	0.000223	-0.001218	60	0.0267	2.4458	7.01	0.000669
562019	4	1	AC	4.5	3007000	0.3	0	3.588	-163.2	-79.6	0	-0.003063	0.000646	0	0	3.588	-179.59	-0.003063
		2	BASE	11.3	468400	0.2	4.5	3.53	77	-40.6	-13.5	0.00226	-0.002789	8	0.1502	3.1476	-30.76	-0.000207
		3	SUBBASE	23.6	56700	0.35	4.5	3.53	3.5	-40.6	-13.5	0.00226	-0.008612	12	0.1493	2.8898	2.65	0.000287
		4	ROADBED	20.6	39400	0.35	15.8	3.078	15	-4.1	-0.7	0.002649	-0.002127	18	0.1252	2.6204	6.77	0.000376
							15.8	3.078	0.3	-4.1	-0.7	0.002649	-0.007173	24	0.1054	2.4181	4.75	0.000324
							39.4	2.262	-0.1	-1.1	0	0.000518	-0.001748	36	0.0647	2.1443	11	0.000331
							39.4	2.262	-0.3	-1.1	0	0.000518	-0.002277	60	0.0104	1.956	8.8	0.00026
811803	4	1	AC	4.1	1898600	0.3	0	12.51	-368.6	-79.6	0	-0.01265	0.007537	0	0	12.51	-416.7	-0.01265
		2	BASE	11.2	14800	0.35	4.1	12.42	346.3	-17.5	-39.5	0.01327	-0.01161	8	0.637	10.5332	-96.25	-0.001485
		3	SUBBASE	36	49400	0.35	4.1	12.42	-3.4	-17.5	-39.5	0.01327	-0.06436	12	0.6451	9.1313	1.72	0.001441
		4	ROADBED	20	17500	0.35	15.3	7.047	-2.9	-6.5	-0.1	0.002654	-0.03009	18	0.4907	7.3899	48.57	0.002721
							15.3	7.047	-1.5	-6.5	-0.1	0.002654	-0.01104	24	0.3496	6.1473	31.02	0.00212
							51.3	5.068	0.4	-1.1	0	0.001215	-0.002721	36	0.1322	4.7721	31.36	0.001274
							51.3	5.068	-0.2	-1.1	0	0.001215	-0.005089	60	0.0154	4.1335	8.85	0.0004
811804	4	1	AC	3.4	1086200	0.3	0	22.56	-433.7	-79.6	0	-0.02604	0.01746	0	0	22.56	-502.98	-0.02604
		2	BASE	14	12300	0.35	3.4	22.44	400	-28.3	-49.3	0.02649	-0.0246	8	1.2403	18.0338	-97.15	-0.001529
		3	SUBBASE	8.5	42500	0.35	3.4	22.44	-4.7	-28.3	-49.3	0.02649	-0.1184	12	1.2	14.9175	21.01	0.004185
		4	ROADBED	34.1	10900	0.45	17.4	11.94	-2.7	-6.2	-0.2	0.003367	-0.03482	18	0.844	11.2992	61.43	0.005608
							17.4	11.94	-1.2	-6.2	-0.2	0.003367	-0.01273	24	0.5825	8.8783	28.33	0.003669
							25.9	10.87	4.1	-3.1	-0.2	0.008712	-0.01405	36	0.2256	6.2835	29.46	0.002079
							25.9	10.87	-0.8	-3.1	-0.2	0.008712	-0.02177	60	0.0294	5.071	9.7	0.000752

Mechanistic responses - West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
821005	4	1	AC	4	2060700	0.3	0	11.68	-372.1	-79.6	0	-0.01177	0.007069	0	0	11.68	-420.26	-0.01177
		2	BASE	10.7	24300	0.35	4	11.61	341.5	-19.7	-40	0.01209	-0.01068	8	0.592	9.8354	-96.99	-0.001389
		3	SUBBASE	12.3	31700	0.35	4	11.61	-3.2	-19.7	-40	0.01209	-0.04956	12	0.6016	8.522	-0.79	0.001231
		4	ROADBED	33	20000	0.35	14.7	7.912	-1.1	-6.2	-0.2	0.005912	-0.02215	18	0.4682	6.8836	43.35	0.002338
							14.7	7.912	-0.4	-6.2	-0.2	0.005912	-0.01849	24	0.347	5.6872	27.38	0.001845
							27	6.275	0.6	-2.8	-0.1	0.004285	-0.01009	36	0.1502	4.286	32.32	0.00123
							27	6.275	-0.2	-2.8	-0.1	0.004285	-0.0133	60	0.0203	3.547	12.31	0.000516
821005	4	1	AC	3.6	1722200	0.3	0	13.28	-397.7	-79.6	0	-0.01494	0.009675	0	0	13.28	-460.15	-0.01494
		2	BASE	8	19000	0.35	3.6	13.2	366.8	-25.4	-34.8	0.01532	-0.01423	8	0.7201	10.7695	-93.3	-0.001058
		3	SUBBASE	12	42100	0.35	3.6	13.2	-4.7	-25.4	-34.8	0.01532	-0.07206	12	0.7024	9.0303	16.11	0.002295
		4	ROADBED	36.4	20400	0.35	11.6	8.769	-3.6	-9.5	-0.2	0.005311	-0.0365	18	0.5021	7.0033	54.41	0.003197
							11.6	8.769	-1.7	-9.5	-0.2	0.005311	-0.01968	24	0.35	5.6327	27.02	0.002154
							23.6	7.004	1.8	-3.8	-0.1	0.005846	-0.01198	36	0.1389	4.1453	27.67	0.00124
							23.6	7.004	-0.1	-3.8	-0.1	0.005846	-0.0178	60	0.0183	3.4318	9.54	0.000467
826006	4	1	AC	5.2	1233000	0.3	0	16.77	-262.3	-79.6	0	-0.01332	0.006204	0	0	16.77	-295.95	-0.01332
		2	BASE	8	10500	0.35	5.2	16.6	239.9	-13.7	-17.5	0.01425	-0.01231	8	0.7101	14.9011	-82.78	-0.002485
		3	SUBBASE	40	33900	0.35	5.2	16.6	-2.8	-13.7	-17.5	0.01425	-0.07098	12	0.7536	13.5725	-13.44	0.000712
		4	ROADBED	20	9200	0.35	13.2	12.04	-2.9	-6.3	-0.1	0.003237	-0.04051	18	0.6274	11.8558	24.37	0.002533
							13.2	12.04	-1.7	-6.3	-0.1	0.003237	-0.01491	24	0.4789	10.5517	23.44	0.002406
							53.2	9.178	0.4	-0.9	0	0.001493	-0.003343	36	0.2122	8.9606	26.19	0.00169
							53.2	9.178	-0.3	-0.9	0	0.001493	-0.007599	60	0.0271	8.1065	9.94	0.000694

Mechanistic responses - South West Region.

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
11001	3	1	AC	3.6	750500	0.31	0	11.84	-239.2	-79.6	0	-0.01909	0.009645	0	0	11.84	-278.59	-0.01909
		2	BASE	6.4	59600	0.35	3.6	11.66	171.1	-40.8	-17.4	0.01724	-0.01978	8	0.8625	8.7003	-38.03	0.000144
		3	ROADBED	50	26900	0.45	3.6	11.66	-4.3	-40.8	-17.4	0.01724	-0.0574	12	0.791	6.8008	21.41	0.003662
							10	8.976	8.2	-13.5	-1.2	0.01657	-0.03219	18	0.5354	4.8965	26.87	0.003628
							10	8.976	-2.4	-13.5	-1.2	0.01657	-0.04088	24	0.3729	3.6935	11.32	0.002216
														36	0.1636	2.4028	11.64	0.001267
														60	0.0223	1.7345	5.02	0.000567
11019	3	1	AC	6.7	709200	0.32	0	10.62	-165.4	-79.6	0	-0.01197	0.004604	0	0	10.62	-178.26	-0.01197
		2	BASE	5.9	51800	0.35	6.7	10.25	118.6	-17	-6.8	0.01192	-0.01357	8	0.6504	9.0023	-47.42	-0.002436
		3	ROADBED	47.4	20000	0.35	6.7	10.25	1.5	-17	-6.8	0.01192	-0.03091	12	0.7023	7.9685	-10.49	0.000158
							12.6	8.881	5.4	-6.4	-0.5	0.01095	-0.01957	18	0.6239	6.7162	6.46	0.001752
							12.6	8.881	0.2	-6.4	-0.5	0.01095	-0.03155	24	0.5109	5.7171	9.75	0.001948
														36	0.2758	4.4048	14.1	0.001685
														60	0.0398	3.571	8.3	0.001007
14126	4	1	AC	13.6	861200	0.3	0	5.293	-92.4	-79.6	0	-0.004531	-0.002481	0	0	5.293	-96.46	-0.004531
		2	BASE	18.2	30000	0.35	13.6	4.723	44.1	-4.6	-2.1	0.00366	-0.003652	8	0.2424	4.5971	-18.78	-0.000684
		3	SUBBASE	36	88700	0.35	13.6	4.723	-0.4	-4.6	-2.1	0.00366	-0.01228	12	0.2602	4.2645	-4.2	-0.000155
		4	ROADBED	20	27200	0.35	31.8	3.332	-0.9	-1.9	0	0.000396	-0.004359	18	0.2563	3.9544	-2.12	0.000211
							31.8	3.332	-0.5	-1.9	0	0.000396	-0.001771	24	0.234	3.6818	1.97	0.000517
							67.8	2.957	-0.2	-0.7	0	0.000138	-0.000656	36	0.1528	3.2819	6.6	0.000723
							67.8	2.957	-0.3	-0.7	0	0.000138	-0.001757	60	0.024	2.9905	5.8	0.000604
15008	4	1	AC	9.2	3967300	0.15	0	4.908	-104.1	-79.6	0	-0.001866	-0.001147	0	0	4.908	-102.21	-0.001866
		2	BASE	5.9	682600	0.3	9.2	4.803	58.3	-11.5	-4	0.001252	-0.000762	8	0.103	4.6962	-21.29	-0.000296
		3	SUBBASE	8.1	49600	0.35	9.2	4.803	7.6	-11.5	-4	0.001252	-0.002266	12	0.1113	4.5742	-6.31	-8.6E-05
		4	ROADBED	36.8	21100	0.35	15.1	4.703	15.9	-2.1	-0.5	0.001712	-0.001715	18	0.11	4.4281	0.53	9.3E-05
							15.1	4.703	0.3	-2.1	-0.5	0.001712	-0.004304	24	0.1006	4.2957	5.97	0.000215
							23.2	4.442	0.3	-1.1	0	0.001132	-0.002647	36	0.0663	4.0925	13.06	0.00031
							23.2	4.442	-0.2	-1.1	0	0.001132	-0.004597	60	0.0109	3.938	11.02	0.000272
16019	4	1	AC	11.8	590300	0.34	0	7.599	-102.4	-79.6	0	-0.006575	-0.001136	0	0	7.599	-111.43	-0.006575
		2	BASE	4.6	16700	0.35	11.8	6.858	55.2	-6.6	-1.3	0.006407	-0.007757	8	0.3586	6.54	-25.17	-0.001428
		3	SUBBASE	36	53700	0.35	11.8	6.858	-1.5	-6.6	-1.3	0.006407	-0.02877	12	0.3951	6.0063	-5.92	-0.000282
		4	ROADBED	20	19100	0.35	16.4	5.748	-2.1	-4.6	0	0.001647	-0.01899	18	0.3807	5.4778	-1.23	0.000536
							16.4	5.748	-1.2	-4.6	0	0.001647	-0.00711	24	0.3344	5.0322	3.15	0.000946
							52.4	4.452	0.1	-0.9	0	0.000703	-0.001849	36	0.2027	4.4118	7.06	0.001063
							52.4	4.452	-0.3	-0.9	0	0.000703	-0.003709	60	0.0301	3.9907	5.27	0.000761

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
53058	4	1	AC	6.3	834300	0.35	0	9.587	-143.1	-79.6	0	-0.007667	0.003138	0	0	9.587	-159.57	-0.007667
		2	BASE	7.5	164800	0.35	6.3	9.306	72	-27.5	-6.8	0.006686	-0.009631	8	0.4067	8.4627	-37.45	-0.001383
		3	SUBBASE	36	28400	0.35	6.3	9.306	3.2	-27.5	-6.8	0.006686	-0.017	12	0.4342	7.8043	-6.62	0.000171
		4	ROADBED	20	14800	0.35	13.8	8.442	16	-5.7	-0.9	0.007436	-0.01034	18	0.3874	7.0758	2.94	0.000972
							13.8	8.442	0.4	-5.7	-0.9	0.007436	-0.0203	24	0.3258	6.5007	5.29	0.001077
							49.8	5.753	-0.1	-0.9	0	0.000842	-0.002826	36	0.1908	5.7276	10.04	0.001036
							49.8	5.753	-0.3	-0.9	0	0.000842	-0.004698	60	0.0291	5.2097	7.32	0.000733
53071	4	1	AC	5.7	1488000	0.3	0	8.327	-124.4	-79.6	0	-0.004312	-0.000336	0	0	8.327	-136.12	-0.004312
		2	BASE	10.8	393900	0.35	5.7	8.168	45.6	-36.4	-7.7	0.003011	-0.00403	8	0.2221	7.7158	-27.52	-0.000536
		3	SUBBASE	36	29500	0.45	5.7	8.168	-0.6	-36.4	-7.7	0.003011	-0.008803	12	0.2306	7.3763	-2.63	0.000169
		4	ROADBED	20	10600	0.45	16.5	7.625	20.1	-3	-0.8	0.003479	-0.004342	18	0.2076	7.0233	1.66	0.000417
							16.5	7.625	-0.3	-3	-0.8	0.003479	-0.008308	24	0.1819	6.7425	3.14	0.000466
							52.5	6.54	-0.4	-0.7	0	0.000284	-0.001057	36	0.1176	6.3459	8.84	0.000555
							52.5	6.54	-0.5	-0.7	0	0.000284	-0.002123	60	0.0193	6.0577	8.07	0.000482
53074	4	1	AC	10.2	1347400	0.15	0	8.008	-97.7	-79.6	0	-0.005126	-0.003546	0	0	8.008	-96.3	-0.005126
		2	BASE	6.8	135100	0.2	10.2	7.677	57.8	-8.4	-3.7	0.00365	-0.001989	8	0.2808	7.4202	-17.96	-0.000682
		3	SUBBASE	36	15000	0.45	10.2	7.677	4.3	-8.4	-3.7	0.00365	-0.007028	12	0.2996	7.0933	-4.8	-0.000176
		4	ROADBED	20	12200	0.45	17	7.37	7.2	-2	-0.4	0.004488	-0.003596	18	0.2945	6.7139	0.79	0.000272
							17	7.37	-0.4	-2	-0.4	0.004488	-0.01103	24	0.2679	6.3731	5.7	0.000593
							53	5.859	-0.6	-0.7	0	7.5E-05	-0.001355	36	0.1751	5.8544	11.86	0.000829
							53	5.859	-0.6	-0.7	0	7.5E-05	-0.001684	60	0.0285	5.4643	9.78	0.000712
54021	4	1	AC	9.6	5953000	0.15	0	4.537	-127	-79.6	0	-0.001562	-0.000641	0	0	4.537	-124.73	-0.001562
		2	BASE	4	21700	0.35	9.6	4.47	101.6	-2.6	-3.1	0.001417	-0.00059	8	0.0901	4.3682	-35.5	-0.000387
		3	SUBBASE	4.3	21900	0.35	9.6	4.47	-0.4	-2.6	-3.1	0.001417	-0.006413	12	0.1018	4.259	-15.05	-0.000164
		4	ROADBED	42.1	24400	0.35	13.6	4.24	-0.4	-1.4	0	0.000991	-0.00517	18	0.1038	4.1117	-0.97	6E-05
							13.6	4.24	-0.4	-1.4	0	0.000991	-0.005137	24	0.0954	3.976	8.76	0.000204
							17.9	4.04	-0.5	-1.2	0	0.000643	-0.004225	36	0.062	3.7647	19.32	0.0003
							17.9	4.04	-0.4	-1.2	0	0.000643	-0.003862	60	0.0101	3.6045	15.32	0.000252
123995	4	1	AC	5.1	728300	0.35	0	9.71	-168.5	-79.6	0	-0.01154	0.005412	0	0	9.71	-199.17	-0.01154
		2	BASE	13.4	91000	0.35	5.1	9.458	97.9	-33.2	-11.2	0.01063	-0.01348	8	0.5794	7.9855	-42.71	-0.001379
		3	SUBBASE	12	8800	0.35	5.1	9.458	-1.4	-33.2	-11.2	0.01063	-0.03234	12	0.5914	6.95	-1.62	0.000979
		4	ROADBED	29.5	24500	0.35	18.5	7.211	12	-3.2	-0.3	0.009568	-0.01276	18	0.4908	5.8329	7.53	0.001665
							18.5	7.211	-0.3	-3.2	-0.3	0.009568	-0.03185	24	0.4015	5.0071	5.75	0.001419
							30.5	4.466	-0.8	-1.9	0	0.001594	-0.015	36	0.2348	3.9363	10.79	0.001264
							30.5	4.466	-0.4	-1.9	0	0.001594	-0.006541	60	0.0369	3.2258	8.2	0.000927

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
123997	4	1	AC	3.1	1215000	0.3	0	24.8	-480.3	-79.6	0	-0.02603	0.01813	0	0	24.8	-558.99	-0.02603
		2	BASE	12.3	12300	0.35	3.1	24.7	446.1	-30.9	-58.4	0.02645	-0.02463	8	1.1911	20.0174	-88.38	-0.000413
		3	SUBBASE	14	51400	0.35	3.1	24.7	-5.7	-30.9	-58.4	0.02645	-0.1275	12	1.1095	16.815	40.52	0.005029
		4	ROADBED	30.6	9200	0.35	15.4	14.01	-4.1	-8.2	-0.2	0.002181	-0.04365	18	0.7224	13.2842	75.7	0.005797
							15.4	14.01	-2.8	-8.2	-0.2	0.002181	-0.01229	24	0.4702	11.0808	27.14	0.003337
							29.4	12.58	4.6	-2.3	-0.2	0.007347	-0.0109	36	0.1669	8.8659	26.54	0.00168
							29.4	12.58	-0.2	-2.3	-0.2	0.007347	-0.02357	60	0.0214	7.9285	7.89	0.000547
124057	4	1	AC	13.2	4080100	0.15	0	2.967	-86.5	-79.6	0	-0.001455	-0.001255	0	0	2.967	-84.76	-0.001455
		2	BASE	7.8	41000	0.35	13.2	2.843	50.7	-2.4	-2.3	0.001043	-0.00044	8	0.0786	2.7983	-14.05	-0.000157
		3	SUBBASE	36	41000	0.35	13.2	2.843	-0.3	-2.4	-2.3	0.001043	-0.003966	12	0.0831	2.7103	-3.81	-5.1E-05
		4	ROADBED	20	40900	0.35	21	2.593	-0.4	-1.3	0	0.000539	-0.002618	18	0.0832	2.618	-1.01	4.2E-05
							21	2.593	-0.4	-1.3	0	0.000539	-0.00263	24	0.0775	2.5328	3.84	0.000145
							57	2.005	-0.4	-0.7	0	-3.2E-05	-0.001071	36	0.0527	2.3989	10.04	0.000235
							57	2.005	-0.4	-0.7	0	-3.2E-05	-0.001066	60	0.0087	2.2953	9.02	0.000217
124099	4	1	AC	3.6	526800	0.3	0	10.21	-182.2	-79.6	0	-0.02017	0.006085	0	0	10.21	-208.78	-0.02017
		2	BASE	10.6	56700	0.35	3.6	9.905	119.8	-48.1	-17.7	0.01833	-0.02286	8	0.8352	6.8487	-11.97	0.002199
		3	SUBBASE	10	59300	0.35	3.6	9.905	-8.3	-48.1	-17.7	0.01833	-0.06873	12	0.6887	5.0523	28.77	0.005135
		4	ROADBED	35.8	38100	0.35	14.2	5.54	0.4	-12.4	-0.5	0.007702	-0.02235	18	0.3938	3.6152	19.77	0.003596
							14.2	5.54	0.4	-12.4	-0.5	0.007702	-0.02131	24	0.2562	2.8658	4.77	0.001644
							24.2	4.111	1.6	-4.9	-0.2	0.004598	-0.01008	36	0.1233	2.1573	4.6	0.000805
							24.2	4.111	0.2	-4.9	-0.2	0.004598	-0.01297	60	0.0188	1.7893	2.84	0.000475
124136	4	1	AC	2.7	1302800	0.3	0	12.7	-358.8	-79.6	0	-0.01776	0.01115	0	0	12.7	-416.32	-0.01776
		2	BASE	9.3	54400	0.35	2.7	12.62	279.2	-49.2	-48.4	0.01611	-0.01686	8	0.7351	9.3275	-30.11	0.001461
		3	SUBBASE	11.5	31300	0.35	2.7	12.62	-9.4	-49.2	-48.4	0.01611	-0.06487	12	0.6281	7.339	48.9	0.004004
		4	ROADBED	36.5	25500	0.35	12	8.619	5.8	-11.9	-0.7	0.01409	-0.02947	18	0.3832	5.4808	43.28	0.003151
							12	8.619	0.5	-11.9	-0.7	0.01409	-0.03877	24	0.2612	4.4035	9.21	0.001541
							23.5	5.844	0.6	-4.3	-0.1	0.006046	-0.01507	36	0.1209	3.2796	14.06	0.000891
							23.5	5.844	0.1	-4.3	-0.1	0.006046	-0.01717	60	0.0176	2.7048	6.67	0.000446
124138	4	1	AC	8	5327200	0.15	0	5.114	-141.7	-79.6	0	-0.001993	-0.000635	0	0	5.114	-140.43	-0.001993
		2	BASE	4.8	454600	0.2	8	5.048	105	-8.5	-6.3	0.001664	-0.000779	8	0.1147	4.8945	-39.55	-0.000483
		3	SUBBASE	36	14700	0.35	8	5.048	7.6	-8.5	-6.3	0.001664	-0.002359	12	0.129	4.7468	-16	-0.000186
		4	ROADBED	20	26700	0.35	12.8	4.966	14.2	-1.6	-0.8	0.00255	-0.00162	18	0.1297	4.5441	0.7	0.000103
							12.8	4.966	-0.2	-1.6	-0.8	0.00255	-0.009443	24	0.1181	4.3569	10.43	0.000268
							48.8	3.13	-0.4	-0.8	0	-0.000104	-0.003151	36	0.0754	4.0702	21.9	0.000375
							48.8	3.13	-0.5	-0.8	0	-0.000104	-0.001695	60	0.0122	3.8558	16.63	0.000306

