TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.
FHWA/TX-85/09+284-6F

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
Load Rating of Light Pavement Structures

5. Report Date
December 1983

6. Performing Organization Code

7. Author(s)
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8. Performing Organization Report No.
Research Report No. 284-6F

9. Performing Organization Name and Address
Texas Transportation Institute
Texas A&M University
College Station, TX 77843

10. Work Unit No.

11. Contract or Grant No.
Study No. 2-8-80-284

13. Type of Report and Period Covered
Interim - September 1979
December 1983

12. Sponsoring Agency Name and Address
Texas State Department of Highways and
Public Transportation; Transportation Planning
Division, P.O. Box 5051 Austin, Texas 78763

14. Sponsoring Agency Code

15. Supplementary Notes
Research performed in cooperation with DOT, FHWA.
Research Study Title: Flexible Pavement Data Base and Design

16. Abstract

This report presents a new approach of determining the damage that overweight vehicles can do to light pavement structures. This computerized procedure uses results obtained from the Dynaflect or the Falling Weight Deflectometer to determine the number of passes of a specific load that will cause a critical level of rut depth in a light pavement structure. This method was based on field observations and ILLI-PAVE, a finite element pavement analysis program.

In the study, hyperbolic curve is used to describe both the stress softening and stress hardening form of load-deflection characteristics observed on light pavements. A method of determining the nonlinear elastic material models for the base course and the subgrade using the Falling Weight Deflectometer or the Dynaflect was developed. From the data collected with the Pavement Dynamic Cone Penetrometer, it appears that the stiffness of the granular base course depends to a large extent on the degree of compaction of the material. The model adopted for repetitive loading follows a hyperbolic-shaped loading and reloading load deflection curve with a linear unloading path. Thick pavement which is usually the stress hardening type appears to be more resistant to rutting. The new approach is shown to be accurate in predicting the development of rut depth with repeated loads applied by a variety of different vehicles.

A computer program is written to incorporate the complete analysis method and a convenient data coding form is provided to make data entry more convenient.

17. Key Words
Load Rating, Light Pavements,
Computerized Procedure.

18. Distribution Statement
No restriction. This document is available
to the public through National Technical
Information Service, 5285 Port Royal Road,
Springfield, Virginia 22161.

19. Security Classif. (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
130

22. Price

Form DOT F 1700.7 (8-69)

LOAD RATING OF LIGHT PAVEMENT STRUCTURES

by

Koon Meng Chua and Robert L. Lytton

Research Report No. 284-6F

Flexible Pavement Data Base and Design

Research Study 2-8-80-284

Conducted for

The Texas State Department of Highways
and Public Transportation

in cooperation with the
U. S. Department of Transportation
Federal Highway Administration

by the

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College Station, Texas

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This report presents a new approach of determining the damage that overweight vehicles can do to light pavement structures. This computerized procedure uses results obtained from the Dynaflect or the Falling Weight Deflectometer to determine the number of passes of a specific load that will cause a critical level of rut depth in a light pavement structure. This method was based on field observations and ILLI-PAVE, a finite element pavement analysis program.

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A computer program is written to incorporate the complete analysis method and a convenient data coding form is provided to make data entry more convenient.

SUMMARY

An increase in volume of overweight vehicle permit applications has caused the Texas Highway Department to look for a more efficient way of determining the damage that can be done to light pavement structures.

A new approach is presented here. This computerized procedure uses results obtained from non-destructive testing methods, namely, the Dynaflect or the Falling Weight Deflectometer to determine the number of passes of a specific set of loads that will cause a critical level of rut depth in a light pavement structure. Conversely, the maximum allowable load can be determined using the rut depth as a criterion for unacceptability. This method was based on field observations and ILLI-PAVE, a finite element pavement analysis program.

In the study, it is found that a hyperbolic curve can be used to describe both the stress softening and stress hardening form of load-deflection characteristics observed on light pavements. It is shown that nonlinear elastic material models for the base course and the subgrade can be determined from the Falling Weight Deflectometer or the Dynaflect. From the data collected with the Pavement Dynamic Cone Penetrometer, it appears that the stiffness of the granular base course depends largely on the degree of compaction of the material. The model adopted for repetitive loading follows a hyperbolic-shaped loading and reloading load-deflection curve with a linear unloading path. Thick pavement which is usually the stress hardening type appears to be more resistant to rutting.

The new approach is shown to be accurate in predicting the development of rut depth with repeated loads applied by a variety of different vehicles.

A computer program is written to incorporate the complete analysis method and a convenient data coding form is provided to make data entry more convenient. A number of example problems are worked to illustrate the use of the program. With the aid of the program, and having in hand field deflection data and the thickness of the base course, it is possible to do the following: (a) determine the maximum load that can be carried by a particular pavement; (b) determine how many passes of a specified vehicle will cause a particular pavement to have an unacceptable level of rutting; (c) determine the effect on rutting of a particular pavement that a specified traffic stream will have.

These capabilities provide the Texas SDHPT with a versatile tool for load rating and load zoning the low volume roads in the State of Texas.

IMPLEMENTATION STATEMENT

This report describes the development of a new load rating method for light pavement structures. The computer program uses results obtained from the Dynaflect or the Falling Weight Deflectometer and can be used exactly as it is presented in this report to determine what is the maximum load a particular pavement can carry and also how many passes of a specified vehicle will cause an unacceptable level of rut depth. The program can be used with new pavements or pavements that already show evidence of rutting. The program input is simple and straight-forward and is expected to be useful to D-18 and D-8 immediately.

DISCLAIMER

The contents of this report reflect the view of the authors who are responsible for the facts and the accuracy of the data presented within. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report is not a standard, a specification or a regulation.

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CHAPTER I

INTRODUCTION

Overweight truck operations in the State of Texas have increased from 7.75% in 1974 to 26.33% in 1976 (1) and this trend is still true at the present time. As a result of the increasing industrial and agricultural activities, heavier trucks and higher traffic volume require the Texas State Department of Highways and Public Transportation (SDHPT) to look into the problem of load zoning of various Farm-to-Market roads which are of the light pavement structure type.

With regard to Farm-to-Market roads in Texas, studies have shown (2) that the Gross Vehicle Weight [GVW] of trucks can range from 33,000 lbs to over 80,000 lbs of which the latter contributes as much as 59% of truck traffic. Many studies (3) are being conducted on the effects of truck size and weight on pavements by various states and the results show that the economic implication is significant.

In evaluating overweight vehicle permit applications, the present practice of the Texas SDHPT is to determine the gross allowable loads on the light pavement structure by testing on undisturbed samples of the subgrade. Texas Triaxial Tests (4) are performed on cored samples. This method requires a considerable amount of labor in the laboratory and the coring process also interrupts traffic. It is obvious that a more efficient method of determining damage to pavement by overweight vehicles is needed.

Presently, no method of load rating of light pavement structures such as the one proposed here has been developed. Among the states that have done load rating of some sort, the AASHO Road Tests results or the AASHO Interim Guide (5) is often consulted.

This report presents a new method which will alleviate the above-mentioned problem. The new approach is a computerized procedure which uses results obtained from non-destructive testing methods, namely, the Dynaflect or the Falling Weight Deflectometer [FWD], to determine the number of passes of a specified load that will cause a critical level of rut depth in a light pavement structure. Conversely, the maximum allowable load on a light pavement structure can be determined using the rut depth as a criterion for unacceptability. Rut depths are caused by accumulating pavement deformation under repeated load applications. Each time a load passes, the pavement fails to rebound as much as it was deflected under load. Establishing the difference between the loading and the unloading path is critical to making a reliable prediction of this rut depth. Some of the advantages of the new approach are:

1. Non-destructive testing will reduce the time and manpower currently required to determine the maximum load allowed on a pavement, will expedite permit evaluation, and will reduce the costs of the overall process.

2. Estimating the maximum allowable number of applications of load on a pavement will assist in planning and budgeting decisions that are related to patterns of future development.

3. The method will assist in evaluating the economic impact of load intensive industries upon the local road maintenance and rehabilitation budget.

This report is divided into five chapters and three appendices. The first chapter serves as an introduction. The second chapter describes the location of the test sites used in the study and the characteristics of the test sections. It also gives a detailed description of the functioning and the use of the Falling Weight Deflectometer and the Dynaflect. The third chapter gives an account of the analysis approach taken. It decribes the finite element program ILLI-PAVE and the material models that were used in the computer analysis and also how deflection basins were generated to verify the adequacy of the program as well as to form a data pool to formulate the load rating procedure. It further describes the load deflection model assumed, the load rating model or rutting model and also the curve fitting techniques used in this study. The fourth chapter describes, discusses and also gives an evaluation of the proposed load rating procedure. The computer program written for this purpose is also intorduced. The final chapter includes the conclusions and recommendations that arise out of this study.

Appendix A lists the data from non-destructive testing of the selected pavement sections using the Falling Weight Deflectometer and the Dynaflect. Appendix B includes the data obtained from a previous study to formulate a multiplier used in the load deflection model of pavements under repetitive loading. Appendix C gives the documentation of the computer program. This includes the program flow-charts, the input instructions, the program listing, a sample input and also a sample output. Appendic D includes the coding forms used with the computer program. Input is self-explanatory.

CHAPTER II

DATA COLLECTION

This task involved the non-destructive testing of 78 pavement sections from 14 Farm-to-Market roads using the Dynaflect and the Falling Weight Deflectometer. In addition, construction drawings were referred to for those sections tested. These data formed the basis for the development of the determination of the load deflection model using the two non-destructive testing methods.

Location of Test Sites

The State of Texas consists of 254 counties divided into 25 highway districts, as shown in Figure 1. In view of the size of the state, a wide variation in climate can be expected. Average annual rainfall varies from about 8 inches at El Paso in West Texas to about 56 inches at the extreme east of the state (6). About 38 inches is recorded for the Bryan-College Station area. Average annual temperature ranges from 53° F in the northwestern edge of the High Plains to 74°F along the Rio Grande in the southernmost section of the state. The pavement sections tested are located in the Brazos and the Burleson Counties of District 17 for the reasons that they are moderately representative of the State as well as their proximity to the TTI. Figures 2 and 3 show the portions of the Farm-to-Market roads that were tested.

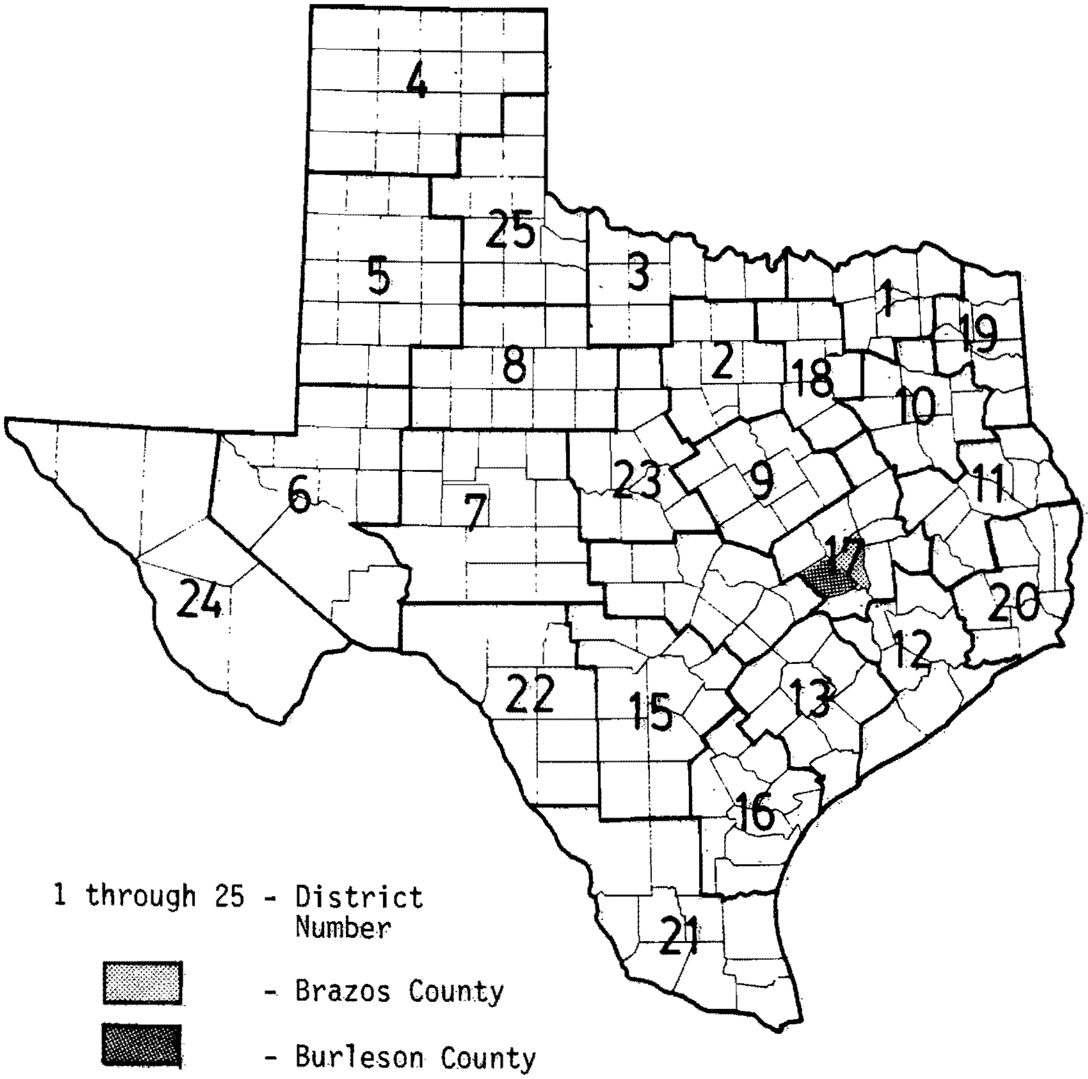


FIGURE 1. Texas District and County Outline Map

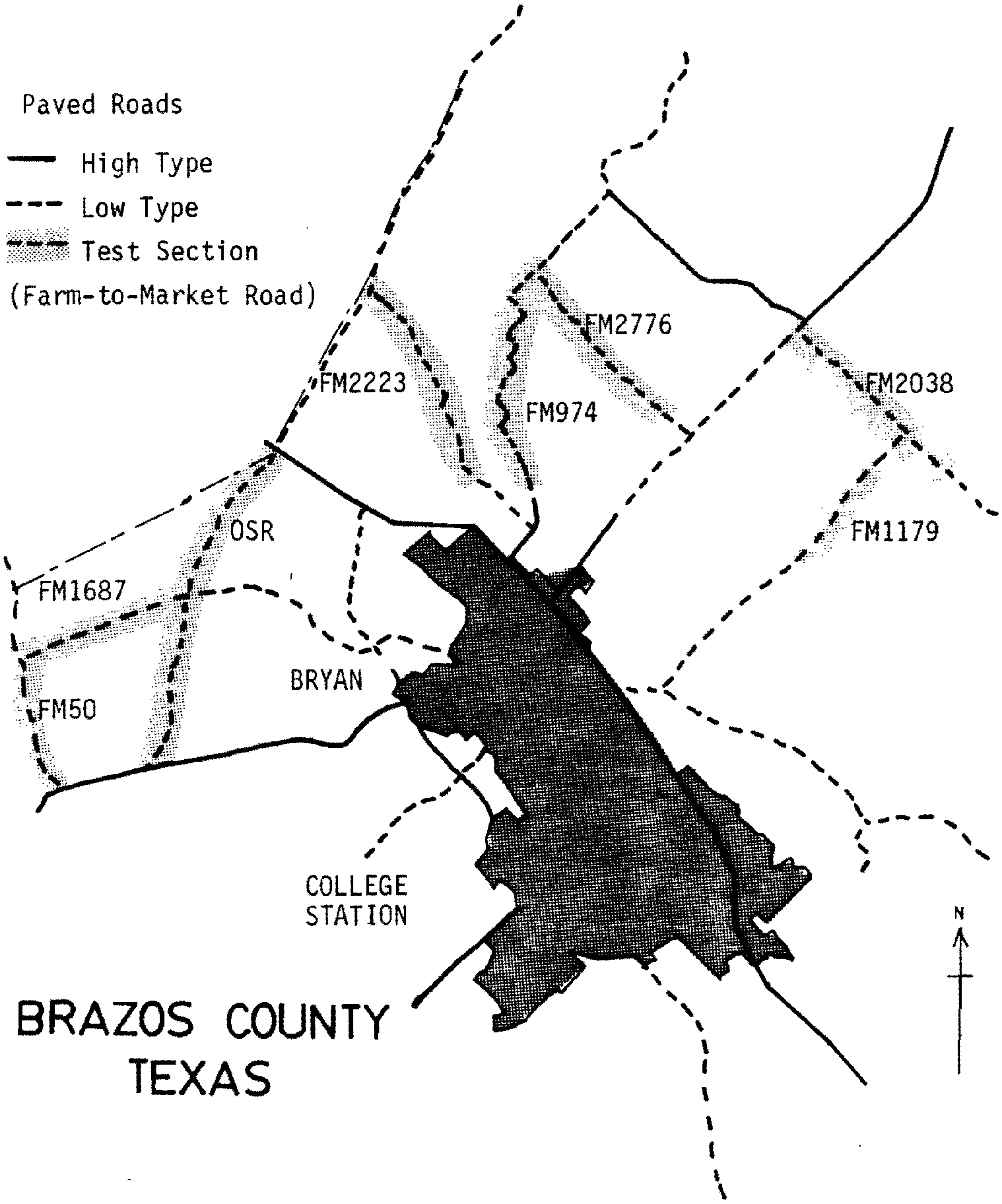


FIGURE 2. Location of Test Sections in Brazos County

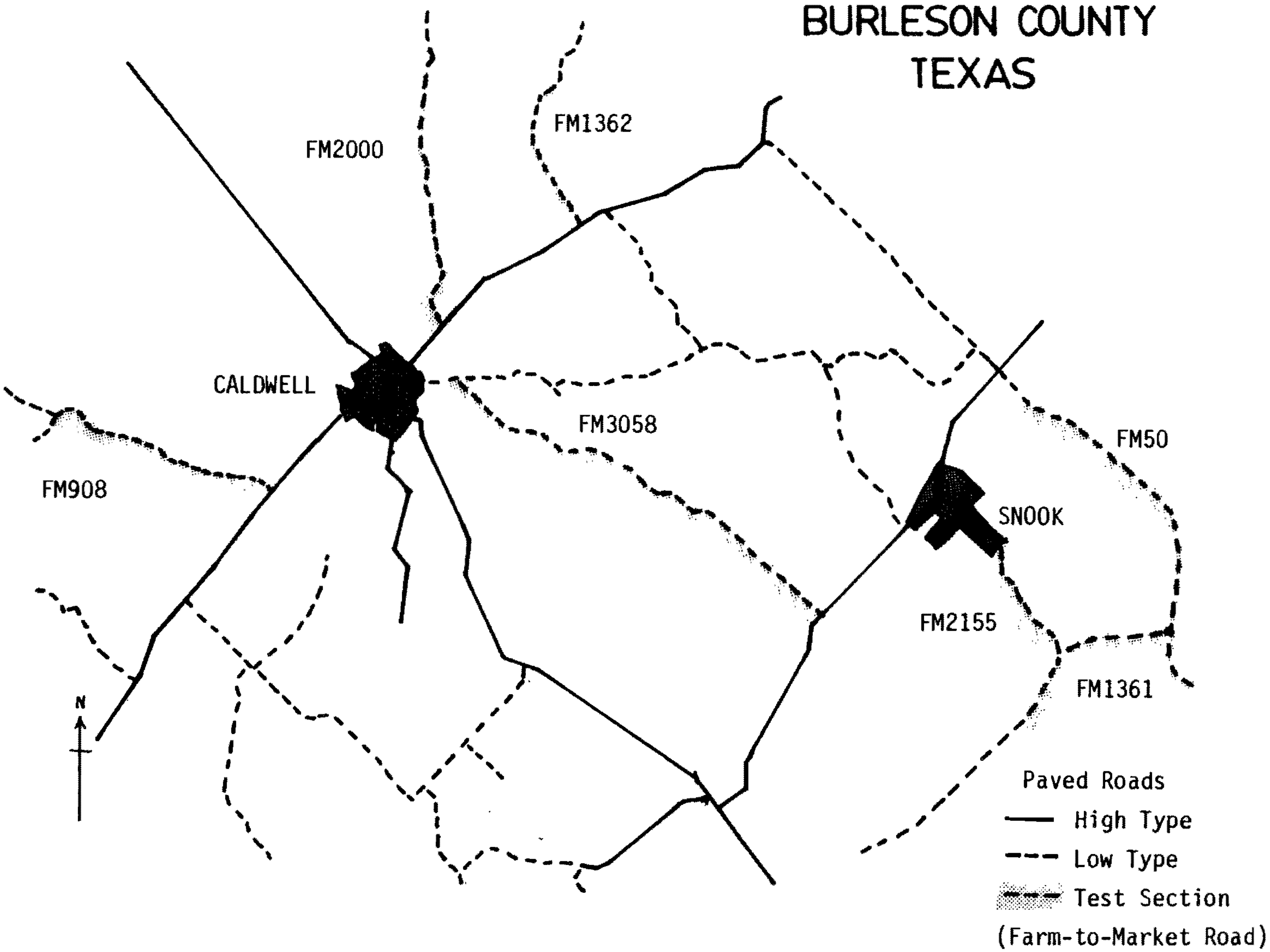


FIGURE 3. Location of Test Sections in Burleson County

Test Sections

The test sections were chosen to be at mile posts (spaced two miles apart) along the Farm-to-Market roads for easy identification and also because it allows the roads to be tested at regular intervals. These sections represent a diverse sampling. Some were constructed or reconstructed as early as 1953 and as late as 1981. Table 1 lists the Farm-to-Market roads that were tested with the corresponding references of construction drawing that were available from the District Office. The base course thicknesses and the field observed base course material type are also given. Figure 4 illustrates the typical cross sections of these roads. Base course thicknesses range from 4 inches to 14 inches. Base course materials were found to consist of crushed stone, river gravel, sandstone and iron-ore. Other types of material, for example oyster shells, are found in other parts of the State. The surface courses or wearing courses, although originally intended to be only a surface treatment course, were measured to be about an inch thick. This is due to numerous seal coat applications.

The pavement sections were first tested with the Falling Weight Deflectometer on the 20th and the 21st of December in 1982. Usually 2 or 3 sections spaced about 10 feet apart were tested at each of the selected mile-posts. The exact spot of each load application was then marked with paint. Subsequently in March of 1983, the Dynaflect was used on these marked sections.

It had been observed (7) that pavements show a constant value

TABLE 1. Relevant Construction Details of Test Sections

Road Name	Mile Post No.	Relevant Construction Details Base Course Thickness (ins)	Drawing No.	Dated	Field Identified Base Course Material Type
District No. 17					
Burleson County					
FM 3058	2 to 4	6	S3021(1)A Sheet 2	10/30/67	Crushed Stone (Caliche)
FM 3058	6 to 8	6	A3119-1-4 Sheet 2	7/17/72	Crushed Stone (Caliche)
	10	6	A3119-1-6 Sheet 2	2/10/77	Crushed Stone (Caliche)
FM 908	10	8	S2216(1) Sheet 2	1/2/58	--
FM 1361	6 to 10	8	C1399-1-9 Sheet 2	3/31/66	--
FM 1362	4 to 8	-- No records - - -	- - -	- - -	- - -
FM 2000	8 to 10	7	A-1129-2-5 Sheet 2	10/29/65	Crushed Stone and Sand Stone
	12	6	833-11C Sheet 2	3/04/75	Gravel
FM 2155	2 to 4	6	R-506-4-2 Sheet 2	8/17/55	River Gravel
FM 50	2 to 4	7.5	CSB457-1-28 Sheet 2	2/19/81	River Gravel
	6 to 16	7.5	CSB457-1-28 Sheet 2	2/19/81	Crushed Stone
Brazos County					
OSR	2 to 4	14	--	3/31/67	Crushed Stone (Caliche)
FM 974	6 to 8	4	C540-3-5 Sheet 2	6/24/58	Crushed Stone (iron ore)
FM 1179	4	6	R-1361-1-3 Sheet 2	10/27/53	Crushed Stone Gravel
FM1687	2	9	C-1560-1 Sheet 2	2/17/59	Gravel
FM 2038	8 to 10	10	CSB2236-1-8 Sheet 2	5/25/78	River Gravel
FM 2776	0 to 2	6	S2654(1)A Sheet 3	1/04/63	River Gravel

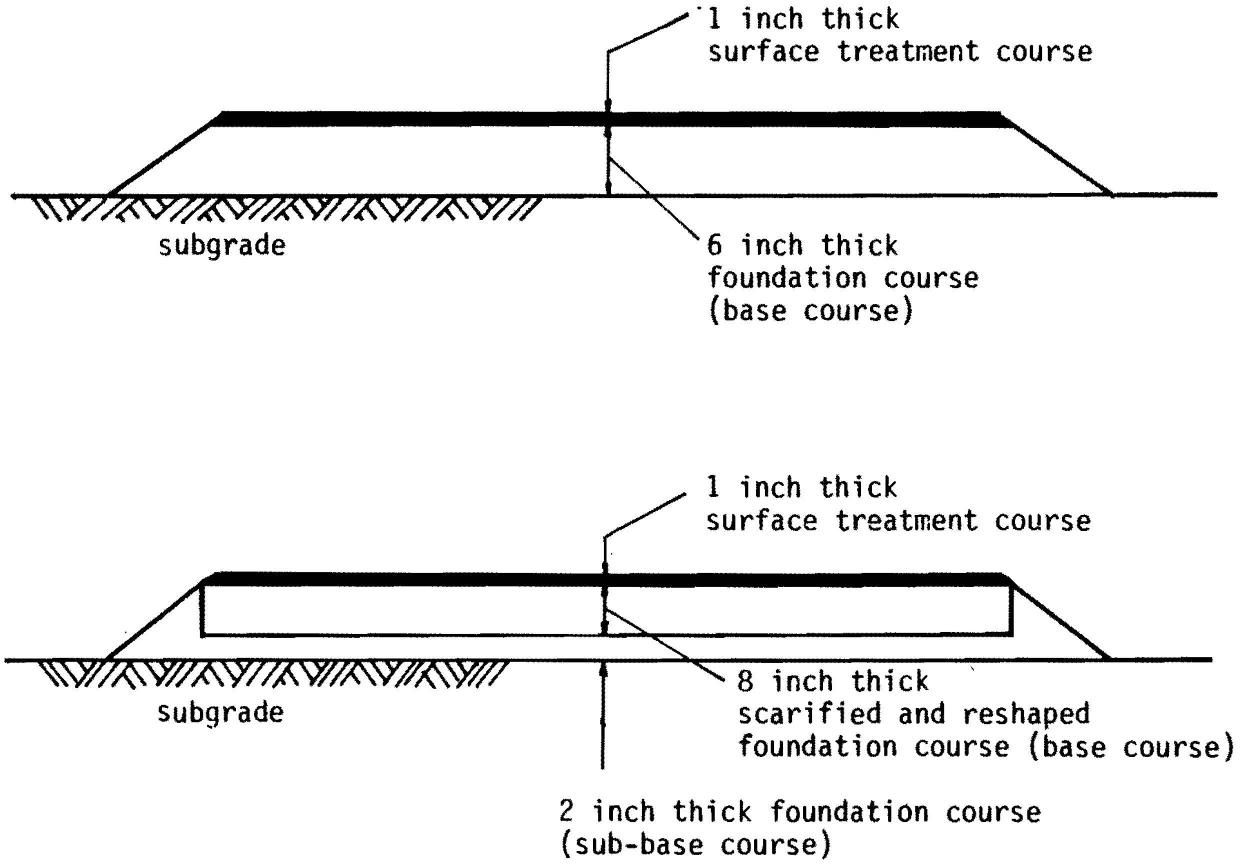


FIGURE 4. Typical Cross-Section of Farm-to-Market Roads

of deflection in response to the same magnitude of loading but when approaching the end of the design life, this value increases sharply. For this reason, the 'standard FWD practice' was to make measurements at points between the wheel paths where the traffic is slight. This was done to obtain a more consistent evaluation of the pavement integrity.

Falling Weight Deflectometer

The Dynatest 8000 FWD Test System which was used in this project consisted of the Dynatest 8002 FWD (8,9) and a complement of system processor and a device which recorded and interpreted the measured loads and deflections. The FWD itself is a light-weight trailer mounted unit, as can be seen in Figure 5.

The FWD can deliver an impulse load of 1,500 lbs to 24,000 lbs to a pavement. The impulse is essentially a half sine curve with a duration of 25 to 30 milliseconds. The load is transmitted to the pavement through a 12 inch diameter loading plate which rests on a thick rubber pad which is in contact with the pavement surface. In principle, the force applied to the pavement is dependent on the mass of the drop-weights used, the height of the drop and the spring constants of the rubber pad as well as that of the overall pavement. In practice however, only the mass of the drop-weights and/or the height of drop is varied. The actual load relayed to the pavement is measured by the load cell located just above the loading plate.

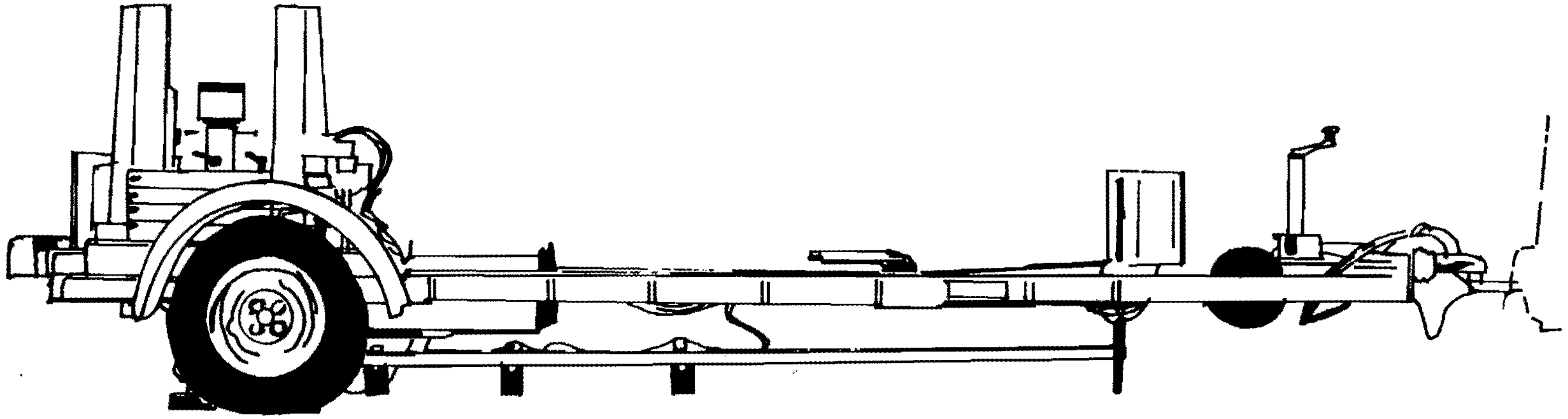


FIGURE 5. The Dynatest Falling Weight Deflectometer

The deflection basin is obtained by monitoring the deflections at seven locations on the pavement surface using velocity transducers. One of these is located in an opening in the center of the loading plate.

In the tests, the height of drop and weight were adjusted to produce four different load levels - 9,000 lbs, 11,000 lbs, 15,000 lbs and 23,000 lbs with the exact magnitude being registered by the load cell. Figure 6 shows the locations of the deflection sensors and a set of typical deflection basins observed at the four different load levels.

Dynaflect

The Dynaflect (18) is currently the most commonly used NDT device in the United States for the purpose of pavement evaluation and design (10). This equipment is a dynamic force generator mounted on a covered trailer, as can be seen in Figure 7. The cyclic force is produced by a pair of counter-rotating unbalanced flywheels and this force oscillates in a sine-wave fashion with an amplitude of 500 lbs at a cycle frequency of 8 cycles per second. This force together with the dead weight of the trailer, which is about 1,600 lbs, is transmitted to the ground via two steel wheels placed 20 inches apart. The peak-to-peak deflections are measured by five geophones placed at 1 foot intervals with the first directly between the wheels. A typical deflection basin obtained is shown in Figure 8.

