AASHO CORRELATION STUDY

Final Report

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ABSTRACT

This report is concerned with the application of the design concepts developed at the AASHO Road Test to the Louisiana in-service pavements. In order to correlate the level of performance determined at the Road Test with that of Louisiana pavements, Present Serviceability Index (PSI) determinations were made on 137 flexible sections and 51 rigid sections. Sixty-one of the 137 flexible sections had hot mix asphaltic concrete (HMAC) surfacing and the remaining had 3-application surface treatment. These sections were broadly categorized according to regional, traffic, structural and design factors.

Data acquisition consisted of making four separate PSI determinations on each test section during the course of the study. Other measurements consisted of three dynaflect deflections and various structural and design determinations. The collected data were analyzed, whenever possible, using appropriate statistical procedures.

The analysis of data indicated that the PSI concept developed at the AASHO Road Test seems to be an adequate parameter for evaluation of performance of pavements in Louisiana. The proposed method of determining performance to some terminal level of PSI offers early prediction of the useful life of the pavement provided a drop of at least one unit in PSI is observed on the p versus log ΣL plot. Comparison of the PSI data with the AASHO Interim Guid design showed 50 percent of the flexible sections with HMAC surfacing to have reached the end of life in half the time period. Similar comparison of rigid sections showed smoother rather than rougher trends during the study time span.

Statistical analysis of data further indicated no significant effect of the regional factor on the performance index of the HMAC sections. However, the effect of this factor on the Dynaflect deflections was quite pronounced.

Two sets of equations have been developed as a result of the regression analysis. One set attempts to describe the relationship between the Performance Index of the pavement and the seasonal Dynaflect deflections. The other set defines the effect of the structural and design variables on the deflection of the pavement. These equations, with additional evaluation for verification, may be used for design of high type flexible pavements.

Recommendations are made concerning the extended evaluations of a few selected sections for verification of the proposed design equations.

CHAPTER I
INTRODUCTION

During the last two decades, there have been three large scale road tests in the United States, the AASHO Road Test at Ottawa, Illinois, being the most comprehensive of the three (1)*. All of these tests were devoted to the study of performance of pavement sections under the influence of different variables. This mass of available information, particularly from the AASHO Road Test, has been translated into guidelines for the design of pavements, both rigid and flexible. However, the guidelines, in the form of performance equations, can be considered applicable, to a certain extent, to conditions comparable to those existing at the road Test Sites and not to divergent conditions. This is bound to be true for Louisiana where the environment is considerably unlike the Road Test.

In order to achieve maximum benefit from the AASHO Road Test findings, it is necessary to translate them into local conditions, provided the relevant experimental data is available. It is the general objective of this research study to furnish Louisiana with the tools for modifying the design equations as necessary to fit the environment, materials and traffic existing in the State. Stated more formally, the general objectives are:

1. To correlate the level of performance determined at the Road Test with performance of in-service Louisiana pavements under normal mixed traffic, and to study the so called regional effect throughout the State.

2. For flexible pavements in Louisiana, to determine the applicability of the factors and coefficients recommended by the AASHO design guides and attempt, if possible, to establish factors or coefficients for Louisiana materials.

3. For rigid pavements, to determine the adjustments to be made to the Road Test equation to account for variation in the slab supporting medium.

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* Underlined numbers in parentheses refer to list of references at the end of this report.

Because of the magnitude of the scope, the study was conducted in separate phases. These were broadly categorized as test section selection, field measurement for performance, sampling and testing, and finally, analysis and evaluation. Furthermore, certain phases of the study provided concomitant information not specifically sought. The bulk of this information has been reported separately in reference (2), (3) and (4).

The report is divided into separate chapters to maintain continuity. The main objectives of this study have been described in the previous paragraphs. Chapter II covers the scope of this study. The terminologies and abbreviations are defined in Chapter III. Chapter IV attempts to discuss the general concept of experimental design with emphasis on the Louisiana study. The experimentation phase of the study for acquisition of data is contained in Chapters V and VI.

Chaper VII presents the performance concept as developed at the AASHO Road Test and as evaluated for the Louisiana Satellite sections. The effects of various design factors on the measured response of performance and deflections are discussed in Chapter VIII. In Chapter IX, an effort is made to present equations relating performance to some of the significant design factors. The conclusions and recommendations drawn from the discussion presented in the previous chapters are summarized in the last chapter of this report.

CHAPTER II
SCOPE

The scope of this study is to correlate the pavement performance predicted by the AASHO Road Test with the Louisiana Department of Highways' in-service pavement performance under normal mixed traffic. The study includes the regional effects throughout the State and the applicability of the factors and coefficients recommended by the AASHO Design Guide for Flexible Section Design to the Louisiana Flexible Section Design Procedure. Factors or coefficients for those materials commonly used in Louisiana but not covered on the Road Tests have been checked. On rigid pavements the study has undertaken the determination of adjustments to be made in the Road Test equation to account for variations in the slab supporting medium. Structural integrity and design are considerations taken into account as supporting information, stressing deflections as a means of determination.

CHAPTER III
TERMINOLOGIES, SYMBOLS AND ABBREVIATIONS

Various terminologies, symbols and abbreviations are defined as follows:

ADL - average daily load, 18-kip equivalent single axle loads per day

ADT - average daily traffic, number of vehicles per day

Base - the layers of relatively high quality materials, natural or stabilized, placed above the subgrade as a stress distributing medium to insure that the stress induced in the subgrade will not exceed its strength.

Binder Course - the layer of asphaltic concrete underlying the surface course

C + P - cracking and patching as used in the correction term of the formula for determining the Present Serviceability Index with the Chloe Profilometer

D - the required thickness of pavement inches for rigid pavement design

d - Dynaflect deflection, .001 in.