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
131004	3	1	AC	7.1	1264600	0.3	0	10.24	-186.3	-79.6	0	-0.0082	0.003069	0	0	10.24	-197.01	-0.0082
		2	BASE	7.1	41800	0.35	7.1	10.02	148.9	-10.6	-8	0.008316	-0.008165	8	0.4702	9.2093	-65.2	-0.00234
		3	ROADBED	45.8	12900	0.45	7.1	10.02	1	-10.6	-8	0.008316	-0.02108	12	0.5339	8.498	-25.28	-0.000604
							14.2	8.913	3.6	-3.1	-0.2	0.008203	-0.01358	18	0.5158	7.534	-0.46	0.000785
							14.2	8.913	-0.6	-3.1	-0.2	0.008203	-0.02013	24	0.4508	6.6938	9.92	0.001299
														36	0.2688	5.4789	21.22	0.001458
														60	0.0417	4.6245	15.06	0.001048
131005	4	1	AC	7.8	1227800	0.3	0	10.68	-167.3	-79.6	0	-0.007328	0.002201	0	0	10.68	-176.08	-0.007328
		2	BASE	9.3	14100	0.35	7.8	10.43	136.4	-8.4	-7.3	0.007765	-0.00758	8	0.4183	9.7547	-56.24	-0.002027
		3	SUBBASE	36	39500	0.45	7.8	10.43	-1.3	-8.4	-7.3	0.007765	-0.03318	12	0.4719	9.135	-19.98	-0.000436
		4	ROADBED	20	10400	0.45	17.1	8.055	-1.5	-3.6	0	0.001976	-0.01802	18	0.4486	8.3237	1.77	0.000828
							17.1	8.055	-1.6	-3.6	0	0.001976	-0.0056	24	0.3834	7.629	10.48	0.001254
							53.1	6.889	0.1	-0.8	0	0.0009	-0.002079	36	0.217	6.6615	18.02	0.001264
							53.1	6.889	-0.5	-0.8	0	0.0009	-0.003417	60	0.0318	6.015	11.26	0.000804
131005	4	1	AC	7.5	1106600	0.3	0	10.2	-167.1	-79.6	0	-0.008138	0.002434	0	0	10.2	-176.07	-0.008138
		2	BASE	8.8	24600	0.35	7.5	9.922	133.4	-10.3	-7.5	0.008495	-0.008426	8	0.4585	9.1518	-53.48	-0.00207
		3	SUBBASE	36	27500	0.45	7.5	9.922	-0.9	-10.3	-7.5	0.008495	-0.02862	12	0.5109	8.462	-17.09	-0.00031
		4	ROADBED	20	11900	0.45	16.3	8.105	-0.5	-4	-0.1	0.004354	-0.01478	18	0.4767	7.5748	3.49	0.001004
							16.3	8.105	-1.1	-4	-0.1	0.004354	-0.01102	24	0.4029	6.8292	10.53	0.001374
							52.3	6.206	-0.2	-0.8	0	0.001	-0.002518	36	0.2254	5.8071	17.04	0.001327
							52.3	6.206	-0.5	-0.8	0	0.001	-0.003511	60	0.0331	5.1303	10.52	0.000836
133015	4	1	AC	9.9	3256400	0.15	0	3.29	-110.6	-79.6	0	-0.002427	-0.001326	0	0	3.29	-108.15	-0.002427
		2	BASE	7	33200	0.2	9.9	3.161	82.4	-5	-4.1	0.002102	-0.000966	8	0.1349	3.0167	-24.41	-0.000433
		3	SUBBASE	36	103000	0.35	9.9	3.161	-0.1	-5	-4.1	0.002102	-0.01161	12	0.1467	2.853	-6.78	-0.000104
		4	ROADBED	20	40000	0.35	16.9	2.499	-0.5	-2.8	0	0.000445	-0.007666	18	0.1425	2.6521	2.79	0.000182
							16.9	2.499	-0.8	-2.8	0	0.000445	-0.002135	24	0.1264	2.4747	8.56	0.000337
							52.9	2.066	-0.1	-0.8	0	0.000186	-0.000695	36	0.0774	2.2133	14.31	0.000405
							52.9	2.066	-0.3	-0.8	0	0.000186	-0.001439	60	0.012	2.0285	10	0.000301
133017	4	1	AC	9.9	2872600	0.15	0	7.736	-96.2	-79.6	0	-0.002337	-0.001666	0	0	7.736	-94.03	-0.002337
		2	BASE	6.4	515300	0.2	9.9	7.581	50.1	-10.8	-3.4	0.001482	-0.000947	8	0.1276	7.4668	-18.1	-0.000327
		3	SUBBASE	36	21700	0.35	9.9	7.581	7.1	-10.8	-3.4	0.001482	-0.002521	12	0.1367	7.3182	-4.88	-8.9E-05
		4	ROADBED	20	12900	0.35	16.3	7.478	13.5	-1.7	-0.7	0.002145	-0.001393	18	0.1352	7.148	0.08	0.000105
							16.3	7.478	-0.2	-1.7	-0.7	0.002145	-0.007127	24	0.1241	6.9937	5.05	0.000256
							52.3	6.242	-0.4	-0.7	0	-7E-06	-0.001944	36	0.0827	6.7561	11.53	0.00038
							52.3	6.242	-0.4	-0.7	0	-7E-06	-0.003288	60	0.0136	6.5737	9.96	0.00034

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
133018	4	1	AC	9.9	2159100	0.15	0	4.884	-96	-79.6	0	-0.003101	-0.002222	0	0	4.884	-93.8	-0.003101
		2	BASE	5.3	514200	0.2	9.9	4.678	47.3	-10.7	-3.2	0.001867	-0.00122	8	0.17	4.5286	-18.43	-0.000449
		3	SUBBASE	36	16500	0.45	9.9	4.678	9.5	-10.7	-3.2	0.001867	-0.002736	12	0.1827	4.331	-5.42	-0.00014
		4	ROADBED	20	20900	0.45	15.2	4.577	18.3	-1.7	-1	0.002892	-0.001776	18	0.182	4.1049	-0.38	0.000122
							15.2	4.577	-0.5	-1.7	-1	0.002892	-0.007539	24	0.1679	3.8981	4.91	0.000336
							51.2	3.474	-0.6	-0.8	0	-4.9E-05	-0.001083	36	0.1125	3.5773	11.69	0.000514
							51.2	3.474	-0.6	-0.8	0	-4.9E-05	-0.000868	60	0.0186	3.3308	10.2	0.000463
133020	4	1	AC	10.1	2253100	0.15	0	4.58	-97.6	-79.6	0	-0.003067	-0.002122	0	0	4.58	-96.32	-0.003067
		2	BASE	6.3	233400	0.2	10.1	4.383	57.9	-8.6	-3.6	0.002188	-0.001205	8	0.1676	4.2277	-17.61	-0.000394
		3	SUBBASE	36	32300	0.45	10.1	4.383	4.4	-8.6	-3.6	0.002188	-0.004224	12	0.1782	4.031	-4.37	-8.8E-05
		4	ROADBED	20	21300	0.45	16.4	4.206	7.2	-2.3	-0.4	0.002649	-0.002244	18	0.1742	3.8044	1.21	0.000178
							16.4	4.206	-0.3	-2.3	-0.4	0.002649	-0.006372	24	0.1575	3.6023	5.9	0.000362
							52.4	3.353	-0.5	-0.7	0	0.000123	-0.000776	36	0.102	3.2962	11.74	0.00049
							52.4	3.353	-0.5	-0.7	0	0.000123	-0.0011	60	0.0165	3.068	9.47	0.000412
134111	3	1	AC	8.4	825800	0.3	0	10.6	-145.7	-79.6	0	-0.009247	0.001448	0	0	10.6	-153.51	-0.009247
		2	BASE	8.5	34900	0.35	8.4	10.2	106.1	-9.3	-6	0.009118	-0.009058	8	0.5283	9.4288	-45.93	-0.002461
		3	ROADBED	43.1	12400	0.45	8.4	10.2	0.8	-9.3	-6	0.009118	-0.0235	12	0.5965	8.6858	-17.32	-0.000702
							16.9	8.82	2.6	-2.8	-0.2	0.007607	-0.01319	18	0.5829	7.7392	-1.52	0.000758
							16.9	8.82	-0.5	-2.8	-0.2	0.007607	-0.01861	24	0.5159	6.9113	6.56	0.00138
														36	0.3176	5.7032	15.08	0.001637
														60	0.0497	4.838	11.61	0.001249
134112	3	1	AC	15.7	651100	0.35	0	5.442	-90.5	-79.6	0	-0.004522	-0.002059	0	0	5.442	-99.49	-0.004522
		2	BASE	36	22700	0.35	15.7	4.665	35.3	-3.1	-1.6	0.003635	-0.004339	8	0.2416	4.6109	-19.43	-0.000912
		3	ROADBED	20	31300	0.35	15.7	4.665	-0.2	-3.1	-1.6	0.003635	-0.01158	12	0.2668	4.2398	-4.19	-0.000319
							51.7	2.748	-0.4	-0.9	0	0.000149	-0.002556	18	0.2727	3.9247	-3.99	4.4E-05
							51.7	2.748	-0.4	-0.9	0	0.000149	-0.001924	24	0.2588	3.646	-0.03	0.000416
														36	0.1817	3.2219	5.22	0.000768
														60	0.0301	2.8973	5.77	0.000752
134112	4	1	AC	16	722300	0.35	0	7.088	-90.3	-79.6	0	-0.004107	-0.001891	0	0	7.088	-99.26	-0.004107
		2	BASE	36	20100	0.35	16	6.381	35.3	-2.7	-1.6	0.003271	-0.003855	8	0.2195	6.3382	-18.61	-0.000777
		3	SUBBASE	36	23500	0.35	16	6.381	-0.2	-2.7	-1.6	0.003271	-0.01094	12	0.2413	6.0048	-4.14	-0.000292
		4	ROADBED	20	22100	0.35	52	4.406	-0.4	-0.9	0	0.000271	-0.003121	18	0.2479	5.7227	-4.2	1.6E-05
							52	4.406	-0.4	-0.9	0	0.000271	-0.002749	24	0.2366	5.4716	-0.2	0.000361
							88	3.65	-0.4	-0.7	0	-0.000157	-0.001628	36	0.1677	5.0857	5.24	0.000699
							88	3.65	-0.4	-0.7	0	-0.000157	-0.001729	60	0.028	4.7875	5.92	0.000699

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
223056	4	1	AC	10.1	1290100	0.3	0	5.658	-106.2	-79.6	0	-0.003803	-0.001003	0	0	5.658	-111.35	-0.003803
		2	BASE	7.5	179100	0.2	10.1	5.347	52.7	-11.3	-3.1	0.003054	-0.003431	8	0.209	5.1201	-24.97	-0.000711
		3	SUBBASE	36	31400	0.35	10.1	5.347	4.3	-11.3	-3.1	0.003054	-0.006832	12	0.228	4.836	-7.21	-0.000174
		4	ROADBED	20	23100	0.35	17.6	5.027	6.9	-2.9	-0.4	0.003349	-0.003162	18	0.2232	4.5329	-1.78	0.000236
							17.6	5.027	0.1	-2.9	-0.4	0.003349	-0.009437	24	0.2012	4.2678	2.98	0.000472
							53.6	3.597	-0.3	-0.8	0	0.000218	-0.001791	36	0.1302	3.8803	8.54	0.00062
							53.6	3.597	-0.4	-0.8	0	0.000218	-0.002381	60	0.0208	3.5953	7.5	0.000522
282807	4	1	AC	10.5	2284600	0.3	0	4.488	-125.8	-79.6	0	-0.002737	-3.5E-05	0	0	4.488	-132.01	-0.002737
		2	BASE	6.7	18200	0.2	10.5	4.312	87.7	-3.9	-3.2	0.002684	-0.002549	8	0.1588	4.1372	-39.52	-0.000786
		3	SUBBASE	36	42600	0.45	10.5	4.312	-0.1	-3.9	-3.2	0.002684	-0.01495	12	0.1825	3.9303	-17.27	-0.000334
		4	ROADBED	20	24500	0.45	17.2	3.476	-0.3	-2	0	0.0009	-0.01045	18	0.1872	3.6725	-5.52	9.7E-05
							17.2	3.476	-1	-2	0	0.0009	-0.002717	24	0.1724	3.437	3.6	0.000363
							53.2	2.93	-0.5	-0.8	0	0.000173	-0.000768	36	0.1131	3.0766	13.17	0.000534
							53.2	2.93	-0.5	-0.8	0	0.000173	-0.001091	60	0.0182	2.8047	11.69	0.000456
283018	4	1	AC	9	6645000	0.15	0	4.332	-129.1	-79.6	0	-0.001429	-0.000565	0	0	4.332	-127.11	-0.001429
		2	BASE	5.8	69600	0.2	9	4.275	103.5	-4.7	-5.1	0.001299	-0.000565	8	0.0813	4.1751	-33.55	-0.000318
		3	SUBBASE	36	69600	0.35	9	4.275	0.3	-4.7	-5.1	0.001299	-0.005245	12	0.0905	4.0728	-11.99	-0.000105
		4	ROADBED	20	22900	0.35	14.8	4.032	0.1	-2.3	-0.1	0.000815	-0.003411	18	0.0896	3.9381	2.23	9.4E-05
							14.8	4.032	-0.4	-2.3	-0.1	0.000815	-0.002974	24	0.0803	3.8174	10.17	0.000201
							50.8	3.506	-0.2	-0.7	0	0.000154	-0.000801	36	0.05	3.6354	18.64	0.000257
							50.8	3.506	-0.3	-0.7	0	0.000154	-0.002068	60	0.0079	3.5028	13.48	0.000199
283019	4	1	AC	9.2	1155400	0.15	0	11.02	-117.9	-79.6	0	-0.007393	-0.003547	0	0	11.02	-115.76	-0.007393
		2	BASE	5.9	12700	0.2	9.2	10.67	91.4	-5.8	-4.5	0.0066	-0.003027	8	0.4107	10.178	-26.09	-0.001309
		3	SUBBASE	36	37800	0.35	9.2	10.67	-0.1	-5.8	-4.5	0.0066	-0.03669	12	0.4449	9.6712	-6.42	-0.000235
		4	ROADBED	20	11000	0.35	15.1	8.883	-0.6	-3.4	0	0.001585	-0.0249	18	0.4249	9.0303	4.76	0.000676
							15.1	8.883	-0.9	-3.4	0	0.001585	-0.007289	24	0.3703	8.4727	10.05	0.001087
							51.1	7.485	0	-0.8	0	0.00077	-0.002189	36	0.2192	7.6752	15.23	0.001205
							51.1	7.485	-0.3	-0.8	0	0.00077	-0.005311	60	0.0333	7.1248	9.88	0.000838
283081	4	1	AC	9.4	1296800	0.3	0	6.832	-134.6	-79.6	0	-0.005258	0.000391	0	0	6.832	-141.35	-0.005258
		2	BASE	5.6	27200	0.2	9.4	6.548	96.9	-6.2	-3.4	0.005234	-0.005131	8	0.3027	6.1591	-42.87	-0.001476
		3	SUBBASE	36	25400	0.45	9.4	6.548	0.6	-6.2	-3.4	0.005234	-0.01874	12	0.3449	5.7468	-17.05	-0.000502
		4	ROADBED	20	17700	0.45	15	5.72	0.5	-3.1	-0.1	0.003575	-0.01191	18	0.3434	5.2298	-3.13	0.000347
							15	5.72	-0.9	-3.1	-0.1	0.003575	-0.009119	24	0.3079	4.7687	5.44	0.000771
							51	4.205	-0.4	-0.8	0	0.000503	-0.001716	36	0.193	4.0893	13.94	0.000972
							51	4.205	-0.5	-0.8	0	0.000503	-0.002087	60	0.0302	3.5957	11.09	0.000759

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
283090	4	1	AC	2.4	2180500	0.3	0	11.87	-435.1	-79.6	0	-0.01312	0.008902	0	0	11.87	-505.18	-0.01312
		2	BASE	5.1	93100	0.2	2.4	11.84	316.9	-50.7	-49.5	0.0109	-0.0114	8	0.5544	9.2462	-46.72	0.000708
		3	SUBBASE	16.8	36400	0.35	2.4	11.84	1.5	-50.7	-49.5	0.0109	-0.04845	12	0.4914	7.6438	46.45	0.002569
		4	ROADBED	35.7	21600	0.35	7.5	10.11	16	-17.4	-2	0.01729	-0.02563	18	0.3246	6.0342	50.64	0.00227
							7.5	10.11	0.5	-17.4	-2	0.01729	-0.0487	24	0.2321	5.0276	12.69	0.001239
							24.3	6.194	1.4	-3.4	-0.1	0.005557	-0.01175	36	0.1097	3.9093	21.69	0.000803
							24.3	6.194	0.1	-3.4	-0.1	0.005557	-0.01581	60	0.016	3.3188	10.18	0.000405
283090	4	1	AC	2.6	2041600	0.3	0	15.17	-540.2	-79.6	0	-0.01763	0.01279	0	0	15.17	-631.04	-0.01763
		2	BASE	5.7	27500	0.2	2.6	15.13	476.7	-38.3	-61.5	0.01698	-0.01623	8	0.7561	11.645	-68.67	0.000698
		3	SUBBASE	15.9	35400	0.35	2.6	15.13	-1.3	-38.3	-61.5	0.01698	-0.1012	12	0.6726	9.3973	62.19	0.003746
		4	ROADBED	35.8	19400	0.35	8.3	10.81	0.3	-15.2	-0.6	0.01177	-0.05525	18	0.4164	7.0917	79.46	0.00355
							8.3	10.81	-1.8	-15.2	-0.6	0.01177	-0.03943	24	0.2754	5.7163	18.35	0.001788
							24.2	7.205	1.7	-3.7	-0.1	0.006592	-0.01373	36	0.1132	4.3137	25.19	0.000971
							24.2	7.205	0	-3.7	-0.1	0.006592	-0.0191	60	0.0159	3.6618	9.61	0.000404
283091	3	1	AC	11.3	1136000	0.3	0	7.234	-107.5	-79.6	0	-0.004363	-0.001055	0	0	7.234	-112.52	-0.004363
		2	BASE	36	39800	0.35	11.3	6.855	63	-5.6	-4.2	0.003942	-0.003961	8	0.2432	6.6262	-27.62	-0.000958
		3	ROADBED	20	16100	0.35	11.3	6.855	-0.1	-5.6	-4.2	0.003942	-0.01198	12	0.27	6.301	-9.11	-0.000301
							47.3	5.191	-0.1	-0.9	0	0.000623	-0.001972	18	0.2683	5.9448	-2.56	0.000241
							47.3	5.191	-0.3	-0.9	0	0.000623	-0.00392	24	0.2428	5.6302	3.24	0.000569
														36	0.1559	5.1658	9.23	0.000755
														60	0.0246	4.8278	7.85	0.000617
285006	4	1	AC	8.3	5213200	0.15	0	2.463	-133.8	-79.6	0	-0.001903	-0.000694	0	0	2.463	-132.17	-0.001903
		2	BASE	8.5	139800	0.2	8.3	2.393	105.6	-7.5	-7.8	0.001701	-0.00078	8	0.1072	2.2503	-33.03	-0.00039
		3	SUBBASE	5.8	46700	0.2	8.3	2.393	1.4	-7.5	-7.8	0.001701	-0.004901	12	0.118	2.1113	-10.13	-0.0001
		4	ROADBED	37.4	48800	0.45	16.8	2.124	2.1	-2.4	-0.1	0.001532	-0.002287	18	0.1144	1.93	4.3	0.000154
							16.8	2.124	0.3	-2.4	-0.1	0.001532	-0.005297	24	0.1012	1.7688	10.91	0.000271
							22.6	1.866	0.2	-1.7	0	0.000975	-0.003745	36	0.0618	1.5323	18.61	0.000326
							22.6	1.866	-0.5	-1.7	0	0.000975	-0.002546	60	0.0098	1.3623	13.01	0.000245
285803	4	1	AC	8	6295100	0.15	0	4.075	-156.9	-79.6	0	-0.001888	-0.00046	0	0	4.075	-155.48	-0.001888
		2	BASE	6.5	80700	0.2	8	4.021	133.9	-4.7	-8.4	0.001782	-0.00074	8	0.1092	3.8672	-46.4	-0.00049
		3	SUBBASE	36	19100	0.35	8	4.021	1	-4.7	-8.4	0.001782	-0.004717	12	0.1238	3.7235	-18.78	-0.000183
		4	ROADBED	20	37000	0.35	14.5	3.796	1.7	-1.7	-0.1	0.002056	-0.002876	18	0.1239	3.5193	2.09	0.000116
							14.5	3.796	-0.3	-1.7	-0.1	0.002056	-0.007636	24	0.1116	3.3335	12.95	0.000273
							50.5	2.282	-0.5	-0.8	0	-5.6E-05	-0.002532	36	0.0695	3.0516	25.11	0.00036
							50.5	2.282	-0.5	-0.8	0	-5.6E-05	-0.001285	60	0.0111	2.8448	17.89	0.000278

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
285803	4	1	AC	7.8	7262700	0.15	0	4.27	-171.9	-79.6	0	-0.001783	-0.000308	0	0	4.27	-168.26	-0.001783
		2	BASE	6.1	26700	0.2	7.8	4.224	151.2	-3.9	-7.7	0.00173	-0.000716	8	0.1042	4.073	-54.93	-0.000516
		3	SUBBASE	36	14200	0.35	7.8	4.224	0.1	-3.9	-7.7	0.00173	-0.007512	12	0.1196	3.9325	-23.21	-0.000201
		4	ROADBED	20	41700	0.35	13.9	3.844	0.2	-1.4	0	0.001617	-0.005438	18	0.1206	3.7281	1.42	0.000102
							13.9	3.844	-0.4	-1.4	0	0.001617	-0.0078	24	0.109	3.5409	14.49	0.000264
							49.9	2.044	-0.5	-0.8	0	-0.000116	-0.003412	36	0.0677	3.2559	28.52	0.000353
							49.9	2.044	-0.5	-0.8	0	-0.000116	-0.001081	60	0.0108	3.0463	20.12	0.000271
351005	4	1	AC	8.8	597100	0.35	0	8.953	-126.8	-79.6	0	-0.00889	0.00226	0	0	8.953	-140.69	-0.00889
		2	BASE	8.1	23000	0.35	8.8	8.37	86.1	-11.5	-4.2	0.009791	-0.01236	8	0.4836	7.624	-34.31	-0.001883
		3	SUBBASE	36	61800	0.35	8.8	8.37	-1.7	-11.5	-4.2	0.009791	-0.03652	12	0.5238	6.867	-6.43	9.7E-05
		4	ROADBED	20	17900	0.35	16.9	6.185	-2.4	-5.9	-0.1	0.002098	-0.01794	18	0.4637	6.042	4.27	0.001394
							16.9	6.185	-1.2	-5.9	-0.1	0.002098	-0.008137	24	0.3711	5.3993	7.45	0.001593
							52.9	4.782	0.4	-1	0	0.000892	-0.001955	36	0.1865	4.6018	9.03	0.001245
							52.9	4.782	-0.3	-1	0	0.000892	-0.004217	60	0.024	4.1385	4.42	0.000617
352118	4	1	AC	11.2	939700	0.3	0	6.273	-117.3	-79.6	0	-0.005998	-0.00064	0	0	6.273	-122.84	-0.005998
		2	BASE	6.9	10000	0.35	11.2	5.824	77.1	-3.6	-2.7	0.005733	-0.005475	8	0.345	5.4849	-35.06	-0.001645
		3	SUBBASE	11.7	9800	0.35	11.2	5.824	-0.5	-3.6	-2.7	0.005733	-0.02269	12	0.3945	5.0353	-14.75	-0.000703
		4	ROADBED	30.2	34700	0.35	18.1	4.506	-0.5	-2	0	0.003688	-0.01636	18	0.4053	4.5009	-5.34	0.000179
							18.1	4.506	-0.5	-2	0	0.003688	-0.01665	24	0.3751	4.0118	2.89	0.000761
							29.8	2.95	-0.7	-1.5	0	0.00049	-0.009899	36	0.2487	3.2608	11.64	0.001155
							29.8	2.95	-0.5	-1.5	0	0.00049	-0.00318	60	0.0401	2.6925	10.58	0.001005
353010	4	1	AC	7.9	2776800	0.15	0	7.385	-142.5	-79.6	0	-0.003777	-0.001145	0	0	7.385	-138.95	-0.003777
		2	BASE	6.6	99200	0.35	7.9	7.259	112.7	-8.7	-6.6	0.003393	-0.001608	8	0.2128	6.9594	-36.7	-0.00083
		3	SUBBASE	36	26300	0.35	7.9	7.259	1.4	-8.7	-6.6	0.003393	-0.008086	12	0.2354	6.6762	-10.9	-0.000198
		4	ROADBED	20	15900	0.35	14.5	6.855	3.8	-2.8	-0.2	0.003485	-0.005566	18	0.2271	6.3001	5.13	0.000327
							14.5	6.855	-0.1	-2.8	-0.2	0.003485	-0.01046	24	0.1999	5.9694	11.99	0.000554
							50.5	5.198	-0.3	-0.8	0	0.00032	-0.002183	36	0.1205	5.4844	19.82	0.000648
							50.5	5.198	-0.3	-0.8	0	0.00032	-0.003403	60	0.0189	5.1397	13.42	0.000473
356033	4	1	AC	2.3	455200	0.35	0	22.83	-221.5	-79.6	0	-0.02637	0.01738	0	0	22.83	-264.08	-0.02637
		2	BASE	3.9	172100	0.35	2.3	22.83	15.3	-63.2	-18.5	0.006805	-0.01721	8	1.2649	18.3713	-44.79	-0.001308
		3	SUBBASE	11.4	22900	0.35	2.3	22.83	-16.5	-63.2	-18.5	0.006805	-0.02996	12	1.2373	15.7	4.32	0.003061
		4	ROADBED	42.4	10200	0.35	6.2	21.49	77.2	-22.7	-7.4	0.0336	-0.04545	18	0.98	12.8758	15.12	0.004174
							6.2	21.49	0.7	-22.7	-7.4	0.0336	-0.09381	24	0.7644	10.8642	9.5	0.003315
							17.6	15.54	3.8	-5	-0.3	0.01791	-0.03291	36	0.4013	8.4389	13.81	0.0025
							17.6	15.54	0.3	-5	-0.3	0.01791	-0.05	60	0.0589	6.989	8.13	0.001491