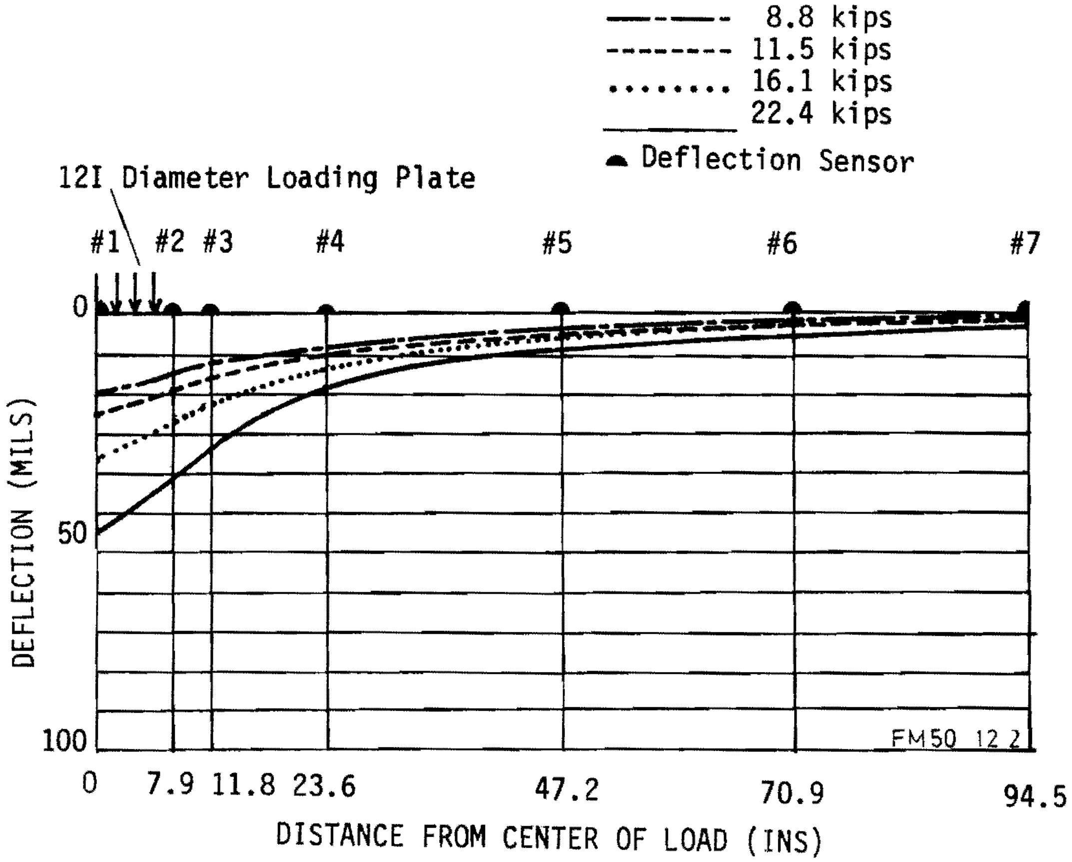


FIGURE 6. Typical Deflection Basin - Falling Weight Deflectometer

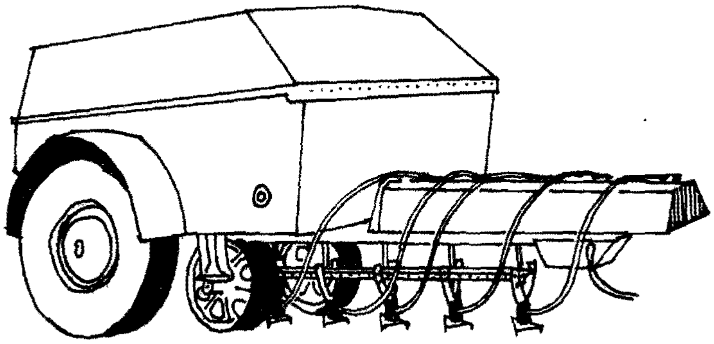


FIGURE 7. The Dynaflect

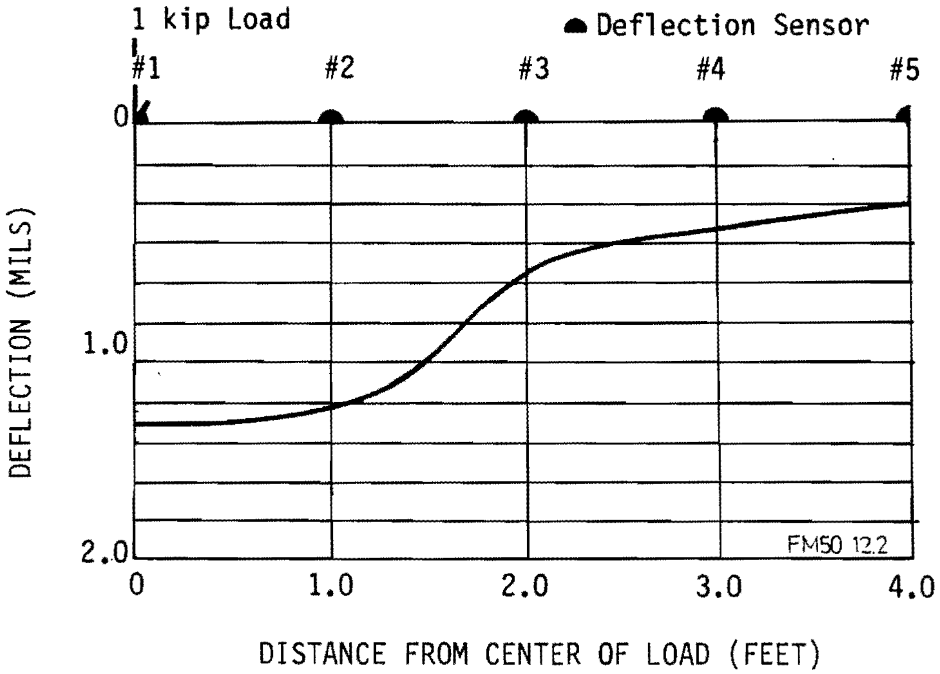


FIGURE 8. Typical Deflection Basin - Dynaflect

CHAPTER III

DATA ANALYSIS

After the data had been collected, it was necessary to verify that the ILLI-PAVE computer program with appropriately assumed material models can reproduce measured deflection basins. Then, ILLI-PAVE was used to generate deflection basins for four different load levels with different combinations of assumed material models, particularly those of the base course and the subgrade, and at the same time using different thicknesses of the base course. These finite element computations were made simulating tests done with an FWD. It was presumed that the last deflection sensor reading, which is 94.5 inches from the center of the loading plate, is related to subgrade material type.

Next, having developed a procedure of identifying material models from FWD deflection sensor readings, a load-deformation equation was formulated for each set of deflection sensor readings. A hyperbolic load-deflection model was adopted and a means of identifying the unknown coefficients was established.

The load rating or rutting model assumed was one that allows for a linear unloading path in the load-deformation curve. The reloading path was assumed to be the same as the loading path. The gradient of the unloading path was determined from actual rut depth and the number of passes of a known load, or estimated from a formulation presented in this study which was based on the backcalculation from observed rut depths. Finally, from the comparisons of deflection basins from the FWD and Dynaflect, a correlation between the first and the last deflection sensors reading of both instruments was made.

The following section discusses the analytical approach adopted, the analytical tools used and the assumptions made.

ILLI-PAVE: Finite Element Analysis

The load-deflection relationship of layered systems was investigated by Burmister (11,12) in the 1940's. He adapted Boussinesq's (1885) theory of distribution of stresses in an elastic half-space under the compressive action of a rigid body to include a layered system. Subsequently, many computerized systems of the closed form solution were developed. These solutions assume linearly elastic material properties.

The finite element approach is now being used to analyze the load-deflection relationships of pavement structures. In the analysis, the body under consideration is divided into a set of elements which are connected at their nodal points. From the material property assumed, that is, the force-displacement relationship, the stiffness at each nodal point is specified. By expressing the nodal forces in terms of displacements and stiffnesses, the equilibrium equations for each nodal point can then be solved to obtain the displacements. The stresses and strains in each element can then be computed.

A finite element program for flexible pavements was being developed by Wilson as early as 1963. Later, he and others (13) presented the technique which can take into account the nonlinear properties of materials in their response to traffic loads.

Modifications were then made by Raad and Figueroa (14) to include a failure model for granular and subgrade soils based on the Mohr-Coulomb theory.

ILLI-PAVE (15,16) is an alternative finite element program. It models an asymmetrical solid of revolution and allows for linear as well as nonlinear stress-dependent elastic moduli for granular and fine-grained soil. This program has been shown to be adequate in predicting the flexible pavement response to load by comparing the results of computer modelling and field test data (17). A similar program, ILLI-CALC (21), allows for the backcalculation of nonlinear resilient moduli from deflection data.

Figure 9 shows the ILLI-PAVE finite element model as an asymmetrical solid of revolution. For the analyses done in this study, a mesh of 121 elements was used. The sizes of the elements were made to be smallest nearest the pavement surface so as to allow for greater accuracy in the computation. To allow for an adequate simulation of the boundary conditions, it was suggested (13) that the depth of the mesh be at least 50 times the radius of the circular loading plate of the FWD which is 6 inches and that the horizontal extent be at least 12 times that radius away from the center of the loading plate. In this case, to accomodate for the FWD last deflection sensor, a width of 96 inches was used. However, from the analyses made at about 11,000 lbs loading, vertical stresses caused by the load input seem to be negligible beyond a depth of about 12 times the radii of the loading plate.

The following paragraphs will describe how ILLI-PAVE was used in

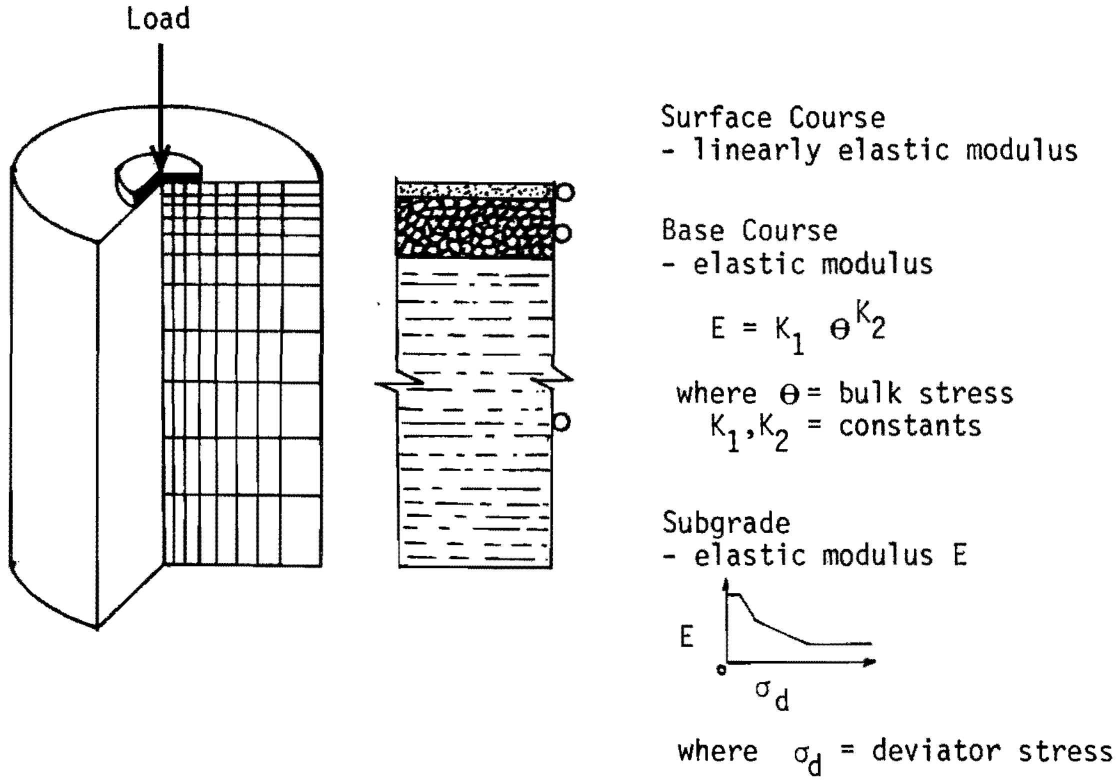


FIGURE 9. The ILLI-PAVE Model:
Finite Element Pavement Analysis

this study and the material models that were input.

A. Pavement Material Models

The Farm-to-Market roads encountered generally show three distinct layers: a surface course, a base course and a subgrade. Some older roads were found to have a subbase consisting of the old road base which was partially scarified and then overlain with new base course material. The subgrade material was found to vary greatly even along the same road.

As an extraneous part of the study of pavement materials, the Pavement Dynamic Cone Penetrometer [DCP] (19) was introduced. This basically consists of a steel rod with a 60° cone of tempered steel at one end. A sliding hammer of about 17.6 lbs falling over a height of 22.6 inches provided the consistent impact load required to penetrate the pavement. The penetration given as inches per blow gives an indication of the stiffnesses of the pavement layers. This instrument was found to be useful in comparing the stiffnesses of the base courses encountered in this study. Figure 10 shows the DCP.

The one-inch thick surface courses did not contribute much to the pavement in terms of rigidity but were nevertheless included in the material modelling in recognition of their presence. The material was assumed to be linearly elastic and to have a modulus of 30,000 psi. The determination of an actual value of the modulus is superfluous as its influence on the analysis was insignificant.

The base course thickness used in the simulations were taken from

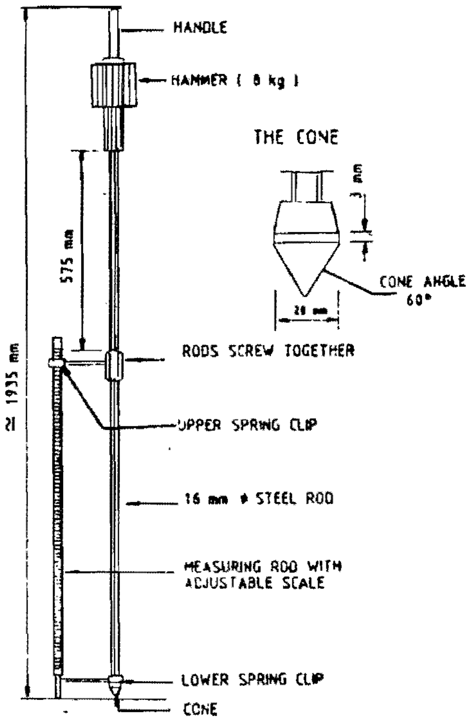


FIGURE 10. The Dynamic Cone Penetrometer (49)

construction drawings. However, more direct means such as using sample coring or the DCP was also used to enhance the accuracy in the simulation. However, the thicknesses found using the DCP differed from the design value by as much as 5 inches for an 8-inch thick base course. However, in most cases the difference was much less. In the ILLI-PAVE analyses, the subbase course, if any, was considered as part of the base course since its material type did not appear to be different. As a point of interest, from the DCP data, it appeared that most old pavements show a distinct interfacial layer between the base course and the subgrade. This might be due to infiltration of fines from the subgrade into the base course layer as well as the presence of moisture.

Base course materials were found to be of the granular, unbound type. Using the DCP it was found that knowledge of the material hardness and shape is not sufficient to categorize its load deflection behavior. Figure 11 shows the rate of penetration of the DCP into a few pavements with different base course materials. It appeared that the major determining factor of the stiffness of the material is the unit weight, that is, the degree of compaction of the material. This characteristic had been realized earlier (<u>20</u>). In view of this, the elastic modulus of the base course material can be expressed as

$$E = K_1 \, \theta^{K_2} \qquad (1)$$

where

θ is the bulk stress or the first stress invariant, and

K_1 the unknown coefficient defining the material.

TABLE 2. Material Properties used in ILLI-PAVE

Property	Surface Course	Base Course	Subgrade			
			Stiff	Medium	Soft	Very Soft
Unit Weight (PCF)	145.00	135.00	125.00	120.00	115.00	110.00
Lateral pressure coefficient at rest	0.87	0.60	0.82	0.82	0.82	0.82
Poisson's Ratio	--	0.38	0.45	0.45	0.45	0.45
Unconfined compressive strength (PSI)	--	--	32.80	22.85	12.90	6.21
Deviator Stress (PSI)						
Upper Limit	--	--	32.80	22.85	12.90	6.21
Lower Limit	--	--	2.00	2.00	2.00	2.00
Deviator Stress at 'breakpoint' (PSI)	--	--	6.20	6.20	6.20	6.20
Initial Elastic Modulus (KSI)	--	--	12.34	7.68	3.02	1.00
Elastic Modulus at Failure (KSI)	--	--	7.605	4.716	1.827	1.00
Constant Elastic Modulus (PSI)	30,000	--	--	--	--	--
Elastic Modulus Model	Linear	(see Fig.12)	(see Fig. 13)			
Friction Angle (^{0})	--	40.0	0.0	0.0	0.0	0.0
Cohesion (PSI)	--	0.0	16.4	11.425	6.45	3.105

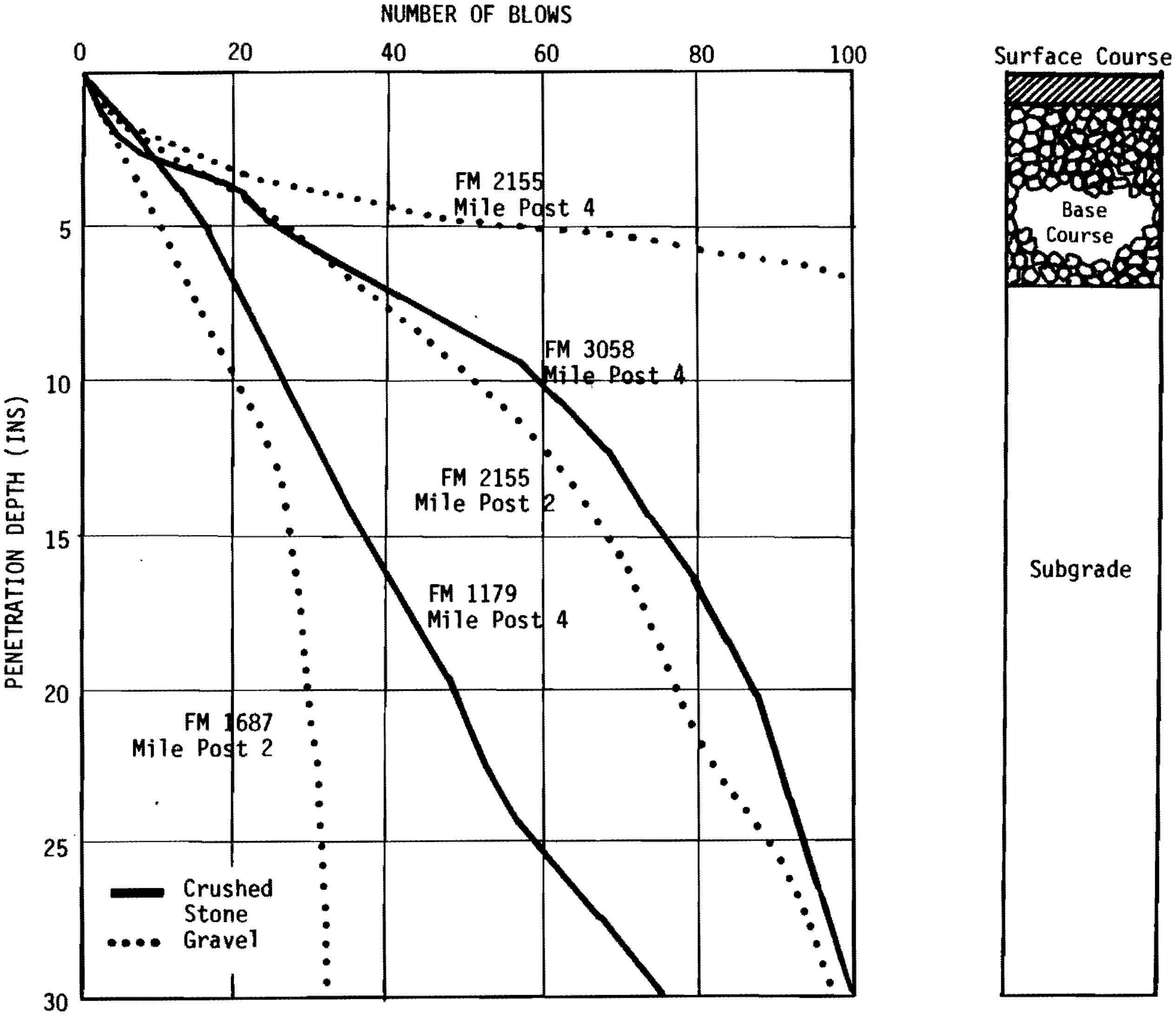


FIGURE 11. Comparison of the Pavement Stiffnesses using the Dynamic Cone Penetrometer

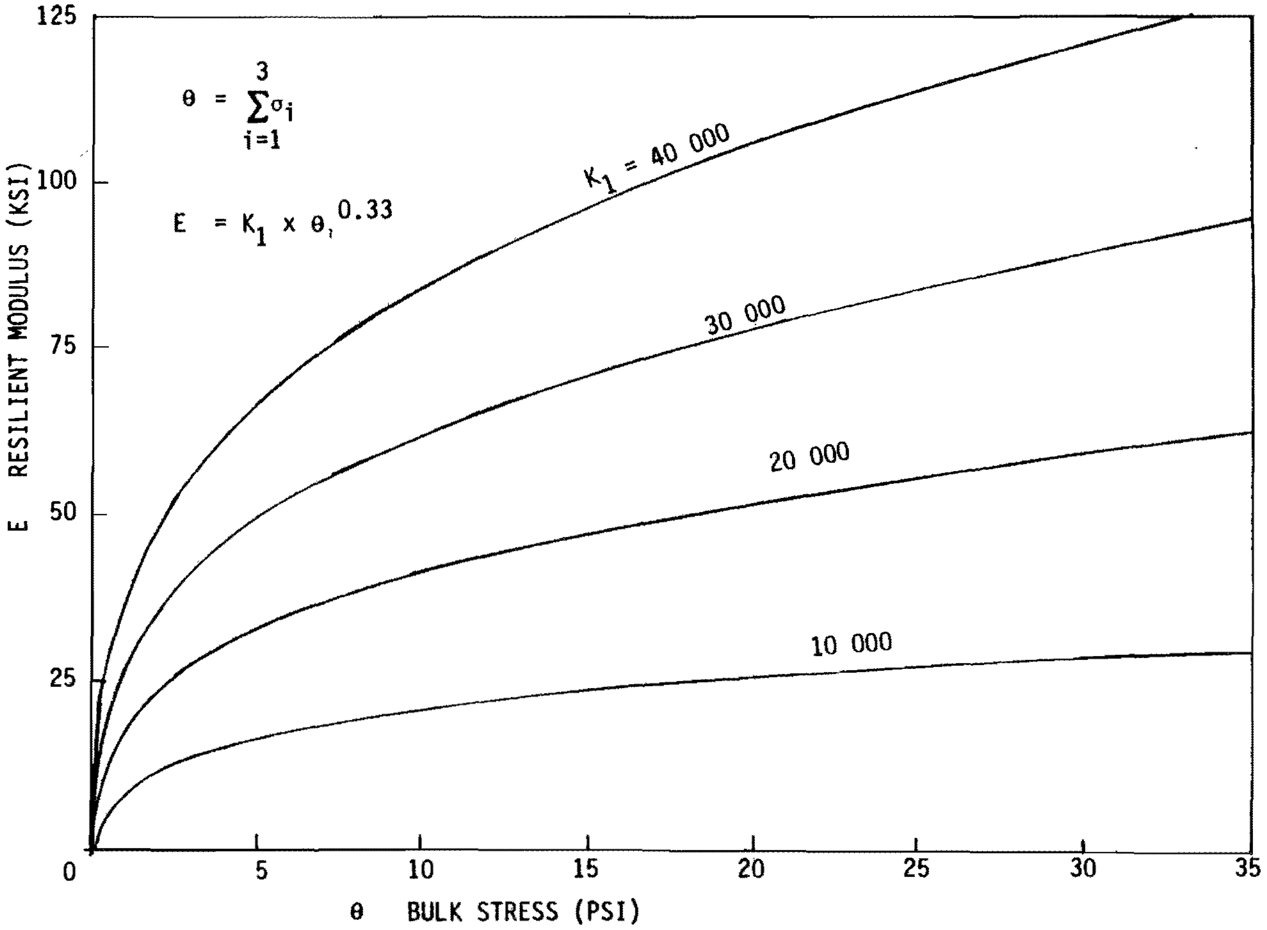


FIGURE 12. Base Course Material Models

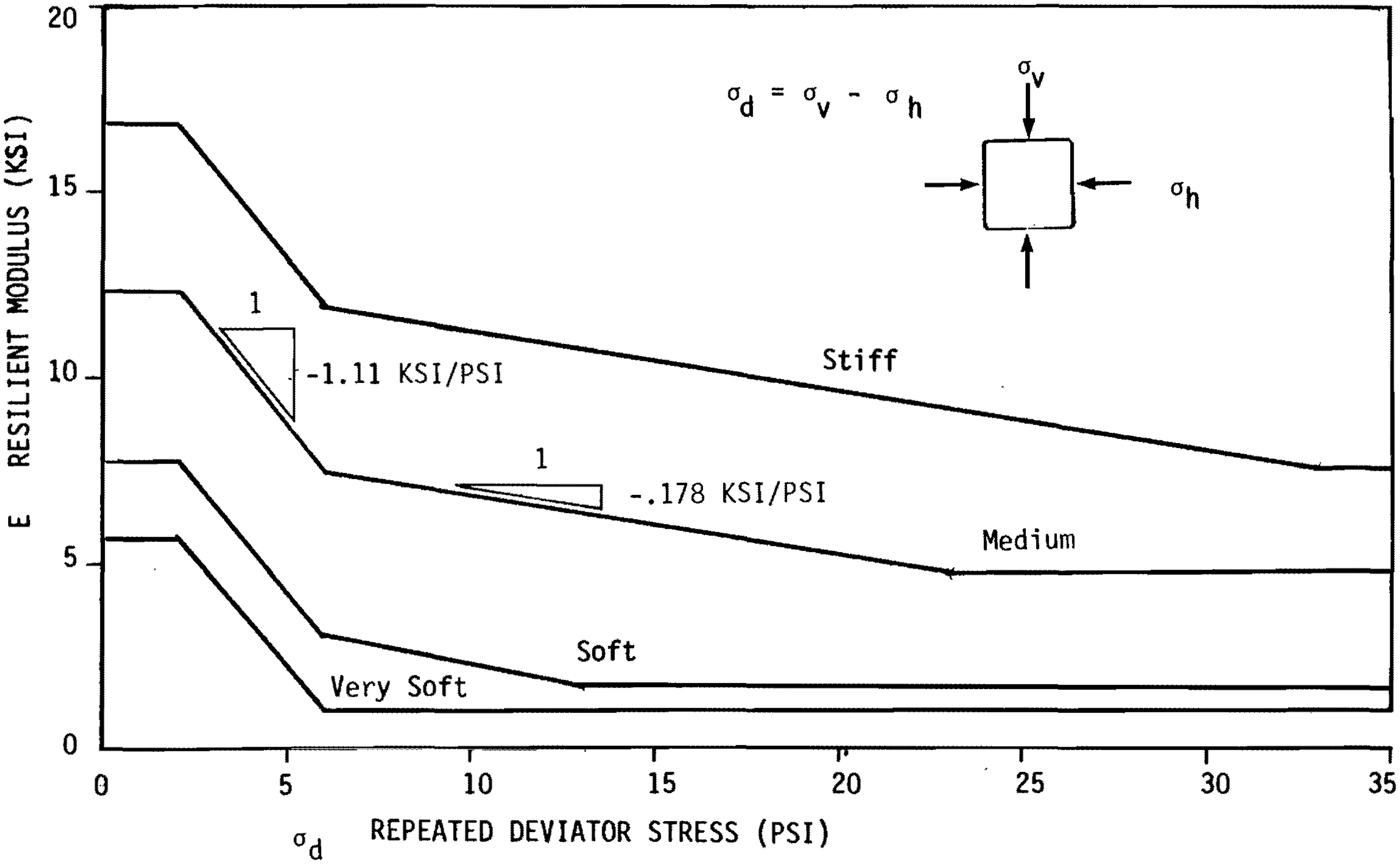


FIGURE 13. Subgrade Soil Material Models

This value shall be referred to as the K_1-value hereafter. The range of K_2-values was reported to be between 0.30 to 0.60 (21,22). Most analyses using ILLI-PAVE (15,21) adopt a range of 0.30 to 0.33 for this value. For practical reasons, in this study a value of 0.33 is assumed. This reduces to one the number of factors to be identified in the base course material. Subsequent analyses showed that this is an adequate assumption. Figure 12 shows the assumed base material model.

Four nonlinear elastic moduli, shown in Figure 13, were used to describe the subgrade properties. They are for the Very Soft, Soft, Medium, and Stiff subgrades. These models had been successfully used before with ILLI-PAVE (15,21)

Table 2 gives a summary of the pavement material properties used in the analyses with ILLI-PAVE.

B. Generation of Deflection Basin using ILLI-PAVE

In order to obtain enough load-deflection data to cover a wide spectrum of light pavement structures with different materials, a series of finite element computer runs were made. These simulations included a combination of four subgrade types, that is, the Very Soft, Soft, Medium and Stiff, and four base course material types with K1-values at 10,000, 100,000, 200,000, and 300,000. In addition, four different base course thicknesses were used: 2-inch, 6-inch, 12-inch and 18-inch thick. For all of the above combinations, four FWD loadings of 80 psi, 100 psi, 140 psi, and 200 psi were used. The corresponding loads were 8765 lbs, 10956 lbs, 15339 lbs and 21913 lbs. In addition to the above framework, other combinations were used as when was necessary. The results of these simulations were found to form a more than adequate pool of data whereby important correlations of various parameters were identified.

C. Matching of Measured Deflection Basin Using ILLI-PAVE

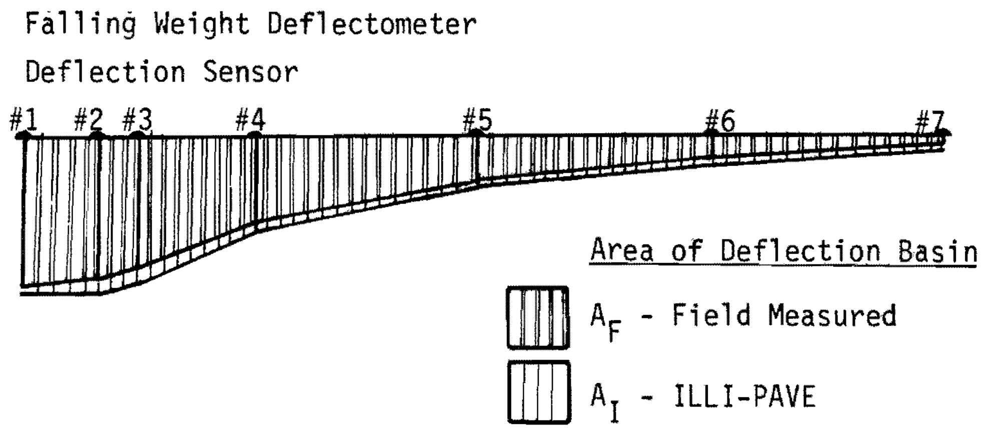
Previous study (17) had shown ILLI-PAVE to be adequate in predicting the response of flexible pavement to loads. That presupposes that use of appropriate material models can actually simulate the response of real pavements.

In this study, measured deflection basins of Farm-to-Market road sections were successfully matched to further show that the program is valid. The procedure was to adjust the input for subgrade and base course material characteristics to obtain field measured deflection basins. This was an iterative process. In this process, if the simulated last deflection sensor value of the FWD was underestimated, it implied that the subgrade assumed was too stiff. And if the first deflection sensor value was found to be too high, a stiffer material model would be used for the base course. Some difference in the curvature of the deflection basin was observed, probably due to the non-uniformity in the base and the subgrade materials. Table 3 shows the results obtained for two of the sections matched.

Load Deflection Model

A hyperbolic relationship between the load and the deflection of

TABLE 3. Comparisons of Measured Deflection Basins with ILLI-PAVE Results



ROAD	FM50		FM3058	
MILEPOST	12		10	
SECTION	2		1	
FWD LOAD (LBS)	11473		11140	
DEFLECTION (MILS)	Field	ILLI-PAVE	Field	ILLI-PAVE
@ SENSOR NO. 1	26.57	26.99	55.75	55.60
2	19.45	22.57	44.61	43.53
3	16.02	19.96	33.50	35.70
4	10.12	4.80	15.59	18.37
5	4.57	2.40	5.71	5.72
6	2.40	2.15	3.54	2.67
7	2.17	1.58	2.74	2.07
RATIO OF A_I/A_F	1.07		1.01	
MEASURED BASE COURSE THICKNESS (INS)	13.5		7.5	
BASE COURSE MODEL WHERE θ = DEVIATOR STRESS (PSI)	$15000\theta^{0.60}$		$20000\theta^{0.33}$	
SUBGRADE MODEL	soft		very soft	

the light pavement structure was assumed. As the hyperbolic stress-strain relationship is true of most soil materials (28,29), and since the light pavement structures considered are composed of soil materials, it is reasonable to adopt this as the load deflection model. The general equation is

$$P = \Delta / (A + B\Delta) \tag{2}$$

where P = load and Δ = deflections

The constants A and B will hereafter be termed Coefficient A and Coefficient B.