E_c - modulus of elasticity of concrete

Flexible Pavement - pavement which uses a relatively light surface together with a base course to distribute the load from the wheels so that the strength of the subgrade will not be exceeded; can be either hot mix or surface treatment

f_t - flexural strength of concrete, psi

GI - Group Index, an empirical quantity calculated from the grading and the Atterberg Limits of the soil

k - modulus of subgrade reaction, pci

MC - moisture content

Pavement - covering of prepared or manufactured product superimposed upon a subgrade or base to serve as an abrasion and weather resisting structural medium and to assist in the distributing of load, sometimes used to designate the composite structure of surface, base and subgrade

pci - pounds per cubic inch

p_o - initial present serviceability index of the pavement (immediately after construction)

Present Serviceability - the ability of a specific section of a pavement to serve, for the use intended, mixed traffic on the day of the rating

psi - pounds per square inch

PSI - Present Serviceability Index, a mathematical combination of values obtained from certain physical measurements of a large number of pavements, so formulated as to predict within presented limits the PSR of these pavements

p - PSI

PSR - Present Serviceability Rating, the mean of the individual ratings made by a panel on a section of pavement

P_t - terminal serviceability of the pavement (end of life)

R - regional factor as defined in the AASHO Interim Guide

Rigid Pavement - pavement constructed with Portland Cement Concrete

RC - Radius of Curvature, size of the deflection bowl as measured in terms of feet

RD - rutting term, a correction value as used in formula for determining PSI with the Chloe Profilometer

R-value - resistance value of the soil as measured at 240 psi exudation pressure relating to the performance of the material in its use

S - soil support term for the existing subgrade material

$\overline{SN}$ - unweighted structural number of a pavement structure

B - $S \times \overline{SN}$, a numerical term for use in determining minimum surface thickness requirements under the Louisiana Flexible Section Design Procedure

a_1, a_2, a_3 - structural layer coefficients of the respective layers that are representative of material quality

D_1, D_2, D_3 - thickness of respective layers of pavement structure, in inches

SN - $a_1D_1 + a_2D_2 + a_3D_3$, weighted structural number of a pavement structure that is a combination of the various layers

Percent Design - $\frac{\text{Actual SN}}{\text{Design SN}}$

Subbase - the lowest layer in flexible pavement structure, generally consists of granular material; in rigid pavement structure, layer between concrete slab and the top of the subgrade soil

Subgrade - the foundation for the flexible or rigid pavement structure; the uppermost material placed in the embankment or remaining in cuts

S_c - modulus of rupture of concrete

Surface - the visible portion of a pavement

Surface Course - the uppermost layer of Asphaltic Concrete surfacing

Surfacing - the layers of Asphaltic Concrete or Portland Cement Concrete material upon which traffic operates

SV - slope variance term as determined with the Chloe Profilometer

T - texturmeter reading, a correction term for texture used in PSI formula as used on surface treatment roads, 10^{-3} inches

Test Section - a one-lane section of test pavement that has the same load assignment for its full length and the same design throughout

Texas Triaxial Test - a method of test intended to provide a rapid procedure for determining the relationship between the stress and strain in a compressed soil sample under various lateral pressure

u_c - Poisson's ratio for concrete

W_t - total equivalent 18-kip single axle loads expected during the design life of the facility

ΣL - total equivalent 18-kip single axle loads on facility to date

CHAPTER IV
EXPERIMENTAL DESIGN

General

Various factors enter into the design of pavement sections. One basic purpose of the satellite study is to examine the effects of these various factors on the behavior and/or performance of the pavement. It is known that in complete exploration of such situations it is not sufficient to vary one factor at a time, but that all combinations of different factor levels be examined in order to explain the effect of each factor and the possible ways in which each factor can be modified by variations of the others. For the study of the variations brought about by deliberate changes in the experimental condition, a useful technique is provided by what is termed a Factorial Experiment.

The advantages of the factorial experiments naturally depend on the purpose of the experiment. If the factors are independent (rarely true in pavement performance), then all the simple effects of the factors considered are equal to the main effects, and hence the main effects are the only quantities required to describe fully the consequences of variation in the factor. By saying that the factors are independent, it is meant that the response (pavement performance) to any factor, say thickness, is the same whether the base material is raw or stabilized. However, if the factors are not independent, as is generally the case in examining pavement performance, then the simple effects of the factors vary according to the combination of the other factors with which these are produced.

Some of the terms generally associated with the factorial experiments, as will be described later, need to be defined.

Factor - The term factor is used in a general way to denote any feature of the experiment which may vary from trial to trial. This may be deflection, thickness, traffic, type of base, etc. These factors are further divided into two classes: qualitative and quantitative. In a qualitative factor the different levels can not be arranged in order of magnitude; different types of base material and regional factors are examples of qualitative factor. On the other hand, a quantitative factor is one whose value can be arranged in numerical order. In pavement design this may well be different thicknesses of base and surface materials, subgrade strength, etc. Although the design and the analysis are the same for the two types of factors, the interpretation is different.

Levels of a factor - The values assigned to factors in the experimental design are termed levels. If base type is examined as raw and stabilized, then it is a two level factor. If surface thickness is examined at 2 inches, 3 inches and 4 inches, then it is a three level factor and so forth.

When only two levels of a factor are used, the only functional form which can be uniquely fitted is a straight line. The implied assumption is that over the range of the factor studied, the relationship between the responses and the values of the factor is linear. Similarly, if three levels are used, a quadratic function is implied, when four levels are used, a cubic function and so on.

Louisiana Design

Generally, satellite studies fall into two broad categories: those in which test sections are selected from existing pavements and those in which sections are new pavements constructed to conform to one or more design variables. The Louisiana study is confined to the former category. Such an approach has some obvious disadvantages, the foremost being that of finding sections which will conform to the structural conditions that existed at the Road Test. As an example, in Louisiana, the subbase in most cases is non-existent. Furthermore, if factorial design is anticipated, then some of the blocks will necessarily be left vacant, since one does not intentionally construct inferior sections (thin surface on poor subgrade with high ADL). Coupled with these problems are the difficulty of obtaining reliable traffic data and the presence of variables such as construction techniques whose effect can not be divorced.

At the inception of the study, the only primary variable specifically defined with respect to its level was the regional variable. The section selection based on this single factor. After a sufficient number of sections were selected in each region, an effort was made to fit them in a factorial type design. After consultation with the design and construction engineers, primary and secondary factors and the levels at which they were to be studied, were defined for flexible sections as follows:

Factor or Variable	Level of Occurrence
Primary Variables	
1. Regional	A_1 - Good (Rainfall & Drainage) A_2 - Poor (Rainfall & Drainage)
2. Traffic	B_1 - High (≥ 35 ADL) B_2 - Low (<35 ADL)
3. Base Type	C_1 - Raw C_2 - Stabilized
4. Base Thickness	D_1 - <8 inches D_2 - ≥ 8 inches
Secondary Variables	
1. Surface Thickness	E_1 - Thin (≤ 2 inches) E_2 - Thick (>2 inches)
2. Subgrade Strength	F_1 - Good (≥ 3.4 Soil Support) F_2 - Poor (<3.4 Soil Support)