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
356033	4	1	AC	2.7	458800	0.35	0	18.72	-195.6	-79.6	0	-0.02243	0.01305	0	0	18.72	-235.68	-0.02243
		2	BASE	4.5	156100	0.35	2.7	18.64	32	-60.4	-14.8	0.008864	-0.01895	8	1.0705	14.9955	-39.5	-0.001098
		3	SUBBASE	12	26100	0.35	2.7	18.64	-11.5	-60.4	-14.8	0.008864	-0.03331	12	1.0462	12.82	4.2	0.00257
		4	ROADBED	40.8	12200	0.35	7.2	17.18	55.3	-19.9	-4.9	0.02726	-0.03819	18	0.8353	10.5765	11.59	0.00337
							7.2	17.18	1.1	-19.9	-4.9	0.02726	-0.07437	24	0.6592	8.9883	7.85	0.002745
							19.2	12.31	3.1	-4.5	-0.2	0.01331	-0.02485	36	0.3539	7.0431	11.84	0.002141
							19.2	12.31	0.2	-4.5	-0.2	0.01331	-0.03714	60	0.0523	5.8633	7.31	0.001322
401015	4	1	AC	1.3	855700	0.3	0	7.998	-120.1	-79.6	0	-0.007178	-0.000385	0	0	7.998	-124.41	-0.007178
		2	BASE	8.1	1121500	0.3	1.3	7.971	-83	-77.1	-8.7	-0.004104	-0.003048	8	0.4225	7.1312	-35.17	-0.002005
		3	SUBBASE	36	12600	0.35	1.3	7.971	-102.5	-77.1	-8.7	-0.004104	-0.00114	12	0.4842	6.5922	-16.57	-0.000866
		4	ROADBED	20	26500	0.35	9.4	7.659	110.9	-5.1	-7.8	0.006856	-0.006637	18	0.4917	5.8865	-3.19	0.000389
							9.4	7.659	-0.5	-5.1	-7.8	0.006856	-0.02457	24	0.4458	5.2425	4.74	0.001046
							45.4	3.42	-0.5	-1.1	0	0.000335	-0.005507	36	0.283	4.2708	13.18	0.001409
							45.4	3.42	-0.4	-1.1	0	0.000335	-0.002854	60	0.0449	3.5533	10.54	0.001126
401015	4	1	AC	1.3	708300	0.3	0	10.54	-147.7	-79.6	0	-0.01141	0.001913	0	0	10.54	-153.53	-0.01141
		2	BASE	8.1	543900	0.3	1.3	10.52	-88.7	-77.2	-12.7	-0.005513	-0.003205	8	0.6515	9.0074	-40.16	-0.002528
		3	SUBBASE	36	11500	0.35	1.3	10.52	-79.3	-77.2	-12.7	-0.005513	-0.005114	12	0.7259	8.077	-17.34	-0.000892
		4	ROADBED	20	25600	0.35	9.4	9.862	93.3	-6.3	-6.6	0.01198	-0.0119	18	0.718	6.9297	-1.62	0.000829
							9.4	9.862	-0.4	-6.3	-6.6	0.01198	-0.03939	24	0.6397	5.9218	6.75	0.001658
							45.4	3.674	-0.6	-1.2	0	0.000617	-0.007046	36	0.3963	4.447	15.75	0.002035
							45.4	3.674	-0.4	-1.2	0	0.000617	-0.003621	60	0.0614	3.3933	11.96	0.001545
401017	3	1	AC	9.8	295200	0.35	0	14.02	-126.1	-79.6	0	-0.0177	0.004326	0	0	14.02	-139.66	-0.0177
		2	BASE	36	9800	0.35	9.8	12.76	82.8	-7.7	-5.4	0.01861	-0.02296	8	1.0088	11.454	-40.44	-0.005232
		3	ROADBED	20	25600	0.35	9.8	12.76	-0.4	-7.7	-5.4	0.01861	-0.05923	12	1.1527	9.9695	-14.11	-0.001512
							45.8	3.829	-0.6	-1.4	0	0.000865	-0.009359	18	1.1289	8.2457	-2.64	0.00148
							45.8	3.829	-0.4	-1.4	0	0.000865	-0.004291	24	0.9939	6.7568	4.48	0.002783
														36	0.6024	4.6385	10.81	0.003166
														60	0.0907	3.1653	8.13	0.002288
404086	3	1	AC	12.3	319300	0.33	0	15.06	-102.1	-79.6	0	-0.01278	-0.00291	0	0	15.06	-109.76	-0.01278
		2	BASE	36	13000	0.35	12.3	13.66	53.3	-5.3	-3.2	0.01154	-0.01296	8	0.7066	13.092	-25.02	-0.002805
		3	ROADBED	20	10100	0.35	12.3	13.66	-0.1	-5.3	-3.2	0.01154	-0.03497	12	0.7853	12.105	-7.63	-0.000929
							48.3	8.608	-0.3	-1	0	0.00121	-0.005791	18	0.7865	11.0908	-3.25	0.000577
							48.3	8.608	-0.3	-1	0	0.00121	-0.007211	24	0.7186	10.2014	2.01	0.001586
														36	0.4694	8.8846	7.64	0.002216
														60	0.0743	7.9215	6.86	0.001865

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
404088	4	1	AC	4.6	864600	0.32	0	15	-209.1	-79.6	0	-0.0138	0.00642	0	0	15	-236.74	-0.0138
		2	BASE	7.7	105400	0.35	4.6	14.82	125.6	-32.9	-14.4	0.01137	-0.01271	8	0.7149	13.0295	-57.75	-0.002124
		3	SUBBASE	6.2	11600	0.2	4.6	14.82	1.9	-32.9	-14.4	0.01137	-0.03043	12	0.7518	11.745	-9.97	0.00056
		4	ROADBED	41.5	10000	0.45	12.3	13.19	23.7	-5.1	-0.7	0.01607	-0.02085	18	0.6595	10.1862	7.15	0.001749
							12.3	13.19	1.1	-5.1	-0.7	0.01607	-0.04569	24	0.5554	8.9401	8.56	0.001802
							18.5	11.04	0.8	-2.8	-0.1	0.00999	-0.02672	36	0.3249	7.2364	18.3	0.001796
							18.5	11.04	-0.5	-2.8	-0.1	0.00999	-0.0242	60	0.051	6.0768	12.89	0.001279
404157	3	1	AC	9.1	3908500	0.15	0	15.21	-126.1	-79.6	0	-0.002367	-0.000987	0	0	15.21	-124.2	-0.002367
		2	BASE	3.7	402400	0.35	9.1	15.11	89.7	-5.6	-3.7	0.001921	-0.000875	8	0.1365	14.9472	-34.83	-0.000576
		3	ROADBED	47.2	6400	0.35	9.1	15.11	9.2	-5.6	-3.7	0.001921	-0.002855	12	0.1541	14.78	-15.08	-0.000252
							12.8	15	16.1	-1.2	-0.7	0.002704	-0.003138	18	0.1577	14.5658	-1.6	7.6E-05
							12.8	15	-0.3	-1.2	-0.7	0.002704	-0.01342	24	0.1459	14.3567	8.08	0.000295
														36	0.0963	14.0317	19.2	0.000455
														60	0.0158	13.78	15.77	0.000396
404165	4	1	AC	2.5	598000	0.3	0	11.98	-165.1	-79.6	0	-0.01577	0.003233	0	0	11.98	-179.65	-0.01577
		2	BASE	5.1	538100	0.3	2.5	11.94	-44.2	-64.5	-14.9	-0.002205	-0.006927	8	0.8812	9.9409	-50.12	-0.003555
		3	SUBBASE	36	12200	0.35	2.5	11.94	-45.8	-64.5	-14.9	-0.002205	-0.006701	12	0.9704	8.605	-15.65	-0.000455
		4	ROADBED	20	34000	0.35	7.6	11.42	127.3	-8.9	-11.5	0.01687	-0.01635	18	0.9017	6.8933	4.54	0.001965
							7.6	11.42	-0.7	-8.9	-11.5	0.01687	-0.05623	24	0.7598	5.4609	10.89	0.002627
							43.6	2.994	-0.7	-1.5	0	0.000838	-0.008454	36	0.4212	3.5024	17.47	0.002523
							43.6	2.994	-0.4	-1.5	0	0.000838	-0.003736	60	0.0611	2.2205	10.37	0.001547
404165	4	1	AC	2.9	608800	0.3	0	10.48	-134.5	-79.6	0	-0.01198	3.8E-05	0	0	10.48	-147.63	-0.01198
		2	BASE	5.6	556400	0.3	2.9	10.36	-30.7	-63.7	-11.4	-0.000704	-0.007982	8	0.6617	8.8923	-37.37	-0.002426
		3	SUBBASE	36	20600	0.35	2.9	10.36	-34.1	-63.7	-11.4	-0.000704	-0.007666	12	0.7205	7.9285	-10.15	-0.00022
		4	ROADBED	20	20200	0.35	8.5	9.875	94.7	-9.4	-8.1	0.01225	-0.0123	18	0.6681	6.7748	3.16	0.001435
							8.5	9.875	-0.4	-9.4	-8.1	0.01225	-0.03835	24	0.5644	5.819	8.06	0.001915
							44.5	4.672	-0.3	-1.3	0	0.001301	-0.005125	36	0.3183	4.5193	12.8	0.001849
							44.5	4.672	-0.3	-1.3	0	0.001301	-0.005367	60	0.0463	3.6648	7.99	0.001173
407024	4	1	AC	2.5	424400	0.35	0	14.4	-53.9	-79.6	0	-0.001852	-0.009982	0	0	14.4	-57.14	-0.001852
		2	BASE	1.3	614800	0.3	2.5	14.14	-45.9	-77.6	-1.6	-0.000745	-0.01097	8	0.158	13.8118	-12.35	-0.001393
		3	SUBBASE	8.1	4318800	0.15	2.5	14.14	-39.8	-77.6	-1.6	-0.000745	-0.008689	12	0.2099	13.585	-5.78	-0.001089
		4	ROADBED	48.1	7100	0.35	3.8	14.03	-42.3	-71.8	-2.9	-0.001293	-0.007552	18	0.248	13.4067	-3.21	-0.000182
							3.8	14.03	-81	-71.8	-2.9	-0.001293	-0.001062	24	0.2385	13.1833	0.36	0.000387
							11.9	13.97	103	-1.4	-9.6	0.001978	-0.000814	36	0.1626	12.835	3.29	0.000725
							11.9	13.97	-0.4	-1.4	-9.6	0.001978	-0.01243	60	0.0264	12.5675	3.24	0.000661

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
451008	4	1	AC	4	582800	0.3	0	18.84	-254.4	-79.6	0	-0.0271	0.01287	0	0	18.84	-284.52	-0.0271
		2	BASE	9.6	35500	0.35	4	18.58	188.5	-33	-24.9	0.02483	-0.02448	8	1.3011	14.6968	-49.47	-0.001513
		3	SUBBASE	36	9400	0.35	4	18.58	-2.6	-33	-24.9	0.02483	-0.07926	12	1.269	12.03	9.92	0.003626
		4	ROADBED	20	27100	0.35	13.6	13.73	10.6	-6.7	-0.6	0.02533	-0.03985	18	0.9666	9.0329	24.08	0.004723
							13.6	13.73	0.3	-6.7	-0.6	0.02533	-0.07117	24	0.7359	6.9191	12.72	0.003428
							49.6	3.591	-0.6	-1.4	0	0.000834	-0.009443	36	0.3675	4.3722	17.45	0.00249
							49.6	3.591	-0.4	-1.4	0	0.000834	-0.00402	60	0.0534	2.8863	8.97	0.001352
451011	3	1	AC	3.3	797900	0.32	0	17.76	-328.7	-79.6	0	-0.02526	0.01736	0	0	17.76	-392.49	-0.02526
		2	BASE	9.7	27900	0.35	3.3	17.61	272	-38.4	-34.1	0.02463	-0.02674	8	1.1273	13.3406	-54.41	0.000351
		3	ROADBED	47	19600	0.35	3.3	17.61	-6.2	-38.4	-34.1	0.02463	-0.09498	12	1.0232	10.574	32.1	0.005204
							13	11.49	1.9	-10.1	-0.5	0.01662	-0.04092	18	0.6594	7.747	43.21	0.00512
							13	11.49	-0.1	-10.1	-0.5	0.01662	-0.04972	24	0.4406	6.0238	14.85	0.002866
														36	0.1812	4.2637	15.36	0.001514
														60	0.0246	3.424	6.02	0.000627
451024	3	1	AC	1.6	1074300	0.3	0	30.73	-648.1	-79.6	0	-0.04131	0.03187	0	0	30.73	-738.94	-0.04131
		2	BASE	4.6	26100	0.35	1.6	30.68	517.7	-74.7	-155.5	0.03649	-0.03666	8	1.4221	19.878	10.48	0.006768
		3	ROADBED	53.8	14500	0.45	1.6	30.68	-16.9	-74.7	-155.5	0.03649	-0.1772	12	1.0907	14	108.41	0.009829
							6.2	23.94	5.8	-27.3	-2.4	0.05028	-0.1188	18	0.5537	9.1072	78.69	0.006484
							6.2	23.94	-7.6	-27.3	-2.4	0.05028	-0.1328	24	0.3366	6.6248	4.64	0.002493
														36	0.132	4.2274	15.99	0.001218
														60	0.0181	3.1577	5.63	0.000461
455017	4	1	AC	8.8	3426400	0.15	0	3.764	-103.9	-79.6	0	-0.002163	-0.001333	0	0	3.764	-102.29	-0.002163
		2	BASE	5.6	796400	0.2	8.8	3.644	53.2	-13.8	-4.4	0.001341	-0.000902	8	0.1193	3.5173	-20.95	-0.000334
		3	SUBBASE	36	27100	0.35	8.8	3.644	10.1	-13.8	-4.4	0.001341	-0.00218	12	0.1287	3.375	-6.21	-9.7E-05
		4	ROADBED	20	35500	0.35	14.4	3.562	21	-2	-1.2	0.00214	-0.001329	18	0.1272	3.2051	0.56	0.000109
							14.4	3.562	-0.1	-2	-1.2	0.00214	-0.006944	24	0.1161	3.0497	6.04	0.000251
							50.4	2.36	-0.4	-0.8	0	9E-06	-0.001807	36	0.0763	2.8134	13.15	0.00036
							50.4	2.36	-0.4	-0.8	0	9E-06	-0.001397	60	0.0125	2.634	10.88	0.000312
455017	4	1	AC	9	4913900	0.15	0	4.779	-118	-79.6	0	-0.001745	-0.000838	0	0	4.779	-116.14	-0.001745
		2	BASE	6.1	498100	0.2	9	4.698	78.1	-8.8	-4.9	0.001341	-0.000685	8	0.0989	4.5863	-29.3	-0.000368
		3	SUBBASE	36	10400	0.35	9	4.698	6.4	-8.8	-4.9	0.001341	-0.002114	12	0.1098	4.4665	-11.28	-0.000143
		4	ROADBED	20	34400	0.35	15.1	4.614	12.2	-1.2	-0.6	0.00199	-0.001241	18	0.1108	4.3118	-0.51	7.1E-05
							15.1	4.614	-0.3	-1.2	-0.6	0.00199	-0.009375	24	0.102	4.1685	7.26	0.000211
							51.1	2.449	-0.5	-0.8	0	-0.000203	-0.004392	36	0.0672	3.9474	16.75	0.000317
							51.1	2.449	-0.5	-0.8	0	-0.000203	-0.001177	60	0.0111	3.7773	13.84	0.000276

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
455034	4	1	AC	8.5	1977900	0.15	0	6.588	-125	-79.6	0	-0.004637	-0.001964	0	0	6.588	-123.23	-0.004637
		2	BASE	4.9	44100	0.2	8.5	6.399	97.9	-7.6	-4.8	0.004154	-0.001952	8	0.2566	6.0614	-27.37	-0.000798
		3	SUBBASE	36	44600	0.35	8.5	6.399	0.7	-7.6	-4.8	0.004154	-0.0154	12	0.2767	5.731	-5.86	-9.6E-05
		4	ROADBED	20	19000	0.35	13.4	5.798	0.4	-4.2	-0.1	0.002701	-0.009887	18	0.2607	5.315	6.42	0.000476
							13.4	5.798	-0.4	-4.2	-0.1	0.002701	-0.008804	24	0.2246	4.9578	11.01	0.000693
							49.4	4.41	-0.1	-0.9	0	0.000538	-0.001773	36	0.1308	4.4524	15.97	0.000735
							49.4	4.41	-0.3	-0.9	0	0.000538	-0.003362	60	0.0198	4.1078	10.07	0.000499
457019	4	1	AC	2.6	819200	0.3	0	7.336	-78.8	-79.6	0	-0.003967	-0.003984	0	0	7.336	-82.99	-0.003967
		2	BASE	7	3001900	0.15	2.6	7.218	-54.3	-72	-8.6	-0.002086	-0.005062	8	0.2525	6.8298	-24.4	-0.001468
		3	SUBBASE	36	25500	0.35	2.6	7.218	-89.4	-72	-8.6	-0.002086	-0.001442	12	0.2991	6.5495	-11.05	-0.000711
		4	ROADBED	20	16300	0.35	9.6	7.126	117.6	-4	-12.3	0.003265	-0.001417	18	0.3095	6.1933	-2.41	0.000213
							9.6	7.126	-0.5	-4	-12.3	0.003265	-0.01192	24	0.2801	5.8565	3.18	0.000685
							45.6	5.164	-0.3	-0.9	0	0.000497	-0.002628	36	0.1746	5.3476	8.05	0.000891
							45.6	5.164	-0.3	-0.9	0	0.000497	-0.003809	60	0.0273	4.9755	6.22	0.000685
457019	4	1	AC	2.7	808200	0.3	0	9.022	-100.6	-79.6	0	-0.005975	-0.002466	0	0	9.022	-107.57	-0.005975
		2	BASE	6.8	1478500	0.15	2.7	8.923	-54.1	-69.2	-9.1	-0.002267	-0.004854	8	0.359	8.2917	-31.25	-0.001811
		3	SUBBASE	36	26900	0.35	2.7	8.923	-53.8	-69.2	-9.1	-0.002267	-0.003528	12	0.4129	7.8648	-12.85	-0.000697
		4	ROADBED	20	13900	0.35	9.5	8.743	93.7	-5.5	-9.7	0.005313	-0.002447	18	0.4135	7.33	-1.71	0.000445
							9.5	8.743	-0.5	-5.5	-9.7	0.005313	-0.01751	24	0.3676	6.8465	4.81	0.000981
							45.5	6.172	-0.1	-0.9	0	0.000904	-0.003095	36	0.2248	6.1357	10.49	0.001174
							45.5	6.172	-0.3	-0.9	0	0.000904	-0.005103	60	0.0346	5.6293	7.81	0.00087
472008	4	1	AC	10.7	1273200	0.3	0	3.175	-87.6	-79.6	0	-0.002825	-0.001926	0	0	3.175	-91.53	-0.002825
		2	BASE	7.3	739600	0.2	10.7	2.836	16	-16.5	-2.3	0.001238	-0.002115	8	0.1483	2.7251	-15.31	-0.00031
		3	SUBBASE	36	22200	0.45	10.7	2.836	7.5	-16.5	-2.3	0.001238	-0.002598	12	0.1562	2.5205	-2.77	-6.7E-05
		4	ROADBED	20	40700	0.45	18	2.721	19.9	-1.8	-1	0.00218	-0.001341	18	0.1557	2.344	-2.9	6.3E-05
							18	2.721	-0.5	-1.8	-1	0.00218	-0.005725	24	0.1467	2.1878	0.5	0.000241
							54	1.826	-0.7	-0.8	0	-1.8E-05	-0.000896	36	0.1033	1.9481	5.58	0.000433
							54	1.826	-0.7	-0.8	0	-1.8E-05	-0.000493	60	0.0174	1.7612	6.12	0.000433
473075	4	1	AC	4.2	1185900	0.31	0	34.17	-357	-79.6	0	-0.01915	0.0121	0	0	34.17	-406.82	-0.01915
		2	BASE	10.3	21200	0.35	4.2	34.05	316.6	-19.9	-34.3	0.01927	-0.01784	8	0.9984	31.2562	-110.3	-0.003209
		3	SUBBASE	36	7600	0.35	4.2	34.05	-1.7	-19.9	-34.3	0.01927	-0.06396	12	1.0532	29.1375	-19.83	0.001007
		4	ROADBED	20	4000	0.35	14.5	29.6	4.1	-4.4	-0.3	0.01941	-0.03416	18	0.888	26.3592	27.19	0.003192
							14.5	29.6	0	-4.4	-0.3	0.01941	-0.05661	24	0.7064	24.1708	23.68	0.002992
							50.5	21.15	-0.2	-0.9	0	0.002587	-0.009849	36	0.3532	21.3583	36.79	0.002443
							50.5	21.15	-0.3	-0.9	0	0.002587	-0.01628	60	0.0518	19.6625	18.15	0.001307

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF (mil)	STRESS (psi) RADIAL	STRESS (psi) VERT	STRESS (psi) SHR	STRAIN RADIAL	STRAIN VERT		RADIAL DISPL	DEFLECTI (mil)	RADIAL STRESS	RADIAL STRAIN
473110	3	1	AC	9.6	501100	0.31	0	7.566	-111.3	-79.6	0	-0.01	-0.0014	0	0	7.566	-117.56	-0.01
		2	BASE	36	34200	0.45	9.6	6.793	66.2	-10.6	-5.2	0.009449	-0.01063	8	0.5402	6.1136	-26.31	-0.001775
		3	ROADBED	20	23300	0.45	9.6	6.793	-1.8	-10.6	-5.2	0.009449	-0.0232	12	0.5791	5.326	-4.79	3.3E-05
							45.6	3.598	-0.1	-1.2	0	0.001373	-0.003132	18	0.5287	4.4932	2.31	0.001231
							45.6	3.598	-0.4	-1.2	0	0.001373	-0.003668	24	0.442	3.8186	5.59	0.001567
														36	0.247	2.9252	8.1	0.001435
														60	0.0354	2.3475	5.12	0.000898
476022	4	1	AC	6.2	413200	0.33	0	11.44	-114.8	-79.6	0	-0.01201	-0.000104	0	0	11.44	-123.76	-0.01201
		2	BASE	6.2	241800	0.2	6.2	10.87	16.6	-36.3	-5.8	0.005639	-0.01167	8	0.6599	9.6774	-28.8	-0.002488
		3	SUBBASE	6.8	14700	0.35	6.2	10.87	8.1	-36.3	-5.8	0.005639	-0.01611	12	0.7258	8.7252	-8.5	-0.000597
		4	ROADBED	40.8	13100	0.45	12.4	10.25	37.6	-5.2	-1.7	0.01269	-0.008504	18	0.7091	7.6927	-2.37	0.000775
							12.4	10.25	0.2	-5.2	-1.7	0.01269	-0.03471	24	0.6382	6.7996	2.76	0.001522
							19.2	8.491	0.1	-2.8	-0.1	0.00704	-0.01952	36	0.4099	5.4933	8.97	0.001981
							19.2	8.491	-0.6	-2.8	-0.1	0.00704	-0.01745	60	0.065	4.544	7.77	0.001631
479025	4	1	AC	4.9	367000	0.35	0	14.6	-154.3	-79.6	0	-0.02016	0.008259	0	0	14.6	-179.89	-0.02016
		2	BASE	1.9	150000	0.35	4.9	14.15	64.6	-34.4	-7.5	0.01528	-0.02107	8	1.0056	11.5347	-35.53	-0.002035
		3	SUBBASE	12	34700	0.35	4.9	14.15	17.1	-34.4	-7.5	0.01528	-0.03084	12	1.0082	9.7317	2	0.002258
		4	ROADBED	41.2	17000	0.35	6.8	13.56	40.8	-22.4	-4.5	0.02293	-0.03427	18	0.7939	7.8669	10.67	0.003582
							6.8	13.56	0.9	-22.4	-4.5	0.02293	-0.06364	24	0.6049	6.5566	7.61	0.002842
							18.8	9.433	3.2	-5.1	-0.2	0.01089	-0.02072	36	0.3076	5.0202	8.59	0.001957
							18.8	9.433	0.2	-5.1	-0.2	0.01089	-0.03046	60	0.0442	4.1208	4.97	0.001121
481046	4	1	AC	13.2	716300	0.32	0	5.663	-94.9	-79.6	0	-0.005231	-0.002241	0	0	5.663	-100.86	-0.005231
		2	BASE	8.4	74800	0.35	13.2	5.006	40.9	-5.7	-1.7	0.004051	-0.004509	8	0.2841	4.8368	-21.09	-0.000987
		3	SUBBASE	5.4	7500	0.35	13.2	5.006	1.9	-5.7	-1.7	0.004051	-0.00869	12	0.3118	4.4405	-5.83	-0.00034
		4	ROADBED	33	24100	0.45	21.6	4.479	3.8	-1.8	-0.1	0.004042	-0.005884	18	0.3154	4.0661	-3.7	0.000127
							21.6	4.479	-0.5	-1.8	-0.1	0.004042	-0.01872	24	0.2951	3.7319	0.88	0.000535
							27	3.615	-0.7	-1.5	0	0.001062	-0.01321	36	0.2027	3.223	6.58	0.000884
							27	3.615	-0.7	-1.5	0	0.001062	-0.003342	60	0.0334	2.8345	6.8	0.000836
481047	4	1	AC	10.2	159500	0.3	0	13.91	-86.2	-79.6	0	-0.02202	-0.01581	0	0	13.91	-90.28	-0.02202
		2	BASE	15.6	40500	0.35	10.2	11.19	29	-17.7	-2.7	0.01561	-0.02256	8	1.0869	10.2139	-10.46	-0.000194
		3	SUBBASE	16.5	14400	0.2	10.2	11.19	0.7	-17.7	-2.7	0.01561	-0.04338	12	1.051	8.555	3.12	0.002139
		4	ROADBED	20	15400	0.45	25.8	7.882	2.7	-3.1	-0.1	0.006906	-0.0122	18	0.8923	7.2688	2.46	0.002662
							25.8	7.882	0.5	-3.1	-0.1	0.006906	-0.02234	24	0.7358	6.304	2.82	0.002617
							42.3	5.519	0.1	-1.3	0	0.002213	-0.009388	36	0.4275	5.1008	3.87	0.002293
							42.3	5.519	-0.5	-1.3	0	0.002213	-0.005932	60	0.0644	4.331	2.88	0.001625