Rewriting equation (2) results in

$$\Delta/P = A + B\Delta \tag{3}$$

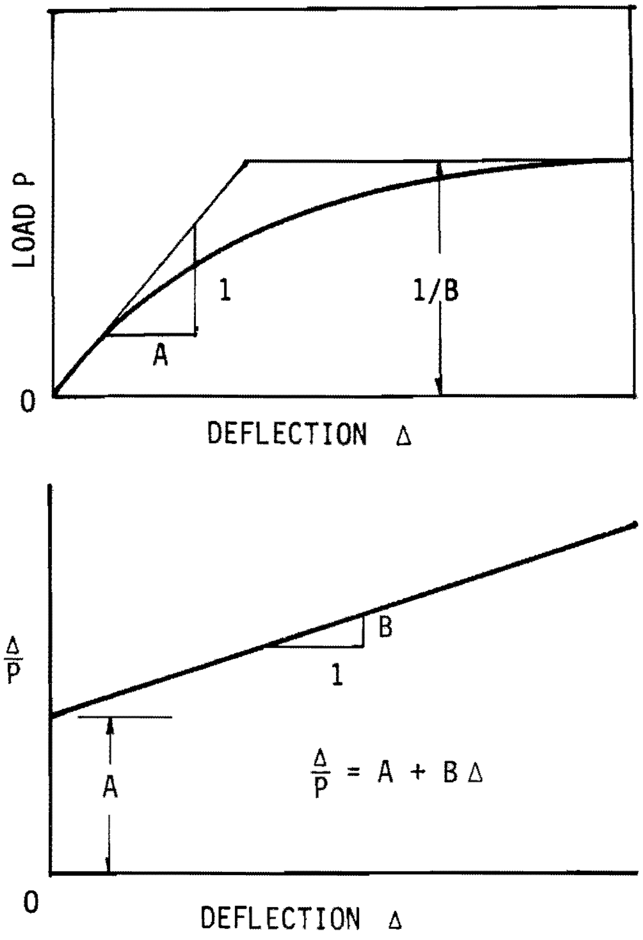
A plot of Δ/P versus Δ yields the straight line as shown in Figure 14 from which the Coefficients A and B are found. The above equation assumes a stress softening behavior. However, extrapolation of field measured maximum deflections for different loads showed that some pavement do stress harden. A typical set of load deflection curves for a Farm-to-Market road is shown in Figure 15. To allow for this, a modified hyperbolic load deflection equation was used.

This expression is

$$\frac{P}{\Delta} = \frac{1}{A} + \frac{1}{C}P \tag{4}$$

where C is a constant.

A plot of P/Δ versus P yields a straight line as is shown in Figure 16 from which A and C are found. Careful examination of the hyperbolic equation shows that by putting as $B = - A / C$ into Equation (2), a stress hardening form of the load deflection behavior



Load Deflection Equation :

$$P = \frac{\Delta}{(A + B\Delta)}$$

FIGURE 14. Load Deflection Model - Stress Softening Form

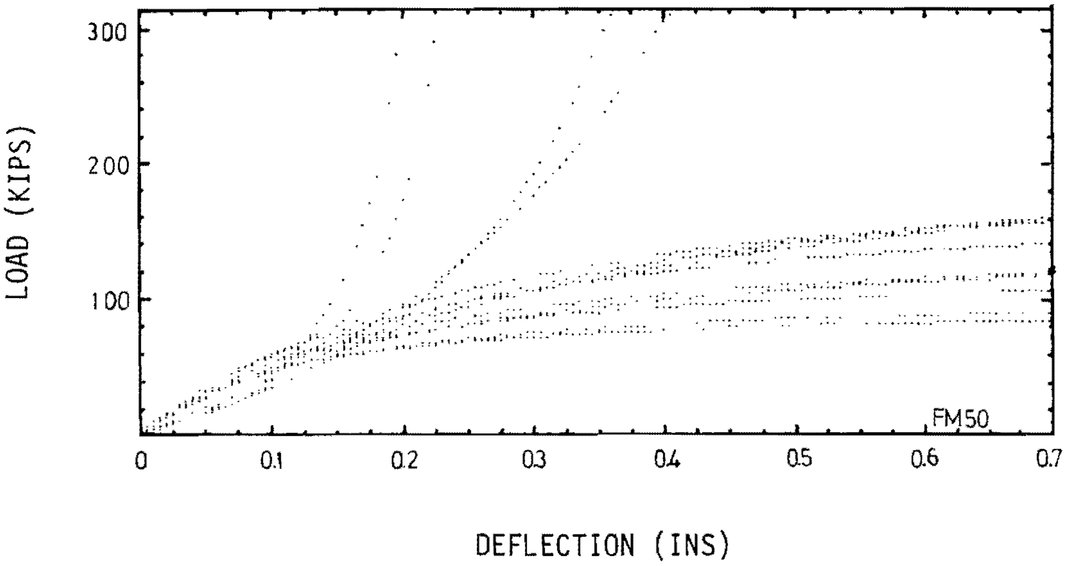
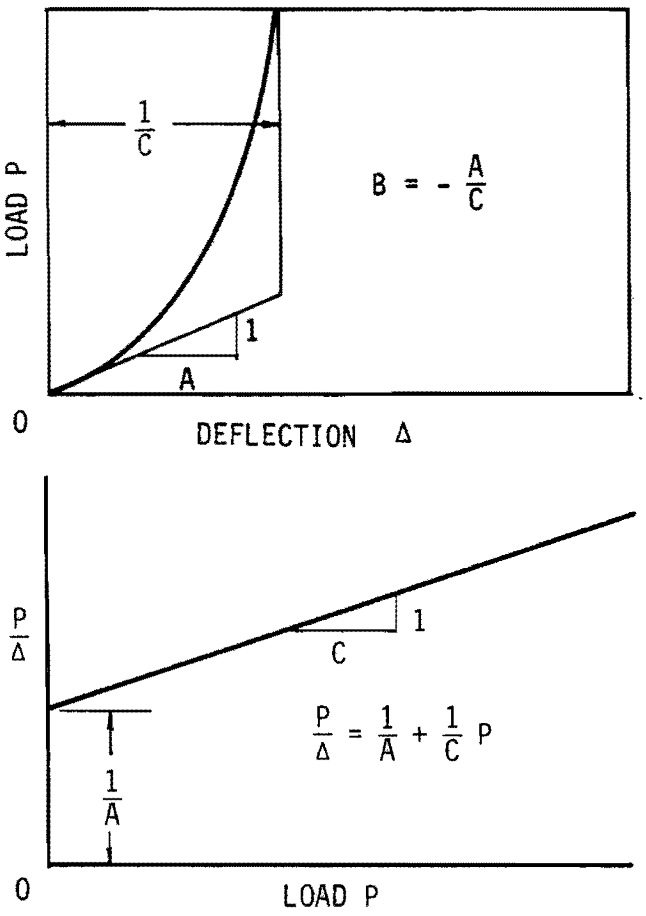


FIGURE 15. Typical Load Deflection Curves of Farm-to-Market Roads



Load Deflection Equation :

$$P = \frac{\Delta}{(A + B\Delta)}$$

FIGURE 16. Load Deflection Model - Stress Hardening Form

results. Henceforth, the above expressions are described as the stress hardening and the stress softening form of the hyperbolic load deflection equation for the pavements considered.

Load Rating/Rutting Model

A rut can be formally defined as (23) "a permanent deformation in and of the pavement layers or subgrades caused by consolidation or lateral movement of the materials due to traffic loads". As the Farm-to-Market roads being considered do not contain much thickness of asphaltic material to move laterally under loads, rutting due to consolidation is the primary concern.

In considering the problem of rebound deformation under repetitive loading, the following information is of some relevance. In the loading and reloading of silica sand, Duncan and Chang (24) found that after the initial loading, the path of which was hyperbolic, the unloading and reloading path could be approximated with a high degree of accuracy as being linear and elastic. In another study Raad and Figueroa (14) observed that the resilient behavior of granular base and subgrade were maintained even after large deformations. Larew and Leonards (25) suggested that the rebound reached an equilibrium value after approximately one thousand repetitions. Thompson and Robnett (40) thought that rebound was related to the moisture level. A widely accepted model for cyclical loading of pavements is yet to be found.

To determine permanent deformation in pavement, Yandell and

Lytton (26) successfully used a three-dimensional mechano-lattice analysis with translating loads. This involved a computer simulation of translating rather than pulsating wheel loads over a pavement section whose material properties were determined in the laboratory. However, the costs of computer time and laboratory testing are too expensive for the immediate objective.

For the purpose of developing a load rating model, the rutting models shown in Figure 17 were assumed. The Type I model shows a stress softening load deflection behavior and the Type II a stress hardening one. The unloading path was assumed to be linear. This path is expressed in terms of the initial slope or initial stiffness of the pavement, by using a multiplier. This multiplier is assumed to be independent of the load level and can be found if information of the measured rut depth as caused by a known number of passes of a certain load is available. In the development of the procedure, by using measured rut depths and the corresponding number of 18-kip Equivalent Single Axle Loads [ESAL] on Farm-to-Market roads obtained from a previous TTI project (27), estimated values for the multiplier can be obtained. These are found to depend on the initial stiffnesses of the pavements.

Curve Fitting Techniques

Curve fitting techniques used in this study were based on the least squares method of regression analysis. The criterion of this method is to find an expression of a curve such that the sum of the

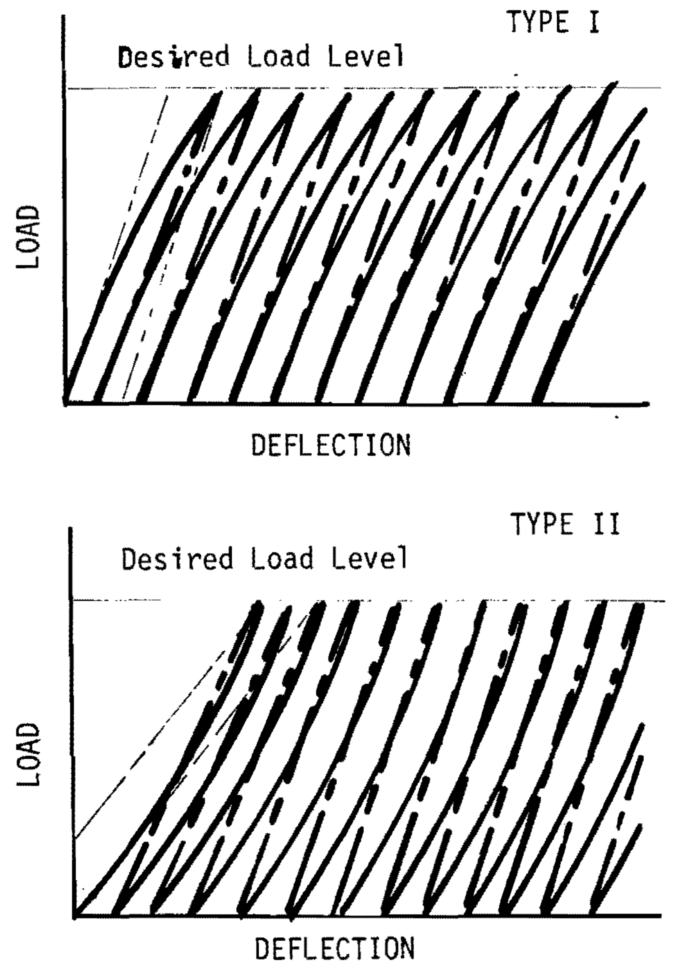


FIGURE 17. Load Deflection Model for Repetitive Loading (Rutting) on Pavement

squared vertical deviations between the curve and the scatter of points is minimized. Regression approaches employed include those to fit a line function, an exponential function, a geometric function, and an Nth order polynomial. For the last, only a second order polynomial was used. In addition, the technique presented earlier for fitting a hyperbolic function was used.

CHAPTER IV

SUMMARY OF RESULTS

Description and Discussion of the Load Rating Procedure

Two approaches to the load rating procedure were developed. One is for use with a Falling Weight Deflectometer and the other, which is based on the first, is for use with a Dynaflect. The following sections present the two approaches in depth.

A. Procedure Using the Falling Weight Deflectometer

1. Obtain field measured response of pavement to FWD pressure of about 100 psi which corresponds to a load of about 10,956 lbs. This loading shall be referred to as the Standard FWD Load. The condition is necessary because much of this procedure was developed based on that load level.

2. Adjust measured deflections at Sensor Nos.1 and 7 to their equivalent values at the Standard FWD Load. This can be done by multiplying the values by the ratio of 10,956 lbs over the registered load transmitted to the pavement. A linear variation can be assumed as the departure will not be expected to be large. These corrected deflections shall be referred to as the FWD deflections for the rest of the procedural outline.

3. Determine Coefficient A of the load-deflection equation. The stiffness of a pavement structure refers to the value obtained by dividing the applied load with the corresponding deflection at the

point of loading. The Overall Stiffness is then the division of the Standard FWD Load by the maximum FWD deflection which will be at Sensor No.1 . The Initial Stiffness, which is the slope of the load-deflection curve near a zero load, is then read off Figure 18 and the inverse of this is the value of Coefficient A. Figure 18 was derived from field-measured deflections.

4. Determine the type of subgrade. With the FWD deflection at Sensor No.7, from Figure 19, the type of subgrade soil model can be determined. Figure 19 was based on field measured deflections.

5. Determine the Standard Deflection. This is the maximum deflection that will be obtained if the particular pavement structure is resting on Very Soft subgrade and loaded with a Standard FWD Load. This value can be obtained from Figure 20. This correlation was derived from the ILLI-PAVE analyses and was found to match the field measured values.

6. Determine the base course material model. By interpolating from the curves shown in Figure 21, the K_1-value of the base course material can be found. Necessary inputs will be the base course thickness and the FWD deflection at Sensor No.1 . These curves were based on the ILLI-PAVE analyses.

7. Determine the Coefficient B of the load deflection equation. As can be seen from Figure 22, the Coefficient B is dependent on the K_1-value of the base course material and the subgrade type. The positive value can be interpolated from the curves shown in the figure. Different scales for the value of Coefficient B are given to adjust for the different subgrade encountered. This figure was based

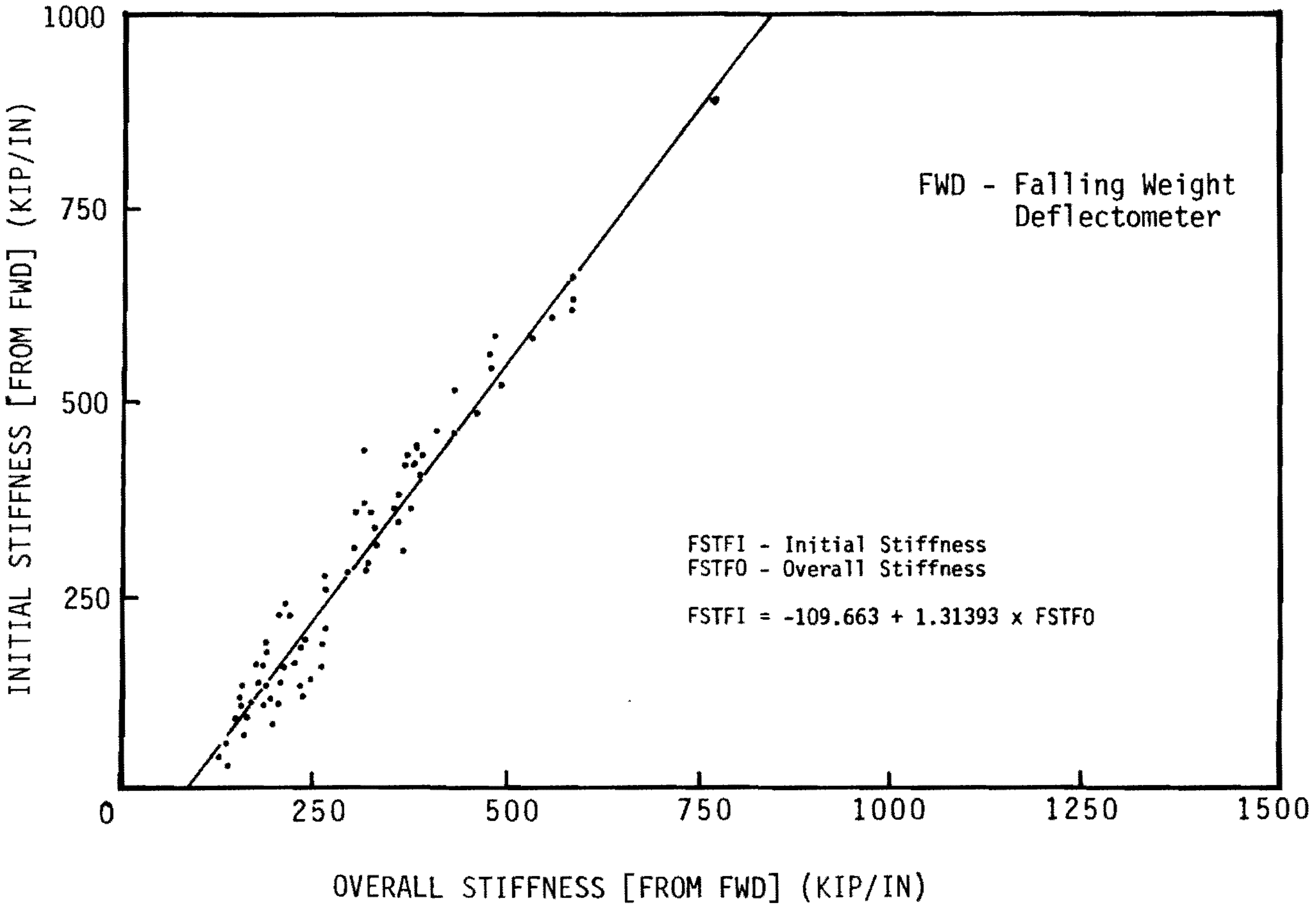


FIGURE 18. Determination of Initial Slope (Stiffness) of Load Deflection Curve

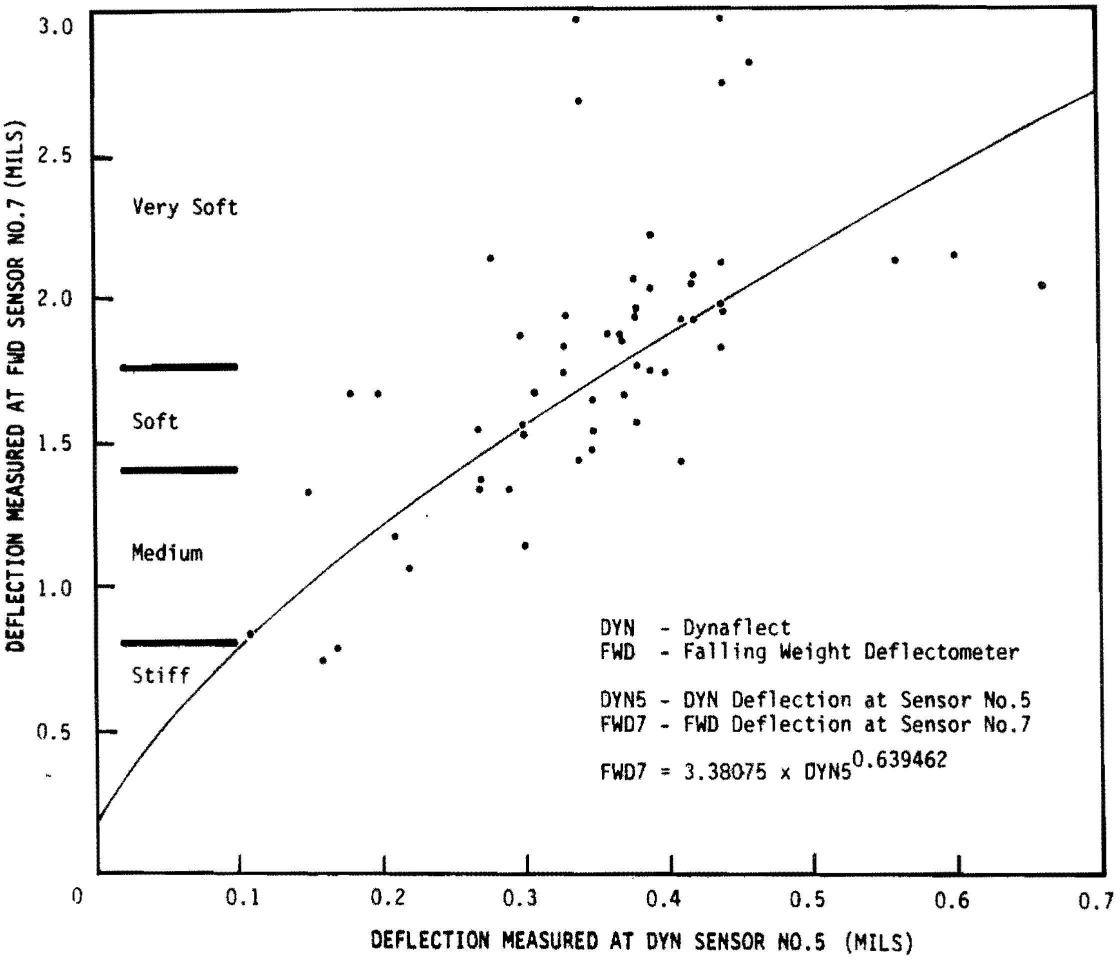


FIGURE 19. Determination of Subgrade Soil Model from Deflection

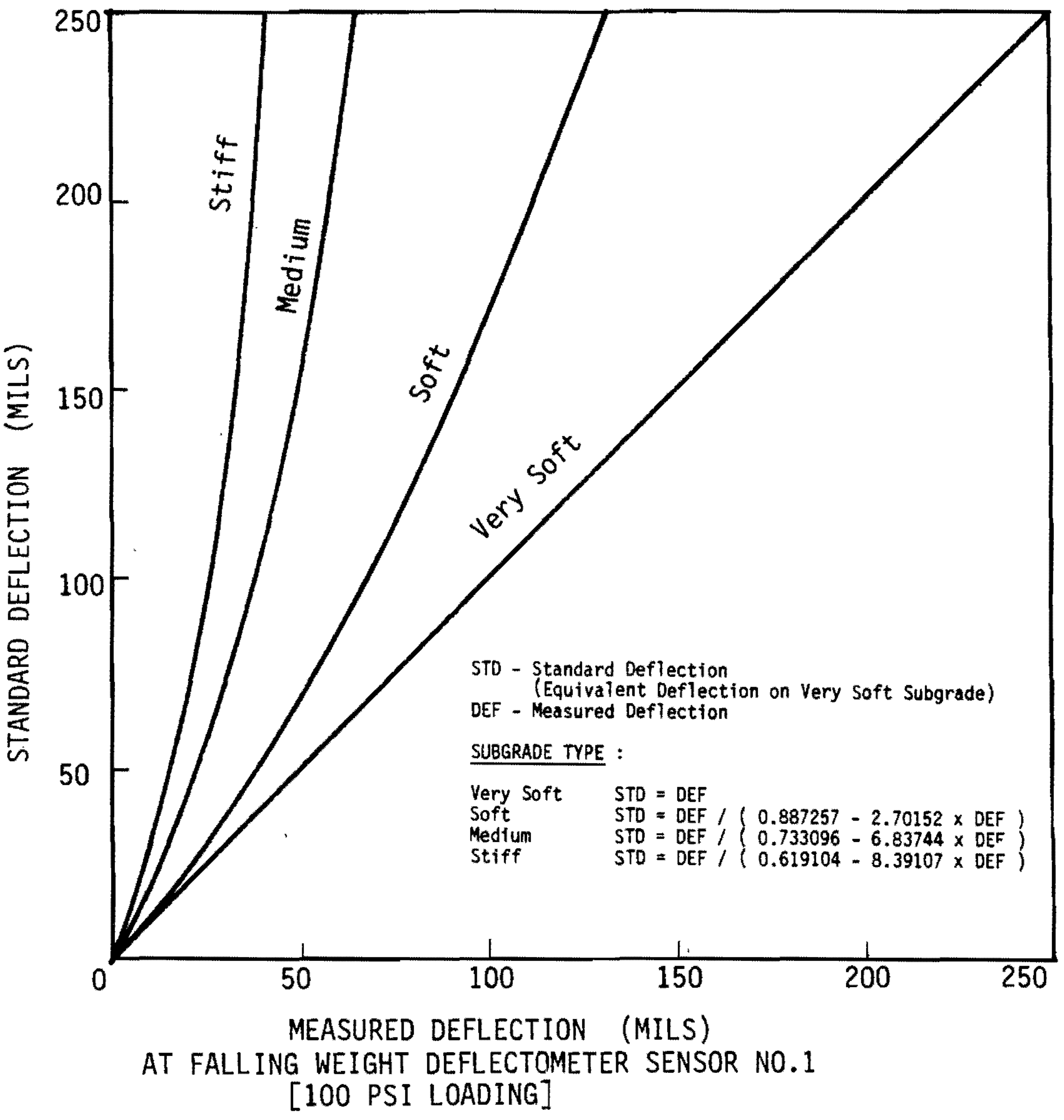


FIGURE 20. Determination of Standard Deflection

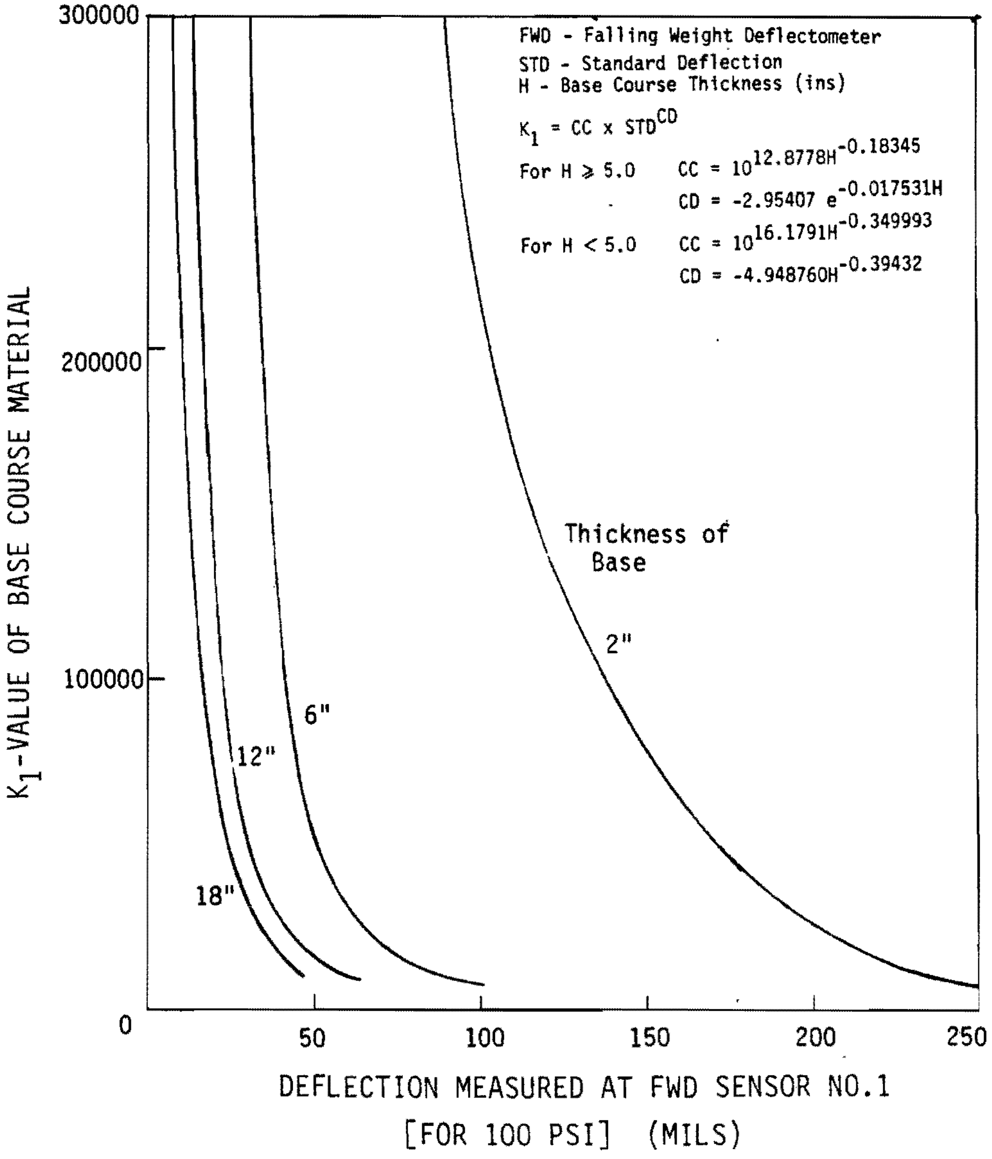
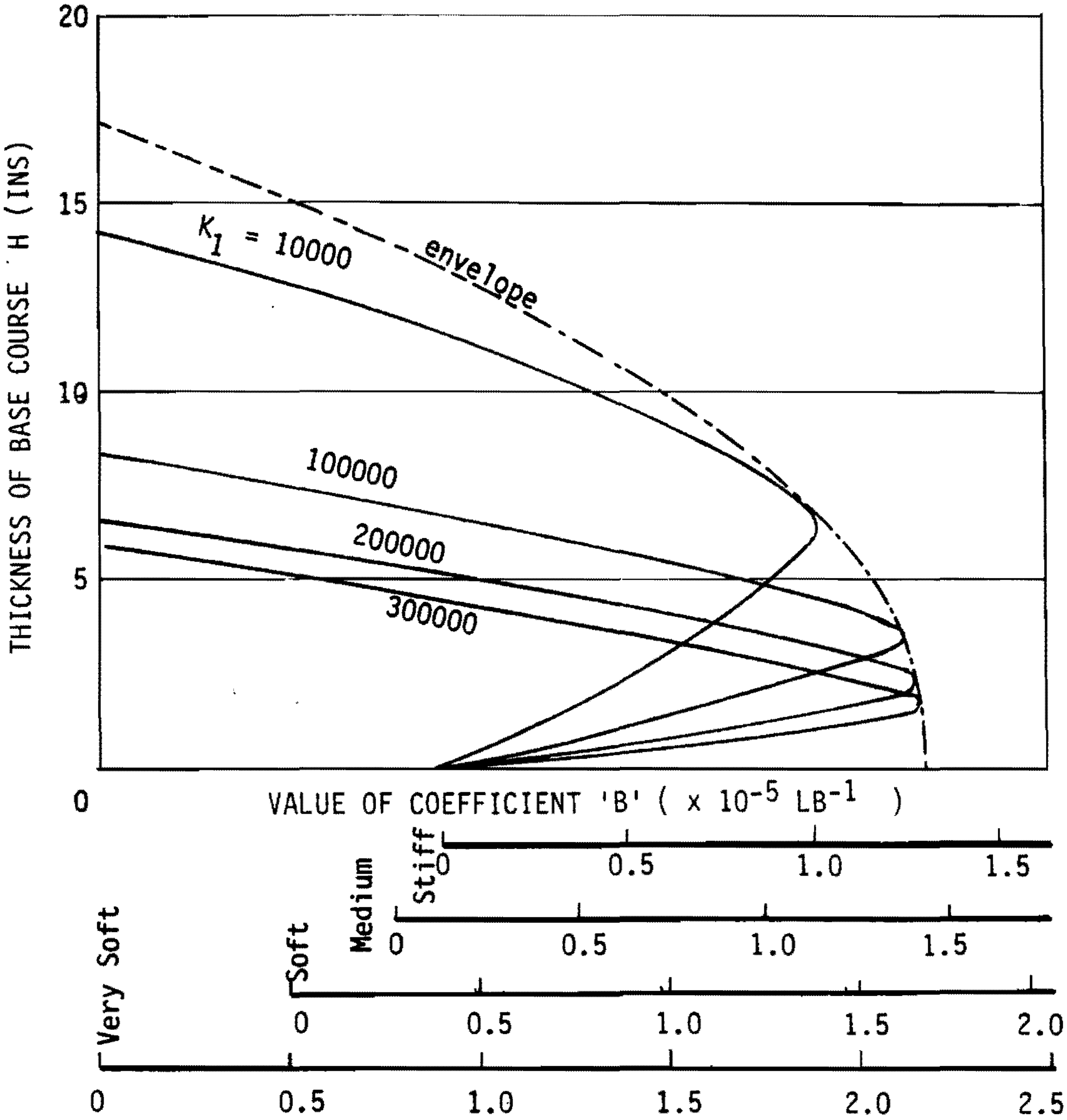


FIGURE 21. Determination of Base Course Material Model from FWD Deflection



B - Coefficient 'B' of Load Deflection Equation
H - Thickness of Base Course
K_1 - Coefficient for Base Course Material Model

$$B = CE + CF \times H + CG \times H^2$$

where $CE = 1.36543 \times 10^{-6} \times K_1^{0.185895}$

$$CF = 3.15679 \times 10^{-6} + 3.24823 \times 10^{-11} \times K_1 - 1.05093 \times 10^{-16} \times K_1^2$$

$$CG = -1.74866 \times 10^{-7} + 1.00162 \times 10^{-11} \times K_1 + 2.3941 \times 10^{-17} \times K_1^2$$

FIGURE 22. Determination of Positive Value of Coefficient B

on ILLI-PAVE analyses. For the negative value of Coefficient B, refer to Figure 23. This value is a linear function of the value of Coefficient A of the load deflection equation. As a check, it was observed that for a positive value of Coefficient B, if the calculated maximum deflection differs from the measured value by more than 20%, then it should be replaced with a negative value which can be found from Figure 23. This step was always found to provide a satisfactory load deflection equation. Figure 23 shows a linear relation between the negative values of Coefficient B and Coefficient A, both of which were calculated from measured deflections.