TABLE IV-1
LOUISIANA EXPERIMENT DESIGN FOR EXISTING PAVEMENT SATELLITE SECTIONS

REGION		GOOD								POOR							
ADL		HIGH				LOW				HIGH				LOW			
BASE TYPE		RAW		STAB		RAW		STAB		RAW		STAB		RAW		STAB	
BASE THICKNESS		<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"
SURFACE THICKNESS	SOIL SUPPORT																
THICK > 2"	POOR	55*	134	140	106 118 133 154				135	92	104 98 172			167	67	166	
	GOOD	139	69	114 156 157	123 152 138						173 82	89		52	185 85	175	183 65
THIN ≤ 2"	POOR <3.4			76	110	160	72		111	105			79	91	60 131		101 95 165
	GOOD ≥3.4	122	68		136		121 70 158	162	142 126					103	97 86	178 96	

* Section Numbers

There are six factors in all; each occurs at two levels, that is, the 2^n class, n being the number of factors. These six factors generate 64 combinations. If the entire experiment was replicated twice, it would require a total of 128 sections to satisfy the requirements of a complete factorial design. The probability that such a factorial exists anywhere in the State is almost negligible.

The factorial design is shown in the form of Table IV-1. The experiment is confined to flexible sections only with hot mix asphaltic concrete surfacing. An attempt was made to fit surface treatment sections into the design but the ADL and surface thickness factors forced most of the section to be grouped onto one side, thereby giving a more imbalanced design than was desired. Furthermore, the main response (Performance Index) which was to be studied from this design was missing for most of the surface treatment sections. This lack of adequate information on the response variable is explained in Chapter VII.

The design, as shown in Table IV-1, falls short of a factorial design because of the 24 vacant blocks. This is one of the main drawbacks of the study of existing pavements for examination of factors that affect their performance. The design as presented approaches a randomized design with missing blocks.

Concerning the factor base type, it should be mentioned that there are four major base type categories generally encountered in Louisiana. The distribution by region of the various types is also unique. The sand shell base course, for example, will only be found in the poor region. Likewise, sand clay gravel bases, both stabilized and raw, are encountered in the good region only. The only type common to both regions is the cement stabilized soil base course.

CHAPTER V
MEASUREMENT PROGRAM

A. Test Sections

The selection of test sections was one of the first parts of this study. This included selection of projects within each region to fit the experimental design as closely as possible and the selection and location of the test sections within each chosen project.

An extensive records search was made to gather the necessary information for the selection of these test projects. Projects which had varying ages but the same typical structural sections were selected in different areas of the state.

A total of 188 projects were selected with 51 having rigid pavement. The remaining 137 projects had flexible pavements, of which 61 were surfaced with hot mix and 76 with surface treatment. Each project had a test section consisting of essentially a half-mile length of pavement with two-1000 foot test units separated by an approximate 640 foot transition zone used for the destructive testing or sampling. Figure V-1 shows a typical sampling plan.

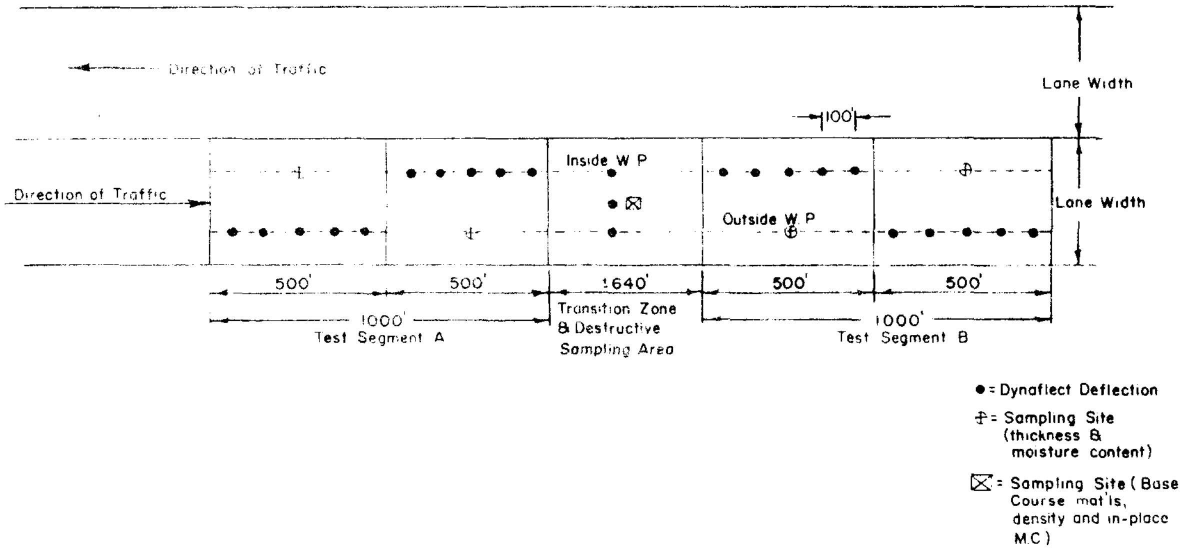


Figure V-1
Typical Sampling Plan

Each project was driven over in an automobile, with the mileage being logged to determine length of possible locations available. Miscellaneous features were noted such as drainage, cut or fill sections, culverts, rural or urban locations, etc. Roughometer roughnesses were obtained to refer to in determining final location selection. The principal determining factors were the test sections had to be: (1) fairly level, (2) free of any curves, except small flat curves if a straight stretch of pavement wasn't available, (3) essentially free of culverts, bridges or interruptions in the pavement or flow of traffic and (4) freely accessible to test vehicles.

Each test section was located, referenced adequately and marked. Figure V-2 shows a state map with geographical locations of all test sections.

B. Instrumentation

The major pieces of equipment used for data accumulation in this study are the Chloe Profilometer, the PCA Road Meter and the Dynaflect. These pieces of equipment are performance measuring devices, either for serviceability measurements of the pavement surface or structural integrity of the section.