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
473110	3	1	AC	9.6	501100	0.31	0	7.566	-111.3	-79.6	0	-0.01	-0.0014	0	0	7.566	-117.56	-0.01
		2	BASE	36	34200	0.45	9.6	6.793	66.2	-10.6	-5.2	0.009449	-0.01063	8	0.5402	6.1136	-26.31	-0.001775
		3	ROADBED	20	23300	0.45	9.6	6.793	-1.8	-10.6	-5.2	0.009449	-0.0232	12	0.5791	5.326	-4.79	3.3E-05
							45.6	3.598	-0.1	-1.2	0	0.001373	-0.003132	18	0.5287	4.4932	2.31	0.001231
							45.6	3.598	-0.4	-1.2	0	0.001373	-0.003668	24	0.442	3.8186	5.59	0.001567
														36	0.247	2.9252	8.1	0.001435
														60	0.0354	2.3475	5.12	0.000898
476022	4	1	AC	6.2	413200	0.33	0	11.44	-114.8	-79.6	0	-0.01201	-0.000104	0	0	11.44	-123.76	-0.01201
		2	BASE	6.2	241800	0.2	6.2	10.87	16.6	-36.3	-5.8	0.005639	-0.01167	8	0.6599	9.6774	-28.8	-0.002488
		3	SUBBASE	6.8	14700	0.35	6.2	10.87	8.1	-36.3	-5.8	0.005639	-0.01611	12	0.7258	8.7252	-8.5	-0.000597
		4	ROADBED	40.8	13100	0.45	12.4	10.25	37.6	-5.2	-1.7	0.01269	-0.008504	18	0.7091	7.6927	-2.37	0.000775
							12.4	10.25	0.2	-5.2	-1.7	0.01269	-0.03471	24	0.6382	6.7996	2.76	0.001522
							19.2	8.491	0.1	-2.8	-0.1	0.00704	-0.01952	36	0.4099	5.4933	8.97	0.001981
							19.2	8.491	-0.6	-2.8	-0.1	0.00704	-0.01745	60	0.065	4.544	7.77	0.001631
479025	4	1	AC	4.9	367000	0.35	0	14.6	-154.3	-79.6	0	-0.02016	0.008259	0	0	14.6	-179.89	-0.02016
		2	BASE	1.9	150000	0.35	4.9	14.15	64.6	-34.4	-7.5	0.01528	-0.02107	8	1.0056	11.5347	-35.53	-0.002035
		3	SUBBASE	12	34700	0.35	4.9	14.15	17.1	-34.4	-7.5	0.01528	-0.03084	12	1.0082	9.7317	2	0.002258
		4	ROADBED	41.2	17000	0.35	6.8	13.56	40.8	-22.4	-4.5	0.02293	-0.03427	18	0.7939	7.8669	10.67	0.003582
							6.8	13.56	0.9	-22.4	-4.5	0.02293	-0.06364	24	0.6049	6.5566	7.61	0.002842
							18.8	9.433	3.2	-5.1	-0.2	0.01089	-0.02072	36	0.3076	5.0202	8.59	0.001957
							18.8	9.433	0.2	-5.1	-0.2	0.01089	-0.03046	60	0.0442	4.1208	4.97	0.001121
481046	4	1	AC	13.2	716300	0.32	0	5.663	-94.9	-79.6	0	-0.005231	-0.002241	0	0	5.663	-100.86	-0.005231
		2	BASE	8.4	74800	0.35	13.2	5.006	40.9	-5.7	-1.7	0.004051	-0.004509	8	0.2841	4.8368	-21.09	-0.000987
		3	SUBBASE	5.4	7500	0.35	13.2	5.006	1.9	-5.7	-1.7	0.004051	-0.00869	12	0.3118	4.4405	-5.83	-0.00034
		4	ROADBED	33	24100	0.45	21.6	4.479	3.8	-1.8	-0.1	0.004042	-0.005884	18	0.3154	4.0661	-3.7	0.000127
							21.6	4.479	-0.5	-1.8	-0.1	0.004042	-0.01872	24	0.2951	3.7319	0.88	0.000535
							27	3.615	-0.7	-1.5	0	0.001062	-0.01321	36	0.2027	3.223	6.58	0.000884
							27	3.615	-0.7	-1.5	0	0.001062	-0.003342	60	0.0334	2.8345	6.8	0.000836
481047	4	1	AC	10.2	159500	0.3	0	13.91	-86.2	-79.6	0	-0.02202	-0.01581	0	0	13.91	-90.28	-0.02202
		2	BASE	15.6	40500	0.35	10.2	11.19	29	-17.7	-2.7	0.01561	-0.02256	8	1.0869	10.2139	-10.46	-0.000194
		3	SUBBASE	16.5	14400	0.2	10.2	11.19	0.7	-17.7	-2.7	0.01561	-0.04338	12	1.051	8.555	3.12	0.002139
		4	ROADBED	20	15400	0.45	25.8	7.882	2.7	-3.1	-0.1	0.006906	-0.0122	18	0.8923	7.2688	2.46	0.002662
							25.8	7.882	0.5	-3.1	-0.1	0.006906	-0.02234	24	0.7358	6.304	2.82	0.002617
							42.3	5.519	0.1	-1.3	0	0.002213	-0.009388	36	0.4275	5.1008	3.87	0.002293
							42.3	5.519	-0.5	-1.3	0	0.002213	-0.005932	60	0.0644	4.331	2.88	0.001625

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
481048	3	1	AC	11.1	491100	0.35	0	8.819	-104.4	-79.6	0	-0.007858	-0.000651	0	0	8.819	-115.2	-0.007858
		2	BASE	36	34900	0.35	11.1	7.975	53.5	-8.7	-3.5	0.00753	-0.009698	8	0.4289	7.5347	-25.92	-0.001745
		3	ROADBED	20	17000	0.35	11.1	7.975	0.1	-8.7	-3.5	0.00753	-0.02203	12	0.4731	6.8828	-5.98	-0.000326
							47.1	5.152	0	-1	0	0.001059	-0.002885	18	0.4538	6.2356	-1.11	0.000676
							47.1	5.152	-0.3	-1	0	0.001059	-0.004849	24	0.3974	5.6929	3.1	0.001134
														36	0.241	4.9433	6.98	0.001256
														60	0.0362	4.4327	5.33	0.000913
481065	4	1	AC	8.3	968600	0.3	0	12.54	-156.3	-79.6	0	-0.008641	0.001914	0	0	12.54	-164.82	-0.008641
		2	BASE	4.8	12900	0.35	8.3	12.2	124.1	-6.8	-4.5	0.008996	-0.00865	8	0.4969	11.4542	-51.49	-0.002402
		3	SUBBASE	36	20000	0.45	8.3	12.2	-1.1	-6.8	-4.5	0.008996	-0.03517	12	0.5634	10.74	-19.89	-0.00068
		4	ROADBED	20	8800	0.45	13.1	10.78	-1.1	-3.9	-0.1	0.004856	-0.02397	18	0.5484	9.817	-0.79	0.000786
							13.1	10.78	-1.5	-3.9	-0.1	0.004856	-0.01307	24	0.4803	9.0112	8.28	0.00138
							49.1	8.378	-0.2	-0.8	0	0.001308	-0.003359	36	0.2867	7.8453	17.05	0.001551
							49.1	8.378	-0.5	-0.8	0	0.001308	-0.004677	60	0.0437	7.0305	12.03	0.001102
481076	4	1	AC	4.7	271200	0.35	0	19.03	-152.7	-79.6	0	-0.02711	0.0107	0	0	19.03	-179.99	-0.02711
		2	BASE	8.4	44200	0.35	4.7	18.36	81.3	-39.7	-10.2	0.02532	-0.03466	8	1.2573	14.7095	-25.74	-0.000384
		3	SUBBASE	36	21100	0.35	4.7	18.36	-3.1	-39.7	-10.2	0.02532	-0.08037	12	1.1765	12.315	10.53	0.004716
		4	ROADBED	20	11600	0.35	13.1	14.07	6.9	-10.8	-0.7	0.01825	-0.03528	18	0.8385	10.1085	12.38	0.004876
							13.1	14.07	0.5	-10.8	-0.7	0.01825	-0.05131	24	0.6099	8.7065	5.99	0.003194
							49.1	7.797	0.1	-1.2	0	0.00212	-0.005441	36	0.3005	7.174	6.34	0.001972
							49.1	7.797	-0.2	-1.2	0	0.00212	-0.008417	60	0.0426	6.3283	3.52	0.001082
481077	4	1	AC	5	636100	0.32	0	10.17	-159.7	-79.6	0	-0.01343	0.00363	0	0	10.17	-181.36	-0.01343
		2	BASE	9.9	75500	0.35	5	9.847	98.6	-33.8	-11.5	0.01259	-0.01464	8	0.6434	8.1601	-29.1	-0.000556
		3	SUBBASE	36	34200	0.35	5	9.847	-2.3	-33.8	-11.5	0.01259	-0.03955	12	0.6171	6.993	8.69	0.002066
		4	ROADBED	20	20200	0.35	14.9	7.494	5.8	-8	-0.5	0.008466	-0.01589	18	0.4563	5.8322	13.96	0.002449
							14.9	7.494	0.4	-8	-0.5	0.008466	-0.02363	24	0.3371	5.0588	7.66	0.001702
							50.9	4.397	0	-1.1	0	0.001001	-0.002943	36	0.1669	4.1857	8.11	0.001098
							50.9	4.397	-0.3	-1.1	0	0.001001	-0.004358	60	0.0239	3.6925	4.47	0.000606
481077	4	1	AC	5.2	484100	0.31	0	9.727	-146.9	-79.6	0	-0.0163	0.002359	0	0	9.727	-165.27	-0.0163
		2	BASE	10.8	53200	0.35	5.2	9.258	94.7	-32.9	-10.9	0.01606	-0.01805	8	0.7594	7.264	-21.46	3.6E-05
		3	SUBBASE	36	48100	0.35	5.2	9.258	-3.2	-32.9	-10.9	0.01606	-0.053	12	0.6983	5.8798	13.59	0.003227
		4	ROADBED	20	27000	0.35	16	5.893	0.5	-9.1	-0.3	0.006399	-0.01755	18	0.4678	4.6017	16.26	0.003373
							16	5.893	0	-9.1	-0.3	0.006399	-0.01874	24	0.3126	3.8303	7.74	0.00206
							52	3.357	0.1	-1.2	0	0.000916	-0.002437	36	0.1315	3.0728	5.6	0.001017
							52	3.357	-0.2	-1.2	0	0.000916	-0.003642	60	0.0174	2.709	2.48	0.000447

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
481087	3	1	AC	7.3	179300	0.35	0	12.27	-101.5	-79.6	0	-0.02036	-0.002474	0	0	12.27	-112.32	-0.02036
		2	BASE	8.4	56600	0.35	7.3	10.53	35	-30.1	-4	0.01815	-0.03116	8	0.9951	8.632	-16.71	-0.001312
		3	ROADBED	44.3	25600	0.35	7.3	10.53	0.4	-30.1	-4	0.01815	-0.0515	12	0.9784	6.889	3.76	0.002364
							15.7	7.848	5.9	-8.4	-0.6	0.01181	-0.02211	18	0.7811	5.4623	4.25	0.003198
							15.7	7.848	0.4	-8.4	-0.6	0.01181	-0.03307	24	0.6081	4.4705	3.46	0.002666
														36	0.3232	3.3228	3.96	0.001937
														60	0.0457	2.6487	2.48	0.001163
481087	3	1	AC	7.1	273300	0.35	0	22.48	-162.8	-79.6	0	-0.0278	0.01509	0	0	22.48	-182.43	-0.0278
		2	BASE	5.9	11600	0.35	7.1	21.46	122.2	-14.5	-5.6	0.03033	-0.038	8	1.5162	18.5615	-50.33	-0.006211
		3	ROADBED	47	11100	0.35	7.1	21.46	-1	-14.5	-5.6	0.03033	-0.09715	12	1.6472	16.0975	-11.31	0.000403
							13	17.08	-0.5	-6.9	-0.2	0.01795	-0.05617	18	1.4461	13.1575	6.58	0.004496
							13	17.08	-0.5	-6.9	-0.2	0.01795	-0.05786	24	1.1589	10.8565	10.06	0.00488
														36	0.5922	7.9443	13.02	0.003859
														60	0.0808	6.1922	6.87	0.002062
481092	4	1	AC	3	1844100	0.31	0	15.62	-501.1	-79.6	0	-0.01766	0.01327	0	0	15.62	-593.56	-0.01766
		2	BASE	5.5	16300	0.35	3	15.56	463	-29.8	-44.2	0.01789	-0.01745	8	0.8039	12.3049	-95.19	-0.000255
		3	SUBBASE	7	54400	0.35	3	15.56	-6.9	-29.8	-44.2	0.01789	-0.09908	12	0.7503	10.0915	38.14	0.003295
		4	ROADBED	44.5	19300	0.35	8.5	11.07	-6.4	-13.8	-0.5	0.004273	-0.05658	18	0.4995	7.6379	72.32	0.003706
							8.5	11.07	-3.9	-13.8	-0.5	0.004273	-0.02025	24	0.3393	6.0656	24.49	0.002148
							15.5	9.737	5.2	-6.8	-0.5	0.01052	-0.01935	36	0.1358	4.3963	29.34	0.001207
							15.5	9.737	-0.4	-6.8	-0.5	0.01052	-0.03324	60	0.0186	3.6037	10.45	0.000472
481094	3	1	AC	1.7	1156200	0.3	0	9.03	-281.3	-79.6	0	-0.01536	0.008731	0	0	9.03	-313.68	-0.01536
		2	BASE	8.5	99500	0.35	1.7	8.98	137	-77.5	-60.9	0.01045	-0.01382	8	0.5428	5.4548	14.1	0.003258
		3	ROADBED	49.8	49700	0.45	1.7	8.98	-24.8	-77.5	-60.9	0.01045	-0.05664	12	0.4036	3.7592	45.28	0.003505
							10.2	5.627	9.6	-18.5	-1.6	0.01206	-0.02536	18	0.2426	2.5828	19.03	0.001776
							10.2	5.627	-3.2	-18.5	-1.6	0.01206	-0.02989	24	0.1763	1.9493	3.73	0.000903
														36	0.0885	1.2781	7.67	0.000591
														60	0.0125	0.9293	4.05	0.000317
481096	4	1	AC	6.9	1970500	0.3	0	7.008	-199.3	-79.6	0	-0.005722	0.002398	0	0	7.008	-211.24	-0.005722
		2	BASE	8.4	16600	0.35	6.9	6.867	172.4	-8.9	-10.1	0.00613	-0.005888	8	0.3246	6.2804	-68.22	-0.001532
		3	SUBBASE	36	49600	0.45	6.9	6.867	-1.6	-8.9	-10.1	0.00613	-0.02862	12	0.3639	5.7713	-23.42	-0.000253
		4	ROADBED	20	19100	0.45	15.3	4.945	-1.7	-4	0	0.001699	-0.01679	18	0.3396	5.0848	5.01	0.000736
							15.3	4.945	-1.8	-4	0	0.001699	-0.004859	24	0.2854	4.5057	14.01	0.001009
							51.3	3.903	0	-0.9	0	0.000726	-0.001726	36	0.1554	3.713	22.39	0.000958
							51.3	3.903	-0.5	-0.9	0	0.000726	-0.002405	60	0.0224	3.197	12.76	0.000568

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
481109	4	1	AC	6.5	1774700	0.3	0	17.12	-229.1	-79.6	0	-0.007539	0.00371	0	0	17.12	-243.74	-0.007539
		2	BASE	6.7	16000	0.2	6.5	16.98	201.1	-8.3	-11	0.007939	-0.00753	8	0.4341	16.1724	-85.09	-0.002225
		3	SUBBASE	36	16600	0.45	6.5	16.98	0.3	-8.3	-11	0.007939	-0.0343	12	0.4948	15.4725	-34.23	-0.000569
		4	ROADBED	20	5500	0.45	13.2	15.21	0.3	-3.2	-0.1	0.005258	-0.02064	18	0.4758	14.4933	0.88	0.000787
							13.2	15.21	-1.1	-3.2	-0.1	0.005258	-0.01376	24	0.4121	13.6417	14.14	0.001263
							49.2	12.86	-0.2	-0.7	0	0.001223	-0.003269	36	0.2376	12.4208	28.57	0.001362
							49.2	12.86	-0.5	-0.7	0	0.001223	-0.005507	60	0.0362	11.5775	18.45	0.000912
481111	4	1	AC	7.8	338700	0.35	0	13.68	-130	-79.6	0	-0.01608	0.004989	0	0	13.68	-144.51	-0.01608
		2	BASE	8.4	34800	0.35	7.8	12.77	79	-17.8	-4.7	0.01653	-0.02229	8	0.8619	11.2575	-35.11	-0.003225
		3	SUBBASE	36	19900	0.45	7.8	12.77	0.5	-17.8	-4.7	0.01653	-0.04592	12	0.9261	9.8678	-5.7	0.000389
		4	ROADBED	20	11900	0.45	16.2	10.23	2.7	-5.7	-0.3	0.0107	-0.02178	18	0.813	8.3788	4.05	0.002411
							16.2	10.23	-0.8	-5.7	-0.3	0.0107	-0.0254	24	0.6596	7.2263	6.36	0.002596
							52.2	6.495	-0.2	-1	0	0.001535	-0.003813	36	0.3562	5.7628	8.59	0.002137
							52.2	6.495	-0.5	-1	0	0.001535	-0.004682	60	0.0507	4.8483	5.29	0.001288
481123	3	1	AC	4.3	1384900	0.3	0	5.092	-186.4	-79.6	0	-0.007893	0.00241	0	0	5.092	-207.71	-0.007893
		2	BASE	16.7	124100	0.35	4.3	4.962	125.7	-37	-18.7	0.00732	-0.007869	8	0.3599	3.8916	-24.14	0.00014
		3	ROADBED	39	50900	0.35	4.3	4.962	-4.6	-37	-18.7	0.00732	-0.02527	12	0.3284	3.1933	18.04	0.001523
							21	2.985	4.1	-4.7	-0.2	0.003323	-0.005949	18	0.2247	2.5253	19.35	0.001449
							21	2.985	0.2	-4.7	-0.2	0.003323	-0.009265	24	0.1611	2.1094	7.35	0.000848
														36	0.0811	1.6555	8.01	0.000516
														60	0.0123	1.3983	4.85	0.000311
481123	3	1	AC	3.7	2491300	0.3	0	5.174	-293.8	-79.6	0	-0.007398	0.004079	0	0	5.174	-338.17	-0.007398
		2	BASE	16.2	82300	0.35	3.7	5.115	247.9	-34.1	-31.4	0.007312	-0.00727	8	0.3411	3.9602	-52.49	-0.000114
		3	ROADBED	40.1	63100	0.35	3.7	5.115	-5.1	-34.1	-31.4	0.007312	-0.02792	12	0.3176	3.1845	25.15	0.00142
							19.9	2.699	0.9	-5.6	-0.2	0.003025	-0.007496	18	0.212	2.3664	39.36	0.001548
							19.9	2.699	0	-5.6	-0.2	0.003025	-0.008809	24	0.1429	1.8541	16.25	0.000924
														36	0.0583	1.3254	15.04	0.000489
														60	0.0079	1.0728	5.85	0.000201
481130	4	1	AC	2.7	1057900	0.3	0	12.9	-346.3	-79.6	0	-0.02104	0.01304	0	0	12.9	-402.59	-0.02104
		2	BASE	18	39200	0.35	2.7	12.8	281.4	-50.3	-55.6	0.01998	-0.02084	8	0.8319	8.8569	-15.09	0.002696
		3	SUBBASE	8	136000	0.2	2.7	12.8	-10.4	-50.3	-55.6	0.01998	-0.08661	12	0.6669	6.5643	61.94	0.005625
		4	ROADBED	31.3	23200	0.45	20.7	5.242	-3	-6.9	-0.4	0.001185	-0.01192	18	0.3415	4.6344	47.51	0.003976
							20.7	5.242	0.3	-6.9	-0.4	0.001185	-0.005146	24	0.2011	3.6931	6.61	0.001566
							28.7	4.906	6.2	-2.9	-0.4	0.004018	-0.003987	36	0.0852	2.8708	7.65	0.000647
							28.7	4.906	-0.7	-2.9	-0.4	0.004018	-0.009946	60	0.0135	2.4958	4.09	0.000338

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
481109	4	1	AC	6.5	1774700	0.3	0	17.12	-229.1	-79.6	0	-0.007539	0.00371	0	0	17.12	-243.74	-0.007539
		2	BASE	6.7	16000	0.2	6.5	16.98	201.1	-8.3	-11	0.007939	-0.00753	8	0.4341	16.1724	-85.09	-0.002225
		3	SUBBASE	36	16600	0.45	6.5	16.98	0.3	-8.3	-11	0.007939	-0.0343	12	0.4948	15.4725	-34.23	-0.000569
		4	ROADBED	20	5500	0.45	13.2	15.21	0.3	-3.2	-0.1	0.005258	-0.02064	18	0.4758	14.4933	0.88	0.000787
							13.2	15.21	-1.1	-3.2	-0.1	0.005258	-0.01376	24	0.4121	13.6417	14.14	0.001263
							49.2	12.86	-0.2	-0.7	0	0.001223	-0.003269	36	0.2376	12.4208	28.57	0.001362
							49.2	12.86	-0.5	-0.7	0	0.001223	-0.005507	60	0.0362	11.5775	18.45	0.000912
481111	4	1	AC	7.8	338700	0.35	0	13.68	-130	-79.6	0	-0.01608	0.004989	0	0	13.68	-144.51	-0.01608
		2	BASE	8.4	34800	0.35	7.8	12.77	79	-17.8	-4.7	0.01653	-0.02229	8	0.8619	11.2575	-35.11	-0.003225
		3	SUBBASE	36	19900	0.45	7.8	12.77	0.5	-17.8	-4.7	0.01653	-0.04592	12	0.9261	9.8678	-5.7	0.000389
		4	ROADBED	20	11900	0.45	16.2	10.23	2.7	-5.7	-0.3	0.0107	-0.02178	18	0.813	8.3788	4.05	0.002411
							16.2	10.23	-0.8	-5.7	-0.3	0.0107	-0.0254	24	0.6596	7.2263	6.36	0.002596
							52.2	6.495	-0.2	-1	0	0.001535	-0.003813	36	0.3562	5.7628	8.59	0.002137
							52.2	6.495	-0.5	-1	0	0.001535	-0.004682	60	0.0507	4.8483	5.29	0.001288
481123	3	1	AC	4.3	1384900	0.3	0	5.092	-186.4	-79.6	0	-0.007893	0.00241	0	0	5.092	-207.71	-0.007893
		2	BASE	16.7	124100	0.35	4.3	4.962	125.7	-37	-18.7	0.00732	-0.007869	8	0.3599	3.8916	-24.14	0.00014
		3	ROADBED	39	50900	0.35	4.3	4.962	-4.6	-37	-18.7	0.00732	-0.02527	12	0.3284	3.1933	18.04	0.001523
							21	2.985	4.1	-4.7	-0.2	0.003323	-0.005949	18	0.2247	2.5253	19.35	0.001449
							21	2.985	0.2	-4.7	-0.2	0.003323	-0.009265	24	0.1611	2.1094	7.35	0.000848
														36	0.0811	1.6555	8.01	0.000516
														60	0.0123	1.3983	4.85	0.000311
481123	3	1	AC	3.7	2491300	0.3	0	5.174	-293.8	-79.6	0	-0.007398	0.004079	0	0	5.174	-338.17	-0.007398
		2	BASE	16.2	82300	0.35	3.7	5.115	247.9	-34.1	-31.4	0.007312	-0.00727	8	0.3411	3.9602	-52.49	-0.000114
		3	ROADBED	40.1	63100	0.35	3.7	5.115	-5.1	-34.1	-31.4	0.007312	-0.02792	12	0.3176	3.1845	25.15	0.00142
							19.9	2.699	0.9	-5.6	-0.2	0.003025	-0.007496	18	0.212	2.3664	39.36	0.001548
							19.9	2.699	0	-5.6	-0.2	0.003025	-0.008809	24	0.1429	1.8541	16.25	0.000924
														36	0.0583	1.3254	15.04	0.000489
														60	0.0079	1.0728	5.85	0.000201
481130	4	1	AC	2.7	1057900	0.3	0	12.9	-346.3	-79.6	0	-0.02104	0.01304	0	0	12.9	-402.59	-0.02104
		2	BASE	18	39200	0.35	2.7	12.8	281.4	-50.3	-55.6	0.01998	-0.02084	8	0.8319	8.8569	-15.09	0.002696
		3	SUBBASE	8	136000	0.2	2.7	12.8	-10.4	-50.3	-55.6	0.01998	-0.08661	12	0.6669	6.5643	61.94	0.005625
		4	ROADBED	31.3	23200	0.45	20.7	5.242	-3	-6.9	-0.4	0.001185	-0.01192	18	0.3415	4.6344	47.51	0.003976
							20.7	5.242	0.3	-6.9	-0.4	0.001185	-0.005146	24	0.2011	3.6931	6.61	0.001566
							28.7	4.906	6.2	-2.9	-0.4	0.004018	-0.003987	36	0.0852	2.8708	7.65	0.000647
							28.7	4.906	-0.7	-2.9	-0.4	0.004018	-0.009946	60	0.0135	2.4958	4.09	0.000338