8. Determination of the Multiplier for the initial slope. This Multiplier when applied to the initial slope (stiffness) of the load deflection curve is the slope of the unloading path describing the deflection of the pavement after the passage of a wheel load. Sixty four light pavement sections from five Farm-to-Market roads, namely FM 418 and FM 365 from District 20, FM 665 in District 16, FM 612 in District 8 and FM 1381 in District 13 were used to backcalculate this Multiplier. Values of this Multiplier from these sections were found to vary from about 0.90 to 1.7. Figure 24 shows a method of estimating this value. However, if the rut depth and the number of passes of a known load is available, for that particular road, the Multiplier can be back-figured from the equation

$$\text{Multiplier} = \Delta P_m \left(\frac{A P_m}{1-B P_m}\right) - \Delta_m \qquad (6)$$

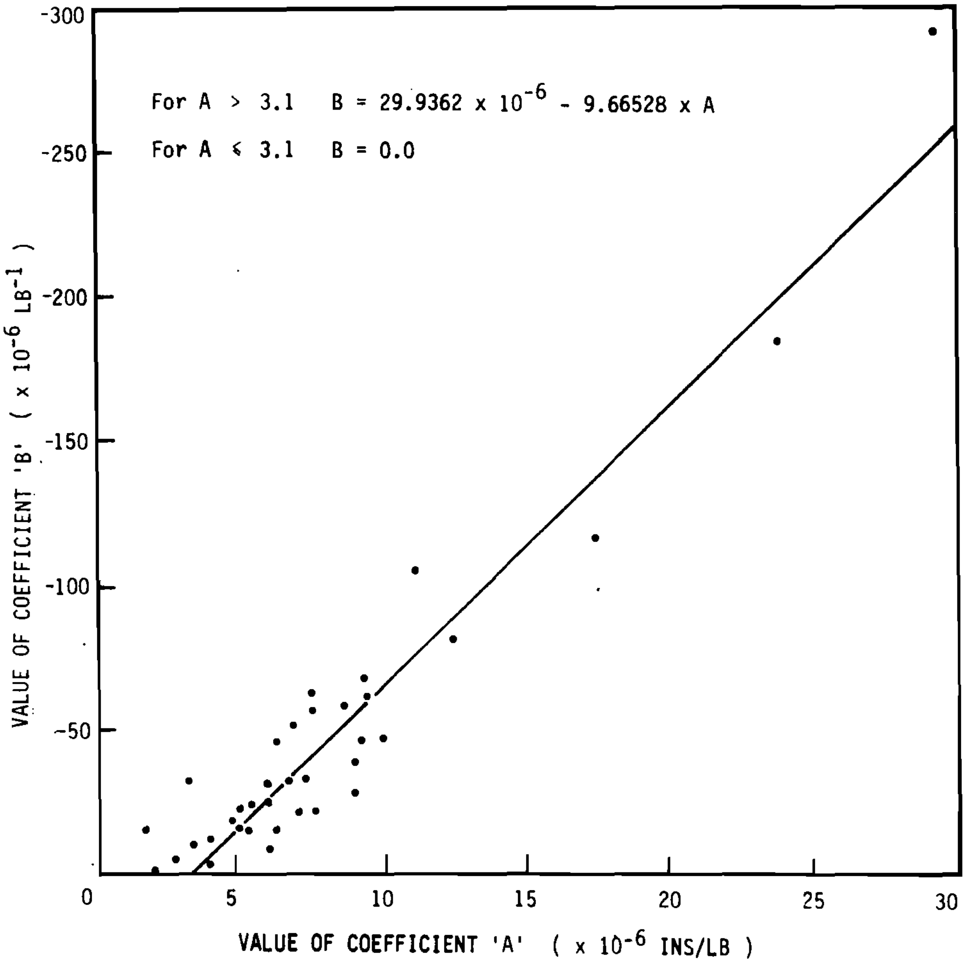


FIGURE 23. Determination of Negative Value of Coefficient B

AMULT - Multiplier of the Initial Stiffness
[Slope of the Load Deflection Curve at near Zero Load]

B - Coefficient 'B' in the Load Deflection Curve

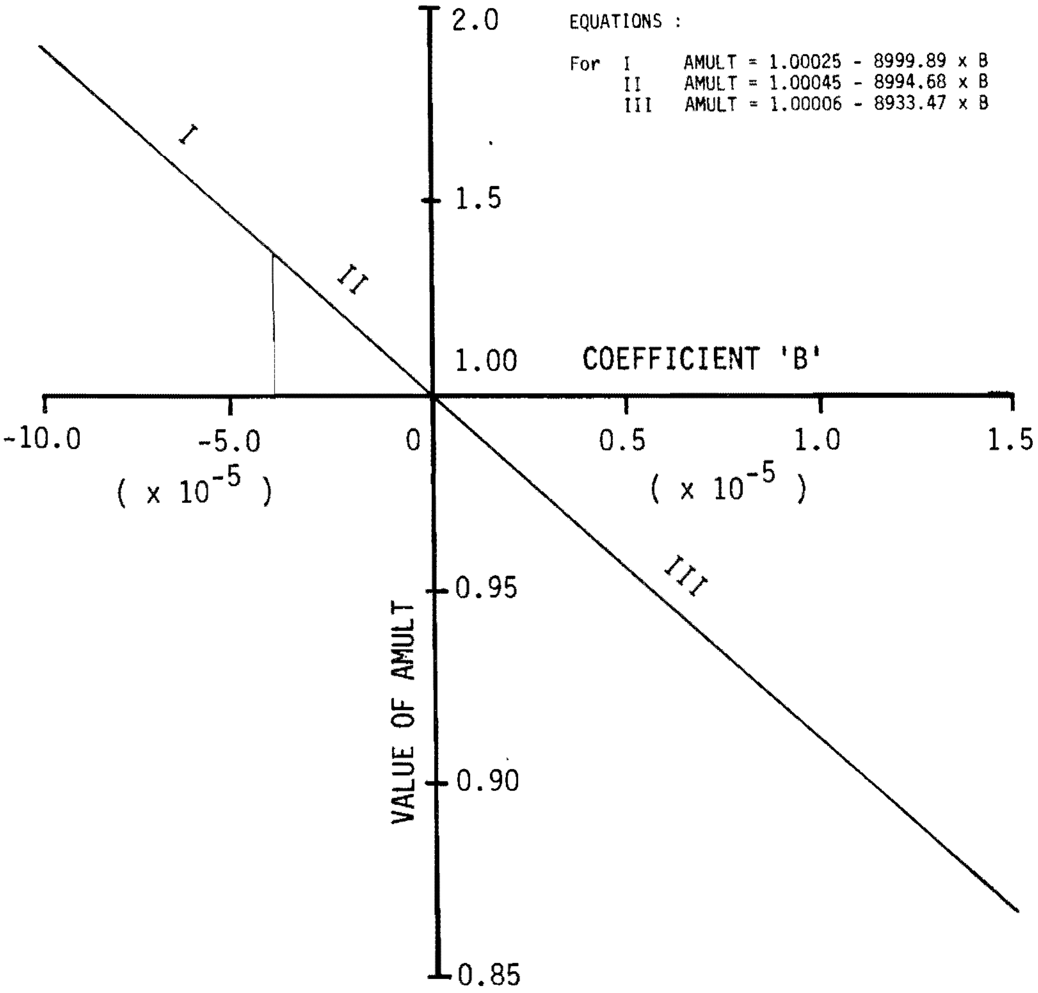


FIGURE 24. Determination of Multiplier of the Initial Slope (Stiffness) for the Unloading Path

where

P_m = measured load

Δ_m = measured rut depth/measured number of passes of P_m

9. Determine the allowable number of passes. The number of passes of a desired load that will cause a specifed rut depth can be easily found from the following expression.

$$N_x = \frac{R_x}{(\Delta_N - \frac{A\ P_x}{\text{Multiplier}})} \qquad (7)$$

where

N_x = the allowable number of passes of a load equal to P_x

R_x = specified rut depth

P_x = specified load and

$$\Delta_N = \frac{A\ P_x}{(\ 1 - B\ P_x\ )}$$

In the case of a set of different loads considered as a single pass, as for that of a multiple axle truck,

$$N_x = \frac{R_x}{\sum_{i=1}^{n} (\Delta N_i - \frac{A\ P_{xi}}{\text{Multiplier}})}$$

where

n = the number of loads in the set

B. Procedure Using the Dynaflect

1. Obtain field measured response of pavement with a Dynaflect.

2. Determine the equivalent FWD deflection for the reading at Dynaflect Sensor No.1. As this approach is based on that described earlier for the FWD, the maximum Dynaflect deflection must be correlated with that of the FWD. Figure 25 shows the relationship between the pavement Overall Stiffness as measured with a Dynaflect with that obtained from the FWD. The equivalent FWD deflection can be calculated from the following expression:

$$\text{FWD deflection} = -\,7.24474 + (\,29.6906 \times \text{Dynaflect Deflection}) \qquad (8)$$

3. Determine Coefficient A of the load deflection equation. The equivalent FWD Overall Stiffness can be obtained from Figure 25. The Initial Stiffness which is the slope of the load deflection curve near a zero load, is then read off Figure 18 and the inverse of this is the value of Coefficient A.

4. Determine the type of subgrade. This is found from Figure 19 using the Dynaflect reading at Sensor No.5 .

5. Determine the Standard Deflection. This value can be obtained from Figure 20 using the equivalent FWD deflection.

6. Determine the base course material model. By interpolating from the curves shown in Figure 21, using the equivalent FWD deflection, the K_1-value of the base course material can be found. The base course thickness must necessarily be known.

7. Determine the Coefficient B of the load deflection equation. The positive value of the Coefficient B can be interpolated from the curves shown in Figure 22. Different scales for the value of Coefficient B are given to adjust for the different subgrade encountered. For the negative value of Coefficient B, refer to Figure

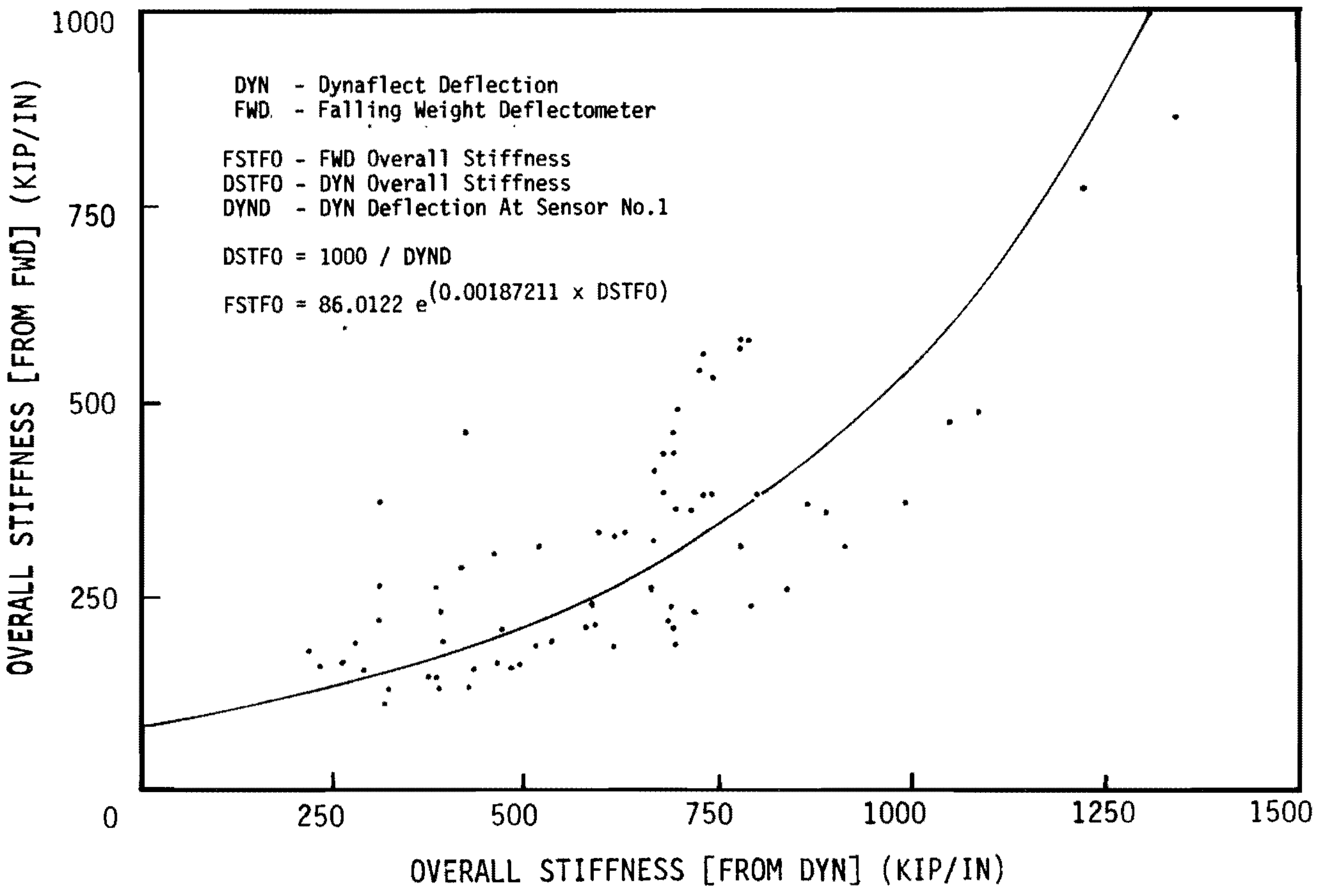


FIGURE 25. Determination of Equivalent FWD Overall Stiffness from Dynaflect Overall Stiffness

23. As a check, it was observed that for a positive value of Coefficient B, if the the calculated maximum deflection differs from the measured value by more than 20%, then it should be replaced with a negative value from Figure 23.

8. Determination of the Multiplier for the initial slope. Figure 24 shows a method of estimating this value. If the rut depth and the number of passes of a known load is available, for that particular road, the Multiplier can be back-figured from the equation

$$\text{Multiplier} = A\,P_m \left(\frac{A\,P_m}{1 - B\,P_m}\right) - \Delta_m \tag{6}$$

where

P_m = measured load

Δ_m = measured rut depth/measured of no. of passes of P_m .

9. Determine the allowable number of passes. The number of passes of a desired load that will cause a specifed rut depth can be easily found from the following expression.

$$N_x = \frac{R_x}{\left(\Delta N - \frac{A\,P_x}{\text{Multiplier}}\right)} \tag{7}$$

where

N_x = the allowable number of passes

R_x = specified rut depth

P_x = specified load and

$$\Delta_N = \frac{A\,P_x}{(\,1 - B\,P_x\,)}$$

In the case of a set of different loads considered as a single pass, as for that of a multiple axle truck,

$$N_x = \frac{R_x}{\sum_{i=1}^{n} (\Delta N_i - \frac{A\ P_{xi}}{\text{Multiplier}})}$$

where

n = the number of loads in the set.

Summary of Load Rating Procedure

Tables 4 and 5 give a summary of the load rating procedure with the use of a Falling Weight Deflectometer and a Dynaflect, respectively.

The Computer Program

A computer program LOADRATE, written in FORTRAN language, facilitates the load rating procedure developed in this study. With slight modifications, this program can also be executed on microcomputers.

This program can calculate the number of passes of a specified load that will cause a specified critical level of rut depth for every section where a deflection basin is input, and then give the average of the number of passes allowed for that particular road. The deflection basin can either be that obtained using a Falling Weight Deflectometer or the Dynaflect. It also has an option to print the

TABLE 4. Summary of Load Rating Procedure Using a Falling Weight Deflectometer

LOAD RATING PROCEDURE USING A FALLING WEIGHT DEFLECTOMETER

1. Obtain deflection basin of pavement to a FWD pressure of about 100 psi which corresponds to a 10956 lbs load.

2. Adjust measured deflections at Sensor Nos. 1 and 7 to their equivalent values at the Standard FWD Load.

   Mulitply by 10956 ÷ applied load measured

3. Determine Coefficient A of the Load Deflection Equation.

   Overall Stiffness = applied load ÷ maximum deflection
   Read Initial Stiffness from Figure 18.

   Coefficient A = 1 ÷ Initial Stiffness

4. Determine the type of subgrade from Figure 19.

5. Determine the Standard Deflection from Figure 20.

6. Determine the K_1-value of the base course material model from Figure 21.

7. Determine the Coefficient B of the Load Deflection Equation from Figure 22. If the value is negative, use Figure 23.

   Check : for positive B,
   if 10956 x A ÷ (1 - 10956 x B)
   differs more than 20% from the Standard Deflection,
   use Figure 23 for a new value of B.

8. Determine the Multiplier for the Initial Stiffness.

   If the rut depth R_m and the number of passes N of a load P_m are known,
   use $$A\ P_m\ \left(\frac{A\ P_m}{1 - B\ P_m}\right) - \Delta_m$$
   and $\Delta_m = R_m \div N$

9. Determine the allowable number of passes N_x of a desired load P_x that will cause a specified rut R_x.

   $$N_x = \frac{R_x}{\left(\Delta_N - \frac{A\ P_x}{\text{Multiplier}}\right)}$$

   and $$\Delta_N = \frac{A\ P_x}{1 - B\ P_x}$$

TABLE 5. Summary of Load Rating Procedure Using a Dynaflect

LOAD RATING PROCEDURE USING A DYNAFLECT

1. Obtain deflection basin of pavement using a Dynaflect.
2. Calculate the equivalent maximum FWD deflection.

   Use -7.24474 + (29.6906 x Dynaflect maximum deflection)
3. Determine Coefficient A of the Load Deflection Equation.

   Overall Stiffness = applied load ÷ max. FWD deflection
   Read Initial Stiffness from Figure 18.

   Coefficient A = 1 ÷ Initial Stiffness
4. Determine the type of subgrade from Figure 19.
5. Determine the Standard Deflection from Figure 20.
6. Determine the K_1-value of the base course material model from Figure 21.
7. Determine the Coeffcicient B of the Load Deflection Equation from Figure 22. If the value is negative, use Figure 23.

   Check : for positive B,
   if 10956 x A ÷ (1 - 10956 x B)
   differs more than 20% from the Standard Deflection,
   use Figure 23 for a new value of B.
8. Determine the Multiplier for the Initial Stiffness.

   If the rut depth R_m and the number of passes N of a load P_m are known,
   use
   $$A\,P_m \left(\frac{A\,P_m}{1 - B\,P_m} \right) - \Delta_m$$
   and $\Delta_m = R_m \div N$
9. Determine the allowable number of passes N_x of a desired load P_x that will cause a specified rut R_x.
   $$N_x = \frac{R_x}{\left(\Delta_N - \dfrac{A\,P_x}{\text{Multiplier}} \right)}$$
   and $$\Delta_N = \frac{A\,P_x}{1 - B\,P_x}$$

material model of the base course and the subgrade for each section considered. The program uses English Units for computation.

Appendix C gives the program documentation including the flow-charts for the main program and the four subroutines. The descriptions of input parameters and the input format is given as a preprocessor in the program listing. A sample input follows the listing of the main program and the subroutines. The output to the sample problem run is also given.

Evaluation of the Accuracy of the Procedure

In the development of this procedure, inaccuracy due to human error is minimized. Readings from the FWD are in the form of a computer read- out. However, those from the Dynaflect are from dial readings. In the correlation of data, valid statistical methods of regression were used to get the best-fit. Despite this, departures observed must be accepted as the normal variation in pavements.

With regards to regression analyses done with field data, Table 6 shows the degree of correlation obtained. It can be seen that those parameters describing the behavior of the pavement structure are better correlated than those between the readings from the FWD and the Dynaflect.

The degree of accuracy of the simulated load deflection model can be seen from Figures 26 through 29. The figures compare the measured maximum deflections of the test sections with those obtained in the procedure at four different load levels using FWD readings. It can be

TABLE 6. Degree of Correlation of Regression Analyses

Description	No. of Data Points	Coefficient of Determination (R^2)	Coefficient of Correlation
FIGURE 18. Determination of Initial Slope (Stiffness) of Load Deflection Curve	72	0.9668	0.9833
FIGURE 19. Determination of Subgrade Soil Model from Deflection	69	0.4936	0.7025
FIGURE 23. Determination of Negative Value of Coefficient B	36	0.9105	0.9542
FIGURE 25. Determination of Equivalent FWD Overall Stiffness from Dynaflect Overall Stiffness	68	0.5031	0.7093

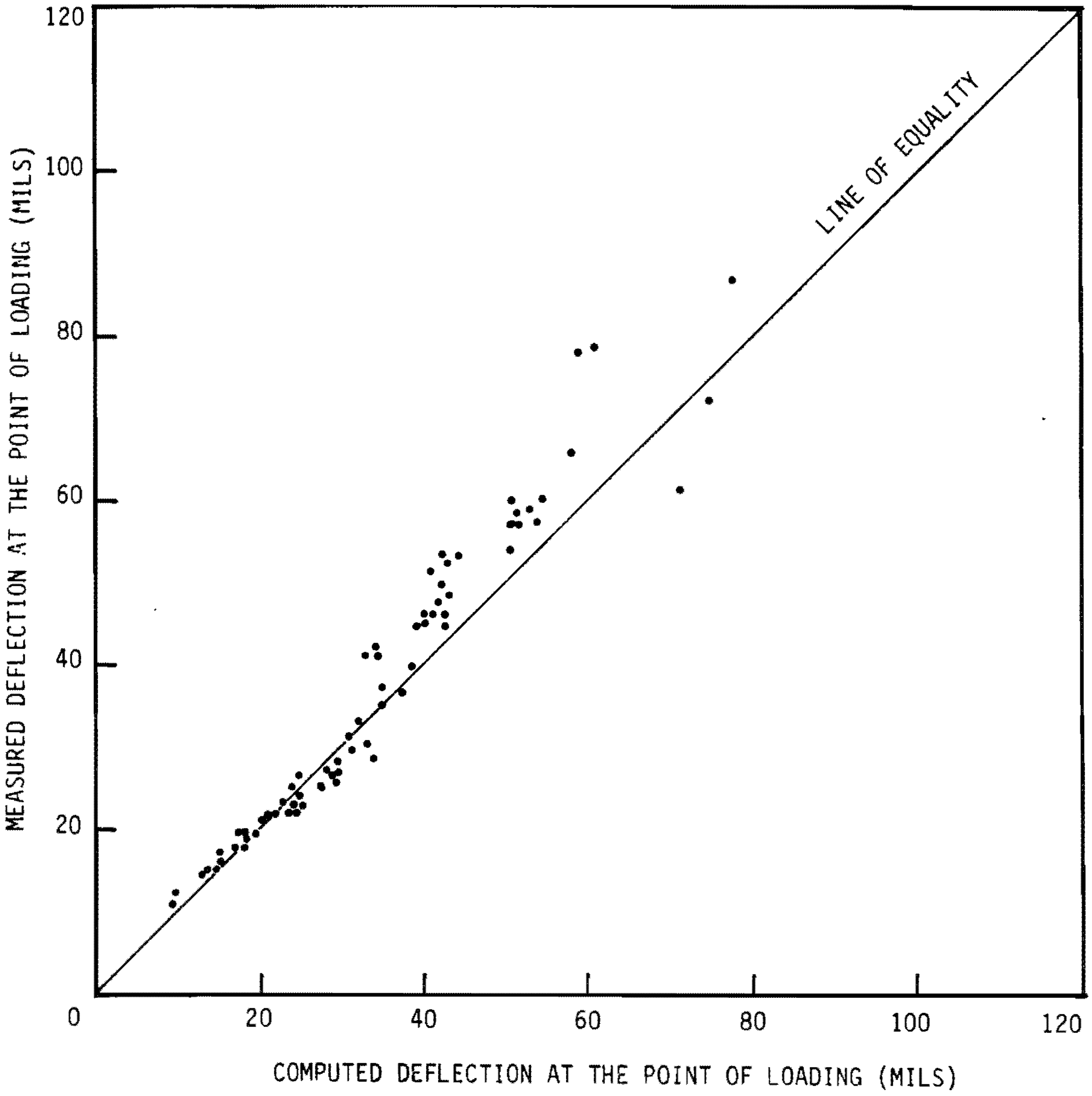


FIGURE 26. Comparison of Measured Deflections with Computed Deflections at about 9000 lbs. Loading

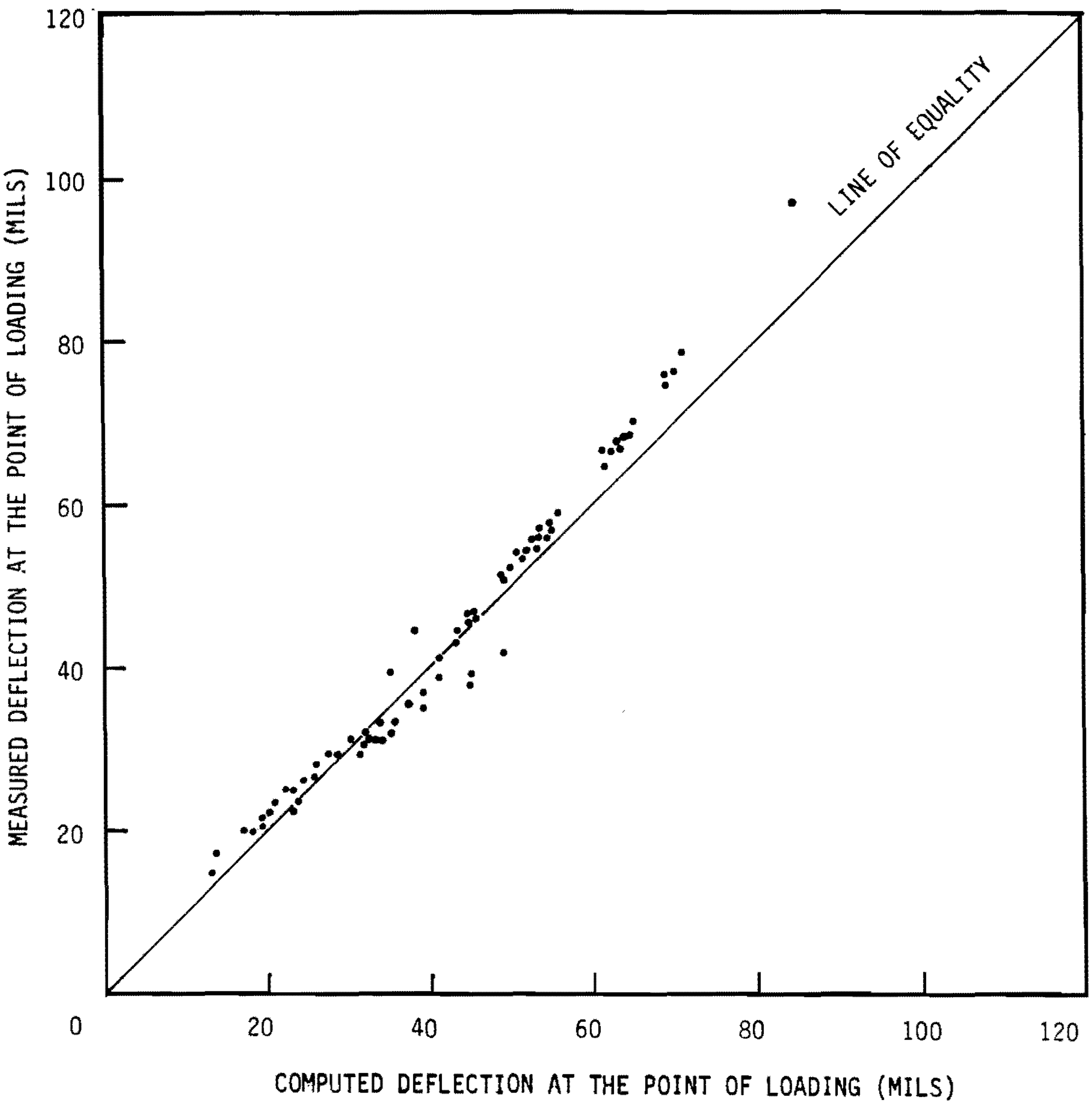


FIGURE 27. Comparison of Measured Deflections with Computed Deflections at about 11000 lbs. Loading

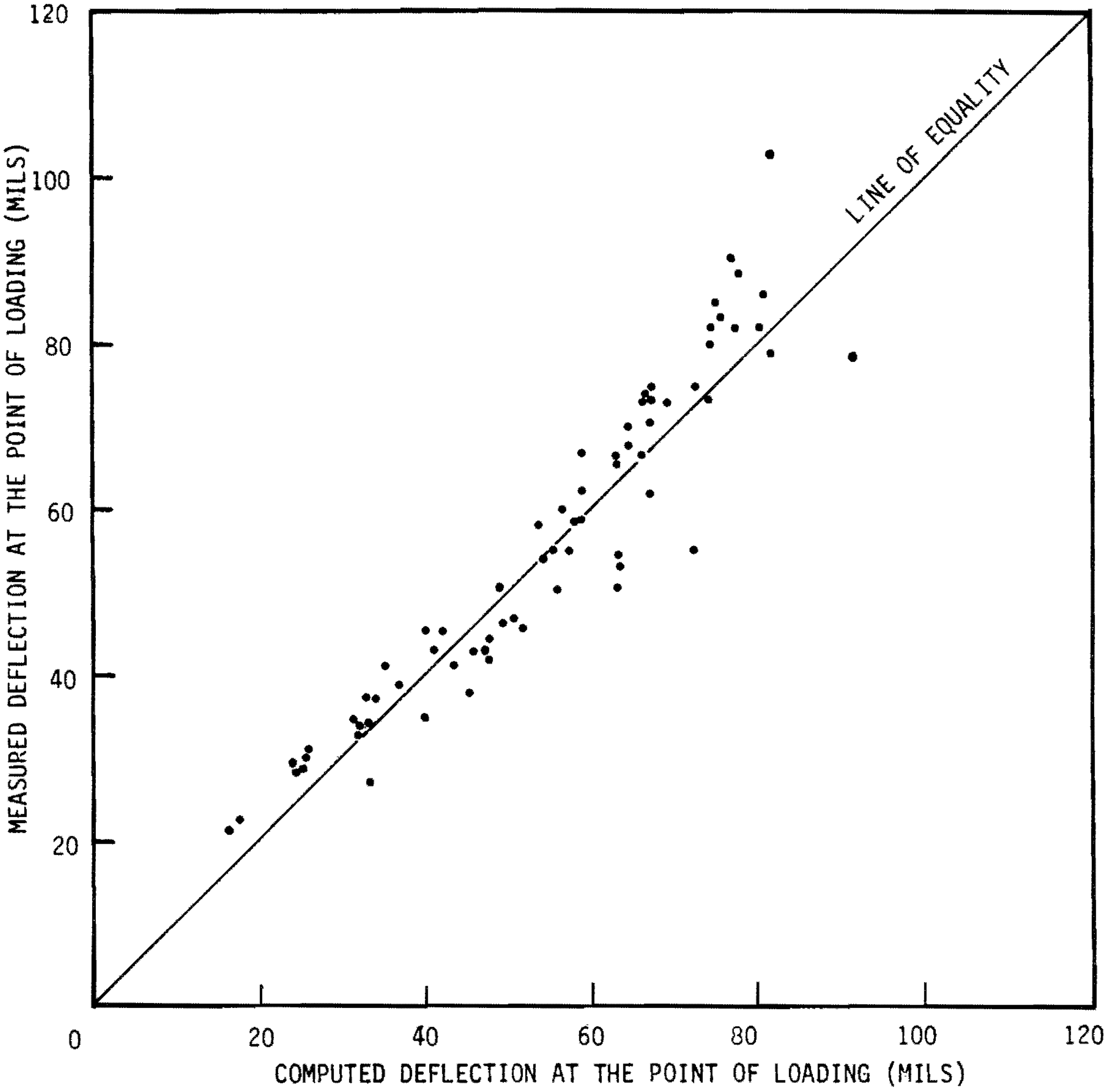


FIGURE 28. Comparison of Measured Deflections with Computed Deflections at about 15000 lbs. Loading

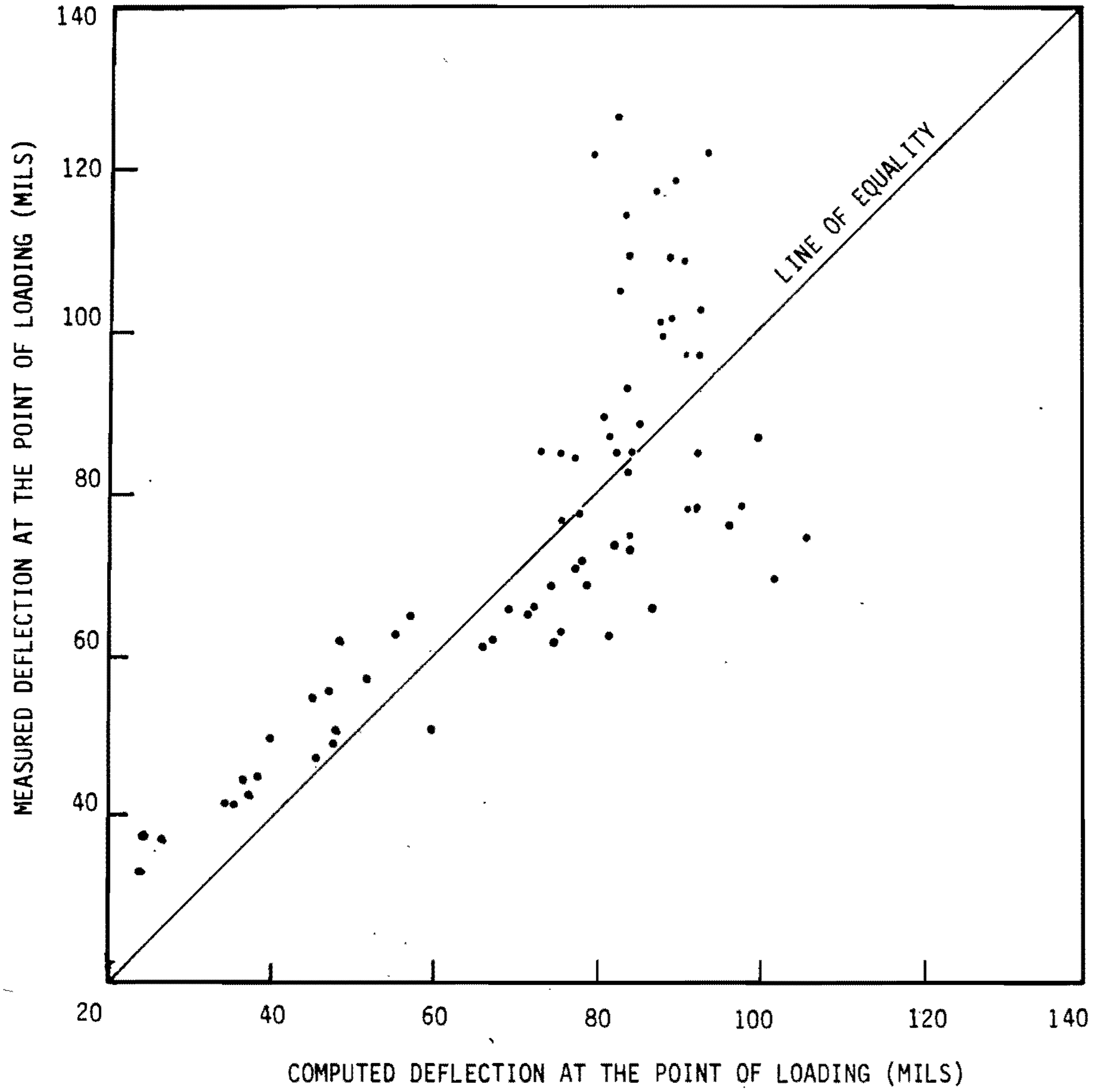


FIGURE 29. Comparison of Measured Deflections with Computed Deflections at about 23000 lbs. Loading

seen that the best result was obtained at the 11000 lbs load level. This was because the material models for the base course and the subgrade were determined based on a 100 psi loading from a FWD. At the 24,000 lbs load level, the deviations were more pronounced. At a lower load level, the load deflection curve seems to closely match that obtained from the field data. It should be noted that the procedure presented uses only one deflection basin. The accuracy of the approach using the FWD is an indication of the accuracy of that approach when using the Dynaflect as the latter was based on the former.