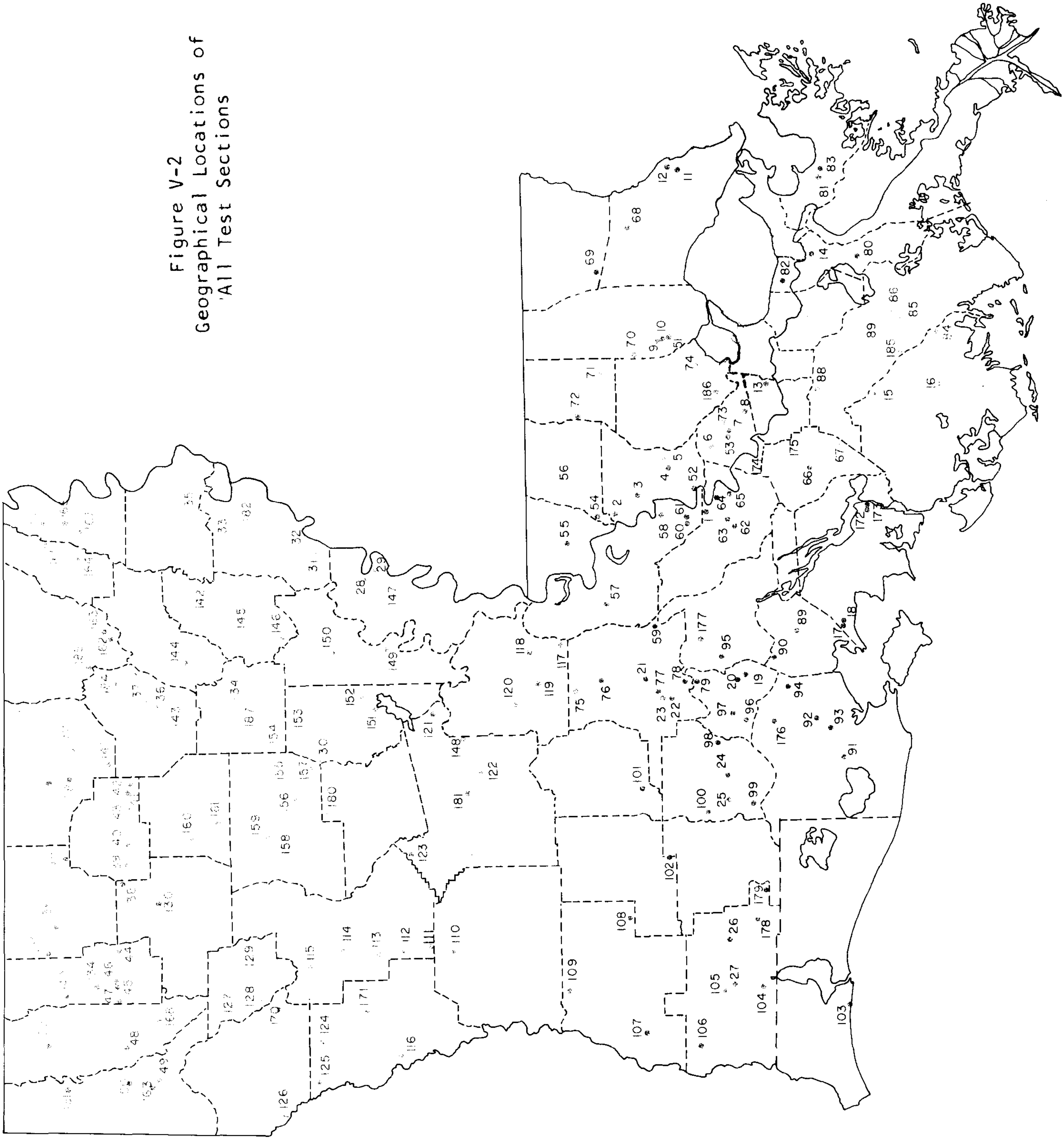
The Chloe Profilometer

The Chloe Profilometer, as described in the Federal Highway Administration's "Chloe Profilometer Operating and Servicing Instructions," is essentially two units: the trailer unit which carries the transducing mechanism and the electronic computer indicator. The electronic computer indicator accepts information from the transducer, performs a computation on it and then indicates the results.

The slope transducer, carried at the rear of the 20 foot trailer, is comprised of two eight-inch wheels mounted nine inches on centers, a roller contact on an upright arm fastened at the pivot point between the wheels and a printed circuit switch with 29 active segments. The transducer provides a continual measure of the angle between the bar connecting the slope wheels and the arbitrary reference of the trailer unit. A slotted disc-photocell combination, attached to one of the carriage wheels, produces a command to sample pulses at six-inch intervals of highway travel.

At each six-inch interval, sample pulses are produced through the 29 active segments. The computer squares these segments plus accumulatively sums up the numbered segments, the squares and the number of six-inch intervals travelled (number of samples). Standard forms are used to record the data accumulation as well as the subsequent **calculations. Formulas** derived from the AASHO Road Test equations are used to calculate the Present Serviceability Indices (PSI's).

Figure V-2
Geographical Locations of
All Test Sections



The PCA Road Meter

The PCA Road meter was developed by the Portland Cement Association to afford a rapid method for the measuring of the effect of slope variance on dynamic behavior of the vehicle, this being a factor in obtaining Present Serviceability Indices of pavements. The PCA Road Meter is correlatable to the Chloe Profilometer for obtaining the Present Serviceability Indices.

The description of the PCA Road Meter, taken from the report by M. P. Brokaw, "Development of the PCA Road Meter, A Rapid Method for Measuring Slope Variance," is as follows: The method of obtaining the slope variance makes use of a simple electro-mechanical device, installed in a conventional passenger automobile (in this case, a 1966 Ford 4-door Custom sedan). The device measures the number and magnitude of rear axle movements in relation to the auto body, and these are statistically summed and correlated with slope variance measured by the Chloe Profilometer.

The device itself consists of a flexible, beaded-steel chain connected to the top center of the rear axle housing in a 1966 Ford 4-door Custom sedan. The steel chain extends vertically through the trunk compartment and then through a small hole in the package deck just back of the rear seat. At this point, the strand passes over a transverse-mounted pulley and is restrained by a tension spring attached to a small post on the package deck near the right side of the body shell. Thus, vertical movement between the center of the axle housing and the package deck is translated to horizontal movement of the chain.

Midway between the pulley and tension spring, a roller micro-switch is attached to the metal chain. The micro-switch roller impinges on a switch plate constructed so that the transverse roller movements can be measured in 1/8 inch increments, either plus or minus, from a reference standing position of the automobile. High-speed electric counters record the accumulations of increments.

The Dynaflect

The description of the Dynaflect System is taken from the operations manual for the system. The Dynaflect System consists of a dynamic force generator mounted on a small two-wheel trailer, a control unit, a sensor assembly and a sensor (geophone) calibration unit. The purpose of the system is to permit rapid and precise measurement of roadway deflections while the trailer is halted briefly at successive test locations.