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
481174	4	1	AC	4.6	313900	0.33	0	25.44	-197.9	-79.6	0	-0.03486	0.01669	0	0	25.44	-228.79	-0.03486
		2	BASE	13.2	25500	0.35	4.6	24.88	136.4	-32.7	-15.9	0.03333	-0.03797	8	1.6831	20.1985	-41.28	-0.002141
		3	SUBBASE	36	8200	0.45	4.6	24.88	-2.8	-32.7	-15.9	0.03333	-0.1082	12	1.6405	16.9725	7.23	0.004844
		4	ROADBED	20	8400	0.45	17.8	17.22	6.6	-4.9	-0.4	0.02293	-0.03715	18	1.2427	13.5625	16.67	0.006133
							17.8	17.22	-0.5	-4.9	-0.4	0.02293	-0.05387	24	0.9435	11.2175	8.88	0.00435
							53.8	9.406	-0.5	-1	0	0.002114	-0.00663	36	0.4903	8.4281	11.39	0.00306
							53.8	9.406	-0.5	-1	0	0.002114	-0.006699	60	0.0737	6.7553	6.9	0.00186
481174	4	1	AC	4.6	674300	0.34	0	15.79	-220.1	-79.6	0	-0.01807	0.01064	0	0	15.79	-259.29	-0.01807
		2	BASE	13.2	40300	0.35	4.6	15.54	164.1	-29.5	-17.6	0.01794	-0.02038	8	0.8862	13.0566	-52.67	-0.001551
		3	SUBBASE	36	15900	0.45	4.6	15.54	-2.7	-29.5	-17.6	0.01794	-0.05896	12	0.8782	11.3275	4.16	0.002313
		4	ROADBED	20	10600	0.45	17.8	11.24	4.9	-5	-0.3	0.01186	-0.02061	18	0.6714	9.4084	19.38	0.003314
							17.8	11.24	-0.5	-5	-0.3	0.01186	-0.0279	24	0.5056	8.0658	11.28	0.002438
							53.8	7.196	-0.3	-0.9	0	0.001426	-0.003876	36	0.2524	6.4826	13.76	0.001661
							53.8	7.196	-0.5	-0.9	0	0.001426	-0.004662	60	0.0372	5.5573	7.64	0.000939
482176	4	1	AC	2.2	479500	0.35	0	9.135	-117.7	-79.6	0	-0.0105	0.000737	0	0	9.135	-130.7	-0.0105
		2	BASE	9.2	399500	0.2	2.2	9.059	-54.5	-72.6	-8.1	-0.002225	-0.007629	8	0.58	7.6212	-29.27	-0.002152
		3	SUBBASE	36	18900	0.45	2.2	9.059	-31.4	-72.6	-8.1	-0.002225	-0.01508	12	0.638	6.813	-9.14	-0.000559
		4	ROADBED	20	17300	0.45	11.4	8.188	50.3	-6.1	-3.8	0.009955	-0.006996	18	0.6239	5.9463	-2.37	0.000734
							11.4	8.188	-1	-6.1	-3.8	0.009955	-0.02437	24	0.5564	5.1962	3.32	0.001426
							47.4	4.655	-0.5	-1.1	0	0.001205	-0.003403	36	0.3487	4.1118	9.31	0.001745
							47.4	4.655	-0.5	-1.1	0	0.001205	-0.003644	60	0.0539	3.3408	7.56	0.001356
482176	4	1	AC	2.3	486100	0.33	0	9.455	-127	-79.6	0	-0.01249	0.001005	0	0	9.455	-141.45	-0.01249
		2	BASE	9.6	272400	0.2	2.3	9.348	-36.8	-71.9	-10.1	-0.000373	-0.01031	8	0.644	7.5601	-24.85	-0.001282
		3	SUBBASE	36	19800	0.45	2.3	9.348	-20.9	-71.9	-10.1	-0.000373	-0.02347	12	0.669	6.5773	-4.25	0.000156
		4	ROADBED	20	19300	0.45	11.9	8.061	39	-6.8	-2.9	0.0114	-0.008671	18	0.6274	5.6074	-0.56	0.000986
							11.9	8.061	-0.9	-6.8	-2.9	0.0114	-0.02747	24	0.5523	4.8071	3.76	0.001502
							47.9	4.239	-0.5	-1.1	0	0.001231	-0.003408	36	0.3418	3.6834	9.32	0.001741
							47.9	4.239	-0.5	-1.1	0	0.001231	-0.003588	60	0.0523	2.905	7.29	0.001319
483669	4	1	AC	4.2	2162600	0.3	0	8.685	-200.5	-79.6	0	-0.0055	0.001953	0	0	8.685	-221.89	-0.0055
		2	BASE	7.6	234600	0.2	4.2	8.615	113.6	-38.4	-15.7	0.004314	-0.004799	8	0.2696	7.8848	-40.56	-0.000423
		3	SUBBASE	8.2	130300	0.2	4.2	8.615	3.6	-38.4	-15.7	0.004314	-0.01617	12	0.2697	7.393	1.78	0.000497
		4	ROADBED	40	11800	0.45	11.8	7.905	9.7	-8.5	-0.9	0.003978	-0.005287	18	0.2261	6.8473	8.95	0.000679
							11.8	7.905	4.4	-8.5	-0.9	0.003978	-0.007844	24	0.191	6.4339	5.52	0.000571
							20	7.507	7.9	-1.7	-0.4	0.005073	-0.003779	36	0.1184	5.8656	14.47	0.000598
							20	7.507	-0.3	-1.7	-0.4	0.005073	-0.0124	60	0.0195	5.466	11.9	0.000488

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
483679	4	1	AC	1.4	773200	0.3	0	9.522	-132	-79.6	0	-0.009023	0.000496	0	0	9.522	-137.02	-0.009023
		2	BASE	8.7	708000	0.2	1.4	9.497	-84.1	-76.5	-10.1	-0.004661	-0.003204	8	0.5126	8.4049	-34.11	-0.00193
		3	SUBBASE	36	15400	0.45	1.4	9.497	-63.6	-76.5	-10.1	-0.004661	-0.007041	12	0.5691	7.7437	-14.23	-0.00068
		4	ROADBED	20	13900	0.45	10.1	8.992	77	-5.2	-6.2	0.008528	-0.00542	18	0.5648	6.9368	-2.11	0.000587
							10.1	8.992	-1.1	-5.2	-6.2	0.008528	-0.02163	24	0.5068	6.2158	5.34	0.001256
							46.1	5.649	-0.5	-1	0	0.001115	-0.003489	36	0.3187	5.1478	13.44	0.001601
							46.1	5.649	-0.5	-1	0	0.001115	-0.003738	60	0.0501	4.371	10.62	0.001257
483779	4	1	AC	8.4	5644600	0.15	0	6.156	-155.9	-79.6	0	-0.002087	-0.000519	0	0	6.156	-154.27	-0.002087
		2	BASE	6.2	18800	0.35	8.4	6.093	135	-2.7	-7.4	0.001996	-0.000798	8	0.1222	5.9295	-48.79	-0.000586
		3	SUBBASE	36	5600	0.45	8.4	6.093	-0.2	-2.7	-7.4	0.001996	-0.00692	12	0.1402	5.7725	-21.89	-0.000252
		4	ROADBED	20	18800	0.45	14.6	5.724	0	-1	0	0.002059	-0.005656	18	0.1431	5.5463	-0.57	9.1E-05
							14.6	5.724	-0.6	-1	0	0.002059	-0.008305	24	0.131	5.3354	12.09	0.000292
							50.6	3.939	-0.7	-0.8	0	-0.000405	-0.002911	36	0.0835	5.0112	26	0.000418
							50.6	3.939	-0.8	-0.8	0	-0.000405	-0.000411	60	0.0135	4.7683	19.51	0.000339
484142	4	1	AC	9.8	7535600	0.15	0	2.036	-106.5	-79.6	0	-0.001005	-0.000592	0	0	2.036	-104.2	-0.001005
		2	BASE	8.7	594200	0.3	9.8	1.98	68.3	-7.9	-4.5	0.000759	-0.000396	8	0.056	1.9234	-23.54	-0.000181
		3	SUBBASE	5.4	5400	0.35	9.8	1.98	3.5	-7.9	-4.5	0.000759	-0.001534	12	0.0612	1.8573	-7.82	-6.1E-05
		4	ROADBED	36.1	63200	0.45	18.5	1.893	7.6	-1.1	-0.1	0.000941	-0.000957	18	0.0611	1.7772	-0.03	4.5E-05
							18.5	1.893	-0.5	-1.1	-0.1	0.000941	-0.01297	24	0.056	1.7038	6.17	0.000117
							23.9	1.232	-0.5	-1	0	-3.1E-05	-0.01136	36	0.0371	1.5901	13.83	0.000173
							23.9	1.232	-0.9	-1	0	-3.1E-05	-0.000352	60	0.0061	1.5035	11.73	0.000153
485154	4	1	AC	8.3	5777200	0.15	0	3.147	-120.8	-79.6	0	-0.001532	-0.000699	0	0	3.147	-119.38	-0.001532
		2	BASE	4.4	955000	0.3	8.3	3.082	75.5	-11.6	-4.9	0.001114	-0.000614	8	0.0862	2.9761	-28.85	-0.000302
		3	SUBBASE	6	90100	0.2	8.3	3.082	10.5	-11.6	-4.9	0.001114	-0.001823	12	0.095	2.8693	-10.1	-0.000101
		4	ROADBED	41.3	29300	0.45	12.7	3.015	20.5	-2.7	-0.7	0.001583	-0.001591	18	0.0944	2.7322	0.97	8.3E-05
							12.7	3.015	1.2	-2.7	-0.7	0.001583	-0.003391	24	0.0859	2.6063	7.97	0.000192
							18.7	2.862	1.2	-1.4	-0.1	0.001396	-0.002077	36	0.0556	2.416	16.77	0.000269
							18.7	2.862	-0.4	-1.4	-0.1	0.001396	-0.003617	60	0.0091	2.2713	13.37	0.000227
485154	4	1	AC	8.1	4359500	0.15	0	2.778	-114.3	-79.6	0	-0.001907	-0.000975	0	0	2.778	-113.01	-0.001907
		2	BASE	4.4	976800	0.3	8.1	2.691	64.1	-14.5	-5	0.001267	-0.000797	8	0.1058	2.5626	-24.52	-0.000321
		3	SUBBASE	6	98100	0.2	8.1	2.691	11.7	-14.5	-5	0.001267	-0.002166	12	0.1148	2.4318	-7.21	-8.4E-05
		4	ROADBED	41.5	37300	0.45	12.5	2.612	24.4	-3.6	-0.9	0.00185	-0.001884	18	0.1123	2.2692	1.89	0.00012
							12.5	2.612	1.4	-3.6	-0.9	0.00185	-0.004042	24	0.1014	2.1233	7.5	0.000237
							18.5	2.432	1.5	-1.7	-0.1	0.001577	-0.002386	36	0.0651	1.9042	14.9	0.000318
							18.5	2.432	-0.3	-1.7	-0.1	0.001577	-0.003907	60	0.0106	1.74	11.74	0.000264

Mechanistic responses - South West Region (continued).

SHRP	NO.	LAYER INFORMATION					DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSE AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
485336	4	1	AC	8.1	7315000	0.15	0	2.352	-138.9	-79.6	0	-0.001417	-0.000473	0	0	2.352	-137.43	-0.001417
		2	BASE	6.1	217900	0.34	8.1	2.303	111.8	-7.4	-6.9	0.001284	-0.00058	8	0.0799	2.1931	-34.96	-0.000297
		3	SUBBASE	36	79200	0.45	8.1	2.303	1.1	-7.4	-6.9	0.001284	-0.003193	12	0.0881	2.0887	-10.78	-7.5E-05
		4	ROADBED	20	41800	0.45	14.2	2.154	2.6	-2.9	-0.2	0.001228	-0.002131	18	0.0853	1.9493	4.92	0.00012
							14.2	2.154	-0.6	-2.9	-0.2	0.001228	-0.003011	24	0.0752	1.8268	11.76	0.000207
							50.2	1.712	-0.4	-0.8	0	0.000135	-0.000473	36	0.0454	1.6457	19.62	0.000243
							50.2	1.712	-0.5	-0.8	0	0.000135	-0.000697	60	0.0071	1.5185	13.34	0.000179
486086	4	1	AC	9.8	895300	0.35	0	5.183	-115	-79.6	0	-0.005037	0.000532	0	0	5.183	-127.15	-0.005037
		2	BASE	17.2	69500	0.35	9.8	4.767	65.5	-11.2	-3.8	0.005017	-0.006543	8	0.2786	4.4061	-32.1	-0.00125
		3	SUBBASE	6	29700	0.2	9.8	4.767	0.3	-11.2	-3.8	0.005017	-0.01407	12	0.3104	3.9855	-8.51	-0.000231
		4	ROADBED	27	27600	0.45	27	3.549	1.2	-2	-0.1	0.002148	-0.004146	18	0.2959	3.5363	-0.89	0.00048
							27	3.549	0.3	-2	-0.1	0.002148	-0.007155	24	0.2577	3.1627	3.78	0.000748
							33	3.181	0.2	-1.5	0	0.001574	-0.005311	36	0.1564	2.6454	8.21	0.000808

Mechanistic responses - South West Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSE AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
485336	4	1	AC	8.1	7315000	0.15	0	2.352	-138.9	-79.6	0	-0.001417	-0.000473	0	0	2.352	-137.43	-0.001417
		2	BASE	6.1	217900	0.34	8.1	2.303	111.8	-7.4	-6.9	0.001284	-0.00058	8	0.0799	2.1931	-34.96	-0.000297
		3	SUBBASE	36	79200	0.45	8.1	2.303	1.1	-7.4	-6.9	0.001284	-0.003193	12	0.0881	2.0887	-10.78	-7.5E-05
		4	ROADBED	20	41800	0.45	14.2	2.154	2.6	-2.9	-0.2	0.001228	-0.002131	18	0.0853	1.9493	4.92	0.00012
							14.2	2.154	-0.6	-2.9	-0.2	0.001228	-0.003011	24	0.0752	1.8268	11.76	0.000207
							50.2	1.712	-0.4	-0.8	0	0.000135	-0.000473	36	0.0454	1.6457	19.62	0.000243
							50.2	1.712	-0.5	-0.8	0	0.000135	-0.000697	60	0.0071	1.5185	13.34	0.000179
486086	4	1	AC	9.8	895300	0.35	0	5.183	-115	-79.6	0	-0.005037	0.000532	0	0	5.183	-127.15	-0.005037
		2	BASE	17.2	69500	0.35	9.8	4.767	65.5	-11.2	-3.8	0.005017	-0.006543	8	0.2786	4.4061	-32.1	-0.00125
		3	SUBBASE	6	29700	0.2	9.8	4.767	0.3	-11.2	-3.8	0.005017	-0.01407	12	0.3104	3.9855	-8.51	-0.000231
		4	ROADBED	27	27600	0.45	27	3.549	1.2	-2	-0.1	0.002148	-0.004146	18	0.2959	3.5363	-0.89	0.00048
							27	3.549	0.3	-2	-0.1	0.002148	-0.007155	24	0.2577	3.1627	3.78	0.000748
							33	3.181	0.2	-1.5	0	0.001574	-0.005311	36	0.1564	2.6454	8.21	0.000808

Mechanistic responses - North Central Region.

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
171002	3	1	AC	13	821600	0.34	0	5.629	-103.6	-79.6	0	-0.004851	-0.000745	0	0	5.629	-112.57	-0.004851
		2	BASE	36	19400	0.45	13	5.075	54.7	-3.5	-2.9	0.004464	-0.005054	8	0.2732	4.8775	-27.93	-0.001285
		3	ROADBED	20	23200	0.45	13	5.075	-0.8	-3.5	-2.9	0.004464	-0.0114	12	0.3114	4.4955	-10.06	-0.00055
							49	3.292	-0.6	-0.9	0	0.000352	-0.001766	18	0.3222	4.1009	-5.44	7.3E-05
							49	3.292	-0.6	-0.9	0	0.000352	-0.001612	24	0.3026	3.7403	0.84	0.000546
														36	0.2067	3.1891	7.99	0.000913
														60	0.0338	2.7675	8.12	0.000846
171002	3	1	AC	13.4	643000	0.34	0	6.905	-97.6	-79.6	0	-0.00557	-0.001595	0	0	6.905	-106.04	-0.00557
		2	BASE	36	27300	0.45	13.4	6.178	46.1	-4.4	-2.5	0.004869	-0.005657	8	0.3056	5.9896	-23.53	-0.001258
		3	ROADBED	20	16600	0.45	13.4	6.178	-0.7	-4.4	-2.5	0.004869	-0.01192	12	0.3411	5.5467	-6.73	-0.000445
							49.4	4.477	-0.4	-0.9	0	0.000605	-0.001794	18	0.3457	5.122	-3.88	0.000163
							49.4	4.477	-0.5	-0.9	0	0.000605	-0.002346	24	0.321	4.7435	1.06	0.000629
														36	0.2161	4.1778	6.69	0.000974
														60	0.0349	3.7543	6.56	0.000875
175020	4	1	AC	8.7	1518200	0.15	0	6.107	-107.6	-79.6	0	-0.00508	-0.002928	0	0	6.107	-105.9	-0.00508
		2	BASE	4.4	237400	0.2	8.7	5.843	64.8	-12.1	-4	0.003644	-0.002169	8	0.278	5.5226	-20.73	-0.000725
		3	SUBBASE	36	32300	0.45	8.7	5.843	8	-12.1	-4	0.003644	-0.006223	12	0.2962	5.1798	-4.29	-9.4E-05
		4	ROADBED	20	17700	0.45	13.1	5.642	13.6	-3.9	-0.9	0.004895	-0.003981	18	0.283	4.7708	3.49	0.000414
							13.1	5.642	-0.3	-3.9	-0.9	0.004895	-0.0115	24	0.2497	4.4118	7.81	0.000671
							49.1	4.144	-0.4	-0.8	0	0.00051	-0.001466	36	0.1539	3.8881	13.03	0.000795
							49.1	4.144	-0.5	-0.8	0	0.00051	-0.002051	60	0.0241	3.513	9.39	0.000606
175151	4	1	AC	8.7	2664300	0.15	0	4.802	-92.4	-79.6	0	-0.002427	-0.001857	0	0	4.802	-91.06	-0.002427
		2	BASE	3.4	2857900	0.2	8.7	4.646	21.4	-16.5	-6	0.000752	-0.000887	8	0.1332	4.5253	-16.9	-0.000322
		3	SUBBASE	36	29300	0.35	8.7	4.646	22.8	-16.5	-6	0.000752	-0.000892	12	0.1428	4.3763	-5.41	-0.000118
		4	ROADBED	20	23800	0.35	12.1	4.617	64.2	-2.3	-5.3	0.001807	-0.001005	18	0.1433	4.2093	-0.78	8.2E-05
							12.1	4.617	-0.3	-2.3	-5.3	0.001807	-0.006567	24	0.1327	4.0534	4.75	0.000262
							48.1	3.471	-0.4	-0.8	0	8.9E-05	-0.001718	36	0.0889	3.8148	11.41	0.000407
							48.1	3.471	-0.4	-0.8	0	8.9E-05	-0.002102	60	0.0146	3.6315	9.87	0.000364
175453	4	1	AC	2.8	1221100	0.3	0	4.677	-62.5	-79.6	0	-0.001722	-0.00349	0	0	4.677	-66.01	-0.001722
		2	BASE	8.4	5207700	0.15	2.8	4.573	-46.9	-73.3	-5.9	-0.000939	-0.003878	8	0.1137	4.4074	-16.73	-0.000644
		3	SUBBASE	4.3	268500	0.3	2.8	4.573	-73.6	-73.3	-5.9	-0.000939	-0.000967	12	0.1358	4.282	-7.77	-0.000399
		4	ROADBED	44.5	18600	0.45	11.2	4.513	83.4	-4.2	-2.8	0.001326	-0.000612	18	0.1467	4.1423	-3.15	2E-06
							11.2	4.513	3.6	-4.2	-2.8	0.001326	-0.002103	24	0.138	4.002	1.18	0.000254
							15.5	4.434	6.3	-1.3	-0.3	0.001774	-0.001907	36	0.0929	3.78	5.43	0.000421
							15.5	4.434	-0.4	-1.3	-0.3	0.001774	-0.00488	60	0.0152	3.6067	5.13	0.00038

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY	NO.	LAYER INFORMATION TYPE	THICK	MODULU	POIS	DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD DEF	STRESS (psi)			STRAIN		RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0. RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
175849	4	1	AC	7.2	5827200	0.15	0	6.514	-168.6	-79.6	0	-0.002185	-0.000408	0	0	6.514	-165.69	-0.002185
		2	BASE	4.3	402800	0.3	7.2	6.46	133.3	-8.8	-6.9	0.001921	-0.00088	8	0.1259	6.2688	-50.35	-0.000576
		3	SUBBASE	36	19100	0.45	7.2	6.46	7.9	-8.8	-6.9	0.001921	-0.003053	12	0.1428	6.0958	-19.59	-0.000202
		4	ROADBED	20	13200	0.45	11.5	6.348	15.6	-1.9	-0.8	0.002834	-0.002815	18	0.1421	5.8488	2.79	0.000142
							11.5	6.348	-0.5	-1.9	-0.8	0.002834	-0.007295	24	0.1278	5.6248	13.82	0.000316
							47.5	5.334	-0.6	-0.7	0	3.5E-05	-0.000999	36	0.0792	5.2857	26.78	0.000413
							47.5	5.334	-0.6	-0.7	0	3.5E-05	-0.001451	60	0.0127	5.0365	18.94	0.000318
176050	4	1	AC	4.8	1154300	0.3	0	7.666	-155.3	-79.6	0	-0.007373	0.001349	0	0	7.666	-167.2	-0.007373
		2	BASE	2.6	1098600	0.3	4.8	7.547	24.6	-34.9	-13.3	0.002538	-0.004072	8	0.4084	6.7075	-45.84	-0.001621
		3	SUBBASE	13.9	52900	0.35	4.8	7.547	25.6	-34.9	-13.3	0.002538	-0.004671	12	0.4475	6.0945	-12.83	-0.000136
		4	ROADBED	38.7	18300	0.45	7.4	7.404	112.3	-12.7	-10.1	0.007514	-0.00738	18	0.4133	5.3334	3.72	0.000893
							7.4	7.404	0.2	-12.7	-10.1	0.007514	-0.02136	24	0.3507	4.7013	8.68	0.001143
							21.3	5.76	2.6	-2.5	-0.1	0.004738	-0.008115	36	0.2028	3.8318	14.83	0.001132
							21.3	5.76	-0.4	-2.5	-0.1	0.004738	-0.0115	60	0.0309	3.243	10.14	0.000779
176050	4	1	AC	4.4	997100	0.3	0	9.373	-151.1	-79.6	0	-0.008229	0.001346	0	0	9.373	-161.85	-0.008229
		2	BASE	2.4	1112200	0.3	4.4	9.251	11.8	-39.6	-14.8	0.002152	-0.004443	8	0.448	8.2918	-40.5	-0.001553
		3	SUBBASE	14	74800	0.35	4.4	9.251	17.9	-39.6	-14.8	0.002152	-0.004626	12	0.482	7.6172	-9.04	5E-05
		4	ROADBED	39.2	13200	0.45	6.8	9.112	114.3	-17.6	-12.2	0.007687	-0.007846	18	0.4366	6.8088	4.71	0.00104
							6.8	9.112	0.3	-17.6	-12.2	0.007687	-0.02169	24	0.3687	6.1523	7.65	0.0012
							20.8	7.512	5.7	-2.3	-0.2	0.0059	-0.008355	36	0.2162	5.2559	13.08	0.001172
							20.8	7.512	-0.4	-2.3	-0.2	0.0059	-0.01431	60	0.0337	4.6453	9.49	0.000847
179267	4	1	AC	8.6	3200100	0.15	0	5.595	-115.4	-79.6	0	-0.002619	-0.001316	0	0	5.595	-113.83	-0.002619
		2	BASE	4.2	706500	0.3	8.6	5.473	67.2	-11.1	-4.5	0.001791	-0.001016	8	0.1475	5.3039	-27.24	-0.000512
		3	SUBBASE	36	19800	0.35	8.6	5.473	13.6	-11.1	-4.5	0.001791	-0.00267	12	0.1625	5.1253	-9.86	-0.000184
		4	ROADBED	20	22000	0.35	12.8	5.375	26.9	-2.1	-1.3	0.002747	-0.002618	18	0.1626	4.8968	0.26	0.000125
							12.8	5.375	-0.2	-2.1	-1.3	0.002747	-0.009157	24	0.1486	4.6885	7.38	0.000323
							48.8	3.777	-0.4	-0.8	0	2.7E-05	-0.002441	36	0.0969	4.3677	15.99	0.000464
							48.8	3.777	-0.4	-0.8	0	2.7E-05	-0.002217	60	0.0158	4.1253	12.88	0.000395
181037	3	1	AC	14.1	1491100	0.3	0	4.131	-96	-79.6	0	-0.002809	-0.001299	0	0	4.131	-100.39	-0.002809
		2	BASE	36	21200	0.45	14.1	3.801	48.4	-2.2	-2.6	0.002287	-0.00214	8	0.1549	3.7203	-21.8	-0.000537
		3	ROADBED	20	26200	0.45	14.1	3.801	-0.7	-2.2	-2.6	0.002287	-0.006198	12	0.171	3.5193	-7.57	-0.000237
							50.1	2.809	-0.6	-0.8	0	4.6E-05	-0.001039	18	0.1766	3.3189	-4.77	1.8E-05
							50.1	2.809	-0.6	-0.8	0	4.6E-05	-0.000875	24	0.1677	3.1348	0.74	0.00027
														36	0.1174	2.8459	7.65	0.000499
														60	0.0196	2.6192	8.11	0.000489