When evaluating the accuracy of the rutting model, it was observed that the analysis is very sensitive to the value of the slope Multiplier. Backcalculation of the number of passes for those sections used to derive the expression for the Multiplier showed that for certain cases, only the order of magnitude could be reproduced. This might be avoided if some rut history were available to compute the Multiplier.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This report presents a new procedure for the load rating of light pavement structures using the Falling Weight Deflectometer or the Dynaflect. A computer program was developed for the procedure. In the course of the study, the following were accomplished.

1. It was found that light pavement structures such as those commonly found in the Farm-to-Market roads, show either a stress-softening form or a stress-hardening form of load-deflection behavior.

2. It was shown that a hyperbolic stress-strain relationship or load-deflection may be used to describe both the stress-softening as well as the stress-hardening form of the load-deflection characteristics of the light pavements.

3. The ILLI-PAVE finite element pavement analysis program was again verified to show that it was capable of simulating deflection basins of flexible light pavement structures to match those measured in the field.

4. A procedure for determining the nonlinear elastic material models for the base course and the subgrade using the Falling Weight Deflectometer or the Dynaflect was developed.

5. It was shown from the Pavement Dynamic Cone Penetrometer data that the stiffness of the granular base course may depend more on the degree of compaction of the material than the shape or hardness of the aggregates.

6. A model of the repetitive loading on pavements was proposed, which assumes a hyperbolic-shaped load-deflection curve with a linear unloading path. The slope of this unloading line was found to be smaller than the initial slope of the load deflection curve for the stress-softening type of pavement but was larger for the stress-hardening type.

7. Pavements with a thicker base course were usually found to show a stress-hardening form of load deflection behavior. This form is more resistant to rutting than the stress-softening form.

8. It was shown that the proposed procedure is capable of reproducing the load-deflection characteristics of the pavement sections tested.

It is recommended that this new procedure of load rating of light pavement structures should be implemented in the State of Texas to alleviate the problem faced in the evaluation of overweight vehicle permit applications.

The following studies may be considered to allow a better understanding of the problem of rutting:

1. The determination of factors that are causing some pavements to show a stress-hardening form of load-deflection behavior should be attempted. This may lead to a design procedure of pavements that will be more resistant to rutting.

2. A more rigorous study of the loading, unloading and reloading characteristic of pavements in the field should be carried out. Such

a study will involve the monitoring of deflections in the pavement layers in the field under repeated loading and unloading.

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APPENDICES

APPENDIX A - FIELD DATA

Falling Weight Deflectometer Readings

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TEXAS TRANSPORTATION INSTITUTE
DYNATEST 8000 FALLING WEIGHT DEFLECTOMETER
DATA OF TEST DONE IN DECEMBER 1982

NOTATIONS : (U) REFERS TO MICROMETERS
          : (KPA) IS KILOPASCAL

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 4.0L
LD.(KPA)         566       732        992        1408
DEF:  1  (U) 606       751        1036       1558
DEF:  2  (U) 305       389        625        842
DEF:  3  (U) 198       264        385        595
DEF:  4  (U) 73        97         139        200
DEF:  5  (U) 32        42         63         87
DEF:  6  (U) 26        35         42         53
DEF:  7  (U) 17        22         35         50

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 4.1L
LD.(KPA)         559       722        993        1407
DEF:  1  (U) 462       590        831        1238
DEF:  2  (U) 285       385        570        969
DEF:  3  (U) 196       263        383        600
DEF:  4  (U) 72        96         142        201
DEF:  5  (U) 33        40         58         85
DEF:  6  (U) 19        25         38         56
DEF:  7  (U) 17        21         31         47

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 4.2L
LD.(KPA)         570       735        999        1409
DEF:  1  (U) 463       606        864        1304
DEF:  2  (U) 270       358        487        776
DEF:  3  (U) 170       234        341        587
DEF:  4  (U) 81        87         126        185
DEF:  5  (U) 28        36         56         83
DEF:  6  (U) 33        28         36         50
DEF:  7  (U) 16        20         29         44

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 8.0L
LD.(KPA)         570       737        1008       1448
DEF:  1  (U) 650       834        1159       1592
DEF:  2  (U) 368       483        690        1010
DEF:  3  (U) 259       352        505        746
DEF:  4  (U) 119       151        235        334
DEF:  5  (U) 48        70         102        146
DEF:  6  (U) 19        40         59         66
DEF:  7  (U) 22        32         43         58
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 8.1L
LD.(KPA)      559       733       984       1434
DEF:  1  (U) 772       958       1280      1756
DEF:  2  (U) 378       494       658       997
DEF:  3  (U) 243       331       463       688
DEF:  4  (U) 103       183       206       371
DEF:  5  (U) 41        64        89        128
DEF:  6  (U) 20        38        38        106
DEF:  7  (U) 19        29        40        58

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 8.2L
LD.(KPA)      551       716       989       1439
DEF:  1  (U) 608       778       1069      1554
DEF:  2  (U) 373       486       683       972
DEF:  3  (U) 261       350       495       724
DEF:  4  (U) 117       166       242       350
DEF:  5  (U) 52        74        104       150
DEF:  6  (U) 28        40        59        90
DEF:  7  (U) 23        30        45        62

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 2.0
LD.(KPA)      604       783       1012      1423
DEF:  1  (U) 483       639       915       1393
DEF:  2  (U) 364       484       694       1051
DEF:  3  (U) 283       382       559       846
DEF:  4  (U) 161       225       327       487
DEF:  5  (U) 81        115       168       242
DEF:  6  (U) 47        70        103       142
DEF:  7  (U) 35        51        74        108

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 2.1
LD.(KPA)      571       751       984       1384
DEF:  1  (U) 637       822       1155      1308
DEF:  2  (U) 379       523       737       1160
DEF:  3  (U) 299       409       593       1001
DEF:  4  (U) 163       234       333       511
DEF:  5  (U) 77        107       157       225
DEF:  6  (U) 47        67        98        143
DEF:  7  (U) 37        49        73        104

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 2.2
LD.(KPA)      567       752       974       1358
DEF:  1  (U) 702       906       1282      1643
DEF:  2  (U) 450       602       856       1298
DEF:  3  (U) 341       468       686       1047
DEF:  4  (U) 177       245       348       539
DEF:  5  (U) 90        122       173       262
DEF:  6  (U) 59        76        109       160
DEF:  7  (U) 41        53        75        110
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 4.0H
LD.(KPA)      582       752       1010      1416
DEF:  1   (U) 530       665       915       1303
DEF:  2   (U) 341       436       603       866
DEF:  3   (U) 224       295       427       1235
DEF:  4   (U) 77        108       158       242
DEF:  5   (U) 32        45        64        90
DEF:  6   (U) 24        32        57        61
DEF:  7   (U) 18        26        36        51

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 4.1H
LD.(KPA)      578       747       1000      1413
DEF:  1   (U) 440       574       793       1167
DEF:  2   (U) 314       411       572       815
DEF:  3   (U) 192       263       377       553
DEF:  4   (U) 75        105       150       217
DEF:  5   (U) 30        43        58        86
DEF:  6   (U) 21        29        42        59
DEF:  7   (U) 19        25        32        49

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 4.2H
LD.(KPA)      564       732       1009      1415
DEF:  1   (U) 441       581       826       1150
DEF:  2   (U) 258       349       502       761
DEF:  3   (U) 170       237       348       525
DEF:  4   (U) 63        91        134       194
DEF:  5   (U) 25        38        53        75
DEF:  6   (U) 17        29        37        52
DEF:  7   (U) 14        23        31        44

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 6.0
LD.(KPA)      571       740       998       1417
DEF:  1   (U) 684       887       1250      1682
DEF:  2   (U) 416       554       796       1202
DEF:  3   (U) 302       415       602       890
DEF:  4   (U) 140       200       288       427
DEF:  5   (U) 58        83        120       171
DEF:  6   (U) 35        53        72        106
DEF:  7   (U) 28        36        52        77

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 6.1
LD.(KPA)      563       729       992       1400
DEF:  1   (U) 720       963       1394      2221
DEF:  2   (U) 345       478       696       1053
DEF:  3   (U) 248       349       506       747
DEF:  4   (U) 132       185       268       388
DEF:  5   (U) 53        76        110       157
DEF:  6   (U) 35        48        69        102
DEF:  7   (U) 30        37        58        79
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 6.2
LD.(KPA)        558       736         996        1430
DEF:  1   (U) 579       785         1109       1673
DEF:  2   (U) 358       502         724        1106
DEF:  3   (U) 263       371         541        808
DEF:  4   (U) 151       212         309        461
DEF:  5   (U) 63        91          132        208
DEF:  6   (U) 43        59          83         128
DEF:  7   (U) 48        37          61         115

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 8.0H
LD.(KPA)        590       760         1161       1463
DEF:  1   (U) 672       859         1330       1515
DEF:  2   (U) 376       503         806        1032
DEF:  3   (U) 230       320         573        726
DEF:  4   (U) 113       167         281        359
DEF:  5   (U) 43        69          118        146
DEF:  6   (U) 24        44          82         76
DEF:  7   (U) 61        65          51         72

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 8.1H
LD.(KPA)        573       748         1004       1441
DEF:  1   (U) 796       976         1303       1859
DEF:  2   (U) 385       500         711        1034
DEF:  3   (U) 245       329         464        643
DEF:  4   (U) 112       158         227        340
DEF:  5   (U) 44        58          90         141
DEF:  6   (U) 28        35          54         83
DEF:  7   (U) 21        28          41         68

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 8.2H
LD.(KPA)        568       761         1017       1464
DEF:  1   (U) 597       794         1090       1522
DEF:  2   (U) 394       541         797        1190
DEF:  3   (U) 269       374         527        770
DEF:  4   (U) 125       181         258        374
DEF:  5   (U) 52        76          109        150
DEF:  6   (U) 32        43          59         87
DEF:  7   (U) 22        32          45         289

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 10.1
LD.(KPA)        519       701         973        1359
DEF:  1   (U) 1146      1416        1877       2917
DEF:  2   (U) 848       1133        1505       2062
DEF:  3   (U) 634       851         1232       1574
DEF:  4   (U) 291       396         544        773
DEF:  5   (U) 110       145         198        286
DEF:  6   (U) 64        90          121        175
DEF:  7   (U) 52        69          94         138
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM3058 10.2
LD.(KPA)      502       669       949       1333
DEF:  1  (U) 1460      1761      2079      2603
DEF:  2  (U) 979       1244      1720      2251
DEF:  3  (U) 693       892       1200      1667
DEF:  4  (U) 278       357       484       692
DEF:  5  (U) 126       165       219       314
DEF:  6  (U) 78        106       137       195
DEF:  7  (U) 55        73        90        123

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM908 10.0
LD.(KPA)      521       689       964       1383
DEF:  1  (U) 1528      1687      2043      2773
DEF:  2  (U) 714       797       941       1252
DEF:  3  (U) 408       476       640       886
DEF:  4  (U) 168       219       271       364
DEF:  5  (U) 88        117       164       222
DEF:  6  (U) 51        148       202       312
DEF:  7  (U) 66        50        69        94

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM908 10.1
LD.(KPA)      502       686       977       1396
DEF:  1  (U) 1293      1381      1713      1901
DEF:  2  (U) 832       916       1074      1282
DEF:  3  (U) 456       535       703       929
DEF:  4  (U) 148       190       260       359
DEF:  5  (U) 94        121       170       236
DEF:  6  (U) 63        79        113       157
DEF:  7  (U) 47        56        80        110

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM908 10.2
LD.(KPA)      502       680       965       1377
DEF:  1  (U) 1355      1468      1843      2251
DEF:  2  (U) 785       903       1109      1473
DEF:  3  (U) 423       506       657       883
DEF:  4  (U) 149       187       253       371
DEF:  5  (U) 91        118       165       231
DEF:  6  (U) 66        83        115       157
DEF:  7  (U) 42        51        75        102

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 6.0
LD.(KPA)      495       677       948       1363
DEF:  1  (U) 1686      1938      2199      2146
DEF:  2  (U) 1123      1284      1641      2196
DEF:  3  (U) 675       864       1181      1640
DEF:  4  (U) 184       255       332       539
DEF:  5  (U) 70        95        140       205
DEF:  6  (U) 44        64        75        121
DEF:  7  (U) 33        47        63        92
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 6.1
LD.(KPA)      520       693       971       1372
DEF:  1  (U) 1443      1663      2082      2552
DEF:  2  (U) 799       886       1540      1941
DEF:  3  (U) 491       646       903       1259
DEF:  4  (U) 92        188       332       485
DEF:  5  (U) 60        86        131       189
DEF:  6  (U) 4         47        97        91
DEF:  7  (U) 31        40        61        149

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 6.2
LD.(KPA)      502       673       954       1368
DEF:  1  (U) 1534      1792      2248      2475
DEF:  2  (U) 977       1167      1324      1927
DEF:  3  (U) 538       725       1044      1328
DEF:  4  (U) 196       216       288       467
DEF:  5  (U) 54        77        113       159
DEF:  6  (U) 62        116       58        102
DEF:  7  (U) 33        53        72        136

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 8.0
LD.(KPA)      480       666       929       1322
DEF:  1  (U) 1821      2015      2928      2459
DEF:  2  (U) 1281      1428      1871      2343
DEF:  3  (U) 700       864       1205      1687
DEF:  4  (U) 221       287       420       598
DEF:  5  (U) 75        101       143       202
DEF:  6  (U) 32        52        76        120
DEF:  7  (U) 32        41        60        80

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 8.1
LD.(KPA)      478       666       958       1341
DEF:  1  (U) 1832      1918      2628      2631
DEF:  2  (U) 1284      1559      1969      2207
DEF:  3  (U) 830       1005      1349      1790
DEF:  4  (U) 271       329       444       626
DEF:  5  (U) 72        94        133       191
DEF:  6  (U) 36        53        76        105
DEF:  7  (U) 27        41        57        82

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 8.2
LD.(KPA)      481       659       930       1359
DEF:  1  (U) 1505      1722      2116      2772
DEF:  2  (U) 1194      1279      1685      2246
DEF:  3  (U) 661       798       1071      1489
DEF:  4  (U) 177       211       300       451
DEF:  5  (U) 53        71        99        138
DEF:  6  (U) 72        60        76        104
DEF:  7  (U) 8         32        48        73
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 10.0
LD.(KPA)      473       649       903       1295
DEF:  1  (U) 2006      1980      2006      2004
DEF:  2  (U) 1310      1600      1956      1938
DEF:  3  (U) 758       992       1388      1976
DEF:  4  (U) 254       358       495       617
DEF:  5  (U) 99        137       198       278
DEF:  6  (U) 67        91        110       240
DEF:  7  (U) 49        71        100       168

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 10.1
LD.(KPA)      479       658       908       1288
DEF:  1  (U) 2231      2473      1981      2008
DEF:  2  (U) 1297      1513      2121      3021
DEF:  3  (U) 772       1010      1401      1969
DEF:  4  (U) 211       333       429       548
DEF:  5  (U) 101       143       203       291
DEF:  6  (U) 35        84        105       230
DEF:  7  (U) 46        68        89        135

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1361 10.2
LD.(KPA)      483       662       915       1306
DEF:  1  (U) 1995      1937      2086      2017
DEF:  2  (U) 1183      1377      1805      2464
DEF:  3  (U) 622       833       1226      1733
DEF:  4  (U) 203       310       408       553
DEF:  5  (U) 87        121       171       243
DEF:  6  (U) 50        99        84        180
DEF:  7  (U) 43        67        81        143

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1362 4.0
LD.(KPA)      530       725       984       1410
DEF:  1  (U) 991       1091      1438      1986
DEF:  2  (U) 661       743       995       1411
DEF:  3  (U) 457       522       709       1010
DEF:  4  (U) 198       249       349       498
DEF:  5  (U) 95        126       176       244
DEF:  6  (U) 50        75        96        138
DEF:  7  (U) 237       231       331       606

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1362 4.1
LD.(KPA)      521       714       976       1400
DEF:  1  (U) 1139      1221      1591      1877
DEF:  2  (U) 612       692       941       1332
DEF:  3  (U) 408       476       650       913
DEF:  4  (U) 187       242       335       467
DEF:  5  (U) 86        123       165       236
DEF:  6  (U) 44        69        93        125
DEF:  7  (U) 187       193       304       524
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1362 6.0
LD.(KPA)      545       701       946       1323
DEF:  1  (U)  964       1322      1902      2764
DEF:  2  (U)  559       786       1183      1771
DEF:  3  (U)  396       551       827       1220
DEF:  4  (U)  151       206       293       410
DEF:  5  (U)  70        101       145       202
DEF:  6  (U)  231       187       325       515
DEF:  7  (U)  123       118       164       268

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1362 6.1
LD.(KPA)      526       676       920       1297
DEF:  1  (U)  1082      1472      2146      2336
DEF:  2  (U)  625       881       1319      2005
DEF:  3  (U)  406       576       861       1310
DEF:  4  (U)  134       193       269       370
DEF:  5  (U)  71        100       143       199
DEF:  6  (U)  366       343       437       611
DEF:  7  (U)  152       157       244       350

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1362 8.0
LD.(KPA)      591       787       1008      1448
DEF:  1  (U)  504       669       940       1561
DEF:  2  (U)  291       389       547       835
DEF:  3  (U)  204       275       385       558
DEF:  4  (U)  87        124       175       265
DEF:  5  (U)  37        52        75        110
DEF:  6  (U)  23        35        46        69
DEF:  7  (U)  70        90        147       186

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM1362 8.1
LD.(KPA)      557       748       977       1410
DEF:  1  (U)  659       848       1175      1721
DEF:  2  (U)  409       531       771       1382
DEF:  3  (U)  275       360       504       726
DEF:  4  (U)  110       149       211       306
DEF:  5  (U)  41        59        82        122
DEF:  6  (U)  30        40        53        78
DEF:  7  (U)  124       138       202       286

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2000 8.0
LD.(KPA)      526       699       985       1403
DEF:  1  (U)  1272      1394      1798      2103
DEF:  2  (U)  751       836       1128      2452
DEF:  3  (U)  469       538       735       1041
DEF:  4  (U)  214       262       366       506
DEF:  5  (U)  93        128       179       237
DEF:  6  (U)  49        73        97        122
DEF:  7  (U)  38        55        62        84
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2000 8.1
LD.(KPA)      513       691       977       1386
DEF:  1  (U) 1381      1422      1560      2186
DEF:  2  (U) 761       834       1133      1577
DEF:  3  (U) 479       551       766       1107
DEF:  4  (U) 223       284       396       554
DEF:  5  (U) 100       142       197       258
DEF:  6  (U) 55        82        113       152
DEF:  7  (U) 40        52        66        60

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2000 10.0
LD.(KPA)      558       731       1004      1429
DEF:  1  (U) 1147      1319      1432      2179
DEF:  2  (U) 710       834       1091      1476
DEF:  3  (U) 479       570       746       1004
DEF:  4  (U) 239       296       395       536
DEF:  5  (U) 94        127       174       237
DEF:  6  (U) 46        62        95        120
DEF:  7  (U) 249       254       384       459

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2000 10.1
LD.(KPA)      554       736       992       1416
DEF:  1  (U) 1175      1365      1783      3240
DEF:  2  (U) 737       866       1130      1532
DEF:  3  (U) 501       591       769       1020
DEF:  4  (U) 256       314       415       552
DEF:  5  (U) 106       141       187       250
DEF:  6  (U) 53        75        102       141
DEF:  7  (U) 175       206       270       330

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2000 12.0
LD.(KPA)      556       740       1011      1440
DEF:  1  (U) 582       801       1167      1768
DEF:  2  (U) 349       490       716       1094
DEF:  3  (U) 244       344       502       760
DEF:  4  (U) 130       183       260       381
DEF:  5  (U) 74        102       141       202
DEF:  6  (U) 49        66        92        131
DEF:  7  (U) 126       175       242       336

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2000 12.1
LD.(KPA)      549       742       1015      1428
DEF:  1  (U) 601       819       1185      1619
DEF:  2  (U) 345       476       694       1055
DEF:  3  (U) 234       326       475       720
DEF:  4  (U) 131       178       255       376
DEF:  5  (U) 74        99        140       204
DEF:  6  (U) 48        62        90        130
DEF:  7  (U) 129       166       241       337
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2155 2.0
LD.(KPA)      519       717       980       1409
DEF:  1  (U) 1044      1122      1405      1818
DEF:  2  (U) 627       674       887       1163
DEF:  3  (U) 444       512       666       890
DEF:  4  (U) 146       160       193       288
DEF:  5  (U) 36        43        98        87
DEF:  6  (U) 0         37        44        97
DEF:  7  (U) 9         26        39        53

DISTRICT: 17  COUNTY: BURLSEON  SECTION: FM2155 2.1
LD.(KPA)      515       709       981       1398
DEF:  1  (U) 1057      1169      1493      1825
DEF:  2  (U) 683       744       960       1207
DEF:  3  (U) 420       503       674       909
DEF:  4  (U) 135       158       216       336
DEF:  5  (U) 22        38        51        73
DEF:  6  (U) 22        40        47        70
DEF:  7  (U) 21        27        43        56

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2155 2.2
LD.(KPA)      512       705       964       1407
DEF:  1  (U) 1056      1173      1515      1748
DEF:  2  (U) 717       748       932       1290
DEF:  3  (U) 429       517       700       970
DEF:  4  (U) 107       142       185       284
DEF:  5  (U) 21        35        47        70
DEF:  6  (U) 9         24        33        67
DEF:  7  (U) 15        27        34        61

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2155 4.0
LD.(KPA)      563       727       1000      1391
DEF:  1  (U) 564       757       1085      1656
DEF:  2  (U) 421       578       836       1318
DEF:  3  (U) 330       459       668       1032
DEF:  4  (U) 167       209       313       480
DEF:  5  (U) 61        83        118       176
DEF:  6  (U) 28        47        58        104
DEF:  7  (U) 31        38        49        81

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2155 4.1
LD.(KPA)      555       717       994       1375
DEF:  1  (U) 568       766       1109      1682
DEF:  2  (U) 413       569       825       1136
DEF:  3  (U) 318       448       657       1000
DEF:  4  (U) 164       215       322       469
DEF:  5  (U) 62        83        121       174
DEF:  6  (U) 48        48        68        118
DEF:  7  (U) 28        35        52        74
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM2155 4.2
LD.(KPA)        550       713       991       1380
DEF:  1   (U) 670       896       1281      1888
DEF:  2   (U) 464       643       910       1172
DEF:  3   (U) 346       489       722       1211
DEF:  4   (U) 165       236       328       482
DEF:  5   (U) 61        85        120       174
DEF:  6   (U) 38        52        69        100
DEF:  7   (U) 28        38        52        77

DISTRICT: 17  COUNTY: BRAZO  SECTION: OSR  2.0
LD.(KPA)        608       785       997       1387
DEF:  1   (U) 555       740       1054      1586
DEF:  2   (U) 423       577       829       1268
DEF:  3   (U) 344       452       622       892
DEF:  4   (U) 202       281       402       593
DEF:  5   (U) 87        123       171       246
DEF:  6   (U) 53        73        101       144
DEF:  7   (U) 41        54        78        108

DISTRICT: 17  COUNTY: BRAZO  SECTION: OSR  2.1
LD.(KPA)        575       755       991       1364
DEF:  1   (U) 588       794       1144      1607
DEF:  2   (U) 419       581       839       1428
DEF:  3   (U) 356       495       770       2133
DEF:  4   (U) 224       313       452       677
DEF:  5   (U) 102       140       202       290
DEF:  6   (U) 58        80        112       162
DEF:  7   (U) 43        59        82        119

DISTRICT: 17  COUNTY: BRAZO  SECTION: OSR  4.0
LD.(KPA)        646       837       1066      1530
DEF:  1   (U) 291       389       545       853
DEF:  2   (U) 219       293       421       626
DEF:  3   (U) 186       253       362       542
DEF:  4   (U) 120       167       238       356
DEF:  5   (U) 69        92        131       187
DEF:  6   (U) 43        58        82        116
DEF:  7   (U) 34        44        66        77

DISTRICT: 17  COUNTY: BRAZO  SECTION: OSR  4.1
LD.(KPA)        606       781       1010      1485
DEF:  1   (U) 315       409       579       956
DEF:  2   (U) 223       302       431       660
DEF:  3   (U) 187       257       371       559
DEF:  4   (U) 123       172       248       358
DEF:  5   (U) 66        92        132       188
DEF:  6   (U) 41        59        82        115
DEF:  7   (U) 35        50        66        79
```

```
DISTRICT: 17  COUNTY: BRAZO  SECTION: FM974 6.0
LD.(KPA)        476         662         918         1312
DEF:  1   (U) 1504         1759        2299        3037
DEF:  2   (U) 800          1025        1402        1955
DEF:  3   (U) 449          580         774         1067
DEF:  4   (U) 162          242         350         513
DEF:  5   (U) 67           102         150         218
DEF:  6   (U) 42           69          96          149
DEF:  7   (U) 32           54          71          109

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM974 6.1
LD.(KPA)        471         648         914         1295
DEF:  1   (U) 1474         4670        2154        2557
DEF:  2   (U) 826          1011        1388        1870
DEF:  3   (U) 470          610         884         1186
DEF:  4   (U) 166          234         340         480
DEF:  5   (U) 67           93          146         211
DEF:  6   (U) 50           67          116         152
DEF:  7   (U) 28           37          50          99

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM974 8.0
LD.(KPA)        485         674         931         1341
DEF:  1   (U) 1313         1487        1906        2793
DEF:  2   (U) 812          969         1252        1708
DEF:  3   (U) 455          576         766         1000
DEF:  4   (U) 159          232         310         432
DEF:  5   (U) 75           86          130         172
DEF:  6   (U) 81           193         74          106
DEF:  7   (U) 26           43          75          84

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM974 8.1
LD.(KPA)        488         677         934         1351
DEF:  1   (U) 1217         1437        1853        2910
DEF:  2   (U) 667          834         1108        1573
DEF:  3   (U) 380          501         682         967
DEF:  4   (U) 129          179         254         363
DEF:  5   (U) 50           70          103         151
DEF:  6   (U) 34           47          68          102
DEF:  7   (U) 25           36          52          72

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM1179 4.0
LD.(KPA)        519         707         979         1374
DEF:  1   (U) 846          1085        1521        2168
DEF:  2   (U) 569          759         1088        1562
DEF:  3   (U) 406          556         805         1161
DEF:  4   (U) 187          265         386         547
DEF:  5   (U) 80           113         163         234
DEF:  6   (U) 46           69          99          146
DEF:  7   (U) 27           44          67          105
```

```
DISTRICT: 17  COUNTY: BRAZO  SECTION: FM1179 4.1
LD.(KPA)      524      715        974        1356
DEF:  1  (U) 756      984        1354       1932
DEF:  2  (U) 524      698        971        1394
DEF:  3  (U) 370      508        724        1044
DEF:  4  (U) 163      233        339        511
DEF:  5  (U) 71       97         139        208
DEF:  6  (U) 41       59         83         127
DEF:  7  (U) 33       44         59         88

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM1687 2.0
LD.(KPA)      534      721        981        1397
DEF:  1  (U) 714      968        1391       1919
DEF:  2  (U) 509      692        1002       1487
DEF:  3  (U) 394      541        778        1175
DEF:  4  (U) 194      269        390        589
DEF:  5  (U) 87       120        171        248
DEF:  6  (U) 53       76         105        154
DEF:  7  (U) 41       56         81         113

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2038 8.0
LD.(KPA)      581      725        1019       1410
DEF:  1  (U) 497      633        864        1212
DEF:  2  (U) 380      496        691        973
DEF:  3  (U) 306      418        588        825
DEF:  4  (U) 170      234        328        463
DEF:  5  (U) 58       83         121        173
DEF:  6  (U) 41       60         83         120
DEF:  7  (U) 33       50         64         92

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2038 8.1
LD.(KPA)      527      703        992        1385
DEF:  1  (U) 690      848        1137       1574
DEF:  2  (U) 512      664        915        1311
DEF:  3  (U) 413      541        757        1083
DEF:  4  (U) 187      261        369        530
DEF:  5  (U) 65       93         132        188
DEF:  6  (U) 46       64         91         127
DEF:  7  (U) 39       50         73         104

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2038 10.0
LD.(KPA)      539      701        991        1389
DEF:  1  (U) 931      1064       1388       1902
DEF:  2  (U) 636      745        988        1369
DEF:  3  (U) 452      539        756        1035
DEF:  4  (U) 206      257        347        485
DEF:  5  (U) 73       100        130        181
DEF:  6  (U) 40       59         78         114
DEF:  7  (U) 32       48         61         84
```

```
DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2038 10.1
LD.(KPA)      525         690         968         1370
DEF:  1  (U) 1129        1290        1693         2263
DEF:  2  (U) 674         804         1078         1535
DEF:  3  (U) 454         555         735          1045
DEF:  4  (U) 193         245         340          478
DEF:  5  (U) 69          92          129          182
DEF:  6  (U) 40          55          77           111
DEF:  7  (U) 30          39          51           79

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2776 0.0
LD.(KPA)      509         693         946         1325
DEF:  1  (U) 894         1183        1708         1961
DEF:  2  (U) 572         796         1174         1779
DEF:  3  (U) 367         530         757          1044
DEF:  4  (U) 171         248         366          542
DEF:  5  (U) 78          109         157          224
DEF:  6  (U) 48          66          96           133
DEF:  7  (U) 34          49          64           91