The system is designed to operate behind any vehicle that has a rigid trailer hitch and a 12 volt battery system. The self-contained trailer and control unit permit deflection measurements of any surface accessible to the tow vehicle and trailer. After initial calibration, successive measurements can be made at widely varying positions by a single operator/driver without him leaving the towing vehicle.

The cyclic force generator utilizes a pair of unbalanced flywheels rotating in opposite directions at a speed of 480 rpm, or 8 cycles per second. The vertical component of the acceleration of the unbalanced mass produces the cyclic force which is applied to the ground through a pair of rigid wheels. The horizontal components cancel by virtue of the counter-rotation. The amount of flywheel unbalance is precisely chosen to produce a 1,000 pound peak-to-peak variation of force during each rotation of the flywheels at the proper speed. A tachometer indicator is provided in the control unit, together with a speed adjustment, to insure operation at the correct rate of 8 cycles per second.

A remote controlled, hydraulic lift mechanism in the trailer moves the force generator with its rigid wheels in or out of contact with the ground. When out of contact, the trailer is supported on pneumatic tires for travel at normal vehicle speeds. With the rigid wheels down and the pneumatic tires lifted, the trailer may be moved short distances from one measuring point to another at speeds up to 6 miles per hour. The sensors are raised and lowered by remote control to enable such moves to be made quickly without need for the operator/driver to leave the towing vehicle.

Roadway deflections are sensed by a series of geophones located as shown in Figure V-3.

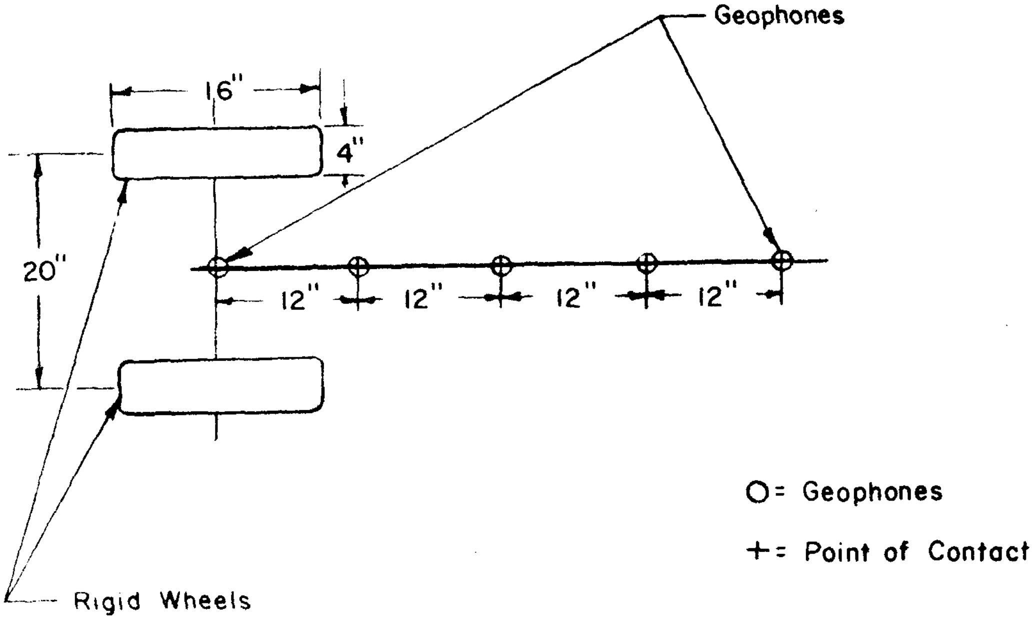


Figure V-3
Dynaflect Sensor Array

Sensor #1 senses the deflection at a point in line with the axis of the force applying wheels, on the center line of the trailer and midway between the wheels themselves. The remaining sensors each sense the deflection occurring directly beneath their respective locations along the center line of the trailer. Each sensor is equipped with a suitable base to enable it to make proper contact with irregular surfaces.

The electrical signals from the sensors are filtered and amplified to produce a reading on a panel meter located in the control unit. A selector switch in the control unit connects each of the sensors, one at a time, to the amplifier. A frequency compensating filter allows the system to respond only to the fundamental frequency component of the motion at 8 cycles per second. Accordingly, each meter reading represents the amplitude of the induced deflection at the location of the operator-selected sensor.

As shown in Figure V-4, the output of the amplifier is rectified, integrated over a period of one second to provide a steady reading and then applied to a direct current meter. By using a sine-wave force preceding a frequency compensating filter in the amplifier, the meter readings become directly proportional to the amplitude of motion at the location of each sensor.