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY		LAYER INFORMATION				DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
183031	4	1	AC	10.4	4939800	0.15	0	5.015	-110.6	-79.6	0	-0.001617	-0.000884	0	0	5.015	-109.15	-0.001617
		2	BASE	4.4	45800	0.35	10.4	4.928	81.9	-3.1	-2.9	0.001387	-0.00059	8	0.0914	4.8367	-26.2	-0.000319
		3	SUBBASE	36	45900	0.45	10.4	4.928	-0.4	-3.1	-2.9	0.001387	-0.004865	12	0.101	4.7293	-10.02	-0.000126
		4	ROADBED	20	15900	0.45	14.8	4.746	-0.4	-1.9	0	0.000927	-0.003533	18	0.1018	4.5946	-0.29	6.9E-05
							14.8	4.746	-0.8	-1.9	0	0.000927	-0.002607	24	0.0933	4.4697	7.15	0.000201
							50.8	4.324	-0.4	-0.6	0	8.7E-05	-0.000526	36	0.0608	4.2778	15.43	0.000291
							50.8	4.324	-0.5	-0.6	0	8.7E-05	-0.00121	60	0.0099	4.1345	12.44	0.000247
195042	4	1	AC	8.1	4476600	0.15	0	7.814	-146	-79.6	0	-0.002452	-0.000726	0	0	7.814	-144.68	-0.002452
		2	BASE	4.1	402800	0.35	8.1	7.736	110.2	-6.8	-5.7	0.002071	-0.000925	8	0.1424	7.547	-43.07	-0.000639
		3	SUBBASE	36	4100	0.45	8.1	7.736	9.6	-6.8	-5.7	0.002071	-0.003198	12	0.1618	7.3648	-18.8	-0.00027
		4	ROADBED	20	14000	0.45	12.2	7.613	18.1	-1.2	-0.8	0.003024	-0.003483	18	0.1648	7.1101	-0.68	0.000102
							12.2	7.613	-0.6	-1.2	-0.8	0.003024	-0.01165	24	0.1513	6.8719	10.45	0.000325
							48.2	5.247	-0.7	-0.8	0	-0.000562	-0.00389	36	0.0978	6.5039	23.42	0.000478
							48.2	5.247	-0.8	-0.8	0	-0.000562	-0.000506	60	0.016	6.2247	18.29	0.000401
201005	3	1	AC	13.5	1165600	0.3	0	6.633	-100.2	-79.6	0	-0.003813	-0.001428	0	0	6.633	-104.62	-0.003813
		2	BASE	36	13700	0.45	13.5	6.223	53.9	-2.2	-2.9	0.003236	-0.00303	8	0.2132	6.0903	-25.27	-0.000859
		3	ROADBED	20	15200	0.45	13.5	6.223	-0.7	-2.2	-2.9	0.003236	-0.008911	12	0.2393	5.8157	-9.56	-0.000391
							49.5	4.798	-0.6	-0.8	0	4.2E-05	-0.001519	18	0.2487	5.5281	-5.4	1.8E-05
							49.5	4.798	-0.6	-0.8	0	4.2E-05	-0.001403	24	0.2361	5.2599	0.87	0.000383
														36	0.1649	4.8413	8.47	0.000704
														60	0.0275	4.514	8.94	0.000687
201009	3	1	AC	11.7	1081200	0.3	0	6.916	-110.4	-79.6	0	-0.004757	-0.000944	0	0	6.916	-115.44	-0.004757
		2	BASE	36	19600	0.35	11.7	6.513	67.4	-3.8	-4.1	0.004366	-0.004231	8	0.2701	6.2707	-31.02	-0.001213
		3	ROADBED	20	20700	0.35	11.7	6.513	-0.3	-3.8	-4.1	0.004366	-0.01454	12	0.3063	5.9178	-12.2	-0.0005
							47.7	4.144	-0.4	-0.9	0	0.000312	-0.003125	18	0.3136	5.5169	-4.8	0.000138
							47.7	4.144	-0.4	-0.9	0	0.000312	-0.003013	24	0.2907	5.1521	2.41	0.000579
														36	0.1941	4.5915	10.22	0.00089
														60	0.0315	4.1682	9.54	0.000787
201010	3	1	AC	8.6	516000	0.35	0	11.12	-145.3	-79.6	0	-0.01262	0.005176	0	0	11.12	-161.43	-0.01262
		2	BASE	36	15100	0.45	8.6	10.48	105.8	-8.7	-7.7	0.01362	-0.01647	8	0.7206	9.3796	-48.75	-0.003661
		3	ROADBED	20	16900	0.45	8.6	10.48	-1.8	-8.7	-7.7	0.01362	-0.03459	12	0.8188	8.3	-17.3	-0.000893
							44.6	5.087	-0.5	-1.3	0	0.001858	-0.005201	18	0.7864	6.9673	-1.1	0.001319
							44.6	5.087	-0.5	-1.3	0	0.001858	-0.005106	24	0.6785	5.83	6.62	0.002105
														36	0.3959	4.2383	13.38	0.002191
														60	0.0588	3.1525	9.25	0.001485

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
201010	3	1	AC	9	1759900	0.3	0	6.261	-145.1	-79.6	0	-0.004297	0.000655	0	0	6.261	-152.65	-0.004297
		2	BASE	36	28200	0.45	9	6.06	110	-5.6	-8.2	0.004364	-0.004197	8	0.2495	5.7219	-48.63	-0.001269
		3	ROADBED	20	17600	0.45	9	6.06	-1.2	-5.6	-8.2	0.004364	-0.01126	12	0.2862	5.379	-20.39	-0.000451
							45	4.303	-0.4	-0.9	0	0.000732	-0.002052	18	0.2861	4.9331	-3.66	0.000282
							45	4.303	-0.5	-0.9	0	0.000732	-0.002568	24	0.2567	4.5324	6.15	0.000642
														36	0.1605	3.939	15.9	0.000812
														60	0.0252	3.5073	12.58	0.000634
203015	4	1	AC	9.3	2587900	0.15	0	5.369	-100.7	-79.6	0	-0.002746	-0.001797	0	0	5.369	-98.71	-0.002746
		2	BASE	4	467200	0.35	9.3	5.206	57.7	-10.9	-3.1	0.001894	-0.001143	8	0.1491	5.0515	-18.23	-0.000355
		3	SUBBASE	36	67700	0.45	9.3	5.206	8	-10.9	-3.1	0.001894	-0.003453	12	0.158	4.8718	-3.39	-3.8E-05
		4	ROADBED	20	15700	0.45	13.3	5.086	14.8	-4	-0.8	0.002348	-0.003088	18	0.1511	4.6636	2.81	0.00021
							13.3	5.086	-0.2	-4	-0.8	0.002348	-0.005484	24	0.134	4.4829	6.88	0.000349
							49.3	4.395	-0.1	-0.7	0	0.000316	-0.000776	36	0.0836	4.216	11.72	0.000423
							49.3	4.395	-0.4	-0.7	0	0.000316	-0.001636	60	0.0132	4.0245	8.73	0.000331
204052	4	1	AC	8.6	1246700	0.15	0	8.597	-102.5	-79.6	0	-0.005858	-0.003705	0	0	8.597	-101.02	-0.005858
		2	BASE	3.6	531100	0.2	8.6	8.273	45.8	-14.3	-4.5	0.003204	-0.002327	8	0.3229	7.9289	-20.21	-0.000874
		3	SUBBASE	36	18900	0.35	8.6	8.273	17.8	-14.3	-4.5	0.003204	-0.003982	12	0.3471	7.5445	-5.72	-0.000234
		4	ROADBED	20	14900	0.35	12.2	8.155	36.2	-3.3	-2.6	0.005555	-0.003406	18	0.341	7.0876	1.2	0.000339
							12.2	8.155	0	-3.3	-2.6	0.005555	-0.01664	24	0.3084	6.6752	6.55	0.000717
							48.2	5.657	-0.3	-0.8	0	0.00042	-0.003178	36	0.198	6.0547	12.91	0.000966
							48.2	5.657	-0.4	-0.8	0	0.00042	-0.003963	60	0.0317	5.5948	10.11	0.000795
204052	4	1	AC	9.7	4428900	0.15	0	6.608	-108.5	-79.6	0	-0.001749	-0.000993	0	0	6.608	-106.31	-0.001749
		2	BASE	4.4	448200	0.2	9.7	6.513	70.6	-7.2	-3.1	0.001335	-0.00068	8	0.0979	6.4124	-24.61	-0.000326
		3	SUBBASE	36	42400	0.35	9.7	6.513	5.9	-7.2	-3.1	0.001335	-0.001994	12	0.1073	6.296	-8.32	-0.00011
		4	ROADBED	20	14100	0.35	14.1	6.447	9.6	-2.3	-0.6	0.001813	-0.001385	18	0.107	6.1515	0.36	8.6E-05
							14.1	6.447	0	-2.3	-0.6	0.001813	-0.005359	24	0.0975	6.0203	6.89	0.000216
							50.1	5.638	-0.3	-0.7	0	0.000147	-0.001136	36	0.0633	5.8191	14.43	0.000304
							50.1	5.638	-0.3	-0.7	0	0.000147	-0.003112	60	0.0103	5.6685	11.6	0.000257
204054	4	1	AC	9.6	2496700	0.15	0	4.209	-103.6	-79.6	0	-0.002938	-0.001821	0	0	4.209	-101.41	-0.002938
		2	BASE	3.5	209900	0.2	9.6	4.039	67.7	-8.3	-2.5	0.002277	-0.001217	8	0.1605	3.8716	-19.85	-0.000419
		3	SUBBASE	36	65600	0.45	9.6	4.039	4.1	-8.3	-2.5	0.002277	-0.004448	12	0.171	3.6763	-4	-5.4E-05
		4	ROADBED	20	22800	0.45	13.1	3.914	5.6	-4.2	-0.5	0.002521	-0.003079	18	0.1634	3.4473	3.23	0.000237
							13.1	3.914	-0.4	-4.2	-0.5	0.002521	-0.005959	24	0.1441	3.2477	7.56	0.000391
							49.1	3.132	-0.2	-0.7	0	0.000341	-0.000854	36	0.0885	2.9573	12.33	0.000459
							49.1	3.132	-0.5	-0.7	0	0.000341	-0.001423	60	0.0138	2.7498	8.83	0.000347

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY	NO.	LAYER INFORMATION				DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
			TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
211034	3	1	AC	14.1	662800	0.3	0	5.722	-88.9	-79.6	0	-0.005576	-0.003573	0	0	5.722	-93	-0.005576
		2	BASE	36	36500	0.45	14.1	4.963	38	-4.5	-2.3	0.004149	-0.004189	8	0.2942	4.8433	-15.95	-0.000645
		3	ROADBED	20	20900	0.45	14.1	4.963	-0.7	-4.5	-2.3	0.004149	-0.01004	12	0.3102	4.4372	-2.84	-0.000107
							50.1	3.559	-0.3	-0.9	0	0.000527	-0.001466	18	0.3045	4.0782	-2.02	0.000238
							50.1	3.559	-0.5	-0.9	0	0.000527	-0.001947	24	0.2796	3.7641	1.53	0.000585
														36	0.1861	3.2992	5.9	0.000853
														60	0.0299	2.9573	5.51	0.000749
216040	4	1	AC	7.6	470000	0.3	0	11.81	-158.9	-79.6	0	-0.01794	0.004641	0	0	11.81	-167.21	-0.01794
		2	BASE	16	12800	0.35	7.6	11.15	123.9	-11.3	-8.5	0.01865	-0.01875	8	1.0017	9.4756	-48.48	-0.004277
		3	SUBBASE	36	13100	0.45	7.6	11.15	-0.9	-11.3	-8.5	0.01865	-0.06148	12	1.1053	7.9702	-13.88	-0.000403
		4	ROADBED	20	43800	0.45	23.6	5.307	-0.2	-3	-0.1	0.007222	-0.02241	18	1.0161	6.0817	4.57	0.002381
							23.6	5.307	-0.8	-3	-0.1	0.007222	-0.01802	24	0.8477	4.5218	10.37	0.003066
							59.6	1.91	-0.9	-1.2	0	0.000389	-0.002902	36	0.4623	2.4221	15.39	0.002813
							59.6	1.91	-0.6	-1.2	0	0.000389	-0.001343	60	0.066	1.071	8.95	0.001675
261012	4	1	AC	5.9	635300	0.34	0	10.48	-146.8	-79.6	0	-0.01126	0.003179	0	0	10.48	-170.05	-0.01126
		2	BASE	6.5	115600	0.35	5.9	10.14	76	-28.5	-6.6	0.009801	-0.01203	8	0.5938	8.849	-42.13	-0.002033
		3	SUBBASE	13.2	27700	0.35	5.9	10.14	3.1	-28.5	-6.6	0.009801	-0.025	12	0.6318	7.8665	-7.03	0.000373
		4	ROADBED	34.4	14800	0.45	12.4	8.976	16.1	-7.3	-0.8	0.01116	-0.01622	18	0.5553	6.7638	4.18	0.00151
							12.4	8.976	1	-7.3	-0.8	0.01116	-0.02819	24	0.4626	5.901	6.16	0.001583
							25.6	6.808	1.1	-2.2	-0.1	0.005309	-0.01072	36	0.2684	4.7557	10.88	0.001469
							25.6	6.808	-0.4	-2.2	-0.1	0.005309	-0.01279	60	0.0412	3.9902	7.91	0.001037
261012	4	1	AC	6.1	970700	0.35	0	13.39	-211.8	-79.6	0	-0.01117	0.007983	0	0	13.39	-239.39	-0.01117
		2	BASE	3	25900	0.35	6.1	13.16	174.5	-13.9	-7	0.01208	-0.01467	8	0.6105	11.8527	-70.68	-0.002536
		3	SUBBASE	29.9	25700	0.35	6.1	13.16	-1.4	-13.9	-7	0.01208	-0.0406	12	0.6655	10.8075	-18.51	0.000116
		4	ROADBED	21	9900	0.45	9.1	12.1	-0.9	-8.5	-0.3	0.009235	-0.03045	18	0.5863	9.4728	9.02	0.001775
							9.1	12.1	-0.9	-8.5	-0.3	0.009235	-0.03057	24	0.4735	8.4129	13.31	0.001923
							39	8.163	0.6	-1.2	0	0.003003	-0.006114	36	0.2461	7.0408	19.19	0.001578
							39	8.163	-0.4	-1.2	0	0.003003	-0.008075	60	0.0352	6.1923	10.57	0.000891
261013	4	1	AC	6.6	641900	0.35	0	10.65	-158.8	-79.6	0	-0.01151	0.005849	0	0	10.65	-177.42	-0.01151
		2	BASE	5	121600	0.35	6.6	10.29	90.7	-20.9	-6	0.01019	-0.01361	8	0.6388	9.0472	-50.84	-0.002873
		3	SUBBASE	16.1	12900	0.35	6.6	10.29	8.7	-20.9	-6	0.01019	-0.02099	12	0.7098	8.036	-15.59	-0.000376
		4	ROADBED	32.3	21600	0.35	11.6	9.417	23.9	-5.7	-1.1	0.01431	-0.01859	18	0.6622	6.7993	0.77	0.001331
							11.6	9.417	0	-5.7	-1.1	0.01431	-0.0416	24	0.5653	5.7687	6.95	0.001809
							27.7	5.469	-0.7	-2.3	0	0.00272	-0.01381	36	0.328	4.3402	14.01	0.001829
							27.7	5.469	-0.3	-2.3	0	0.00272	-0.009524	60	0.049	3.3727	9.6	0.001237

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
261013	4	1	AC	6.7	593900	0.35	0	11.33	-161.2	-79.6	0	-0.01267	0.006723	0	0	11.33	-180.56	-0.01267
		2	BASE	4.8	49900	0.35	6.7	10.9	111.4	-18.1	-5.4	0.01306	-0.01684	8	0.6816	9.5281	-47.02	-0.002561
		3	SUBBASE	18.6	25400	0.35	6.7	10.9	1.4	-18.1	-5.4	0.01306	-0.03431	12	0.7324	8.407	-9.11	0.000348
		4	ROADBED	29.9	17900	0.35	11.5	9.6	4.7	-8.3	-0.5	0.01188	-0.02321	18	0.6375	7.0988	6.61	0.002007
							11.5	9.6	0.3	-8.3	-0.5	0.01188	-0.03316	24	0.5126	6.0838	8.99	0.00209
							30.1	6.375	0.3	-2.2	0	0.00382	-0.009516	36	0.27	4.7918	12.16	0.001684
							30.1	6.375	-0.1	-2.2	0	0.00382	-0.01184	60	0.0383	3.9958	7	0.000973
263068	4	1	AC	9	5213700	0.15	0	3.588	-123	-79.6	0	-0.001725	-0.000759	0	0	3.588	-121.1	-0.001725
		2	BASE	4.4	528700	0.35	9	3.513	85.6	-6.9	-4.1	0.001379	-0.000655	8	0.0985	3.3985	-32.15	-0.000389
		3	SUBBASE	36	16300	0.35	9	3.513	7.9	-6.9	-4.1	0.001379	-0.002232	12	0.1102	3.2793	-12.89	-0.000156
		4	ROADBED	20	46300	0.35	13.4	3.424	14.7	-1.6	-0.6	0.001908	-0.002268	18	0.1114	3.121	-0.48	7.2E-05
							13.4	3.424	-0.3	-1.6	-0.6	0.001908	-0.007598	24	0.1024	2.9738	8.08	0.000217
							49.4	1.831	-0.5	-0.8	0	-0.000104	-0.002927	36	0.0669	2.7475	18.02	0.00032
							49.4	1.831	-0.5	-0.8	0	-0.000104	-0.000963	60	0.0109	2.576	14.54	0.000273
269029	4	1	AC	7.2	2955500	0.15	0	4.75	-87.6	-79.6	0	-0.002041	-0.001715	0	0	4.75	-85.93	-0.002041
		2	BASE	8.2	1771600	0.15	7.2	4.619	14.2	-32	-5.2	0.000566	-0.001238	8	0.1085	4.5086	-12.57	-0.000169
		3	SUBBASE	15	7100	0.35	7.2	4.619	6.2	-32	-5.2	0.000566	-0.001881	12	0.1129	4.3848	-2.25	-2.7E-05
		4	ROADBED	29.6	23100	0.45	15.4	4.542	32.4	-1.3	-1.5	0.001539	-0.000631	18	0.1112	4.2561	-0.58	6.9E-05
							15.4	4.542	-0.4	-1.3	-1.5	0.001539	-0.01078	24	0.1038	4.1394	3.29	0.000185
							30.4	3.227	-0.5	-0.8	0	-0.000138	-0.007196	36	0.0718	3.9573	9.54	0.000311
							30.4	3.227	-0.7	-0.8	0	-0.000138	-0.000727	60	0.0121	3.8133	9.06	0.000301
269029	4	1	AC	7.4	3075800	0.15	0	3.532	-83.5	-79.6	0	-0.001847	-0.001691	0	0	3.532	-81.75	-0.001847
		2	BASE	7.9	2140700	0.15	7.4	3.402	10.5	-31.9	-4.8	0.000443	-0.00115	8	0.0974	3.3104	-10.86	-0.000121
		3	SUBBASE	12	27200	0.35	7.4	3.402	5.5	-31.9	-4.8	0.000443	-0.001545	12	0.1002	3.201	-1.39	-7E-06
		4	ROADBED	32.7	25900	0.45	15.3	3.339	32.9	-1.8	-1.6	0.001295	-0.00055	18	0.0984	3.0907	-0.49	6.4E-05
							15.3	3.339	-0.3	-1.8	-1.6	0.001295	-0.004797	24	0.0916	2.9921	3.08	0.000165
							27.3	2.926	-0.3	-0.9	0	0.000382	-0.002555	36	0.0634	2.8372	8.73	0.000274
							27.3	2.926	-0.6	-0.9	0	0.000382	-0.0016	60	0.0106	2.7163	8.29	0.000265
269030	4	1	AC	7	5303700	0.15	0	5.063	-99.5	-79.6	0	-0.001324	-0.000879	0	0	5.063	-97.65	-0.001324
		2	BASE	9.1	1816800	0.15	7	4.994	32.1	-29.1	-6.2	0.000584	-0.000741	8	0.0707	4.9083	-16.04	-0.000138
		3	SUBBASE	31.4	5200	0.35	7	4.994	7.5	-29.1	-6.2	0.000584	-0.001684	12	0.0741	4.8227	-2.65	-1.2E-05
		4	ROADBED	20	50700	0.35	16.1	4.923	24.8	-1.1	-1.3	0.001146	-0.000473	18	0.0718	4.7279	0.7	6.6E-05
							16.1	4.923	-0.4	-1.1	-1.3	0.001146	-0.01226	24	0.066	4.6446	4.33	0.00013
							47.5	1.685	-0.4	-0.8	0	-0.000231	-0.009188	36	0.0449	4.5146	11.11	0.0002
							47.5	1.685	-0.6	-0.8	0	-0.000231	-0.000715	60	0.0075	4.4138	10.16	0.000188