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2776 0.1
LD.(KPA)      485         666         918         1284
DEF:  1  (U) 1378        1704        1877         2991
DEF:  2  (U) 783         1038        1468         2152
DEF:  3  (U) 464         655         951          1404
DEF:  4  (U) 197         286         419          623
DEF:  5  (U) 80          112         155          230
DEF:  6  (U) 49          67          98           137
DEF:  7  (U) 34          51          68           97

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2776 2.0
LD.(KPA)      491         669         927         1328
DEF:  1  (U) 1009        1301        1680         3105
DEF:  2  (U) 582         781         1147         1722
DEF:  3  (U) 357         497         710          1091
DEF:  4  (U) 121         169         239          352
DEF:  5  (U) 55          75          102          145
DEF:  6  (U) 38          53          71           101
DEF:  7  (U) 29          39          52           78

DISTRICT: 17  COUNTY: BRAZO  SECTION: FM2776 2.1
LD.(KPA)      497         665         920         1314
DEF:  1  (U) 801         1049        1489         2180
DEF:  2  (U) 491         667         974          1504
DEF:  3  (U) 317         449         656          1024
DEF:  4  (U) 115         167         243          363
DEF:  5  (U) 50          71          97           141
DEF:  6  (U) 35          50          59           96
DEF:  7  (U) 26          38          49           74
```

```
DISTRICT: 17  COUNTY: BRAZO  SECTION: FM1687 2.1
LD.(KPA)      530       714       983       1387
DEF:  1  (U) 678       936       1374      2147
DEF:  2  (U) 467       654       953       1484
DEF:  3  (U) 366       513       750       1113
DEF:  4  (U) 179       258       386       584
DEF:  5  (U) 93        130       184       273
DEF:  6  (U) 54        77        102       158
DEF:  7  (U) 38        54        78        120

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 2.0
LD.(KPA)      516       694       961       1381
DEF:  1  (U) 953       1166      1580      1961
DEF:  2  (U) 616       779       1078      1538
DEF:  3  (U) 402       532       695       1047
DEF:  4  (U) 167       232       333       476
DEF:  5  (U) 77        108       157       222
DEF:  6  (U) 50        67        97        158
DEF:  7  (U) 37        51        74        108

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 2.1
LD.(KPA)      506       685       952       1362
DEF:  1  (U) 1175      1428      1903      3100
DEF:  2  (U) 748       944       1276      1816
DEF:  3  (U) 490       648       890       1275
DEF:  4  (U) 197       270       386       562
DEF:  5  (U) 84        111       164       247
DEF:  6  (U) 57        68        102       163
DEF:  7  (U) 42        49        77        120

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 4.0
LD.(KPA)      524       714       983       1380
DEF:  1  (U) 1241      1451      1861      2354
DEF:  2  (U) 839       1033      1352      1825
DEF:  3  (U) 586       749       1004      1373
DEF:  4  (U) 248       335       466       652
DEF:  5  (U) 98        136       194       280
DEF:  6  (U) 59        85        120       177
DEF:  7  (U) 317       332       377       609

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 4.1
LD.(KPA)      528       712       978       1367
DEF:  1  (U) 1174      1360      1735      2216
DEF:  2  (U) 779       950       1230      1654
DEF:  3  (U) 527       674       894       1219
DEF:  4  (U) 199       273       382       525
DEF:  5  (U) 80        112       161       235
DEF:  6  (U) 52        74        106       156
DEF:  7  (U) 52        54        80        115
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 12.0
LD.(KPA)       566        731        1015       1438
DEF:  1   (U)  536        703        990        1455
DEF:  2   (U)  406        549        751        1109
DEF:  3   (U)  317        437        635        980
DEF:  4   (U)  166        233        344        507
DEF:  5   (U)  83         117        169        246
DEF:  6   (U)  42         65         96         137
DEF:  7   (U)  38         52         74         107

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 12.0L
LD.(KPA)       568        732        1029       1434
DEF:  1   (U)  527        677        945        1376
DEF:  2   (U)  373        507        681        1028
DEF:  3   (U)  288        397        550        760
DEF:  4   (U)  155        212        318        485
DEF:  5   (U)  78         109        159        229
DEF:  6   (U)  50         69         83         116
DEF:  7   (U)  34         50         71         107

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 12.0R
LD.(KPA)       537        711        1007       1402
DEF:  1   (U)  795        1000       1372       1483
DEF:  2   (U)  550        732        1006       1452
DEF:  3   (U)  393        551        796        1164
DEF:  4   (U)  200        278        413        612
DEF:  5   (U)  92         130        187        271
DEF:  6   (U)  50         69         100        159
DEF:  7   (U)  39         56         82         119

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 12.1
LD.(KPA)       574        743        1029       1433
DEF:  1   (U)  495        663        943        1345
DEF:  2   (U)  377        511        676        1054
DEF:  3   (U)  292        398        586        880
DEF:  4   (U)  185        252        359        510
DEF:  5   (U)  81         119        169        243
DEF:  6   (U)  38         70         93         141
DEF:  7   (U)  37         51         75         104

DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 12.2
LD.(KPA)       556        722        1014       1408
DEF:  1   (U)  511        675        955        1420
DEF:  2   (U)  362        494        680        988
DEF:  3   (U)  292        407        583        875
DEF:  4   (U)  225        257        323        468
DEF:  5   (U)  89         116        166        233
DEF:  6   (U)  43         61         89         138
DEF:  7   (U)  44         55         75         90
```

```
DISTRICT: 17  COUNTY: BURLESON   SECTION: FM50 14.0
LD.(KPA)       586        757        1020       1495
DEF:  1   (U) 397        523        742        1128
DEF:  2   (U) 308        419        604        842
DEF:  3   (U) 241        332        483        737
DEF:  4   (U) 161        222        323        502
DEF:  5   (U) 84         118        170        250
DEF:  6   (U) 47         66         100        146
DEF:  7   (U) 37         54         79         115

DISTRICT: 17  COUNTY: BURLESON   SECTION: FM50 14.1
LD.(KPA)       579        765        1027       1444
DEF:  1   (U) 443        583        854        1275
DEF:  2   (U) 309        442        621        862
DEF:  3   (U) 247        344        495        736
DEF:  4   (U) 163        223        324        474
DEF:  5   (U) 82         116        167        247
DEF:  6   (U) 67         79         97         143
DEF:  7   (U) 43         51         77         112

DISTRICT: 17  COUNTY: BURLESON   SECTION: FM50 14.2
LD.(KPA)       598        754        1015       1469
DEF:  1   (U) 796        559        787        1157
DEF:  2   (U) 278        430        598        844
DEF:  3   (U) 250        335        532        901
DEF:  4   (U) 155        290        323        461
DEF:  5   (U) 81         120        169        250
DEF:  6   (U) 27         141        97         145
DEF:  7   (U) 40         55         77         111

DISTRICT: 17  COUNTY: BURLESON   SECTION: FM50 16.0
LD.(KPA)       594        752        1034       1480
DEF:  1   (U) 383        507        727        1067
DEF:  2   (U) 304        411        582        874
DEF:  3   (U) 240        331        479        709
DEF:  4   (U) 139        215        299        452
DEF:  5   (U) 71         100        143        207
DEF:  6   (U) 37         53         78         122
DEF:  7   (U) 30         42         61         86

DISTRICT: 17  COUNTY: BURLESON   SECTION: FM50 16.1
LD.(KPA)       582        744        1011       1448
DEF:  1   (U) 406        537        760        1112
DEF:  2   (U) 329        443        616        965
DEF:  3   (U) 246        343        512        717
DEF:  4   (U) 160        218        302        485
DEF:  5   (U) 66         92         134        195
DEF:  6   (U) 53         85         96         169
DEF:  7   (U) 33         46         78         96
```

```
DISTRICT: 17  COUNTY: BURLESON  SECTION: FM50 16.2
LD.(KPA)       566        728        994        1464
DEF:  1  (U) 385        506        718        1071
DEF:  2  (U) 289        394        561        822
DEF:  3  (U) 237        324        467        701
DEF:  4  (U) 144        200        286        421
DEF:  5  (U) 70         96         140        205
DEF:  6  (U) 40         59         84         121
DEF:  7  (U) 29         40         58         85
```

Dynaflect Readings

TEXAS TRANSPORTATION INSTITUTE
DYNAFLECT
DATA OF TEST DONE IN MARCH 1983

NOTATIONS : W1 W2 W3 W4 W5 REFERS TO DEFLECTIONS
@ SENSORS MEASURED IN MILS

DISTRICT: 17 COUNTY: BURLESON ROAD NAME: FM1361

SECTION	W1	W2	W3	W4	W5
6.0	2.64	1.26	.6	.42	.3
6.1	2.13	1.11	.54	.38	.3
6.2	2.28	1.11	.55	.38	.28
8.0	2.31	1.23	.52	.32	.2
8.1	2.61	1.44	.56	.31	.18
8.2	2.07	1.05	.39	.23	.15
10.0	3.1	1.74	.96	.64	.44
10.1	3.2	1.74	.99	.66	.46
10.2	2.61	1.44	.78	.57	.44

DISTRICT: 17 COUNTY: BURLESON ROAD NAME: FM3058

SECTION	W1	W2	W3	W4	W5
2.0	1.44	1.08	.81	.56	.39
2.1	1.41	1.08	.74	.56	.38
2.2	1.68	1.23	.81	.6	.42
4.0	1.02	.6	.35	.26	.11
4.1	.96	.56	.33	.24	.17
4.2	.93	.56	.32	.24	.16
6.0	1.62	1.08	.61	.41	.29
6.1	1.29	1.02	.6	.41	.27
6.2	1.38	1.02	.63	.44	.27
8.0	1.14	.84	.46	.33	.21
8.1	1.11	.66	.42	.29	.22
8.2	1.17	.78	.42	.29	.3
10.1	2.52	1.74	.96	.55	.34
10.2	3.4	1.83	.93	.51	.34

DISTRICT: 17 COUNTY: BURLESON ROAD NAME: FM908

SECTION	W1	W2	W3	W4	W5
10.0	3.8	.8	.55	.46	.38
10.1	1.44	1.02	.69	.6	.39
10.2	1.44	.96	.58	.48	.39

DISTRICT: 17 COUNTY: BURLESON ROAD NAME: FM2000

SECTION	W1	W2	W3	W4	W5
8.0	2.13	1.53	1.14	.87	.6
8.1	1.89	1.5	1.14	.86	.66
10.0	1.41	1.08	.74	.55	.39
10.1	1.47	1.14	.74	.53	.35
12.0	3.3	1.14	.78	.54	.22
12.1	1.4	1	.7	.5	.4

DISTRICT: 17 COUNTY: BURLESON ROAD NAME: FM2155

SECTION	W1	W2	W3	W4	W5
2.0	1.2	.7	.38	.28	.25
2.1	1.26	.93	.53	.38	.29
2.2	1.44	.73	.35	.24	.15
4.0	1.35	.96	.53	.38	.29
4.1	1.26	.93	.51	.36	.28
4.2	1.52	1.05	.55	.38	.28

DISTRICT: 17 COUNTY: BURLESON ROAD NAME: FM50

SECTION	W1	W2	W3	W4	W5
2.0	1.71	1.14	.67	.57	.38
2.1	1.98	1.29	.76	.53	.4
4.0	1.65	1.11	.67	.52	.36
4.1	1.68	1.11	.64	.45	.36
12.0	1.53	1.16	.75	.53	.38
12.1	1.44	1.14	.71	.51	.37
12.2	1.44	1.14	.72	.52	.38
14.0	1.29	1.08	.74	.58	.44
14.1	1.35	1.08	.75	.58	.44
14.2	1.38	1.08	.75	.58	.44
16.0	1.29	1.05	.7	.49	.35
16.1	1.38	1.08	.7	.5	.31
16.2	1.29	1.05	.7	.5	.35

DISTRICT: 17 COUNTY: BRAZOS ROAD NAME: OSR

SECTION	W1	W2	W3	W4	W5
2.0	1.74	1.35	.87	.56	.37
2.1	1.77	1.41	.96	.64	.44
4.0	1.08	.93	.68	.53	.41
4.1	1.11	.96	.68	.54	.4

DISTRICT: 17 COUNTY: BRAZOS ROAD NAME: FM974

SECTION	W1	W2	W3	W4	W5
8.0	1.56	.99	.58	.52	.33
8.1	1.47	.96	.58	.68	.34

```
DISTRICT: 17  COUNTY: BRAZOS  ROAD NAME: FM1179
SECTION     W1      W2      W3      W4      W5
 4.0        1.77    1.17    .73     .52     .37
 4.1        1.68    1.14    .65     .46     .35

DISTRICT: 17  COUNTY: BRAZOS  ROAD NAME: FM1687
SECTION     W1      W2      W3      W4      W5
 2.0        2.04    1.32    1.38    .79     .56
 2.1        1.95    1.38    .79     .56     .42

DISTRICT: 17  COUNTY: BRAZOS  ROAD NAME: FM2038
SECTION     W1      W2      W3      W4      W5
 8.0        1.56    1.11    .67     .48     .36
 8.1        1.83    1.26    .73     .5      .33
10.0        1.44    1.15    .61     .43     .33
10.1        1.59    1.25    .57     .4      .27

DISTRICT: 17  COUNTY: BRAZOS  ROAD NAME: FM2776
SECTION     W1      W2      W3      W4      W5
 0.0        2.13    1.44    .84     .59     .41
 0.1        2.01    1.41    .86     .58     .42
 2.0        1.74    1.05    .54     .44     .38
 2.1        1.53    .99     .53     .38     .3
```

APPENDIX B - DATA USED TO COMPUTE THE MULTIPLIER

DISTRICT: 20 COUNTY:HARDIN ROAD:FM418
RECORDED RUT(INS): 0.75 LOAD(LBS): 9000. PASSES:0.6240D 06

DATE: 7/21/1976 DYNAFLECT

SECTION NO.	BASE THICKNESS (INS)	DEFLECTIONS (MILS)				
		W1	W2	W3	W4	W5
2031- 1	13.50	1.20	0.93	0.72	0.60	0.51
2031- 2	13.50	1.20	1.11	0.71	0.58	0.49
2031- 3	13.50	1.53	1.08	0.64	0.46	0.36
2031- 4	13.50	1.50	1.05	0.64	0.48	0.38
2031- 5	13.50	1.62	1.02	0.58	0.42	0.35
2031- 6	13.50	1.74	1.14	0.64	0.46	0.38
2031- 7	13.50	1.38	0.64	0.22	0.11	0.08
2031- 8	13.50	1.53	0.72	0.21	0.10	0.07
2031- 9	13.50	2.34	1.50	0.81	0.54	0.42
2031-10	13.50	1.92	1.26	0.80	0.56	0.42
2031-11	13.50	1.14	0.58	0.34	0.24	0.19
2031-12	13.50	1.08	0.61	0.36	0.25	0.19
2031-13	13.50	0.96	0.58	0.33	0.23	0.17
2031-14	13.50	1.02	0.53	0.32	0.22	0.17

DISTRICT: 20 COUNTY:JEFFERSON ROAD:FM 365
RECORDED RUT(INS): 0.75 LOAD(LBS): 9000. PASSES:0.2087D 06

DATE: 7/21/1976 DYNAFLECT

SECTION NO.	BASE THICKNESS (INS)	DEFLECTIONS (MILS)				
		W1	W2	W3	W4	W5
2057- 3	7.00	2.34	1.56	1.08	0.84	0.68
2057- 4	7.00	2.46	1.68	1.11	0.87	0.69
2057- 5	7.00	1.38	1.02	0.77	0.66	0.55
2057- 6	7.00	1.77	1.08	0.81	0.69	0.57
2057- 7	7.00	1.50	1.14	0.82	0.66	0.51
2057- 8	7.00	1.74	1.26	0.80	0.65	0.50
2057- 9	7.00	1.44	1.02	0.61	0.44	0.35
2057-10	7.00	1.59	1.14	0.68	0.48	0.36
2057-11	7.00	1.14	0.84	0.57	0.44	0.35
2057-12	7.00	1.20	0.87	0.58	0.44	0.34
2057-13	7.00	0.96	0.68	0.45	0.35	0.27
2057-14	7.00	1.20	0.82	0.54	0.38	0.29

DISTRICT: 16 COUNTY:NUECES ROAD:FM 665
RECORDED RUT(INS): 0.75 LOAD(LBS): 9000. PASSES:0.1860D 06

DATE: 8/25/1976 DYNAFLECT

SECTION NO.	BASE THICKNESS (INS)	DEFLECTIONS (MILS) W1	W2	W3	W4	W5
1705- 1	12.00	2.50	1.71	1.26	0.84	0.59
1705- 2	12.00	2.70	1.68	1.14	0.78	0.56
1705- 3	12.00	2.10	1.20	0.78	0.48	0.34
1705- 4	12.00	2.10	1.23	0.81	0.52	0.36
1705- 5	12.00	2.34	1.47	0.96	0.66	0.44
1705- 6	12.00	2.40	1.50	0.96	0.66	0.44
1705- 7	12.00	2.88	1.86	1.05	0.66	0.40
1705- 8	12.00	2.90	1.71	1.02	0.66	0.39
1705- 9	12.00	1.83	1.26	0.84	0.56	0.42
1705-10	12.00	2.07	1.32	0.87	0.60	0.42
1705-11	12.00	2.25	1.44	0.90	0.60	0.43
1705-12	12.00	2.28	1.41	0.90	0.60	0.42
1705-13	12.00	1.80	1.11	0.75	0.49	0.36
1705-14	12.00	1.74	1.02	0.72	0.46	0.34

DISTRICT: 8 COUNTY:BORDEN ROAD:FM 612
RECORDED RUT(INS): 0.75 LOAD(LBS): 9000. PASSES:0.2528D 05

DATE: 11/20/1975 DYNAFLECT

SECTION NO.	BASE THICKNESS (INS)	DEFLECTIONS (MILS) W1	W2	W3	W4	W5
835- 1	5.00	2.70	1.38	0.54	0.30	0.20
835- 2	5.00	2.16	1.38	0.72	0.42	0.26
835- 3	5.00	1.62	1.02	0.44	0.25	0.15
835- 4	5.00	1.50	0.83	0.36	0.23	0.14
835- 5	5.00	1.44	0.90	0.44	0.28	0.17
835- 6	5.00	1.38	0.85	0.38	0.22	0.15
835- 7	5.00	1.44	0.77	0.33	0.21	0.14
835- 8	5.00	1.26	0.58	0.26	0.16	0.12
835- 9	5.00	1.32	0.70	0.30	0.18	0.12
835-10	5.00	1.14	0.58	0.40	0.16	0.11

DISTRICT: 13 COUNTY:FAYETTE ROAD:FM 1381

RECORDED RUT(INS): 0.75 LOAD(LBS): 9000. PASSES:0.1385D 06

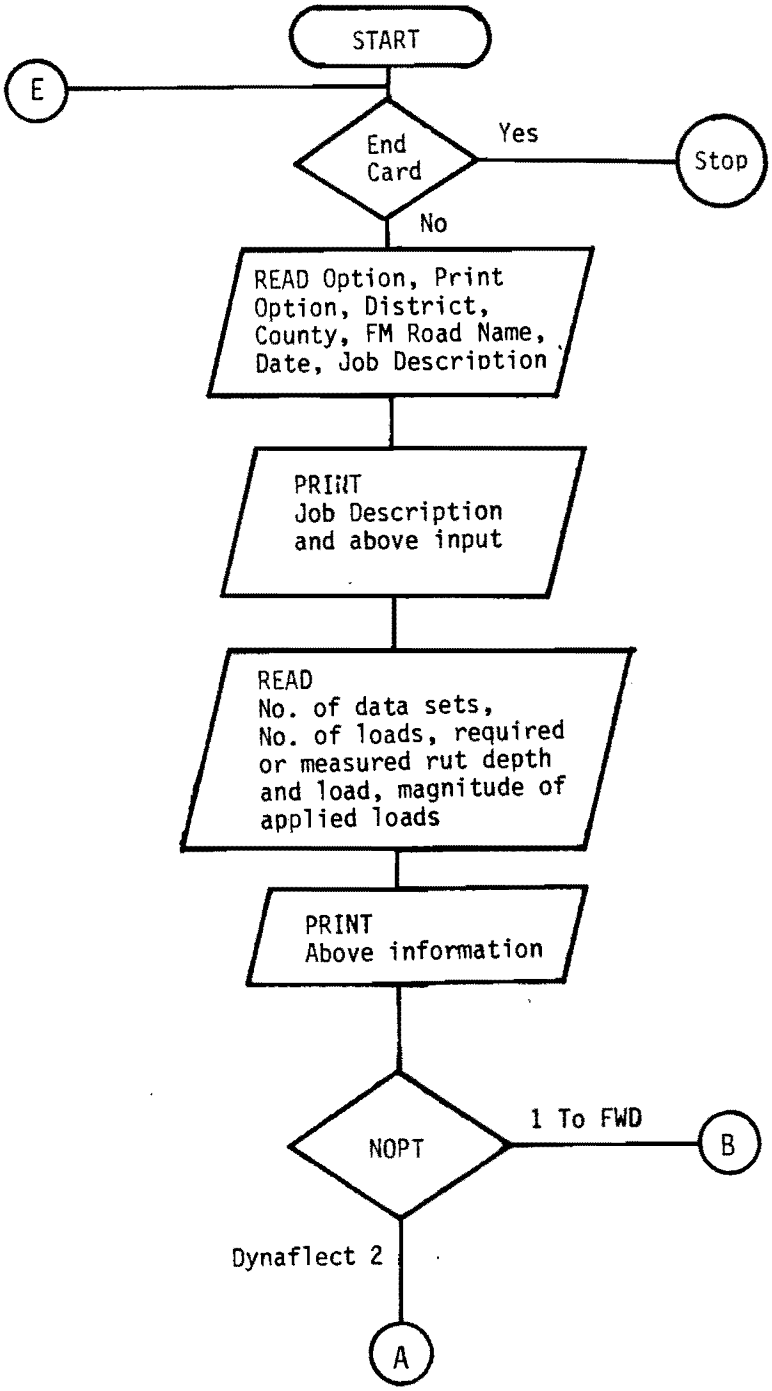
DATE: 7/29/1976 DYNAFLECT

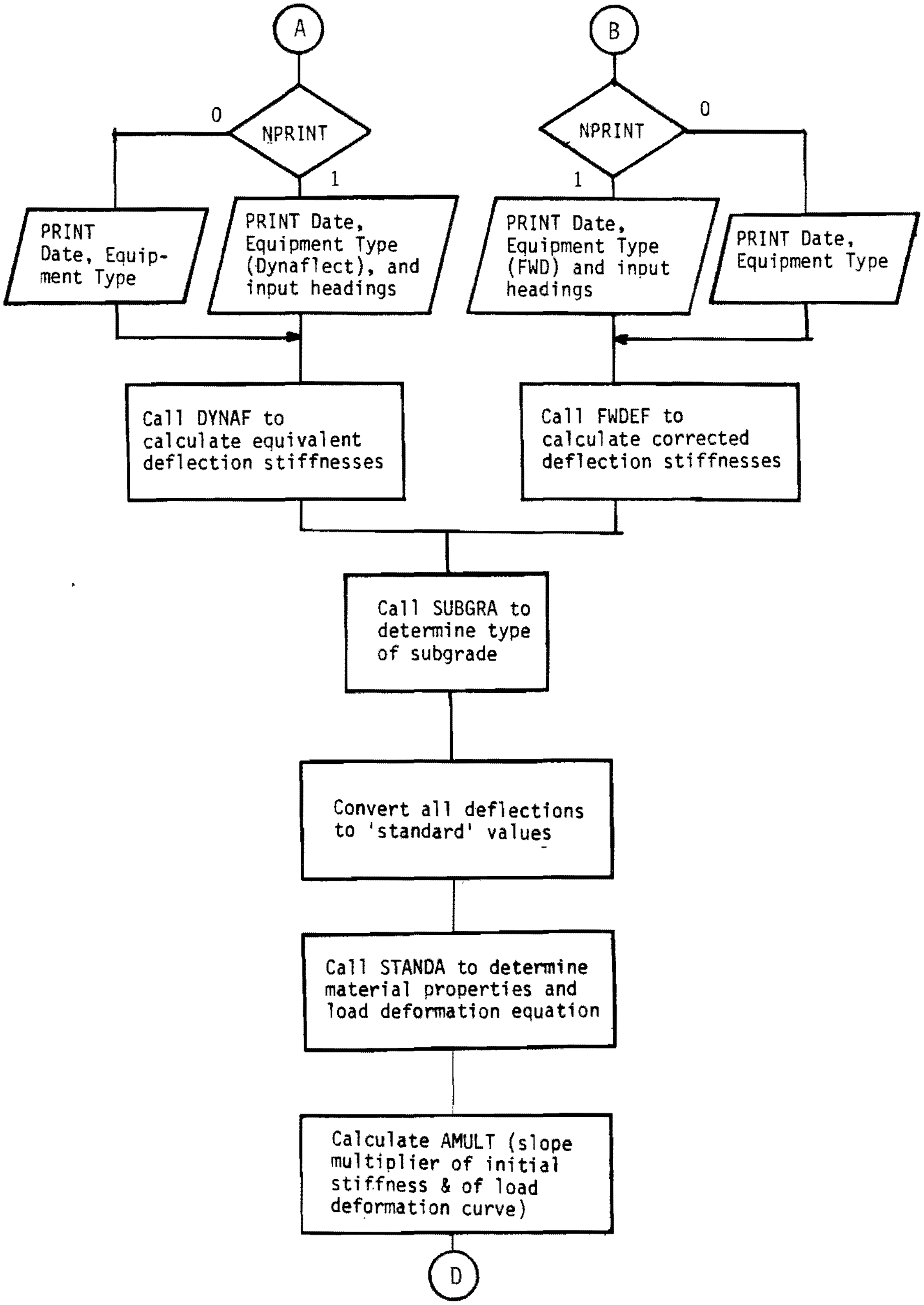
SECTION NO.	BASE THICKNESS (INS)	DEFLECTIONS (MILS) W1	W2	W3	W4	W5
1361- 1	9.00	3.20	1.50	0.66	0.33	0.20
1361- 2	9.00	3.50	1.68	0.75	0.36	0.20
1361- 3	9.00	2.71	1.59	0.90	0.46	0.32
1361- 4	9.00	3.20	1.80	0.96	0.49	0.31
1361- 5	9.00	1.32	0.90	0.50	0.32	0.22
1361- 6	9.00	1.32	0.84	0.48	0.32	0.22
1361- 7	9.00	2.19	1.41	0.84	0.53	0.36
1361- 8	9.00	2.34	1.50	0.93	0.56	0.37
1361- 9	9.00	2.10	1.20	0.74	0.50	0.37
1361-10	9.00	2.34	1.26	0.74	0.50	0.38
1361-11	9.00	2.46	1.47	0.74	0.44	0.33
1361-12	9.00	2.70	1.65	0.75	0.46	0.34
1361-13	9.00	2.01	1.08	0.56	0.36	0.00
1361-14	9.00	1.92	1.05	0.53	0.34	0.25

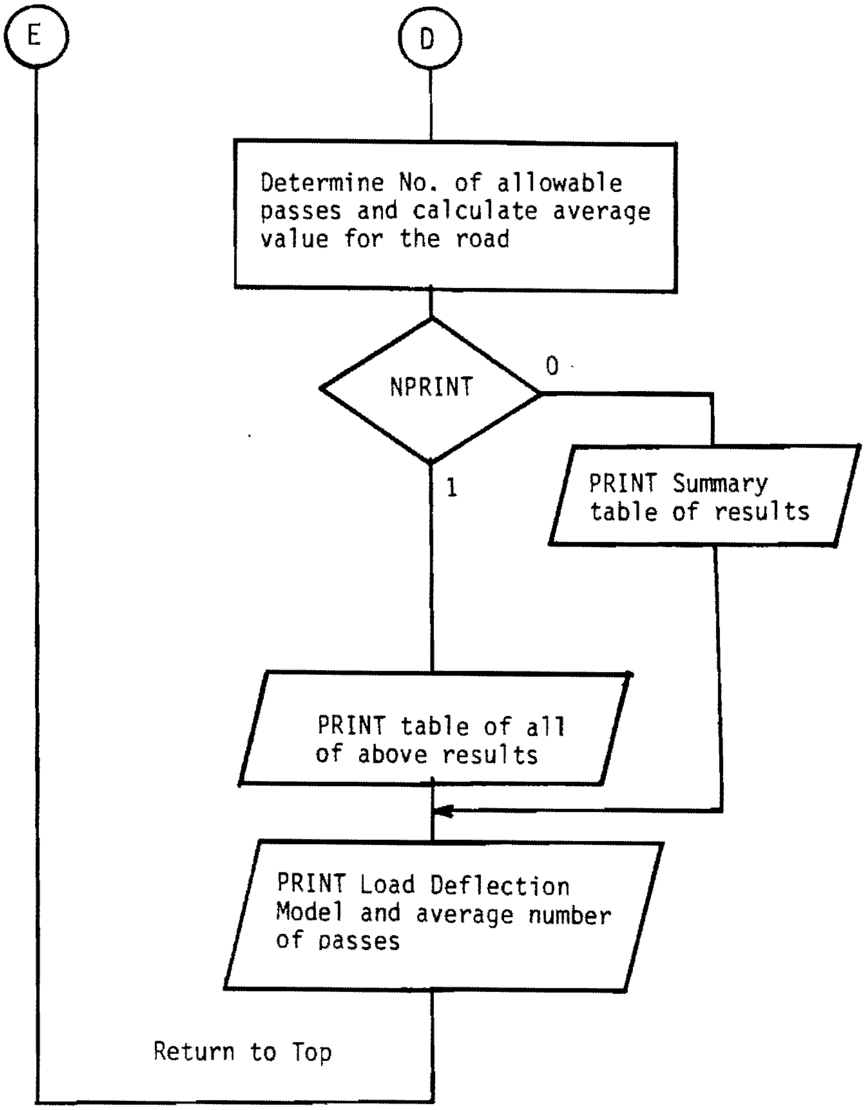
APPENDIX C - COMPUTER PROGRAM

Flow-Charts

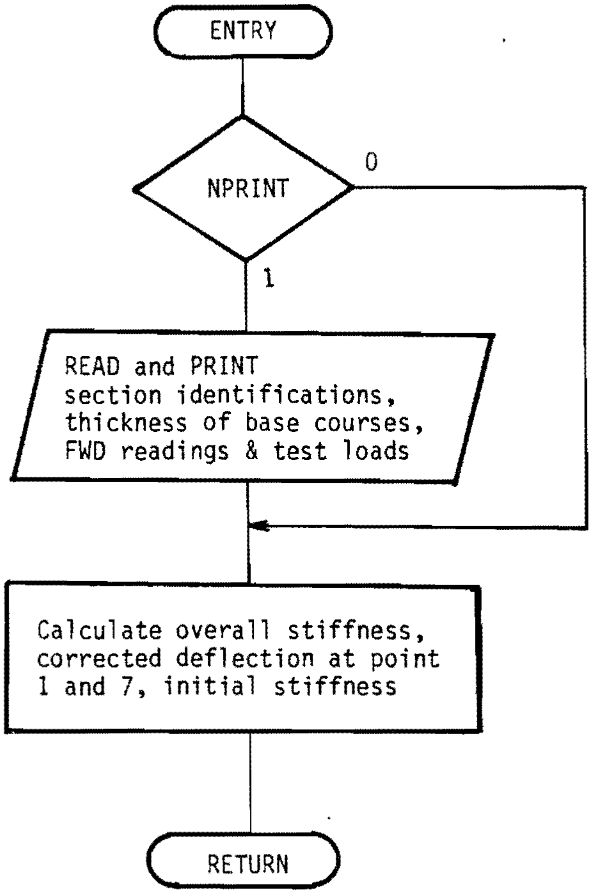
MAIN PROGRAM FLOW CHART



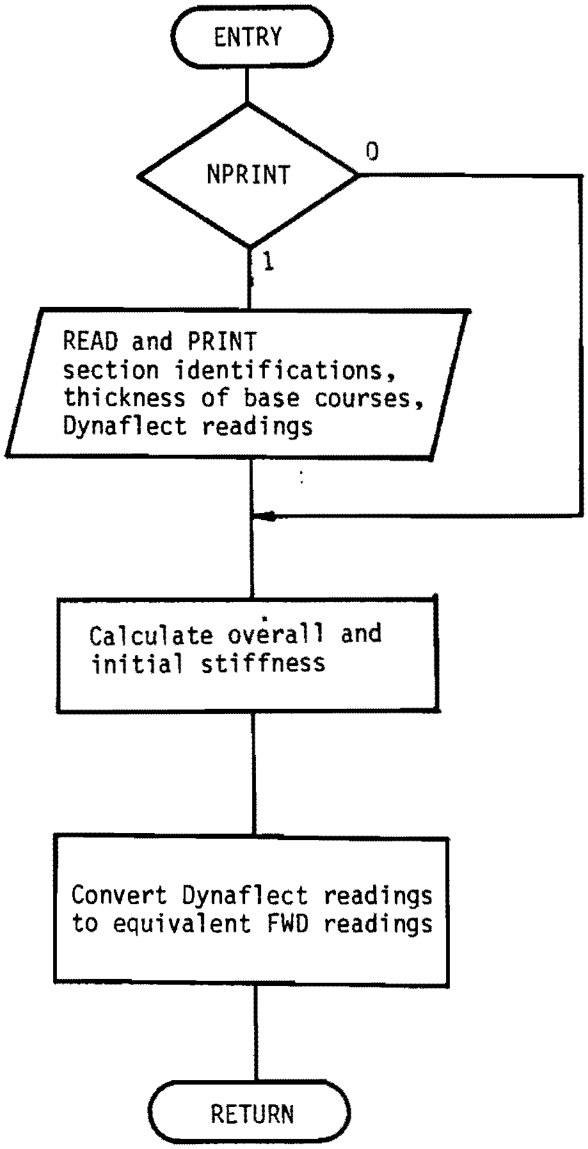

A
B
NPRINT
0
1
NPRINT
0
1
PRINT Date, Equipment Type
PRINT Date, Equipment Type (Dynaflect), and input headings
PRINT Date, Equipment Type (FWD) and input headings
PRINT Date, Equipment Type
Call DYNAF to calculate equivalent deflection stiffnesses
Call FWDEF to calculate corrected deflection stiffnesses
Call SUBGRA to determine type of subgrade
Convert all deflections to 'standard' values
Call STANDA to determine material properties and load deformation equation
Calculate AMULT (slope multiplier of initial stiffness & of load deformation curve)
D


E
D
Determine No. of allowable passes and calculate average value for the road
NPRINT
0
1
PRINT Summary table of results
PRINT table of all of above results
PRINT Load Deflection Model and average number of passes
Return to Top

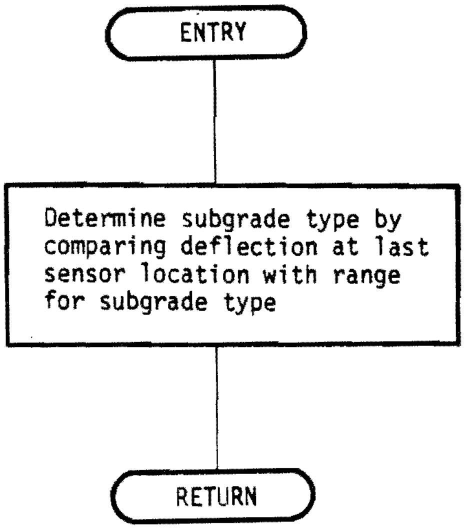
SUBROUTINE FWDEF FLOW CHART



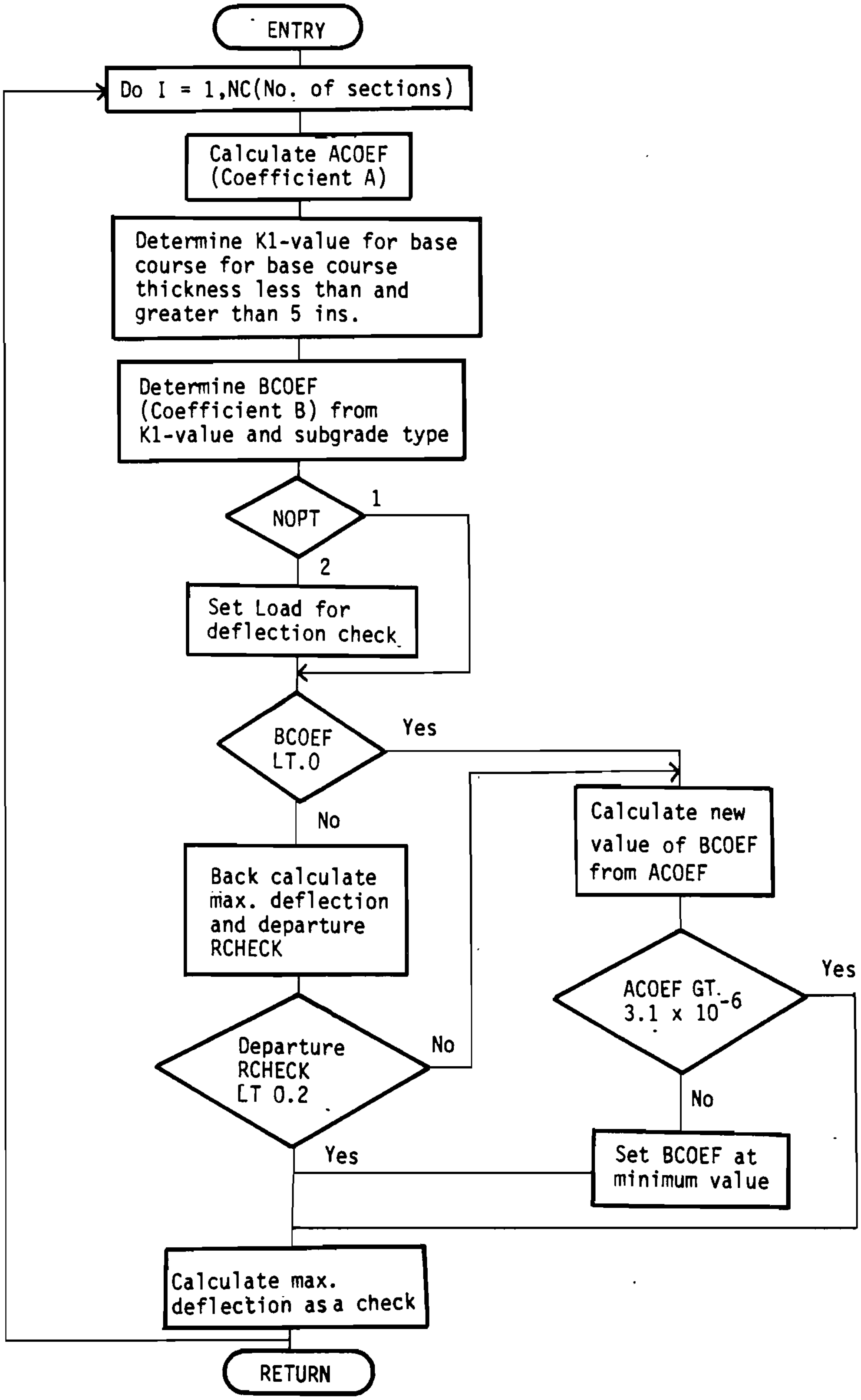
SUBROUTINE DYNAF FLOW CHART



SUBROUTINE SUBGRA FLOW CHART



SUBROUTINE STANDA FLOW CHART



Input Instructions, Listing and Sample Input