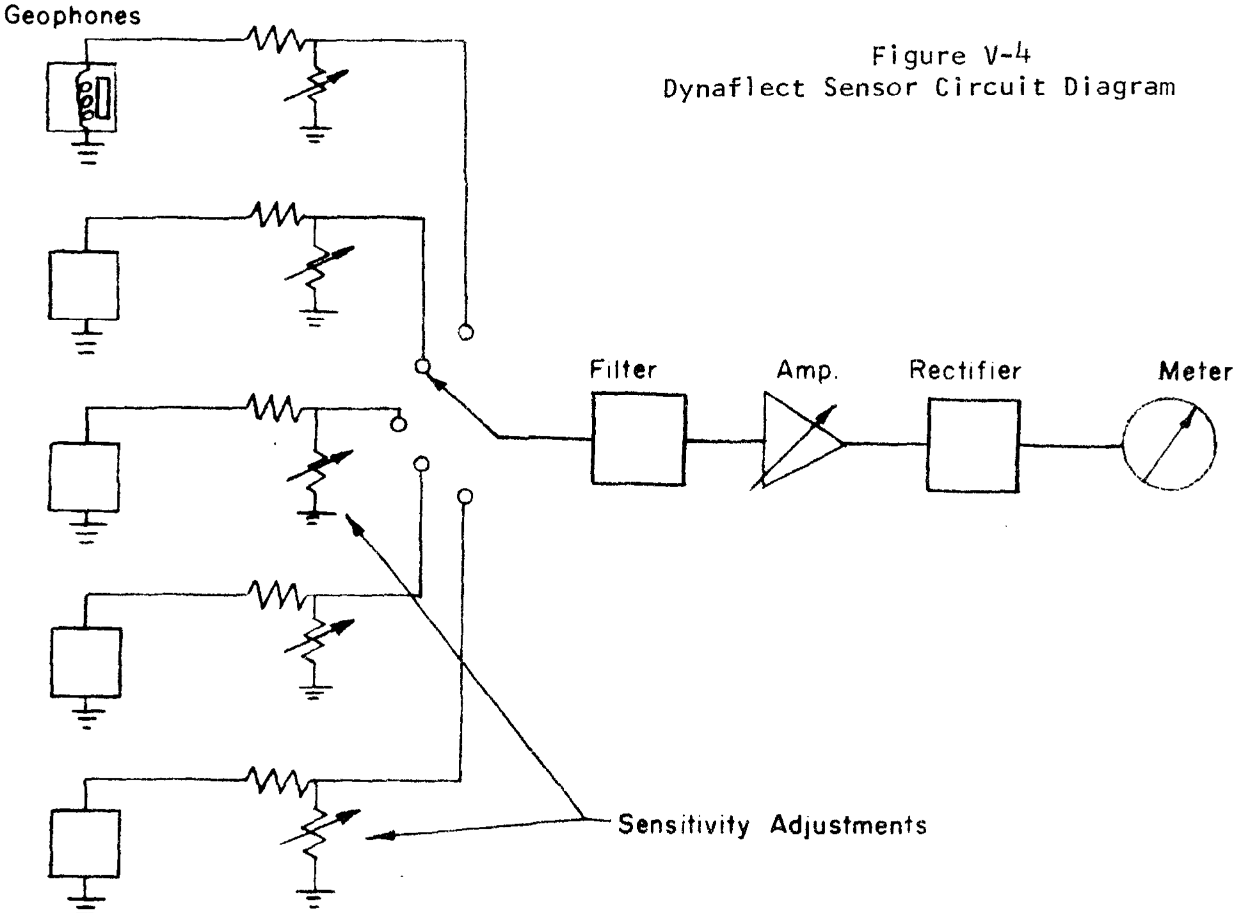


Figure V-4
Dynaflect Sensor Circuit Diagram

The scale of the meter is calibrated directly in milli-inches (thousandths of an inch). The six scale ranges (from 0.1 milli-inch full scale to 30 milli-inches full scale) are selected by a switch which sets the appropriate amplifier gain for each range.

Calibration of the entire motion sensing and measuring portions of the system is accomplished by placing the sensors on a cam-actuated platform inside the calibrator unit. This platform provides a fixed 0.005 inch vertical motion at 8 cycles per second. The corresponding meter reading of 5 milli-inches is set in the control unit by adjustment of an individual sensitivity control for each geophone. Subsequent deflection measurements are thus comparisons against this standard deflection.

Other pieces of field equipment used in this study include: Benkelman beams, dial gauges, 18-kip axle load reaction vehicles, core drills, sand-cone density measuring devices, a rut measuring device, shovels, picks, auger, a distance measuring wheel and a texturemeter.

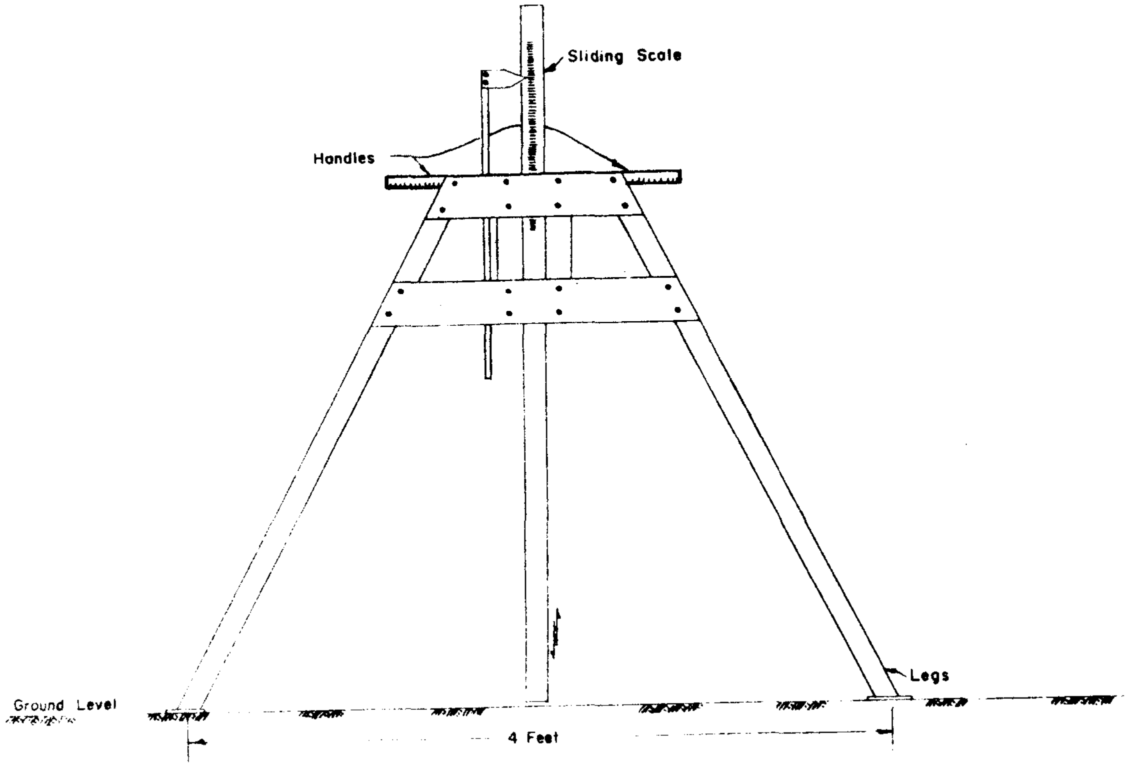


Figure V-5
Rut Depth Measuring Device

C. Materials Sampling and Testing Procedures

Initial field sampling was concentrated on the flexible test sections having hot mix asphaltic concrete wearing courses. Later, surface treatment and Portland Cement Concrete test sections were sampled and tested.

Sampling was accomplished through the use of two methods, core holes and test pits. Thickness of each layer (pavement, base and subbase) was determined from both core holes and test pits. The test pits were the principal sources of in-place densities and samples for gradation. Core holes yielded moisture samples of the base, subbase and basement soils, along with test cores of cement treated bases. Gradation, plasticity indices, R-values and moisture-density relationships were obtained in the laboratory from samples obtained from the test pits. Samples of hot mix asphaltic concrete wearing courses and the binder courses were taken and sent to the laboratory for analysis. A typical sampling plan is found in Figure V-1.