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
271016	4	1	AC	3.3	1586600	0.3	0	14.18	-411	-79.6	0	-0.01683	0.01111	0	0	14.18	-476.81	-0.01683
		2	BASE	6	20200	0.35	3.3	14.1	376.7	-28.6	-34	0.01717	-0.01617	8	0.7706	11.2154	-74.14	-0.000217
		3	SUBBASE	36	35000	0.35	3.3	14.1	-6.1	-28.6	-34	0.01717	-0.08345	12	0.7152	9.2465	36.67	0.003328
		4	ROADBED	20	18000	0.35	9.3	10	-4.4	-13.3	-0.3	0.008696	-0.04988	18	0.4629	7.1183	63.36	0.00374
							9.3	10	-2.4	-13.3	-0.3	0.008696	-0.03274	24	0.2995	5.801	23.68	0.002156
							45.3	5.293	0.4	-1.4	0	0.001978	-0.004544	36	0.1059	4.4981	21.7	0.001064
							45.3	5.293	-0.2	-1.4	0	0.001978	-0.006899	60	0.0132	3.9475	6.38	0.000339
271018	4	1	AC	4.5	650600	0.33	0	20.7	-241.8	-79.6	0	-0.02149	0.01254	0	0	20.7	-281.76	-0.02149
		2	BASE	4	29700	0.35	4.5	20.44	194.2	-25.3	-11.6	0.02181	-0.02323	8	1.0517	17.4499	-56.51	-0.001713
		3	SUBBASE	36	21900	0.35	4.5	20.44	-2.3	-25.3	-11.6	0.02181	-0.07116	12	1.0343	15.3275	7.2	0.003041
		4	ROADBED	20	8400	0.35	8.5	18.08	1.2	-13.8	-0.7	0.01871	-0.04902	18	0.7641	12.9675	26.81	0.004385
							8.5	18.08	-0.8	-13.8	-0.7	0.01871	-0.05913	24	0.5464	11.3525	15.41	0.003137
							44.5	10.76	0.5	-1.2	0	0.003218	-0.006588	36	0.237	9.5717	15.13	0.001856
							44.5	10.76	-0.2	-1.2	0	0.003218	-0.01209	60	0.0318	8.6563	6.32	0.000812
271019	4	1	AC	3.6	637000	0.35	0	14.99	-248.2	-79.6	0	-0.02152	0.01566	0	0	14.99	-312.52	-0.02152
		2	BASE	6.3	47100	0.35	3.6	14.8	179.5	-40	-16.5	0.02039	-0.02642	8	0.9738	11.3375	-49.34	-7.4E-05
		3	SUBBASE	36	24300	0.35	3.6	14.8	-4.5	-40	-16.5	0.02039	-0.06906	12	0.8975	9.1143	19.3	0.004169
		4	ROADBED	20	20700	0.35	9.9	11.57	6.7	-14.3	-1	0.01952	-0.04024	18	0.6022	6.9078	27.55	0.004186
							9.9	11.57	0.1	-14.3	-1	0.01952	-0.05728	24	0.4148	5.5382	11.47	0.002533
							45.9	4.705	-0.1	-1.5	0	0.001766	-0.005259	36	0.1804	4.1102	11.55	0.001395
							45.9	4.705	-0.2	-1.5	0	0.001766	-0.006253	60	0.0244	3.3958	5.01	0.000623
271019	4	1	AC	3.6	754000	0.35	0	15.18	-276.2	-79.6	0	-0.02061	0.01601	0	0	15.18	-349.65	-0.02061
		2	BASE	6.3	36200	0.35	3.6	15	219.5	-36.4	-18.5	0.02056	-0.02554	8	0.9319	11.6351	-56.28	-4.8E-05
		3	SUBBASE	36	28100	0.35	3.6	15	-5.3	-36.4	-18.5	0.02056	-0.07539	12	0.8549	9.4555	23.05	0.004199
		4	ROADBED	20	17900	0.35	9.9	11.42	1.2	-14.5	-0.7	0.01592	-0.04219	18	0.5553	7.2599	34.62	0.004254
							9.9	11.42	-0.6	-14.5	-0.7	0.01592	-0.04914	24	0.3682	5.9303	13.61	0.002464
							45.9	5.335	0.1	-1.4	0	0.001961	-0.004932	36	0.1494	4.6003	12.3	0.00124
							45.9	5.335	-0.2	-1.4	0	0.001961	-0.006908	60	0.02	3.9732	4.91	0.000512
271019	4	1	AC	4.6	611300	0.33	0	14.53	-210.2	-79.6	0	-0.01933	0.009872	0	0	14.53	-244.63	-0.01933
		2	BASE	6.6	31400	0.35	4.6	14.23	164.6	-28.6	-13.9	0.02005	-0.02192	8	0.9119	11.5823	-39.81	-0.000593
		3	SUBBASE	36	35300	0.35	4.6	14.23	-4	-28.6	-13.9	0.02005	-0.07195	12	0.8593	9.7625	15.24	0.003578
		4	ROADBED	20	14400	0.35	11.2	10.74	-1.7	-12.8	-0.4	0.01056	-0.03655	18	0.5831	7.8981	26.06	0.004178
							11.2	10.74	-1	-12.8	-0.4	0.01056	-0.03386	24	0.3887	6.7387	12.4	0.002617
							47.2	6.32	0.5	-1.2	0	0.001941	-0.004116	36	0.1545	5.5816	9.66	0.001297
							47.2	6.32	-0.2	-1.2	0	0.001941	-0.007227	60	0.0201	5.0423	3.75	0.000515

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
271028	3	1	AC	9.6	955400	0.3	0	8.253	-125.3	-79.6	0	-0.00645	-7.1E-05	0	0	8.253	-131.34	-0.00645
		2	BASE	36	29100	0.35	9.6	7.856	85.4	-7.2	-6.3	0.006298	-0.006336	8	0.3646	7.4007	-36.52	-0.00161
		3	ROADBED	20	17100	0.35	9.6	7.856	-0.3	-7.2	-6.3	0.006298	-0.01969	12	0.4086	6.8988	-12.57	-0.000434
							45.6	5.108	-0.1	-1	0	0.000915	-0.003069	18	0.3982	6.2999	-1.21	0.000526
							45.6	5.108	-0.3	-1	0	0.000915	-0.004602	24	0.3514	5.7798	5.5	0.000965
														36	0.2145	5.0313	11.83	0.001118
														60	0.0328	4.5057	8.9	0.000827
271029	3	1	AC	8	868500	0.3	0	8.548	-149.4	-79.6	0	-0.009102	0.001652	0	0	8.548	-157.57	-0.009102
		2	BASE	36	24700	0.35	8	8.175	113.8	-9.5	-9.9	0.009305	-0.009213	8	0.5102	7.3717	-43.99	-0.002121
		3	ROADBED	20	23600	0.35	8	8.175	-0.6	-9.5	-9.9	0.009305	-0.03007	12	0.5635	6.6265	-13.33	-0.000294
							44	3.984	-0.3	-1.3	0	0.001081	-0.00425	18	0.5258	5.6992	3.17	0.001102
							44	3.984	-0.3	-1.3	0	0.001081	-0.004516	24	0.4447	4.9228	9.07	0.001507
														36	0.2501	3.8601	14.55	0.001461
														60	0.0365	3.1595	9.04	0.000924
271029	3	1	AC	8.6	880600	0.34	0	10.85	-146.6	-79.6	0	-0.007739	0.002794	0	0	10.85	-160.73	-0.007739
		2	BASE	36	23800	0.35	8.6	10.48	107.4	-8.4	-8	0.008193	-0.009513	8	0.4436	9.809	-49.21	-0.00225
		3	ROADBED	20	12800	0.35	8.6	10.48	-0.4	-8.4	-8	0.008193	-0.02614	12	0.505	9.158	-18.23	-0.000606
							44.6	6.848	-0.1	-1	0	0.001327	-0.004028	18	0.4898	8.3443	-1.78	0.000733
							44.6	6.848	-0.3	-1	0	0.001327	-0.006349	24	0.4272	7.6448	6.41	0.001249
														36	0.2549	6.6484	14	0.00137
														60	0.0386	5.9578	10.16	0.000973
271087	3	1	AC	15.3	1965500	0.3	0	3.988	-91.6	-79.6	0	-0.001961	-0.001118	0	0	3.988	-95.58	-0.001961
		2	BASE	36	17100	0.35	15.3	3.726	42.2	-1.7	-2.1	0.001505	-0.001399	8	0.1063	3.6896	-19.49	-0.000338
		3	ROADBED	20	37100	0.35	15.3	3.726	-0.4	-1.7	-2.1	0.001505	-0.006769	12	0.1163	3.55	-6	-0.000144
							51.3	2.265	-0.5	-0.8	0	-0.000111	-0.002704	18	0.1201	3.4193	-4.64	0
							51.3	2.265	-0.5	-0.8	0	-0.000111	-0.001187	24	0.1151	3.2995	0.23	0.000169
														36	0.0821	3.1098	6.75	0.000339
														60	0.0138	2.9598	7.55	0.000345
273013	4	1	AC	7.6	6238000	0.15	0	7.456	-182	-79.6	0	-0.002212	-0.000308	0	0	7.456	-178.44	-0.002212
		2	BASE	5	21500	0.35	7.6	7.405	162.4	-3.4	-7.2	0.002166	-0.000883	8	0.1299	7.2115	-59.87	-0.000662
		3	SUBBASE	36	6400	0.35	7.6	7.405	-0.1	-3.4	-7.2	0.002166	-0.006947	12	0.1498	7.0335	-26.01	-0.000266
		4	ROADBED	20	23100	0.35	12.6	7.096	0.2	-1.2	0	0.002417	-0.005983	18	0.1516	6.7718	1.09	0.000121
							12.6	7.096	-0.4	-1.2	0	0.002417	-0.0139	24	0.1373	6.5302	15.47	0.00033
							48.6	3.635	-0.5	-0.8	0	-0.00031	-0.007223	36	0.0853	6.1603	31	0.000445
							48.6	3.635	-0.5	-0.8	0	-0.00031	-0.001759	60	0.0137	5.8898	21.84	0.000343

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
274034	3	1	AC	10.5	7686600	0.15	0	14.04	-115.8	-79.6	0	-0.001096	-0.000546	0	0	14.04	-114.32	-0.001096
		2	BASE	3.6	46600	0.35	10.5	13.98	87.8	-1.7	-2.5	0.000953	-0.000385	8	0.0631	13.9196	-30.69	-0.000254
		3	ROADBED	45.9	6700	0.35	10.5	13.98	0.1	-1.7	-2.5	0.000953	-0.002511	12	0.071	13.8425	-13.89	-0.000121
							14.1	13.9	0.3	-0.9	0	0.00109	-0.002354	18	0.0735	13.7583	-2.75	2.1E-05
							14.1	13.9	-0.4	-0.9	0	0.00109	-0.009317	24	0.0687	13.6642	6.58	0.000127
														36	0.0464	13.5192	17.28	0.000211
														60	0.0077	13.4075	15.1	0.000193
274034	3	1	AC	9.5	5689500	0.15	0	25.73	-132	-79.6	0	-0.001709	-0.000643	0	0	25.73	-129.81	-0.001709
		2	BASE	3.6	35500	0.35	9.5	25.66	106.9	-1.9	-3	0.00156	-0.000637	8	0.0995	25.5438	-38.92	-0.000453
		3	ROADBED	46.9	3600	0.35	9.5	25.66	0.2	-1.9	-3	0.00156	-0.003679	12	0.1135	25.425	-17.6	-0.000206
							13.1	25.53	0.6	-0.9	-0.1	0.001898	-0.003571	18	0.1169	25.26	-2.05	5.1E-05
							13.1	25.53	-0.3	-0.9	-0.1	0.001898	-0.01686	24	0.1082	25.1025	8.89	0.00022
														36	0.071	24.86	20.91	0.000339
														60	0.0116	24.6775	16.85	0.00029
274050	4	1	AC	7.9	5566600	0.15	0	5.93	-159.6	-79.6	0	-0.002138	-0.000472	0	0	5.93	-155.82	-0.002138
		2	BASE	5	39200	0.35	7.9	5.87	137.3	-4.9	-5.9	0.00205	-0.000878	8	0.1232	5.6925	-46.95	-0.000559
		3	SUBBASE	36	36600	0.35	7.9	5.87	-0.5	-4.9	-5.9	0.00205	-0.007394	12	0.1392	5.5268	-17.44	-0.000184
		4	ROADBED	20	18000	0.35	12.9	5.558	-0.4	-2.4	-0.1	0.001438	-0.00529	18	0.1376	5.2956	3.74	0.000157
							12.9	5.558	-0.4	-2.4	-0.1	0.001438	-0.005559	24	0.1226	5.0862	13.89	0.000322
							48.9	4.542	-0.3	-0.8	0	0.000229	-0.00153	36	0.0746	4.7748	24.64	0.000399
							48.9	4.542	-0.3	-0.8	0	0.000229	-0.002825	60	0.0117	4.5518	16.75	0.000294
275076	4	1	AC	9.1	6606600	0.15	0	6.226	-138.8	-79.6	0	-0.00156	-0.000523	0	0	6.226	-136.75	-0.00156
		2	BASE	6.5	13000	0.35	9.1	6.168	115.6	-2.6	-5.8	0.001456	-0.000592	8	0.0908	6.0581	-41.31	-0.000416
		3	SUBBASE	36	12700	0.35	9.1	6.168	-0.4	-2.6	-5.8	0.001456	-0.008053	12	0.1036	5.9455	-18.3	-0.000181
		4	ROADBED	20	20300	0.35	15.6	5.71	-0.4	-1.1	0	0.000883	-0.006272	18	0.1059	5.7883	-1.15	5.9E-05
							15.6	5.71	-0.4	-1.1	0	0.000883	-0.006409	24	0.0974	5.6434	10.02	0.000209
							51.6	4.068	-0.4	-0.7	0	-0.000214	-0.003368	36	0.063	5.4165	22.16	0.000308
							51.6	4.068	-0.5	-0.7	0	-0.000214	-0.002013	60	0.0103	5.245	17.28	0.000256
276064	4	1	AC	6.3	541400	0.31	0	8.596	-105.1	-79.6	0	-0.0086	-0.002018	0	0	8.596	-111.22	-0.0086
		2	BASE	7.2	227400	0.3	6.3	8.088	24.3	-37.3	-5.2	0.005209	-0.009861	8	0.4396	7.2868	-18.22	-0.000745
		3	SUBBASE	4.8	145400	0.35	6.3	8.088	1.3	-37.3	-5.2	0.005209	-0.01646	12	0.4488	6.633	-0.56	0.000367
		4	ROADBED	41.7	17900	0.35	13.5	7.358	12.4	-8	-1	0.004792	-0.006789	18	0.4083	6.0286	0.52	0.000733
							13.5	7.358	6.5	-8	-1	0.004792	-0.008593	24	0.3613	5.5457	2	0.000883
							18.3	6.99	12.2	-3.1	-0.5	0.006185	-0.008057	36	0.2368	4.8648	6.22	0.001094
							18.3	6.99	0.2	-3.1	-0.5	0.006185	-0.01724	60	0.0386	4.3695	5.87	0.000966

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
295047	4	1	AC	8.1	4194200	0.15	0	6.773	-161.4	-79.6	0	-0.002923	-0.000657	0	0	6.773	-159.97	-0.002923
		2	BASE	3.5	26800	0.35	8.1	6.692	140.9	-2.9	-5.1	0.002809	-0.001129	8	0.1707	6.4541	-50.12	-0.000809
		3	SUBBASE	36	9300	0.45	8.1	6.692	0.1	-2.9	-5.1	0.002809	-0.007601	12	0.1952	6.2295	-21.72	-0.00033
		4	ROADBED	20	15200	0.45	11.6	6.451	0.5	-1.5	-0.1	0.003042	-0.006658	18	0.1975	5.9069	0.73	0.000153
							11.6	6.451	-0.7	-1.5	-0.1	0.003042	-0.009189	24	0.1794	5.6096	13.15	0.00042
							47.6	4.819	-0.7	-0.8	0	-0.000142	-0.001916	36	0.1128	5.1532	26.8	0.000577
							47.6	4.819	-0.7	-0.8	0	-0.000142	-0.001105	60	0.0182	4.8155	19.44	0.000454
295047	4	1	AC	8.5	5029800	0.15	0	6.34	-153.7	-79.6	0	-0.002305	-0.000595	0	0	6.34	-152.03	-0.002305
		2	BASE	3.5	17300	0.35	8.5	6.27	132.6	-2.2	-4.3	0.002199	-0.000879	8	0.135	6.0916	-48.01	-0.000647
		3	SUBBASE	36	5300	0.45	8.5	6.27	-0.1	-2.2	-4.3	0.002199	-0.007115	12	0.1548	5.9188	-21.63	-0.000281
		4	ROADBED	20	18300	0.45	12	6.038	0.1	-1.1	0	0.002423	-0.006516	18	0.1583	5.6711	-0.79	9.7E-05
							12	6.038	-0.7	-1.1	0	0.002423	-0.009427	24	0.145	5.4404	11.8	0.00032
							48	4.036	-0.7	-0.8	0	-0.000386	-0.003169	36	0.0927	5.0836	25.58	0.000462
							48	4.036	-0.8	-0.8	0	-0.000386	-0.000482	60	0.015	4.8163	19.31	0.000376
295081	4	1	AC	10.1	3414500	0.15	0	5.023	-105.8	-79.6	0	-0.002225	-0.001325	0	0	5.023	-104.49	-0.002225
		2	BASE	4.4	281000	0.35	10.1	4.897	69.8	-5.9	-3.1	0.001724	-0.000823	8	0.1244	4.774	-22.95	-0.000385
		3	SUBBASE	36	33500	0.45	10.1	4.897	4.6	-5.9	-3.1	0.001724	-0.003069	12	0.1357	4.6285	-7.98	-0.000137
		4	ROADBED	20	17000	0.45	14.5	4.78	7.9	-2.1	-0.4	0.002078	-0.002722	18	0.1356	4.4501	0.15	0.000103
							14.5	4.78	-0.4	-2.1	-0.4	0.002078	-0.005112	24	0.124	4.2864	6.56	0.000268
							50.5	4.105	-0.5	-0.7	0	7.6E-05	-0.000645	36	0.081	4.0357	14.08	0.000386
							50.5	4.105	-0.5	-0.7	0	7.6E-05	-0.001172	60	0.0132	3.8467	11.47	0.00033
295403	4	1	AC	4.3	1705200	0.3	0	11.8	-209.8	-79.6	0	-0.007347	0.0028	0	0	11.8	-231.92	-0.007347
		2	BASE	6	228400	0.2	4.3	11.71	118.8	-35.6	-14.5	0.005645	-0.006109	8	0.3737	10.738	-50.47	-0.00089
		3	SUBBASE	36	31800	0.35	4.3	11.71	7.7	-35.6	-14.5	0.005645	-0.01623	12	0.3845	10.0525	-3.9	0.000494
		4	ROADBED	20	10500	0.35	10.3	11.1	24.9	-7.8	-2	0.00929	-0.00788	18	0.3257	9.2398	11.98	0.001063
							10.3	11.1	0.6	-7.8	-2	0.00929	-0.02529	24	0.2654	8.6067	10.82	0.001001
							46.3	8.054	0.2	-0.9	0	0.001274	-0.003027	36	0.1449	7.7766	17.76	0.000882
							46.3	8.054	-0.3	-0.9	0	0.001274	-0.006601	60	0.0217	7.2483	10.59	0.000547
295403	4	1	AC	3.6	2786800	0.3	0	6.013	-189.1	-79.6	0	-0.004018	0.001198	0	0	6.013	-213.38	-0.004018
		2	BASE	6.5	846800	0.2	3.6	5.982	46.9	-50.4	-13.3	0.001628	-0.002941	8	0.2154	5.4525	-58.2	-0.000805
		3	SUBBASE	36	23700	0.35	3.6	5.982	4.5	-50.4	-13.3	0.001628	-0.006081	12	0.2352	5.0868	-18.37	-0.000107
		4	ROADBED	20	26200	0.35	10.1	5.736	57.1	-4.2	-4.2	0.005405	-0.003303	18	0.2237	4.6221	-1.3	0.000325
							10.1	5.736	-0.1	-4.2	-4.2	0.005405	-0.01632	24	0.1984	4.2239	7.06	0.000515
							46.1	3.328	-0.4	-1	0	0.000365	-0.002836	36	0.1232	3.6394	20.32	0.000636
							46.1	3.328	-0.4	-1	0	0.000365	-0.00266	60	0.0195	3.2198	15.58	0.00049

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY		LAYER INFORMATION				DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
295413	4	1	AC	3.7	1501500	0.3	0	8.595	-184.9	-79.6	0	-0.007277	0.002025	0	0	8.595	-209.17	-0.007277
		2	BASE	5	545500	0.2	3.7	8.534	47.8	-47.5	-12.5	0.002987	-0.005326	8	0.3887	7.5742	-55.77	-0.001382
		3	SUBBASE	36	24900	0.35	3.7	8.534	8.4	-47.5	-12.5	0.002987	-0.009231	12	0.4191	6.9058	-14.05	2.1E-05
		4	ROADBED	20	20100	0.35	8.7	8.205	65.1	-7.3	-5.9	0.009708	-0.006313	18	0.3818	6.0698	4.64	0.00086
							8.7	8.205	0.1	-7.3	-5.9	0.009708	-0.02833	24	0.3236	5.3795	10.17	0.001068
							44.7	4.492	-0.2	-1.1	0	0.000986	-0.003735	36	0.1844	4.428	18.78	0.001066
							44.7	4.492	-0.3	-1.1	0	0.000986	-0.004515	60	0.0277	3.7945	12	0.000698
313028	4	1	AC	8.2	4598600	0.15	0	5.69	-144.5	-79.6	0	-0.002354	-0.000715	0	0	5.69	-142.92	-0.002354
		2	BASE	2.6	142800	0.2	8.2	5.613	118.5	-5.4	-4.6	0.00216	-0.000933	8	0.1347	5.4288	-39.59	-0.000555
		3	SUBBASE	36	38600	0.45	8.2	5.613	2.7	-5.4	-4.6	0.00216	-0.003948	12	0.1507	5.2535	-14.48	-0.000183
		4	ROADBED	20	15100	0.45	10.8	5.524	3.8	-3	-0.3	0.002556	-0.003158	18	0.1489	5.0133	3.25	0.000167
							10.8	5.524	-0.6	-3	-0.3	0.002556	-0.006327	24	0.133	4.7967	12.07	0.000342
							46.8	4.653	-0.4	-0.7	0	0.000305	-0.00098	36	0.0818	4.4742	21.76	0.000429
							46.8	4.653	-0.5	-0.7	0	0.000305	-0.001734	60	0.013	4.2405	15.24	0.000325
313028	4	1	AC	8.4	4941000	0.15	0	5.182	-129.4	-79.6	0	-0.001937	-0.000764	0	0	5.182	-127.95	-0.001937
		2	BASE	2.2	1743300	0.2	8.4	5.107	80.7	-7.5	-5.6	0.001381	-0.000669	8	0.1118	4.9714	-35.85	-0.00047
		3	SUBBASE	36	17600	0.45	8.4	5.107	28.5	-7.5	-5.6	0.001381	-0.001074	12	0.1261	4.8335	-15.44	-0.000202
		4	ROADBED	20	17200	0.45	10.6	5.084	46.3	-1.7	-3.5	0.00214	-0.001181	18	0.1286	4.6469	-0.91	7.5E-05
							10.6	5.084	-0.6	-1.7	-3.5	0.00214	-0.006	24	0.1182	4.4736	8.89	0.000251
							46.6	4.165	-0.6	-0.7	0	-4.4E-05	-0.000997	36	0.077	4.2046	19.88	0.000371
							46.6	4.165	-0.6	-0.7	0	-4.4E-05	-0.001043	60	0.0126	4	15.86	0.000315
317017	4	1	AC	3.2	173900	0.35	0	12.61	-48.2	-79.6	0	-0.002803	-0.027	0	0	12.61	-52.18	-0.002803
		2	BASE	7.9	2346300	0.15	3.2	11.78	-46.2	-73.3	-7.1	-0.003049	-0.02503	8	0.2852	11.3141	-12.18	-0.00345
		3	SUBBASE	5	8000	0.35	3.2	11.78	-100.6	-73.3	-7.1	-0.003049	-0.001787	12	0.4081	10.8575	-4.86	-0.002408
		4	ROADBED	43.9	7800	0.45	11.1	11.65	114.8	-2.8	-4.4	0.004052	-0.001717	18	0.4833	10.4658	-2.36	-0.000256
							11.1	11.65	-0.4	-2.8	-4.4	0.004052	-0.01799	24	0.4583	10.0219	0.48	0.000842
							16.1	10.87	-0.4	-1.4	0	0.002839	-0.01393	36	0.3041	9.3188	2.68	0.001412
							16.1	10.87	-0.7	-1.4	0	0.002839	-0.009413	60	0.0486	8.779	2.48	0.001218
382001	4	1	AC	2.5	510800	0.3	0	9.498	-76.7	-79.6	0	-0.006046	-0.006584	0	0	9.498	-80.33	-0.006046
		2	BASE	6.2	2794400	0.2	2.5	9.314	-55	-72.3	-11.3	-0.003376	-0.008105	8	0.3929	8.7284	-24.79	-0.002474
		3	SUBBASE	3	20000	0.35	2.5	9.314	-139.4	-72.3	-11.3	-0.003376	-0.000472	12	0.472	8.2837	-11.6	-0.001219
		4	ROADBED	48.3	11400	0.45	8.7	9.22	170	-4.3	-7.2	0.004801	-0.002723	18	0.4905	7.6928	-2.38	0.000334
							8.7	9.22	-0.2	-4.3	-7.2	0.004801	-0.01462	24	0.4433	7.1297	3.25	0.001104
							11.7	8.821	0.2	-2.3	-0.1	0.004738	-0.01243	36	0.2731	6.2789	8.15	0.001424
							11.7	8.821	-0.9	-2.3	-0.1	0.004738	-0.01324	60	0.0426	5.6615	6.07	0.00107