```
C
C LOADRATE PROGRAM : VERSION DATED 12 NOVEMBER 1983 K.M.CHUA
C
C*********************************************************************
C*                     TEXAS TRANSPORTATION INSTITUTE                *
C*                      LOAD RATING OF LIGHT PAVEMENT                *
C*                           PROJECT NO  2284                        *
C*                                FOR                                *
C*                        TEXAS  HIGHWAY DEPARTMENT                  *
C*                                1983                               *
C*                                                                   *
C*********************************************************************
C
C PROGRAM DESCRIPTION : ______________________________________________
C
C THIS PROGRAM DETERMINES THE NUMBER OF PASSES FOR A SPECIFIC LOAD THAT
C WILL CAUSE A CRITICAL LEVEL OF RUT DEPTH IN FARM-TO-MARKET ROADS.
C
C A HYPERBOLIC LOAD-DEFLECTION MODEL IS USED. THE RESULTS ARE BASED
C ON AN EXTENSIVE STUDY OF LOAD-DEFLECTION CHARACTERISTICS OF LIGHT
C PAVEMENT STRUCTURES USING THE FALLING WEIGHT DEFLECTOMETER AND THE
C DYNAFLECT.
C
C
C WHEN USING A FALLING WEIGHT DEFLECTOMETER, A LOADING OF ABOUT 100 PSI
C SHOULD BE USED AND IS ASSUMED AS SUCH IN THE ANALYSIS.
C
C A 1 INCH THICK SURFACE/WEARING COURSE OF MODULUS OF ELASTICITY OF
C 30000 PSI (WHICH IS COMMONLY ENCOUNTERED) IS ASSUMED.
C
C BASE COURSE MODEL : MODULUS = K1 * (FIRST STRESS INVARIANT)**0.33
C
C SUBGRADE MODEL : REFER TRB852 P.44 TABLE 2.
C____________________________________________________________________
C
C DEFINITIONS OF INPUT VARIABLES : ___________________________________
C
C NOPT       : OPTION FOR TYPE OF INPUT FROM FIELD MEASUREMENTS
C               1 = DYNATEST 8000 FALLING WEIGHT DEFLECTOMETER
C               2 = DYNAFLECT
C NPRINT     : OPTION FOR AMOUNT OF OUTPUT
C              0 = SUMMARIZED          1 = DETAILED
C IDIST      : DISTRICT NUMBER
C CTY        : COUNTY NAME
C FM         : ROAD NAME
C JJOB       : JOB DESCRIPTION (ONE LINE)
C NC         : NUMBER OF SETS OF READINGS
C NX         : NUMBER OF AXLES FOR THE VEHICLE
C RUTX       : MAXIMUM ALLOWABLE RUT DEPTH (INS)
C RUTM       : MEASURED RUT DEPTH (INS) -OPTIONAL-
C ALOADM     : LOAD CORRESPONDING TO RUTM -OPTIONAL-
C PASSM      : NUMBER OF PASSES OF ALOADM -OPTIONAL-
C WLOAD(I)   : LOADING(LBS) FROM EACH WHEEL OF THE VEHICLE IN ONE PASS
C NSECT1     : SECTION IDENTIFICATION (4-DIGITS)
C NSECT2     : SECTION IDENTIFICATION (2-DIGITS)
C NDATE1     : MONTH
C NDATE2     : DAY
C NDATE3     : YEAR
C BASEH      : THICKNESS OF BASE AND SUB-BASE (IF ANY) IN INCHES.
C FWD(I)     : DEFLECTIONS  FROM FALLING WEIGHT DEFLECTOMETER IN MILS.
C DYN(I)     : DEFLECTIONS FROM DYNAFLECT IN MILS.
C PFWD(I)    : CORRESPONDING TEST LOAD (LBS)
C              THIS LOAD SHOULD BE ABOUT 10956 LBS OR 100PSI ON THE FWD
C              LOADING PLATE.
C
C____________________________________________________________________
C
C DATA INPUT : _______________________________________________________
C
C CARD 1      : FORMAT (I1,I1,I2,3A4,4X,4A4,I2,I2,I4)
C VARIABLES READ : NOPT,NPRINT,IDIST,COUNTY,FMNAME,NDATE1,NDATE2,NDATE3
C
C CARD 2      : FORMAT (17A4)
C VARIABLE READ : JOB
C
C CARD 3      : FORMAT (I2,I2,1X,F5.2,11X,F5.2,F6.0,E10.4)
C VARIABLES READ : NC,NX,RUTX,RUTM,ALOADM,PASSM
C
C CARD 4 TO NX : FORMAT (F10.0)
```

```
C VARIABLE READ : WLOAD(I)
C
C FOR NOPT = 1 (DT8000FWD)
C CARD 5 TO NC : FORMAT (I4,I2,13X,F5.2,7F5.2,1X,6.0)
C VARIABLES READ : NSECT1,NSECT2,BASEH,FWD(1) TO FWD(7),PFWD(I)
C
C FOR NOPT = 2 (DYNAFLECT)
C CARD 5 TO NC : FORMAT (I4,I2,13X,F5.2,5F5.3)
C VARIABLES READ : NSECT1,NSECT2,BASEH,DYN(1) TO DYN(5)
C
C
C_____________________________________________________________________
C
C
C
C MAIN PROGRAM ********************************************************
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION    FWD(20,7),DYN(20,5),DEF(20,7),STD(20,7),ISUB(20),STFI
     *(20),ACOEF(20),BCOEF(20),H(20),K1(20),NSECT1(20),NSECT2(20)
     *,BASEH(20),PASS(20),CTY(3),FM(4),STFO(20),PMAX(20),STIFF(20)
     *,AMULT(20),W(20),PFWD(20),WLOAD(20),JJOB(17)
C
C DATA INPUT / PRINT TITLE / SELECT OPTION
C
   90 READ(5,100,END=5000)NOPT,NPRINT,IDIST,(CTY(L),L=1,3),(FM(M),M=1,4)
     *,NDATE1,NDATE2,NDATE3
  100 FORMAT(I1,I1,I2,3A4,4X,4A4,I2,I2,I4)
      WRITE (6,110)
  110 FORMAT(1H1,/,5X,'TEXAS HIGHWAY DEPARTMENT')
      WRITE (6,120)
  120 FORMAT(5X,'LOAD RATING OF LIGHT PAVEMENT'/)
      READ(5,122) (JJOB(I),I=1,17)
  122 FORMAT(17A4)
      WRITE(6,125) (JJOB(I),I=1,17)
  125 FORMAT(5X,'JOB:',17A4,/)
      WRITE (6,130) IDIST,(CTY(L),L=1,3),(FM(M),M=1,4)
  130 FORMAT(5X,'DISTRICT:',I3,5X,'COUNTY:',3A4,4X,'ROAD:',4A4)
      READ (5,140) NC,NX,RUTX,RUTM,ALOADM,PASSM
  140 FORMAT (I2,I2,1X,F5.2,11X,F5.2,F6.0,E10.4)
      DO 134 II=1,NX
      READ (5,135) WLOAD(II)
  135 FORMAT(F10.0)
  134 CONTINUE
      WRITE (6,150) RUTX
  150 FORMAT(5X,'ALLOWABLE RUT(INS):',F5.2)
C
C TO PRINT VEHICLE DESCRIPTION
C
      WRITE(6,154)
  154 FORMAT(5X,'AXLE NUMBER',3X,'WHEEL LOAD(LBS)')
      DO 156 II=1,NX
      WRITE(6,155) II,WLOAD(II)
  155 FORMAT(10X,I2,8X,F10.0)
  156 CONTINUE
      WRITE(6,160) RUTM,ALOADM,PASSM
  160 FORMAT(/5X,'RECORDED RUT(INS):',F5.2,3X,'LOAD(LBS):',F6.0,3X,'PASS
     *ES:',E10.4/)
C
C TO SELECT TYPES OF EXECUTION
C
      IF (NOPT.EQ.1) GO TO 162
      IF (NOPT.EQ.2) GO TO 164
C
C ***** FALLING WEIGHT DEFLECTOMETER **********************************
C
  162 WRITE (6,1020) NDATE1,NDATE2,NDATE3
 1020 FORMAT (5X,'DATE: ',I2,'/',I2,'/',I4,2X,'FALLING WEIGHT DEFLECTOME
     *TER'//)
C TO PRINT CARD IMAGE
C
      IF (NPRINT.EQ.0) GO TO 195
C
      WRITE(6,170)
  170 FORMAT(5X,'SECTION',4X,'BASE',21X,'DEFLECTIONS')
      WRITE(6,180)
  180 FORMAT(5X,'  NO.',4X,'THICKNESS',20X,'(MILS)',29X,'LOAD')
      WRITE(6,190)
  190 FORMAT(5X,11X,'(INS)',5X,'W1      W2      W3      W4      W5      W6
     *  W7        (LBS)'/)
```

```
  195 CONTINUE
C
C TO READ IN RESULTS
C
      CALL FWDEF (NC,NSECT1,NSECT2,BASEH,FWD,STFI,DEF,H,STFO,PLOAD,PFWD,
     *NPRINT)
      GO TO 1500
C
C ***** DYNAFLECT ***************************************************
C
  164 WRITE(6,2020) NDATE1,NDATE2,NDATE3
 2020 FORMAT(5X,'DATE: ',I2,'/',I2,'/',I4,2X,'DYNAFLECT'///)
C
      IF (NPRINT.EQ.0) GO TO 295
C TO PRINT CARD IMAGE FOR DYNAFLECT
      WRITE(6,270)
  270 FORMAT(5X,'SECTION',4X,'BASE',16X,'DEFLECTIONS')
      WRITE(6,280)
  280 FORMAT(5X,'  NO.',4X,'THICKNESS',16X,'(MILS)')
      WRITE(6,290)
  290 FORMAT(5X,11X,'(INS)',5X,'W1      W2      W3      W4      W5'/)
  295 CONTINUE
C
C TO READ IN RESULTS
C
      CALL DYNAF (NC,NSECT1,NSECT2,BASEH,DYN,STFI,DEF,H,STFO,PLOAD,
     *NPRINT)
      GO TO 1500
C
C
C
C TO DETERMINE TYPE OF SUBGRADE
 1500 CONTINUE
      CALL SUBGRA (NC,DEF,ISUB)
C
C TO CONVERT  READINGS TO STANDARD DEFLECTIONS
C
      DO 800 I=1,NC
      IF(ISUB(I).EQ.1) GO TO 700
      IF(ISUB(I).EQ.2) GO TO 710
      IF(ISUB(I).EQ.3) GO TO 720
      IF(ISUB(I).EQ.4) GO TO 730
  700 STD(I,1)=DEF(I,1)
      GO TO 790
  710 STD(I,1)=DEF(I,1)/(0.887257-2.70152D-03*DEF(I,1))
      GO TO 790
  720 STD(I,1)=DEF(I,1)/(0.733096-6.83744D-03*DEF(I,1))
      GO TO 790
  730 STD(I,1)=DEF(I,1)/(0.619104-8.39107D-03*DEF(I,1))
      GO TO 790
  790 CONTINUE
  800 CONTINUE
C
C TO DETERMINE MATERIAL PROPERTIES AND
C LOAD DEFORMATION EQUATION.
C
      CALL STANDA (NC,STFI,ISUB,H,ACOEF,BCOEF,STD,K1,W,PLOAD,PFWD,NOPT,F
     *WD,DEF,DYN,P)
C
C TO DETERMINE THE MULTIPLIER FOR 1/ACOEF
C
      APASSN=0
      DO 1300 I=1,NC
      IF (BCOEF(I).LE.0) GO TO 888
      AMULT(I)=-0.893347 * BCOEF(I) /10.D-05 + 1.00006
      GO TO 999
  888 IF (BCOEF(I).LT.-0.4D-04) GO TO 887
      AMULT(I) = 1.00045 - 0.899468 * BCOEF(I)/10.D-05
      GO TO 999
  887 AMULT(I) = 1.00025 - 0.899989 * BCOEF(I) / 10.D-05
  999 IF(RUTM.LE.0) GO TO 1090
      DEFM=RUTM/PASSM
      AMULT(I)=ACOEF(I)*ALOADM/(ACOEF(I)*ALOADM/(1-BCOEF(I)*ALOADM)-DEFM
     *)
 1090 CONTINUE
C
C TO DETERMINE THE NUMBER OF PASSES ALLOWED
C
      DSUM=0
      DO 1113 K=1,NX
```

```
      DEFN=WLOAD(K)*ACOEF(I)/(1-WLOAD(K)*BCOEF(I))
      DSUM=DSUM+(DEFN-WLOAD(K)*ACOEF(I)/AMULT(I))
 1113 CONTINUE
 1111 PASSN=RUTX/DSUM
      PASS(I)=DABS(PASSN)
C
C TO CALCULATE AVERAGE NUMBER OF PASSES ALLOWED
C
      APASSN=PASS(I) + APASSN
 1200 CONTINUE
 1300 CONTINUE
C
      GO TO 4000
C
C MAIN PROGRAM CONTINUES
C
 4000 CONTINUE
C
      IF (NPRINT.EQ.0) GO TO 4500
      WRITE(6,200)
  200 FORMAT(//,5X,'SECTION',3X,'LAYER PROPERTIES',6X,'LOAD DEFORMATION'
     *,6X,'NO. OF')
      WRITE(6,210)
  210 FORMAT(5X,2X,'NO.',4X,'BASE/SUBB',1X,'SUBGRADE',6X,'CHARACTERISTIC
     *S',5X,'ALLOWABLE')
      IF (NOPT.NE.1) GO TO 227
      WRITE(6,220)
  220 FORMAT(5X,10X,'K1-VALUE',2X,'TYPE',4X,'STIFF(LB/IN)',2X,'BCOEF'
     *,7X,'PASSES',4X,' AMULT',5X,'W1CHECK'/)
      GO TO 229
  227 WRITE(6,228)
  228 FORMAT(5X,10X,'K1-VALUE',2X,'TYPE',4X,'STIFF(LB/IN)',2X,'BCOEF'
     *,7X,'PASSES',4X,' AMULT'/)
  229 CONTINUE
C
      DO 4200 I=1,NC
      STIFF(I)=1/ACOEF(I)
      IF(ISUB(I).EQ.2) GO TO 4120
      IF(ISUB(I).EQ.3) GO TO 4140
      IF(ISUB(I).EQ.4) GO TO 4160
      IF (NOPT.NE.1) GO TO 4001
      WRITE(6,230) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I),W(I)
  230 FORMAT(5X,I4,'-',I2,2X,I8,1X,'VERY SOFT ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8,1X,F6.2)
      GO TO 4200
 4001 WRITE(6,231) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I)
  231 FORMAT(5X,I4,'-',I2,2X,I8,1X,'VERY SOFT ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8)
      GO TO 4200
 4120 IF (NOPT.NE.1) GO TO 4002
      WRITE(6,240) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I),W(I)
  240 FORMAT(5X,I4,'-',I2,2X,I8,2X,'  SOFT   ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8,1X,F6.2)
      GO TO 4200
 4002 WRITE(6,241) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I)
  241 FORMAT(5X,I4,'-',I2,2X,I8,2X,'  SOFT   ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8)
      GO TO 4200
 4140 IF (NOPT.NE.1) GO TO 4003
      WRITE(6,250) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I),W(I)
  250 FORMAT(5X,I4,'-',I2,2X,I8,2X,' MEDIUM  ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8,1X,F6.2)
      GO TO 4200
 4003 WRITE(6,251) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I)
  251 FORMAT(5X,I4,'-',I2,2X,I8,2X,' MEDIUM  ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8)
      GO TO 4200
 4160 IF (NOPT.NE.1) GO TO 4004
      WRITE(6,260) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
     *,AMULT(I),W(I)
  260 FORMAT(5X,I4,'-',I2,2X,I8,2X,' STIFF   ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8,1X,F6.2)
      GO TO 4200
 4004 WRITE(6,261) NSECT1(I),NSECT2(I),K1(I),STIFF(I),BCOEF(I),PASS(I)
```

```
     *,AMULT(I)
  261 FORMAT(5X,I4,'-',I2,2X,I8,2X,' STIFF    ',E10.3,1X,E12.5,1X,E10.3,
     *1X,F10.8)
 4200 CONTINUE
C
      WRITE(6,300)
  300 FORMAT(////,5X,'LOAD DEFLECTION MODEL : '/)
      WRITE(6,310)
  310 FORMAT(5X, 'LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)')
      APASSN=APASSN/NC
      WRITE(6,320) APASSN
  320 FORMAT(5X,'AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : ',
     *E10.4/)
      GO TO 4600
C
 4500 CONTINUE
C
      IF(NOPT.EQ.1) GO TO 4400
C TO PRINT CARD IMAGE FOR DYNAFLECT
      WRITE(6,370)
  370 FORMAT(5X,'SECTION',4X,'BASE',16X,'DEFLECTIONS',15X,'NO. OF')
      WRITE(6,380)
  380 FORMAT(5X,'  NO.',4X,'THICKNESS',16X,'(MILS)',16X,'ALLOWABLE')
      WRITE(6,390)
  390 FORMAT(5X,11X,'(INS)',5X,'W1      W2      W3      W4      W5',6X,
     * 'PASSES'/)
      DO 206 I=1,NC
      WRITE(6,205) NSECT1(I),NSECT2(I),BASEH(I),(DYN(I,J),J=1,5),PASS(I)
  205 FORMAT(5X,I4,'-',I2,3X,F5.2,2X,5(2X,F5.2),3X,E10.3)
  206 CONTINUE
      GO TO 4550
C
 4400 CONTINUE
C TO PRINT CARD IMAGE FOR FALLING WEIGHT DEFLECTOMETER
C
      WRITE(6,17)
   17 FORMAT(5X,'SECTION',4X,'BASE',21X,'DEFLECTIONS',30X,'NO. OF')
      WRITE(6,18)
   18 FORMAT(5X,'  NO.',4X,'THICKNESS',20X,'(MILS)',24X,'LOAD',3X,
     *' ALLOWABLE')
      WRITE(6,19)
   19 FORMAT(5X,11X,'(INS)',5X,'W1      W2      W3      W4      W5      W6
     *  W7    (LBS)    PASSES'/)
      DO 36 I=1,NC
      WRITE(6,105) NSECT1(I),NSECT2(I),BASEH(I),(FWD(I,J),J=1,7),PFWD(I)
     *,PASS(I)
  105 FORMAT (5X,I4,'-',I2,3X,F5.2,2X,7(2X,F5.2),2X,F6.0,1X,E10.3)
   36 CONTINUE
C
 4550 CONTINUE
C
      APASSN=APASSN/NC
      WRITE(6,32) APASSN
   32 FORMAT(///5X,'AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : ',
     *E10.4/)
 4600 CONTINUE
C TO RETURN TO FIRST STEP
      GO TO 90
C
C ENDING THE PROGRAM
C
 5000 CONTINUE
      WRITE (6,810)
  810 FORMAT(1H1,///,5X,'END OF JOB')
      STOP
      END
C
      SUBROUTINE FWDEF (NC,NSECT1,NSECT2,BASEH,FWD,STFI,DEF,H,STFO,PLOAD
     *,PFWD,NPRINT)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION NSECT1(20),NSECT2(20),BASEH(20),FWD(20,7),STFI(20),DEF(2
     *0,7),H(20),STFO(20),PFWD(20)
      DO 1015 I=1,NC
C
      READ (5,1010) NSECT1(I),NSECT2(I),BASEH(I),(FWD(I,J),J=1,7),PFWD(I
     *)
 1010 FORMAT (I4,I2,12X,F5.2,7(1X,F5.2),1X,F6.0)
      IF(NPRINT.EQ.0) GO TO 1006
      WRITE(6,1005) NSECT1(I),NSECT2(I),BASEH(I),(FWD(I,J),J=1,7),PFWD(I
     *)
```

```
 1005 FORMAT (5X,I4,'-',I2,3X,F5.2,2X,7(2X,F5.2),6X,F6.0)
 1006 CONTINUE
      PLOAD=10956.3
      STFO(I)=PFWD(I)/FWD(I,1)
      DEF(I,1)=PLOAD/STFO(I)
      STFI(I)= -109.663 + 1.31393 * STFO(I)
      DEF(I,7) = FWD(I,7)*PLOAD/PFWD(I)
      H(I)=BASEH(I)
 1015 CONTINUE
      RETURN
      END
C
      SUBROUTINE DYNAF (NC,NSECT1,NSECT2,BASEH,DYN,STFI,DEF,H,STFO,PLOAD
     *,NPRINT)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION NSECT1(20),NSECT2(20),BASEH(20),DYN(20,5),STFI(20),H(20)
     *,DEF(20,7),STFO(20)
      DO 2015 I=1,NC
C
C COMPUTATION WITH DYNAFLECT DATA ************************************
C
      READ(5,2010) NSECT1(I),NSECT2(I),BASEH(I),(DYN(I,J),J=1,5)
 2010 FORMAT(I4,I2,12X,F5.2,5(1X,F5.2))
      IF (NPRINT.EQ.0) GO TO 2006
C
      WRITE(6,2005) NSECT1(I),NSECT2(I),BASEH(I),(DYN(I,J),J=1,5)
 2005 FORMAT(5X,I4,'-',I2,3X,F5.2,2X,5(2X,F5.2))
 2006 CONTINUE
      PLOAD=1000.0
C TO CONVERT DYNAFLECT READINGS TO DEF( )
      DEF(I,7)=3.38075*DYN(I,5)**0.639462
      DEF(I,1)= -7.24474 + (29.6906 * DYN(I,1))
C TO OBTAIN STIFFNESSES
      STFO(I)= 86.0122*DEXP(1.87211D-03*PLOAD/DYN(I,1))
      STFI(I)= -109.663 + 1.31393 * STFO(I)
      H(I)=BASEH(I)
 2015 CONTINUE
      RETURN
      END
C
      SUBROUTINE SUBGRA (NC,DEF,ISUB)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION ISUB(20),DEF(20,7)
      DO 595 I=1,NC
C TO DETERMINE TYPE OF SUBGRADE
      IF (DEF(I,7).GE.1.75) GO TO 510
      IF (DEF(I,7).GE.1.4.AND.DEF(I,7).LT.1.75) GO TO 520
      IF (DEF(I,7).GE.0.80.AND.DEF(I,7).LT.1.4) GO TO 530
      IF (DEF(I,7).LT.0.80) GO TO 540
  510 ISUB(I)=1
      GO TO 590
  520 ISUB(I)=2
      GO TO 590
  530 ISUB(I)=3
      GO TO 590
  540 ISUB(I)=4
      GO TO 590
  590 CONTINUE
  595 CONTINUE
      RETURN
      END
C
      SUBROUTINE STANDA (NC,STFI,ISUB,H,ACOEF,BCOEF,STD,K1,W,PLOAD,PFWD,
     *NOPT,FWD,DEF,DYN,P)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION H(20),STFI(20),ACOEF(20),K1(20),STD(20,7),BCOEF(20),
     *ISUB(20),W(20),PFWD(20),FWD(20,7),DEF(20,7),DYN(20,5)
      DO 695 I=1,NC
C TO DETERMINE INITIAL STIFFNESS AND COEFFICIENT 'A'
C
      ACOEF(I) = 1 / (STFI(I) * 1000)
C
C TO OBTAIN K1-VALUE FOR BASE COURSE
C MODEL : E = K1 * BULK STRESS**0.33
C
      IF (H(I).GT.5.0) GO TO 1100
C     FOR BASE THICKNESS OF LESS THAN 5 INS.
      CC = 10**(16.1791*H(I)**(-0.349993))
      CD = -4.94876 * H(I)**(-0.39432)
      GOTO 1111
```