1. Embankment Soils

Three 30 pound samples of each embankment soil were taken from each test pit and sent ot the laboratory for testing. Gradations, Atterberg Limits and R-values were determined. Test procedures used were LDH Designation: TR 407 - Standard Method of Mechanical Analysis of Soils; LDH Designation: TR 423 - Soil Classification and LDH Designation: TR 428 - Atterberg Limits of Soils. R-value was determined by California Test Method No. 301-C - Method of Test for Determination of the Resistance "R" Value of Treated and Untreated Bases, Subbases and Basement Soils by the Stabilometer. R-values were run at 240 psi exudation pressure.

The in-place density of the embankment soil was run using Test Method LDH Designation: TR 401 - In-Place Density Determination. Field moisture contents were determined by Test Method LDH Designation: TR 403 - Moisture Content of Soil Samples, while laboratory moisture contents were determined by LDH Designation: TR 415 - Moisture-Density Relationships Using Family of Curves.

2. Untreated Base and Subbase Materials

Three 30 pound samples of each layer of material beneath the pavement layer (down to the embankment soil) were taken from each test pit and sent to the laboratory for testing. Test procedures used were AASHO Designation: T-27 - Method of Test for Sieve Analysis of Fine and Coarse Aggregates, LDH Designation: TR 407 - Standard Method of Mechanical Analysis of Soils; LDH Designation: TR 423 - Soil Classification and LDH Designation: TR 428 - Atterberg Limits of Soils. R-value was determined by California Test Method No. 301-C - Method of Test for Determination of the Resistance "R" Value of Treated and Untreated Bases, Subbases and Basement Soils by the Stabilometer. R-values were run at 240 psi exudation pressure. R-values were used to determine the soil support values of various layers.

The in-place densities of the base or subbase layers were run using Test Method LDH Designation: TR 401 - In-Place Density Determination. Field moisture contents were run for each layer, and moisture-density relationships were determined.

3. Treated Base and Subbase Materials

Where the base or subbase was stabilized, 4 cores were obtained whenever possible. Densities of the cores were determined, and the compressive strengths of the stabilized cores were obtained along with the moisture-density relationship. Test procedures included AASHO Designation: T 24 - Method of Securing, Preparing and Testing Specimens from Hardened Concrete for Compressive and Flexural Strengths. However, in this case, no standard method was used, and the procedure used was modified to fit the situation.

4. Asphalt Surface Courses

Four cores were taken from the wearing and binder courses of the asphaltic concrete pavement, and samples of the loose broken up asphaltic concrete pavement were taken from each test pit. Stability and density tests were determined for each layer along with the specific gravity and percentage of asphalt. Standard tests included LDH Designation: TR 304 - Method of Test for Determination of Specific Gravity of Compressed Bituminous Mixtures; LDH Designation: TR 305 - The Stability and Flow of Asphaltic Concrete Mixtures - Marshall Method and LDH Designation: TR 307 - Bitumen Content of Paving Mixtures by Reflux Extractor.

5. PCC Pavement

Four cores were taken from the PCC pavement, with the thickness of the core measured to determine the thickness of the pavement layer. Compressive strengths of the cores also were determined. Test Procedures included AASHO Designation: T 24 - Methods of Securing, Preparing and Testing Specimens from Hardened Concrete for Compressive and Flexural Strengths.

D. Field Testing for Performance

The purpose of highways is to enable people to comfortably and economically travel from one location to another making use of various types of vehicles. The motoring public consciously or subconsciously will rate these highways as to their rideability. There are many devices developed to measure mechanically the roughness (in one form or another) to the road; among these are the BPR Roughometer, the Chloe Profilometer, the PCA Road Meter, the Mays Road Meter, the California Profilograph and similar devices, the Colorado Accelerometer, the Kentucky Accelerometer and the General Motors Profilometer. The AASHO Road Test was instrumental in developing several means of expressing the capability of a highway section in carrying traffic adequately.

The Present Serviceability of a highway is defined as the ability of a specific section of pavement to serve high speed, high volume, mixed (truck and automobile) traffic in its existing condition.

The Individual Present Serviceability Rating is an independent rating by an individual giving the Present Serviceability of a section of highway using a numerical rating of from 0 to 5, with the description being as follows:

4 - 5 very good
3 - 4 good
2 - 3 fair
1 - 2 poor
0 - 1 very poor

The Present Serviceability Rating (PSR) is the mean of the individual ratings as determined by the members of a panel.

The Present Serviceability Index (PSI) is a mathmatical combination of values obtained from certain physical measurements of a large number of pavements so formulated as to predict within limits the PSR for those pavements. The physical measurements involved in determining the PSI of flexible-pavements were the slope variance (SV), the cracking and patching (C+P) and the rut depth (RD) corrections. We had the same variables for the rigid pavements except for having no rut depth measurement. The Chloe Profilometer was the primary device used to obtain the slope variance, this being accomplished by accumulatively counting the SV's electronically at 6 inch intervals. There were several draw backs to the Chloe Profilometer, the principal one being the slowness of operation (3 mph) while others were the frequent breakdown rate due to the electronic nature of the device, the safety problem in its use and the need for numerous personnel in the operation of the device.

The cracking and patching refers to the area per 1000 square feet of pavement which has Class 2 or 3 cracking and the area per 1000 square feet of pavement which has patching. Generally this type cracking can be termed alligator cracking. This is for flexible pavements. Cracking on rigid pavements refers to the total linear feet of Class 3 and Class 4 cracks per 1000 square feet of pavement area. Patching on rigid pavements refers to the area of asphalt patching per 1000 square feet of pavement area.

Cracking and patching values were estimated by personnel as they walked over each section. The C + P term is approximated because it has only a small effect on the value of the PSI.

The rut depth was determined by measurement with a portable depth measuring device. This device measures the difference of elevation between the wheelpath and a line connecting two points, each two feet away from the center of the wheelpath. See Figure V-5 for a diagram of this device. The average rut depth of the flexible pavement was obtained using an average of 20 readings each test segment (1000 feet) of the section. Generally this term did not affect the PSI significantly.

A texturemeter was developed at the Texas Transportation Institute for determining a correction factor for surface texture on surface treatment roads. An equation was suggested for modifying the serviceability taking into account the surface texture.

The equation Texas used with the texture reading was as follows:

$$PSI = 4.85 - 1.91 \log (1+\overline{SV}) - 0.01\sqrt{C + P} - 1.38\,\overline{RD}^2 + 0.81 \log (1+T),$$

where: PSI = Present Serviceability Index

$\overline{RD}$ = rut depth, in.

$C + P$ = area of cracking and patching per 1000 sq. ft. of pavement area

T = texture reading in units of 10^{-3} in.