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
393801	4	1	AC	9	2577200	0.15	0	16.62	-85.7	-79.6	0	-0.002282	-0.001998	0	0	16.62	-84.13	-0.002282
		2	BASE	4.7	1831200	0.2	9	16.45	21.2	-18.6	-4.1	0.000779	-0.001002	8	0.1218	16.3478	-12.31	-0.000189
		3	SUBBASE	36	56800	0.45	9	16.45	13.3	-18.6	-4.1	0.000779	-0.001297	12	0.1266	16.2125	-2.17	-2.8E-05
		4	ROADBED	20	4100	0.45	13.7	16.4	37.8	-2.7	-2.6	0.001672	-0.000996	18	0.1242	16.0633	0.05	9.9E-05
							13.7	16.4	-0.4	-2.7	-2.6	0.001672	-0.004066	24	0.1141	15.9367	4.01	0.000232
							49.7	15.9	-0.2	-0.5	0	0.000206	-0.000599	36	0.0765	15.7383	9.38	0.000348
							49.7	15.9	-0.4	-0.5	0	0.000206	-0.003819	60	0.0126	15.5925	8.25	0.000314
394018	4	1	AC	10	3625500	0.15	0	3.285	-104.2	-79.6	0	-0.002061	-0.001264	0	0	3.285	-102.99	-0.002061
		2	BASE	3.5	744500	0.3	10	3.166	61	-6.8	-3.1	0.001428	-0.000726	8	0.1156	3.0556	-22.91	-0.000365
		3	SUBBASE	36	17900	0.35	10	3.166	12.4	-6.8	-3.1	0.001428	-0.001882	12	0.1266	2.9218	-8.72	-0.00015
		4	ROADBED	20	55700	0.35	13.5	3.104	21.3	-1.7	-1	0.002068	-0.00197	18	0.1282	2.7573	-0.97	7E-05
							13.5	3.104	-0.3	-1.7	-1	0.002068	-0.007792	24	0.1187	2.6049	5.91	0.000237
							49.5	1.534	-0.5	-0.8	0	-7.5E-05	-0.002772	36	0.079	2.3681	14.13	0.000366
							49.5	1.534	-0.5	-0.8	0	-7.5E-05	-0.000843	60	0.013	2.1858	11.99	0.000325
394018	4	1	AC	10.6	5976000	0.15	0	2.454	-102	-79.6	0	-0.001215	-0.000776	0	0	2.454	-100.49	-0.001215
		2	BASE	3.8	733400	0.3	10.6	2.38	63.2	-5.2	-2.6	0.000892	-0.000424	8	0.068	2.3186	-22.18	-0.000213
		3	SUBBASE	36	28800	0.35	10.6	2.38	7.3	-5.2	-2.6	0.000892	-0.001253	12	0.0744	2.241	-8.34	-8.7E-05
		4	ROADBED	20	58900	0.35	14.4	2.337	12.1	-1.6	-0.6	0.001217	-0.001215	18	0.0754	2.1467	-1.16	3.8E-05
							14.4	2.337	-0.2	-1.6	-0.6	0.001217	-0.004573	24	0.0699	2.0586	5.58	0.000137
							50.4	1.426	-0.5	-0.8	0	-6E-05	-0.00161	36	0.0468	1.9211	13.63	0.000215
							50.4	1.426	-0.5	-0.8	0	-6E-05	-0.000759	60	0.0077	1.815	11.73	0.000193
463013	4	1	AC	9.4	3532100	0.15	0	6.886	-128.6	-79.6	0	-0.002671	-0.001066	0	0	6.886	-126.38	-0.002671
		2	BASE	3.5	9200	0.35	9.4	6.775	103.9	-2.9	-2.9	0.002446	-0.001026	8	0.1536	6.5955	-35.41	-0.000647
		3	SUBBASE	36	26200	0.45	9.4	6.775	-0.8	-2.9	-2.9	0.002446	-0.01654	12	0.173	6.407	-14.4	-0.000258
		4	ROADBED	20	12700	0.45	12.9	6.249	-0.9	-1.8	0	0.000941	-0.01334	18	0.1748	6.1537	0.04	0.000126
							12.9	6.249	-1.1	-1.8	0	0.000941	-0.003334	24	0.1594	5.9215	9.36	0.000359
							48.9	5.538	-0.5	-0.7	0	0.000193	-0.001058	36	0.1022	5.5633	19.34	0.000504
							48.9	5.538	-0.5	-0.7	0	0.000193	-0.001774	60	0.0165	5.2963	14.86	0.000412
553010	4	1	AC	10.7	2013100	0.15	0	5.632	-98.4	-79.6	0	-0.003454	-0.002357	0	0	5.632	-96.85	-0.003454
		2	BASE	7.8	89600	0.35	10.7	5.408	64.1	-5.7	-3.7	0.002678	-0.001294	8	0.1897	5.2383	-18.71	-0.000487
		3	SUBBASE	36	26800	0.35	10.7	5.408	1	-5.7	-3.7	0.002678	-0.006424	12	0.2031	5.017	-5.07	-0.000127
		4	ROADBED	20	21900	0.35	18.5	5.046	2.1	-2.1	-0.1	0.002337	-0.003986	18	0.1994	4.76	1.04	0.000195
							18.5	5.046	-0.1	-2.1	-0.1	0.002337	-0.007386	24	0.1805	4.5295	6.16	0.000418
							54.5	3.764	-0.4	-0.8	0	9.7E-05	-0.001857	36	0.1163	4.1828	12.08	0.000563
							54.5	3.764	-0.4	-0.8	0	9.7E-05	-0.002259	60	0.0187	3.9242	9.58	0.000467

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
553012	4	1	AC	7	862900	0.15	0	15.1	-131.4	-79.6	0	-0.01116	-0.004143	0	0	15.1	-128.75	-0.01116
		2	BASE	6	100000	0.35	7	14.72	86.8	-18	-7.1	0.008636	-0.005289	8	0.6042	13.7977	-26.11	-0.00165
		3	SUBBASE	5.8	27000	0	7	14.72	4.2	-18	-7.1	0.008636	-0.01993	12	0.6411	12.985	-3.27	4.3E-05
		4	ROADBED	41.2	8900	0.35	13	13.83	11.8	-5	-0.5	0.009336	-0.01329	18	0.5926	11.9683	7.06	0.001156
							13	13.83	2.5	-5	-0.5	0.009336	-0.01791	24	0.5127	11.1217	9.81	0.001494
							18.8	13.11	2.7	-2.4	-0.2	0.009936	-0.008912	36	0.3093	9.9007	15.48	0.001644
							18.8	13.11	0.1	-2.4	-0.2	0.009936	-0.02793	60	0.0489	9.0415	10.8	0.001226
553014	4	1	AC	10.3	5228400	0.15	0	2.734	-109.5	-79.6	0	-0.001511	-0.000842	0	0	2.734	-108.08	-0.001511
		2	BASE	6	76200	0.35	10.3	2.652	80.2	-3.9	-3.8	0.001286	-0.00056	8	0.085	2.5667	-25.04	-0.000283
		3	SUBBASE	36	56700	0.45	10.3	2.652	-0.2	-3.9	-3.8	0.001286	-0.003918	12	0.0933	2.4657	-8.98	-0.000102
		4	ROADBED	20	34400	0.45	16.3	2.464	0	-2	-0.1	0.000913	-0.002611	18	0.0933	2.3412	0.4	7.5E-05
							16.3	2.464	-0.7	-2	-0.1	0.000913	-0.002444	24	0.0849	2.2268	7.31	0.000191
							52.3	2.065	-0.5	-0.7	0	7E-05	-0.000453	36	0.0548	2.0527	14.97	0.000267
							52.3	2.065	-0.5	-0.7	0	7E-05	-0.000666	60	0.0088	1.923	11.77	0.000221
553015	4	1	AC	9.8	4083600	0.15	0	5.718	-117.3	-79.6	0	-0.002075	-0.001007	0	0	5.718	-114.92	-0.002075
		2	BASE	8	49800	0.35	9.8	5.617	89.4	-4.3	-4.8	0.001819	-0.000802	8	0.1176	5.4893	-29.35	-0.000444
		3	SUBBASE	36	36800	0.35	9.8	5.617	-0.3	-4.3	-4.8	0.001819	-0.005839	12	0.1305	5.3475	-10.74	-0.000159
		4	ROADBED	20	18100	0.35	17.8	5.263	-0.1	-1.8	0	0.001151	-0.003515	18	0.1306	5.1651	0.62	0.000108
							17.8	5.263	-0.3	-1.8	0	0.001151	-0.004342	24	0.1186	4.9982	8.26	0.000273
							53.8	4.438	-0.3	-0.7	0	0.00011	-0.001315	36	0.0758	4.7462	16.47	0.000374
							53.8	4.438	-0.4	-0.7	0	0.00011	-0.002531	60	0.0122	4.558	12.7	0.000305
553015	4	1	AC	9.4	4698600	0.15	0	6.405	-124.8	-79.6	0	-0.001941	-0.000826	0	0	6.405	-122.64	-0.001941
		2	BASE	8	41000	0.35	9.4	6.32	98.8	-4.1	-5.6	0.00175	-0.000755	8	0.1107	6.1914	-32.75	-0.00044
		3	SUBBASE	36	40100	0.35	9.4	6.32	-0.4	-4.1	-5.6	0.00175	-0.006259	12	0.1237	6.0565	-12.4	-0.000161
		4	ROADBED	20	15400	0.35	17.4	5.934	-0.4	-1.8	0	0.000949	-0.003769	18	0.1238	5.8771	0.92	0.000106
							17.4	5.934	-0.4	-1.8	0	0.000949	-0.003851	24	0.1121	5.7137	9.26	0.000264
							53.4	5.187	-0.3	-0.7	0	0.000139	-0.001227	36	0.0711	5.4652	18.16	0.000356
							53.4	5.187	-0.3	-0.7	0	0.000139	-0.002919	60	0.0114	5.2828	13.66	0.000285
556354	4	1	AC	9.6	8239901	0.15	0	2.581	-127.3	-79.6	0	-0.001132	-0.000462	0	0	2.581	-125.07	-0.001132
		2	BASE	3.3	85600	0.35	9.6	2.533	101.3	-2.4	-2.6	0.001021	-0.000426	8	0.0654	2.4582	-35.93	-0.000284
		3	SUBBASE	17.7	16600	0.35	9.6	2.533	0.4	-2.4	-2.6	0.001021	-0.00236	12	0.0741	2.3803	-15.51	-0.000123
		4	ROADBED	29.4	55500	0.35	12.9	2.459	0.9	-1.3	-0.1	0.001217	-0.002272	18	0.0757	2.2724	-1.31	4E-05
							12.9	2.459	-0.4	-1.3	-0.1	0.001217	-0.006195	24	0.0698	2.1731	8.64	0.000146
							30.6	1.634	-0.5	-1	0	-2E-06	-0.003546	36	0.0455	2.0185	19.52	0.000219
							30.6	1.634	-0.5	-1	0	-2E-06	-0.001059	60	0.0074	1.9005	15.61	0.000186

Mechanistic responses - North Central Region (continued).

SHRP	NO.		LAYER INFORMATION				DEPTH	MECHANISTIC RESPONSES UNDER THE LOAD						RAD.	MECHANISTIC RESPONSES AT DEPTH = 0.			
ID	LAY	NO.	TYPE	THICK	MODULU	POIS	(in)	DEF	STRESS (psi)			STRAIN		DIST.	RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT	(in)	DISPL	(mil)	STRESS	STRAIN
833802	4	1	AC	9.8	6626200	0.15	0	7.057	-121	-79.6	0	-0.001325	-0.000604	0	0	7.057	-118.62	-0.001325
		2	BASE	5.8	77600	0.35	9.8	6.996	92.8	-3.6	-3.9	0.001162	-0.000502	8	0.076	6.9124	-32.4	-0.000312
		3	SUBBASE	6.9	90800	0.2	9.8	6.996	0	-3.6	-3.9	0.001162	-0.003289	12	0.0854	6.822	-13.39	-0.00013
		4	ROADBED	37.5	10800	0.45	15.6	6.853	0	-1.4	-0.1	0.000659	-0.001833	18	0.0869	6.7024	-1.09	4.8E-05
							15.6	6.853	0.4	-1.4	-0.1	0.000659	-0.001719	24	0.0802	6.5913	7.79	0.000166
							22.5	6.754	0.9	-0.8	-0.1	0.000998	-0.001339	36	0.0527	6.4188	17.74	0.000249
							22.5	6.754	-0.5	-0.8	-0.1	0.000998	-0.003763	60	0.0087	6.2868	14.64	0.000217
836450	4	1	AC	4.1	499100	0.32	0	14.21	-211.8	-79.6	0	-0.02446	0.01165	0	0	14.21	-242.68	-0.02446
		2	BASE	4.5	31000	0.35	4.1	13.88	156.2	-35.5	-13	0.02412	-0.02674	8	1.098	10.3639	-28.45	0.000622
		3	SUBBASE	3	78600	0.35	4.1	13.88	-6.5	-35.5	-13	0.02412	-0.09283	12	0.9887	8.0982	22.06	0.00508
		4	ROADBED	48.4	25200	0.35	8.6	10.67	-6	-19.1	-1.3	0.008946	-0.04759	18	0.6453	5.9389	24.28	0.00478
							8.6	10.67	0.6	-19.1	-1.3	0.008946	-0.02495	24	0.4384	4.6433	8.88	0.002711
							11.6	9.92	11.1	-12.7	-1.4	0.01483	-0.0261	36	0.1946	3.3205	8.55	0.001453
							11.6	9.92	-0.6	-12.7	-1.4	0.01483	-0.04671	60	0.027	2.6557	3.97	0.000687
836451	4	1	AC	4.1	540000	0.35	0	15.15	-229.9	-79.6	0	-0.02328	0.01573	0	0	15.15	-276.12	-0.02328
		2	BASE	9.8	33500	0.35	4.1	14.86	171.4	-34.9	-20.2	0.02338	-0.02821	8	1.0682	11.4195	-41.69	-0.000214
		3	SUBBASE	4.5	32900	0.35	4.1	14.86	-4.5	-34.9	-20.2	0.02338	-0.08228	12	0.9903	9.1583	17.96	0.004457
		4	ROADBED	41.6	20800	0.35	13.9	9.78	1.2	-9.7	-0.4	0.01216	-0.03142	18	0.667	6.8953	25.93	0.004664
							13.9	9.78	1	-9.7	-0.4	0.01216	-0.03146	24	0.458	5.4919	10.43	0.00279
							18.4	8.576	2	-6.3	-0.3	0.01065	-0.02342	36	0.2034	4.0303	10.09	0.001508
							18.4	8.576	0.1	-6.3	-0.3	0.01065	-0.03051	60	0.0287	3.2793	4.8	0.000728
836454	4	1	AC	3	750400	0.3	0	7.825	-109.2	-79.6	0	-0.007301	-0.001996	0	0	7.825	-119.52	-0.007301
		2	BASE	7.9	728900	0.3	3	7.693	-32.8	-67.5	-8.3	-0.000573	-0.006774	8	0.4106	6.838	-29.6	-0.001605
		3	SUBBASE	36	20100	0.35	3	7.693	-36.7	-67.5	-8.3	-0.000573	-0.006221	12	0.4566	6.2903	-10.72	-0.000546
		4	ROADBED	20	22200	0.35	10.9	7.254	70.5	-5.4	-4.6	0.00681	-0.006806	18	0.4551	5.6662	-2.7	0.000409
							10.9	7.254	-0.3	-5.4	-4.6	0.00681	-0.02153	24	0.4116	5.1128	3.74	0.000973
							46.9	4.01	-0.4	-1	0	0.000592	-0.00376	36	0.263	4.293	10.45	0.001287
							46.9	4.01	-0.4	-1	0	0.000592	-0.003535	60	0.0414	3.696	8.68	0.001039
836454	4	1	AC	3.2	2300000	0.3	0	7.791	-239.7	-79.6	0	-0.0064	0.002891	0	0	7.791	-272.49	-0.0064
		2	BASE	7.4	359000	0.3	3.2	7.755	107.8	-50.9	-20.5	0.003867	-0.005149	8	0.3148	6.7904	-55.2	-0.000612
		3	SUBBASE	36	23300	0.35	3.2	7.755	-1.4	-50.9	-20.5	0.003867	-0.01337	12	0.3209	6.155	-4.67	0.000403
		4	ROADBED	20	23000	0.35	10.6	7.082	41.7	-5.9	-2.5	0.008461	-0.008793	18	0.2783	5.4121	8.25	0.000731
							10.6	7.082	0.2	-5.9	-2.5	0.008461	-0.02398	24	0.2362	4.8264	8.78	0.000743
							46.6	3.856	-0.3	-1	0	0.000627	-0.00331	36	0.1386	4.019	21.08	0.000776
							46.6	3.856	-0.3	-1	0	0.000627	-0.003458	60	0.0215	3.4763	14.21	0.00054

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY	LAYER INFORMATION					DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
		NO.	TYPE	THICK	MODULU	POIS		DEF (mil)	STRESS (psi)			STRAIN			RADIAL DISPL	DEFLECTI (mil)	RADIAL STRESS	RADIAL STRAIN
									RADIAL	VERT	SHR	RADIAL	VERT					
901802	3	1	AC	7.2	189800	0.3	0	29.82	-158.1	-79.6	0	-0.04428	0.01123	0	0	29.82	-166.67	-0.04428
		2	BASE	36	6700	0.45	7.2	28.25	122.2	-13	-11.5	0.04595	-0.04684	8	2.4102	23.9168	-43.58	-0.008705
		3	ROADBED	20	9400	0.45	7.2	28.25	-3	-13	-11.5	0.04595	-0.118	12	2.589	20.16	-8.41	0.000978
							43.2	10.16	-0.7	-1.7	0	0.005572	-0.01523	18	2.2658	15.6192	8.63	0.007165
							43.2	10.16	-0.4	-1.7	0	0.005572	-0.01399	24	1.8085	12.0258	11.43	0.00775
														36	0.909	7.4527	13.64	0.0061
														60	0.123	4.6987	6.78	0.003138
901802	3	1	AC	7.4	199100	0.35	0	26.69	-164.3	-79.6	0	-0.03853	0.02117	0	0	26.69	-184.09	-0.03853
		2	BASE	36	6200	0.45	7.4	25.24	126.5	-12.3	-10.4	0.04244	-0.05215	8	2.1453	21.3427	-54.8	-0.009855
		3	ROADBED	20	12900	0.45	7.4	25.24	-2.7	-12.3	-10.4	0.04244	-0.1097	12	2.3775	17.8975	-15.53	-0.000598
							43.4	7.606	-1	-1.8	0	0.004183	-0.01374	18	2.148	13.6417	4.54	0.005795
							43.4	7.606	-0.5	-1.8	0	0.004183	-0.01057	24	1.7505	10.2131	10.26	0.006982
														36	0.912	5.7195	14.46	0.005854
														60	0.1248	2.9295	7.78	0.003181
906400	3	1	AC	10.8	259900	0.3	0	14.72	-96.5	-79.6	0	-0.01618	-0.007222	0	0	14.72	-101.01	-0.01618
		2	BASE	36	24800	0.35	10.8	13.05	47.1	-10.5	-3.7	0.01357	-0.01544	8	0.8495	12.2434	-17.95	-0.001837
		3	ROADBED	20	10700	0.35	10.8	13.05	0.2	-10.5	-3.7	0.01357	-0.03945	12	0.8822	11.0275	-1.45	0.000429
							46.8	8.251	0.2	-1.1	0	0.001942	-0.004606	18	0.8022	9.8757	1.63	0.001776
							46.8	8.251	-0.2	-1.1	0	0.001942	-0.008226	24	0.6784	8.9503	4.04	0.00227
														36	0.3905	7.7292	6.21	0.002177
														60	0.0567	6.9375	4.17	0.001436
906400	3	1	AC	9.5	199000	0.3	0	15.12	-99.2	-79.6	0	-0.0219	-0.008454	0	0	15.12	-103.68	-0.0219
		2	BASE	36	24300	0.35	9.5	13.11	49.5	-14.8	-4.5	0.01895	-0.02311	8	1.1262	11.7515	-17.4	-0.001954
		3	ROADBED	20	14200	0.35	9.5	13.11	0	-14.8	-4.5	0.01895	-0.05599	12	1.14	10.0657	0.89	0.001542
							45.5	6.616	0.1	-1.3	0	0.002211	-0.005428	18	0.9729	8.5047	4.13	0.003207
							45.5	6.616	-0.2	-1.3	0	0.002211	-0.008087	24	0.7756	7.3288	5.03	0.003268
														36	0.405	5.8987	5.63	0.002536
														60	0.0551	5.0562	3.13	0.001406
181028	3	1	AC	15.4	821900	0.3	0	5.797	-90.3	-79.6	0	-0.004575	-0.002772	0	0	5.797	-94.19	-0.004575
		2	BASE	36	11700	0.45	15.4	5.168	40.2	-2	-2	0.003446	-0.003234	8	0.2462	5.0928	-18.48	-0.000729
		3	ROADBED	20	20900	0.45	15.4	5.168	-0.6	-2	-2	0.003446	-0.009595	12	0.2671	4.7648	-5.17	-0.000285
							51.4	3.556	-0.7	-0.8	0	-2.3E-05	-0.001741	18	0.2738	4.466	-4.18	2.4E-05
							51.4	3.556	-0.7	-0.8	0	-2.3E-05	-0.000985	24	0.2612	4.1928	0.34	0.000397
														36	0.1854	3.7654	6.44	0.000771
														60	0.0312	3.4312	7.1	0.000777

Mechanistic responses - North Central Region (continued).

SHRP ID	NO. LAY	NO.	LAYER INFORMATION				DEPTH (in)	MECHANISTIC RESPONSES UNDER THE LOAD						RAD. DIST. (in)	MECHANISTIC RESPONSES AT DEPTH = 0.			
			TYPE	THICK	MODULU	POIS		DEF	STRESS (psi)			STRAIN			RADIAL	DEFLECTI	RADIAL	RADIAL
								(mil)	RADIAL	VERT	SHR	RADIAL	VERT		DISPL	(mil)	STRESS	STRAIN
271085	3	1	AC	12	358500	0.34	0	15.31	-108.3	-79.6	0	-0.01205	-0.000812	0	0	15.31	-117.73	-0.01205
		2	BASE	36	10800	0.45	12	14.1	60.8	-4.5	-3.6	0.01145	-0.01308	8	0.6816	13.5021	-29.77	-0.003185
		3	ROADBED	20	7600	0.45	12	14.1	-0.8	-4.5	-3.6	0.01145	-0.0285	12	0.7752	12.545	-10.84	-0.001271
							48	9.902	-0.4	-0.9	0	0.001439	-0.004466	18	0.7916	11.5275	-4.78	0.000396
							48	9.902	-0.5	-0.9	0	0.001439	-0.005437	24	0.7314	10.605	1.72	0.001499
														36	0.4857	9.2142	8.69	0.002237
														60	0.0782	8.174	8.2	0.001959
276251	4	1	AC	7.9	287900	0.3	0	10.36	-103	-79.6	0	-0.0159	-0.00478	0	0	10.36	-107.32	-0.0159
		2	BASE	10	64100	0.35	7.9	9.146	45.1	-24	-4.3	0.01302	-0.01816	8	0.8017	7.9139	-17.28	-0.001141
		3	SUBBASE	36	24500	0.35	7.9	9.146	0.8	-24	-4.3	0.01302	-0.03617	12	0.7996	6.681	2.21	0.001452
		4	ROADBED	20	24800	0.35	17.9	7.006	5.6	-5.7	-0.4	0.008582	-0.01489	18	0.6662	5.5634	4.51	0.002314
							17.9	7.006	0.3	-5.7	-0.4	0.008582	-0.02379	24	0.5338	4.7418	4.41	0.002127
							53.9	3.625	-0.3	-1.1	0	0.000707	-0.00342	36	0.294	3.731	5.36	0.001701
							53.9	3.625	-0.3	-1.1	0	0.000707	-0.003474	60	0.0427	3.1045	3.49	0.001083
469197	4	1	AC	5.5	278100	0.35	0	25.27	-176.8	-79.6	0	-0.03241	0.01594	0	0	25.27	-211.55	-0.03241
		2	BASE	5	16400	0.35	5.5	24.51	127.8	-24.5	-7	0.03401	-0.0398	8	1.6387	20.4715	-47.86	-0.004096
		3	SUBBASE	9	30400	0.35	5.5	24.51	-3.2	-24.5	-7	0.03401	-0.1198	12	1.6673	17.495	-0.81	0.00334
		4	ROADBED	40.5	7500	0.45	10.5	20.01	-3.5	-12.5	-0.5	0.01293	-0.06081	18	1.3228	14.2392	12.77	0.005798
							10.5	20.01	-0.7	-12.5	-0.5	0.01293	-0.03943	24	1.0183	11.9283	9.09	0.004589
							19.5	17.24	6.9	-4	-0.4	0.01917	-0.02931	36	0.5325	9.1494	10.93	0.003255
							19.5	17.24	-0.6	-4	-0.4	0.01917	-0.04597	60	0.0802	7.464	6.91	0.002023