```
C
C     FOR BASE THICKNESS OF 5 INS AND ABOVE
 1100 CC = 10**(12.8778*H(I)**(-0.18345))
      CD = -2.95407 * DEXP(-0.0175321*H(I))
C
C
 1111 AK1 = CC * STD(I,1)**CD
      K1(I) =     AK1
C
C TO DETERMINE COEFFICIENT 'B'
C
 2222 CONTINUE
      CE = 1.36543D-06*AK1**0.185895
      CF = 3.15679D-06+3.24823D-11*AK1 -1.05093D-16*AK1**2
      CG = -1.74866D-07 -1.00162D-11*AK1 +2.3941D-17*AK1**2
C
      BCOEF(I) = CE + CF*H(I) + CG*H(I)**2
      IF (ISUB(I).EQ.1) GO TO 690
      IF (ISUB(I).EQ.2) GO TO 620
      IF (ISUB(I).EQ.3) GO TO 630
      IF (ISUB(I).EQ.4) GO TO 640
  620 BCOEF(I)=BCOEF(I)-0.5D-05
      GO TO 690
  630 BCOEF(I)=BCOEF(I)-0.75D-05
      GO TO 690
  640 BCOEF(I)=BCOEF(I)-0.9D-05
      GO TO 690
  690 CONTINUE
      IF (NOPT.EQ.1) GO TO 5555
      PFWD(I)=PLOAD
 5555 CONTINUE
      IF (BCOEF(I).LT.0) GO TO 5560
      WCHECK=10956.3*ACOEF(I)/(1-10956.3*BCOEF(I))*1000.0
      RCHECK =DABS((WCHECK-DEF(I,1))/DEF(I,1))
      IF (RCHECK.LT.0.20) GO TO 5556
 5560 BCOEF(I)=-( -29.9362D-06 + 9.66528 * ACOEF(I))
      IF (ACOEF(I).GT.3.1D-06) GO TO 5556
      BCOEF(I)= -0.001D-10
 5556 W(I)=PFWD(I)*ACOEF(I)/(1-PFWD(I)*BCOEF(I))*1000.0
  695 CONTINUE
      RETURN
      END
C
C THE FOLLOWING IS THE SAMPLE DATA INPUT -------------------------------
C
1 17BURLESON        FM2000          12201982
SAMPLE PROBLEM 1
 6 4 0.75
   9000.0
   15000.
   20000.
   25000.
000800            7.000 54.88 32.91 21.18 10.31 5.039 2.874 2.165 11108.
000801            7.000 55.98 32.83 21.69 11.18 5.591 3.228 2.047 10981.
001000            7.000 51.93 32.83 22.44 11.65 5.000 2.441 1.200 11616.
001001            7.000 53.74 34.09 23.27 12.36 5.551 2.953 1.700 11696.
001200            6.000 31.53 19.29 13.54 7.205 4.016 2.598 1.300 11759.
001201            6.000 32.24 18.74 12.83 7.007 3.898 2.441 1.200 11791.
2 17BURLESON        FM2000          03011983
SAMPLE PROBLEM 2
 6 4 0.75
   9000.0
   15000.
   20000.
   25000.
000800            7.000 2.130 1.530 1.140 0.870 0.600
000801            7.000 1.890 1.500 1.140 0.860 0.660
001000            7.000 1.410 1.080 0.740 0.550 0.390
001001            7.000 1.470 1.140 0.740 0.530 0.350
001200            6.000 3.300 1.140 0.780 0.540 0.220
001201            6.000 1.470 1.080 0.780 0.540 0.400
1117BURLESON        FM2000          12201982
SAMPLE PROBLEM 3
 6 1 0.75
   9000.0
000800            7.000 54.88 32.91 21.18 10.31 5.039 2.874 2.165 11108.
000801            7.000 55.98 32.83 21.69 11.18 5.591 3.228 2.047 10981.
001000            7.000 51.93 32.83 22.44 11.65 5.000 2.441 1.200 11616.
001001            7.000 53.74 34.09 23.27 12.36 5.551 2.953 1.700 11696.
001200            6.000 31.53 19.29 13.54 7.205 4.016 2.598 1.300 11759.
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001201            6.000 32.24 18.74 12.83 7.007 3.898 2.441 1.200 11791.
1117BURLESON        FM2000          12201982
SAMPLE PROBLEM 4
 6 1 0.75
    15000.
000800            7.000 54.88 32.91 21.18 10.31 5.039 2.874 2.165 11108.
000801            7.000 55.98 32.83 21.69 11.18 5.591 3.228 2.047 10981.
001000            7.000 51.93 32.83 22.44 11.65 5.000 2.441 1.200 11616.
001001            7.000 53.74 34.09 23.27 12.36 5.551 2.953 1.700 11696.
001200            6.000 31.53 19.29 13.54 7.205 4.016 2.598 1.300 11759.
001201            6.000 32.24 18.74 12.83 7.007 3.898 2.441 1.200 11791.
1117BURLESON        FM2000          12201982
SAMPLE PROBLEM 5
 6 1 0.75
    20000.
000800            7.000 54.88 32.91 21.18 10.31 5.039 2.874 2.165 11108.
000801            7.000 55.98 32.83 21.69 11.18 5.591 3.228 2.047 10981.
001000            7.000 51.93 32.83 22.44 11.65 5.000 2.441 1.200 11616.
001001            7.000 53.74 34.09 23.27 12.36 5.551 2.953 1.700 11696.
001200            6.000 31.53 19.29 13.54 7.205 4.016 2.598 1.300 11759.
001201            6.000 32.24 18.74 12.83 7.007 3.898 2.441 1.200 11791.
1117BURLESON        FM2000          12201982
SAMPLE PROBLEM 6
 6 1 0.75
    25000.
000800            7.000 54.88 32.91 21.18 10.31 5.039 2.874 2.165 11108.
000801            7.000 55.98 32.83 21.69 11.18 5.591 3.228 2.047 10981.
001000            7.000 51.93 32.83 22.44 11.65 5.000 2.441 1.200 11616.
001001            7.000 53.74 34.09 23.27 12.36 5.551 2.953 1.700 11696.
001200            6.000 31.53 19.29 13.54 7.205 4.016 2.598 1.300 11759.
001201            6.000 32.24 18.74 12.83 7.007 3.898 2.441 1.200 11791.
2117BURLESON        FM2000          03011983
SAMPLE PROBLEM 7
 6 1 0.75
    9000.0
000800            7.000 2.130 1.530 1.140 0.870 0.600
000801            7.000 1.890 1.500 1.140 0.860 0.660
001000            7.000 1.410 1.080 0.740 0.550 0.390
001001            7.000 1.470 1.140 0.740 0.530 0.350
001200            6.000 3.300 1.140 0.780 0.540 0.220
001201            6.000 1.470 1.080 0.780 0.540 0.400
2117BURLESON        FM2000          03011983
SAMPLE PROBLEM 8
 6 1 0.75
    15000.
000800            7.000 2.130 1.530 1.140 0.870 0.600
000801            7.000 1.890 1.500 1.140 0.860 0.660
001000            7.000 1.410 1.080 0.740 0.550 0.390
001001            7.000 1.470 1.140 0.740 0.530 0.350
001200            6.000 3.300 1.140 0.780 0.540 0.220
001201            6.000 1.470 1.080 0.780 0.540 0.400
2117BURLESON        FM2000          03011983
SAMPLE PROBLEM 9
 6 1 0.75
    20000.
000800            7.000 2.130 1.530 1.140 0.870 0.600
000801            7.000 1.890 1.500 1.140 0.860 0.660
001000            7.000 1.410 1.080 0.740 0.550 0.390
001001            7.000 1.470 1.140 0.740 0.530 0.350
001200            6.000 3.300 1.140 0.780 0.540 0.220
001201            6.000 1.470 1.080 0.780 0.540 0.400
2117BURLESON        FM2000          03011983
SAMPLE PROBLEM 10
 6 1 0.75
    25000.
000800            7.000 2.130 1.530 1.140 0.870 0.600
000801            7.000 1.890 1.500 1.140 0.860 0.660
001000            7.000 1.410 1.080 0.740 0.550 0.390
001001            7.000 1.470 1.140 0.740 0.530 0.350
001200            6.000 3.300 1.140 0.780 0.540 0.220
001201            6.000 1.470 1.080 0.780 0.540 0.400
21 8BORDEN          FM 612          11201975
SAMPLE RUN --FOR BACKCALCULATING THE SLOPE MULTIPLIER
10 1 1.00             0.75 9000.0     25279.0
    9000.0
 83501            5.000 2.700 1.380 0.540 0.300 0.200
 83502            5.000 2.160 1.380 0.720 0.420 0.260
 83503            5.000 1.620 1.020 0.440 0.250 0.150
 83504            5.000 1.500 0.830 0.360 0.230 0.140
 83505            5.000 1.440 0.900 0.440 0.280 0.170
```

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83506                5.000 1 380 0.850 0.380 0.220 0.150
83507                5.000 1.440 0.770 0.330 0.210 0.140
83508                5.000 1.260 0.580 0.260 0.160 0.120
83509                5.000 1.320 0.700 0.300 0.180 0.120
83510                5.000 1.140 0.580 0.400 0.160 0.110
```

Sample Output

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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 1

DISTRICT: 17     COUNTY:BURLESON          ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER    WHEEL LOAD(LBS)
      1             9000.
      2            15000.
      3            20000.
      4            25000.

RECORDED RUT(INS): 0.00   LOAD(LBS):     0.   PASSES:0.0000D 00

DATE: 12/20/1982  FALLING WEIGHT DEFLECTOMETER


SECTION    BASE                      DEFLECTIONS                                     NO. OF
  NO.    THICKNESS                      (MILS)                              LOAD    ALLOWABLE
           (INS)     W1      W2      W3      W4      W5      W6      W7     (LBS)    PASSES

  8- 0     7.00     54.88   32.91   21.18   10.31    5.04    2.87    2.17   11108.  0.113D 02
  8- 1     7.00     55.98   32.83   21.69   11.18    5.59    3.23    2.05   10981.  0.104D 02
 10- 0     7.00     51.93   32.83   22.44   11.65    5.00    2.44    1.20   11616.  0.156D 02
 10- 1     7.00     53.74   34.09   23.27   12.36    5.55    2.95    1.70   11696.  0.142D 02
 12- 0     6.00     31.53   19.29   13.54    7.21    4.02    2.60    1.30   11759.  0.361D 02
 12- 1     6.00     32.24   18.74   12.83    7.01    3.90    2.44    1.20   11791.  0.336D 02


AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.2020D 02
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 2

DISTRICT: 17      COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1             9000.
      2            15000.
      3            20000.
      4            25000.

RECORDED RUT(INS): 0.00   LOAD(LBS):     0.   PASSES:0.0000D 00

DATE:  3/ 1/1983  DYNAFLECT


SECTION    BASE               DEFLECTIONS                  NO. OF
  NO.    THICKNESS               (MILS)                   ALLOWABLE
           (INS)     W1      W2      W3      W4      W5     PASSES

   8- 0    7.00     2.13    1.53    1.14    0.87    0.60   0.121D 02
   8- 1    7.00     1.89    1.50    1.14    0.86    0.66   0.176D 02
  10- 0    7.00     1.41    1.08    0.74    0.55    0.39   0.838D 02
  10- 1    7.00     1.47    1.14    0.74    0.53    0.35   0.327D 02
  12- 0    6.00     3.30    1.14    0.78    0.54    0.22   0.558D 01
  12- 1    6.00     1.47    1.08    0.78    0.54    0.40   0.345D 02


AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.3105D 02
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 3

DISTRICT: 17     COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1             9000.

RECORDED RUT(INS): 0.00   LOAD(LBS):    0.   PASSES:0.0000D 00

DATE: 12/20/1982  FALLING WEIGHT DEFLECTOMETER


SECTION    BASE                       DEFLECTIONS
  NO.    THICKNESS                      (MILS)                                  LOAD
          (INS)    W1     W2     W3     W4     W5     W6     W7               (LBS)

   8- 0    7.00    54.88  32.91  21.18  10.31   5.04   2.87   2.17           11108.
   8- 1    7.00    55.98  32.83  21.69  11.18   5.59   3.23   2.05           10981.
  10- 0    7.00    51.93  32.83  22.44  11.65   5.00   2.44   1.20           11616.
  10- 1    7.00    53.74  34.09  23.27  12.36   5.55   2.95   1.70           11696.
  12- 0    6.00    31.53  19.29  13.54   7.21   4.02   2.60   1.30           11759.
  12- 1    6.00    32.24  18.74  12.83   7.01   3.90   2.44   1.20           11791.


SECTION   LAYER PROPERTIES      LOAD DEFORMATION      NO. OF
  NO.    BASE/SUBB SUBGRADE      CHARACTERISTICS     ALLOWABLE
          K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF        PASSES     AMULT      W1CHECK

   8- 0     30369 VERY SOFT  0.156D 06 -0.31908D-04  0.770D 05 1.28745631   52.48
   8- 1     27980 VERY SOFT  0.148D 06 -0.35336D-04  0.818D 05 1.31828598   53.43
  10- 0      3555   MEDIUM   0.184D 06 -0.22523D-04  0.673D 05 1.20303594   49.97
  10- 1     17387    SOFT    0.176D 06 -0.24886D-04  0.693D 05 1.22429461   51.38
  12- 0     43477   MEDIUM   0.380D 06  0.83217D-05  0.442D 05 0.92571837   34.27
  12- 1     40461   MEDIUM   0.371D 06  0.86308D-05  0.415D 05 0.92295711   35.39



LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.6350D 05
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 4

DISTRICT: 17     COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1            15000.

RECORDED RUT(INS): 0.00   LOAD(LBS):    0.   PASSES:0.0000D 00

DATE: 12/20/1982  FALLING WEIGHT DEFLECTOMETER


SECTION    BASE                     DEFLECTIONS
  NO.    THICKNESS                    (MILS)                              LOAD
          (INS)     W1     W2     W3     W4     W5     W6      W7         (LBS)

   8- 0     7.00    54.88  32.91  21.18  10.31   5.04   2.87   2.17        11108.
   8- 1     7.00    55.98  32.83  21.69  11.18   5.59   3.23   2.05        10981.
  10- 0     7.00    51.93  32.83  22.44  11.65   5.00   2.44   1.20        11616.
  10- 1     7.00    53.74  34.09  23.27  12.36   5.55   2.95   1.70        11696.
  12- 0     6.00    31.53  19.29  13.54   7.21   4.02   2.60   1.30        11759.
  12- 1     6.00    32.24  18.74  12.83   7.01   3.90   2.44   1.20        11791.


SECTION   LAYER PROPERTIES      LOAD DEFORMATION      NO. OF
  NO.    BASE/SUBB SUBGRADE      CHARACTERISTICS     ALLOWABLE
          K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF        PASSES     AMULT      W1CHECK

   8- 0     30369 VERY SOFT  0.156D 06 -0.31908D-04  0.778D 02 1.28745631  52.48
   8- 1     27980 VERY SOFT  0.148D 06 -0.35336D-04  0.705D 02 1.31828598  53.43
  10- 0      3555   MEDIUM   0.184D 06 -0.22523D-04  0.110D 03 1.20303594  49.97
  10- 1     17387    SOFT    0.176D 06 -0.24886D-04  0.995D 02 1.22429461  51.38
  12- 0     43477   MEDIUM   0.380D 06  0.83217D-05  0.305D 03 0.92571837  34.27
  12- 1     40461   MEDIUM   0.371D 06  0.86308D-05  0.284D 03 0.92295711  35.39



LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.1578D 03
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 5

DISTRICT: 17      COUNTY:BURLESON         ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1             20000.

RECORDED RUT(INS): 0.00   LOAD(LBS):     0.   PASSES:0.0000D 00

DATE: 12/20/1982  FALLING WEIGHT DEFLECTOMETER


SECTION    BASE                        DEFLECTIONS
 NO.     THICKNESS                        (MILS)                                      LOAD
           (INS)     W1       W2       W3       W4       W5       W6       W7          (LBS)

  8- 0     7.00     54.88    32.91    21.18    10.31     5.04     2.67     2.17        11108.
  8- 1     7.00     55.98    32.83    21.69    11.18     5.59     3.23     2.05        10981.
 10- 0     7.00     51.93    32.83    22.44    11.65     5.00     2.44     1.20        11616.
 10- 1     7.00     53.74    34.09    23.27    12.36     5.55     2.95     1.70        11696.
 12- 0     6.00     31.53    19.29    13.54     7.21     4.02     2.60     1.30        11759.
 12- 1     6.00     32.24    18.74    12.83     7.01     3.90     2.44     1.20        11791.


SECTION   LAYER PROPERTIES       LOAD DEFORMATION       NO. OF
 NO.     BASE/SUBB SUBGRADE       CHARACTERISTICS       ALLOWABLE
          K1-VALUE   TYPE     STIFF(LB/IN)  BCOEF        PASSES       AMULT      W1CHECK

  8- 0      30369 VERY SOFT  0.156D 06 -0.31908D-04  0.352D 02 1.28745631  52.48
  8- 1      27980 VERY SOFT  0.148D 06 -0.35336D-04  0.322D 02 1.31828598  53.43
 10- 0       3555   MEDIUM   0.184D 06 -0.22523D-04  0.487D 02 1.20303594  49.97
 10- 1      17387    SOFT    0.176D 06 -0.24886D-04  0.443D 02 1.22429461  51.38
 12- 0      43477   MEDIUM   0.380D 06  0.83217D-05  0.119D 03 0.92571837  34.27
 12- 1      40461   MEDIUM   0.371D 06  0.86308D-05  0.111D 03 0.92295711  35.39


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.6517D 02
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 6

DISTRICT: 17     COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1            25000.

RECORDED RUT(INS): 0.00   LOAD(LBS):    0.   PASSES:0.0000D 00

DATE: 12/20/1982  FALLING WEIGHT DEFLECTOMETER


SECTION    BASE                     DEFLECTIONS
  NO.    THICKNESS                    (MILS)                              LOAD
          (INS)      W1     W2     W3     W4     W5     W6     W7         (LBS)

   8- 0    7.00    54.88  32.91  21.18  10.31   5.04   2.87   2.17       11108.
   8- 1    7.00    55.98  32.83  21.69  11.18   5.59   3.23   2.05       10981.
  10- 0    7.00    51.93  32.83  22.44  11.65   5.00   2.44   1.20       11616.
  10- 1    7.00    53.74  34.09  23.27  12.36   5.55   2.95   1.70       11696.
  12- 0    6.00    31.53  19.29  13.54    7.21  4.02   2.60   1.30       11759.
  12- 1    6.00    32.24  18.74  12.83    7.01  3.90   2.44   1.20       11791.

SECTION   LAYER PROPERTIES      LOAD DEFORMATION      NO. OF
  NO.    BASE/SUBB SUBGRADE      CHARACTERISTICS     ALLOWABLE
          K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF       PASSES      AMULT     W1CHECK

   8- 0     30369 VERY SOFT  0.156D 06 -0.31908D-04  0.213D 02 1.28745631  52.48
   8- 1     27980 VERY SOFT  0.148D 06 -0.35336D-04  0.195D 02 1.31828598  53.43
  10- 0      3555    MEDIUM   0.184D 06 -0.22523D-04  0.289D 02 1.20303594  49.97
  10- 1     17387    SOFT     0.176D 06 -0.24886D-04  0.264D 02 1.22429461  51.38
  12- 0     43477   MEDIUM   0.380D 06  0.83217D-05  0.625D 02 0.92571837  34.27
  12- 1     40461   MEDIUM   0.371D 06  0.86308D-05  0.581D 02 0.92295711  35.39


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.3611D 02
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 7

DISTRICT: 17     COUNTY:BURLESON         ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER    WHEEL LOAD(LBS)
      1              9000.

RECORDED RUT(INS): 0.00   LOAD(LBS):     0.   PASSES:0.0000D 00

DATE:  3/ 1/1983  DYNAFLECT


SECTION    BASE                  DEFLECTIONS
  NO.    THICKNESS                  (MILS)
           (INS)      W1      W2      W3      W4      W5

  8- 0      7.00     2.13    1.53    1.14    0.87    0.60
  8- 1      7.00     1.89    1.50    1.14    0.86    0.66
 10- 0      7.00     1.41    1.08    0.74    0.55    0.39
 10- 1      7.00     1.47    1.14    0.74    0.53    0.35
 12- 0      6.00     3.30    1.14    0.78    0.54    0.22
 12- 1      6.00     1.47    1.08    0.78    0.54    0.40

SECTION   LAYER PROPERTIES       LOAD DEFORMATION      NO. OF
  NO.    BASE/SUBB SUBGRADE       CHARACTERISTICS     ALLOWABLE
          K1-VALUE  TYPE     STIFF(LB/IN)  BCOEF        PASSES      AMULT

  8- 0      27795 VERY SOFT  0.163D 06 -0.29539D-04  0.741D 05 1.26614338
  8- 1      39667 VERY SOFT  0.195D 06 -0.19719D-04  0.652D 05 1.17781897
 10- 0      97648 VERY SOFT  0.317D 06  0.35344D-05  0.838D 05 0.96848570
 10- 1      46098    SOFT    0.294D 06  0.73670D-05  0.389D 05 0.93424741
 12- 0         34   MEDIUM   0.896D 05 -0.77889D-04  0.896D 05 1.70124384
 12- 1     131541 VERY SOFT  0.294D 06  0.70676D-05  0.406D 05 0.93692154


LOAD DEFLECTION MODEL  :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.6535D 05
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 8

DISTRICT: 17     COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1            15000.

RECORDED RUT(INS): 0.00   LOAD(LBS):     0.   PASSES:0.0000D 00

DATE:  3/ 1/1983  DYNAFLECT


SECTION   BASE                DEFLECTIONS
  NO.   THICKNESS                (MILS)
          (INS)     W1     W2     W3     W4     W5

   8- 0   7.00     2.13   1.53   1.14   0.87   0.60
   8- 1   7.00     1.89   1.50   1.14   0.86   0.66
  10- 0   7.00     1.41   1.08   0.74   0.55   0.39
  10- 1   7.00     1.47   1.14   0.74   0.53   0.35
  12- 0   6.00     3.30   1.14   0.78   0.54   0.22
  12- 1   6.00     1.47   1.08   0.78   0.54   0.40

SECTION   LAYER PROPERTIES      LOAD DEFORMATION      NO. OF
  NO.   BASE/SUBB SUBGRADE       CHARACTERISTICS     ALLOWABLE
         K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF         PASSES       AMULT

   8- 0     27795 VERY SOFT  0.163D 06 -0.29539D-04  0.839D 02 1.26614338
   8- 1     39667 VERY SOFT  0.195D 06 -0.19719D-04  0.126D 03 1.17781897
  10- 0     97648 VERY SOFT  0.317D 06  0.35344D-05  0.675D 03 0.96848570
  10- 1     46098    SOFT    0.294D 06  0.73670D-05  0.273D 03 0.93424741
  12- 0        34   MEDIUM   0.896D 05 -0.77889D-04  0.354D 02 1.70124384
  12- 1    131541 VERY SOFT  0.294D 06  0.70676D-05  0.287D 03 0.93692154


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.2468D 03
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 9

DISTRICT: 17      COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1            20000.

RECORDED RUT(INS): 0.00   LOAD(LBS):     0.   PASSES:0.0000D 00

DATE:  3/ 1/1983  DYNAFLECT


SECTION    BASE                DEFLECTIONS
 NO.    THICKNESS                 (MILS)
           (INS)     W1     W2     W3     W4     W5

   8- 0    7.00     2.13   1.53   1.14   0.87   0.60
   8- 1    7.00     1.89   1.50   1.14   0.86   0.66
  10- 0    7.00     1.41   1.08   0.74   0.55   0.39
  10- 1    7.00     1.47   1.14   0.74   0.53   0.35
  12- 0    6.00     3.30   1.14   0.78   0.54   0.22
  12- 1    6.00     1.47   1.08   0.78   0.54   0.40

SECTION   LAYER PROPERTIES      LOAD DEFORMATION      NO. OF
 NO.    BASE/SUBB SUBGRADE      CHARACTERISTICS     ALLOWABLE
          K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF        PASSES     AMULT

   8- 0     27795 VERY SOFT  0.163D 06 -0.29539D-04  0.378D 02 1.26614338
   8- 1     39667 VERY SOFT  0.195D 06 -0.19719D-04  0.554D 02 1.17781897
  10- 0     97648 VERY SOFT  0.317D 06  0.35344D-05  0.2730 03 0.96848570
  10- 1     46098    SOFT    0.294D 06  0.73670D-05  0.108D 03 0.93424741
  12- 0        34   MEDIUM   0.896D 05 -0.77889D-04  0.171D 02 1.70124384
  12- 1    131541 VERY SOFT  0.294D 06  0.70676D-05  0.113D 03 0.93692154


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.1007D 03
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE PROBLEM 10

DISTRICT: 17     COUNTY:BURLESON        ROAD:FM2000
ALLOWABLE RUT(INS): 0.75
AXLE NUMBER   WHEEL LOAD(LBS)
      1            25000.

RECORDED RUT(INS): 0.00   LOAD(LBS):    O.   PASSES:0.0000D 00

DATE:  3/ 1/1983  DYNAFLECT


SECTION    BASE              DEFLECTIONS
  NO.    THICKNESS              (MILS)
           (INS)     W1     W2     W3     W4     W5

   8- 0    7.00     2.13   1.53   1.14   0.87   0.60
   8- 1    7.00     1.89   1.50   1.14   0.86   0.66
  10- 0    7.00     1.41   1.08   0.74   0.55   0.39
  10- 1    7.00     1.47   1.14   0.74   0.53   0.35
  12- 0    6.00     3.30   1.14   0.78   0.54   0.22
  12- 1    6.00     1.47   1.08   0.78   0.54   0.40

SECTION   LAYER PROPERTIES      LOAD DEFORMATION      NO. OF
  NO.    BASE/SUBB SUBGRADE      CHARACTERISTICS     ALLOWABLE
          K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF        PASSES     AMULT

   8- 0      27795 VERY SOFT  0.163D 06 -0.29539D-04  0.227D 02 1.26614338
   8- 1      39667 VERY SOFT  0.195D 06 -0.19719D-04  0.326D 02 1.17781897
  10- 0      97648 VERY SOFT  0.317D 06  0.35344D-05  0.148D 03 0.96848570
  10- 1      46098    SOFT    0.294D 06  0.73670D-05  0.568D 02 0.93424741
  12- 0         34   MEDIUM   0.896D 05 -0.77889D-04  0.108D 02 1.70124384
  12- 1     131541 VERY SOFT  0.294D 06  0.70676D-05  0.599D 02 0.93692154


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.5507D 02
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE RUN --FOR BACKCALCULATING THE SLOPE MULTIPLIER

DISTRICT:  8      COUNTY:BORDEN          ROAD:FM 612
ALLOWABLE RUT(INS): 1.00
AXLE NUMBER   WHEEL LOAD(LBS)
      1             9000.

RECORDED RUT(INS): 0.75   LOAD(LBS): 9000.   PASSES:0.2528D 05

DATE: 11/20/1975  DYNAFLECT


SECTION   BASE               DEFLECTIONS
 NO.     THICKNESS               (MILS)
           (INS)     W1      W2      W3      W4      W5

 835- 1    5.00     2.70    1.38    0.54    0.30    0.20
 835- 2    5.00     2.16    1.38    0.72    0.42    0.26
 835- 3    5.00     1.62    1.02    0.44    0.25    0.15
 835- 4    5.00     1.50    0.83    0.36    0.23    0.14
 835- 5    5.00     1.44    0.90    0.44    0.28    0.17
 835- 6    5.00     1.38    0.85    0.38    0.22    0.15
 835- 7    5.00     1.44    0.77    0.33    0.21    0.14
 835- 8    5.00     1.26    0.58    0.26    0.16    0.12
 835- 9    5.00     1.32    0.70    0.30    0.18    0.12
 835-10    5.00     1.14    0.58    0.40    0,16    0.11

SECTION   LAYER PROPERTIES      LOAD DEFORMATION       NO. OF
 NO.     BASE/SUBB SUBGRADE      CHARACTERISTICS      ALLOWABLE
          K1-VALUE  TYPE     STIFF(LB/IN)  BCOEF        PASSES      AMULT

 835- 1       691   MEDIUM    0.116D 06 -0.53087D-04   0.337D 05 1.47862390
 835- 2     29654    SOFT     0.159D 06 -0.30773D-04   0.337D 05 1.27780952
 835- 3     19797   MEDIUM    0.249D 06 -0.88382D-05   0.337D 05 1.08050215
 835- 4     29195   MEDIUM    0.284D 06  0.10639D-04   0.337D 05 0.90501794
 835- 5     35678   MEDIUM    0.305D 06  0.10450D-04   0.337D 05 0.90677925
 835- 6     43826   MEDIUM    0.329D 06  0.10154D-04   0.337D 05 0.90951474
 835- 7     35678   MEDIUM    0.305D 06  0.10450D-04   0.337D 05 0.90677925
 835- 8     67388   MEDIUM    0.390D 06  0.91008D-05   0.337D 05 0.91917692
 835- 9     54157   MEDIUM    0.357D 06  0.97180D-05   0.337D 05 0.91351896
 835-10    107011   MEDIUM    0.474D 06  0.70874D-05   0.337D 05 0.93758519


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.3371D 05
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TEXAS HIGHWAY DEPARTMENT
LOAD RATING OF LIGHT PAVEMENT

JOB:SAMPLE RUN --TO VERIFY THE BACKCALCULATION OF THE SLOPE MULTIPLIER

DISTRICT:  8     COUNTY:BORDEN          ROAD:FM 612
ALLOWABLE RUT(INS): 1.00
AXLE NUMBER   WHEEL LOAD(LBS)
      1             9000.

RECORDED RUT(INS): 0.00   LOAD(LBS):    0.   PASSES:0.0000D 00

DATE: 11/20/1975  DYNAFLECT


SECTION    BASE                DEFLECTIONS
  NO.     THICKNESS              (MILS)
           (INS)     W1     W2     W3     W4     W5

 835- 1    5.00     2.70   1.38   0.54   0.30   0.20
 835- 2    5.00     2.16   1.38   0.72   0.42   0.26
 835- 3    5.00     1.62   1.02   0.44   0.25   0.15
 835- 4    5.00     1.50   0.83   0.36   0.23   0.14
 835- 5    5.00     1.44   0.90   0.44   0.28   0.17
 835- 6    5.00     1.38   0.85   0.38   0.22   0.15
 835- 7    5.00     1.44   0.77   0.33   0.21   0.14
 835- 8    5.00     1.26   0.58   0.26   0.16   0.12
 835- 9    5.00     1.32   0.70   0.30   0.18   0.12
 835-10    5.00     1.14   0.58   0.40   0.16   0.11

SECTION   LAYER PROPERTIES      LOAD DEFORMATION       NO. OF
  NO.    BASE/SUBB SUBGRADE      CHARACTERISTICS      ALLOWABLE
          K1-VALUE  TYPE    STIFF(LB/IN)  BCOEF         PASSES      AMULT

 835- 1       691   MEDIUM   0.116D 06 -0.53087D-04  0.116D 06 1.47802935
 835- 2     29654    SOFT    0.159D 06 -0.30773D-04  0.101D 06 1.27723957
 835- 3     19797   MEDIUM   0.249D 06 -0.88382D-05  0.801D 05 1.07994676
 835- 4     29195   MEDIUM   0.284D 06  0.10639D-04  0.336D 05 0.90501954
 835- 5     35678   MEDIUM   0.305D 06  0.10450D-04  0.369D 05 0.90670844
 835- 6     43826   MEDIUM   0.329D 06  0.10154D-04  0.411D 05 0.90935360
 835- 7     35678   MEDIUM   0.305D 06  0.10450D-04  0.369D 05 0.90670844
 835- 8     67388   MEDIUM   0.390D 06  0.91008D-05  0.549D 05 0.91875839
 835- 9     54157   MEDIUM   0.357D 06  0.97180D-05  0.468D 05 0.91324430
 835-10    107011   MEDIUM   0.474D 06  0.70874D-05  0.869D 05 0.93674456


LOAD DEFLECTION MODEL :

LOAD = DEFLECTION / (BCOEF*DEFLECTION + 1/STIFFNESS)
AVERAGE NUMBER OF PASSES TO CAUSE SPECIFIED RUT : 0.6336D 05
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APPENDIX D - CODING FORMS

LOADRATING OF LIGHT PAVEMENT STRUCTURES	PROBLEM :	PAGE OF
	PROGRAMMER :	DATE

1 5 10 15 20 25 30 35 40 45 50 55 60 65 68

OPT	NPR	DI	COUNTY		FM NAME	MO	DAY	YEAR

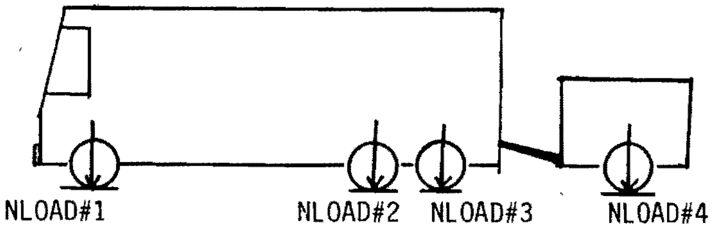
DI District No.

JOB DESCRIPTION

NC	NX		RUTX		RUTM	ALOAD	PASSM

NLOAD

OPT	1 = Falling Weight Deflectometer (FWD)	
	2 = Dynaflect (DYN)	
NPR	0 or blank = Summary Table	
	1 = All Information	
RUTX	Allowable Rut Depth (ins.)	
RUTM	Measured Rut Depth (ins.)	
ALOAD	Load Level corresponding to RUTM (lbs.)	
PASSM	Measured No. of Passes of ALOAD	
NC	Number of Cards to be read for FWD or DYN	
NX	Number of Axles of Vehicle	
NLOAD	Single Wheel Load (lbs.)	



LOADRATING OF LIGHT PAVEMENT STRUCTURES

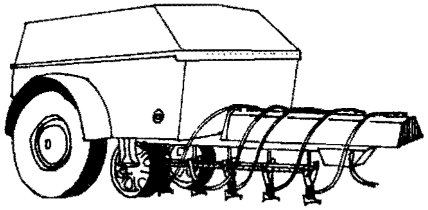
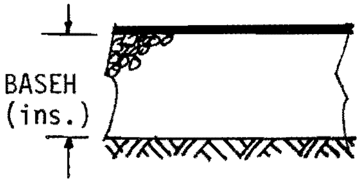
PROBLEM :

PROGRAMMER :

PAGE OF

DATE

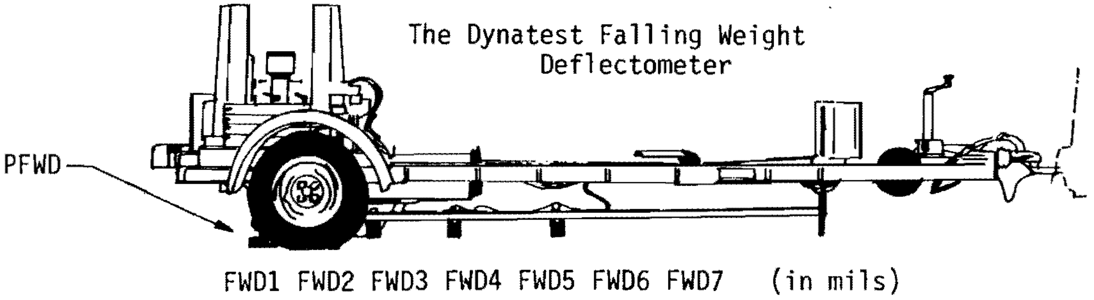
5 6 7 20 30 40

CONT	NO.		BASEH	DYN1	DYN2	DYN3	DYN4	DYN5	COMMENTS
									The Dynaflect  DYN1 DYN2 DYN3 DYN4 DYN5 (in mils) 

LOADRATING OF LIGHT PAVEMENT STRUCTURES	PROBLEM :	PAGE OF
	PROGRAMMER :	DATE

5 6 7 20 30 40 50 60

CONT	NO.		BASEH	FWD1	FWD2	FWD3	FWD4	FWD5	FWD6	FWD7		PFWD


The Dynatest Falling Weight Deflectometer