$\overline{SV}$ = slope variance

A texture term was added because it was found that rough textured pavements resulted in relatively high profilometer readings, thus lowering the PSI value. If a surface was smooth, the texture reading would be zero, while the coarser the texture of the pavement, the larger the reading. Texas included the texture in their PSI equation for flexible pavements (to be used on surface treatment roads) in order to give them a better prediction of serviceability, However, after numerous measurements and initial analysis of results from data in this State, this surface texture correction was eliminated from use. This measure of texture did not significantly improve the correlations developed to predict the Present Serviceability in Louisiana.

The following are the equations found to fit the ratings made at the Road Test for rigid and flexible pavements when using the Chloe Profilometer.

Rigid - $PSI = 5.41 - 1.80 \log (1 + \overline{SV}) - 0.09\sqrt{C + P}$

Flexible - $PSI = 5.03 - 1.91 \log (1 + \overline{SV}) - 0.01\sqrt{C + P} - 1.38\ \overline{RD}^2$

where: PSI = Present Serviceability Index

$\overline{SV}$ = slope variance

$\overline{RD}$ = rut depth, in.

C + P = area of cracking and patching per 1000 square foot for flexible pavement and linear feet of cracking and area of patching per 1000 square foot for rigid pavement.

E. Traffic

The traffic is considered in terms of the Average Daily Equivalent 18-kip Single Axle Load (ADL). Table 2 of the Appendix shows ADL equivalencies used in this State in a traffic summary form for calculation of ADL's. The Louisiana Department of Highways' Traffic and Planning Section has the responsibility of determining the various Average Daily Traffic (ADT) and the Average Daily Equivalent 18-kip Single Axle Loads (ADL) for the State Road network. Several combined methods are used to convert the ADT's to ADL's. As an example, Table 2 of the Appendix is also a summary of the ADL determination for one specific highway location.

Throughout the State of Louisiana there are 50 permanent vehicle count stations operating 365 days a year. In addition to this, there were 2800 routine counting stations (now there are 4000) that were operated twice a year from 1 to 24 hour periods. There are 13 truck weighing stations throughout the State where trucks are physically weighed. Once every 5 years a complete coverage is made of the State in which a count over a 24 hour period is made for every State road. This is accomplished by taking it parish (county) by parish and extending it over a 5 year interval of time so that by the end of that 5 year period every parish (county) and every road will have been covered.

For this AASHO Correlation Study every test section had a 4 to 8 hour manual count, in which every vehicle was classified and the percentage of each vehicle type was determined. Then this percentage was used to expand the ratio of vehicle types for a 24 hour period in terms of ADT. The total ADT of each section was obtained from the actual count on the road or by using the count of the nearest counting station of a similar type road. The ADT of each vehicle type was multiplied by the appropriate 18-kip equivalent factor, and the ADL (18-kip equivalent) was obtained for each vehicle type and summed for all the traffic during a day.

Total summation of Loads (ΣL - 18-kip Equivalent ADL's) was obtained by multiplying the number of days the road has been in use since construction times the ADL. Traffic and Planning Section provides this figure for all sections once a year as of the last day of the year. The ADL will change every year so a continuous yearly summation is required to give the closest approximation to the actual traffic picture. The actual traffic figure (ΣL) used in the Study for any certain date during the year is obtained by plotting the end of the year ΣL's for each year, then taking off this curve the ΣL for the particular date needed. In this manner, traffic data is obtained for the times when Dynaflect deflections are run or when PSI's are run, therefore giving the best possible approximations of the traffic picture.

In the design of highways, projected ADT's are generally obtained as follows:

Example: Projected 1985 ADT = AG (1.00 + SLI)

where:
A = the present ADT
B = the generation factor
S = the State growth factor
L = the local growth factor
I = the Interstate growth factor

Since this is the standard Federal Highway Administration method for projecting ADT's, and this method is not involved in this Study, an explanation of the method will not be made here. All traffic count data obtained in this Study was from actual counts either from the section itself or a similar type road and in some instances expanded; however, no traffic count data was projected to the future.

Traffic determination is an important criteria in any design method or analysis of data, and it is extremely difficult to obtain perfectly true picture of traffic conditions. However, general traffic comparisons can be made from data that is available.

CHAPTER VI
DATA ACCUMULATION

In August of 1965, data accumulation began with the first Present Serviceability Index determinations on all test sections throughout the State. The Chloe Profilometer was used as the principal index gathering device. Since all these sections were in-service roads, these first PSI's were not p_om the initial PSI of new construction. A value of 4.20 generally has to be assumed for po, the initial PSI. The first set of PSI's took 9 months to complete because of numerous equipment breakdowns, lack of personnel at critical times and the slowness of the operation of the Chloe Profilometer. It was intended to acquire a set of PSI's for each year of the study.

Figure V-1 shows a typical section layout. Generally a section was one-half mile long, consisting of four 500 foot lengths with a center length approximately 640 feet long for destructive sampling and testing. The first two 500 foot lengths were designated Test Segment A while the last two 500 foot lengths were designated Test Segment B. The Chloe Profilometer was run first on the outside wheelpath of the first 500 foot length, then the inside wheelpath of the second 500 foot length, the inside wheelpath of the third 500 foot length and finally the outside wheelpath of the fourth 500 foot length. This procedure was followed as long as the Chloe Profilometer was used as the principal PSI gathering device.

At one time, due to a breakdown of the Chloe Profilometer, an attempt was made to correlate the BPR Roughometer with the Chloe Profilometer by using the data for the Chloe obtained from recently completed sections while running the BPR Roughometer over these same sections. It was thought that the BPR Roughometer would be faster and would be an acceptable replacement for the Chloe Profilometer; however, a good correlation was not obtained using this method with the limited data available. The Chloe Profilometer was repaired by this time, so testing was resumed using the Chloe Profilometer as before.

Lack of speed still was a serious drawback, so when a new device was introduced to the highway industry which measured the effect of slope variance on dynamic behavior of the vehicle in which the device was placed, the decision was made to correlate this device (the PCA Road Meter) with the Chloe Profilometer. The PCA Road Meter Correlation is found in Interim Report No. 2 of the AASHO Correlation Study. Upon completion of this correlation in 1968, the PCA Road Meter was installed as the primary PSI gathering device, and the Chloe Profilometer was only used as a backup or a check upon accuracy of the data obtained. The PCA Road Meter was operated at a speed of 50 mph, running one-half mile sections three times and obtaining an average PSI value.

The readings from the PCA Road Meter measured the accumulated deformations between the rear axle and the body of the car. The PCA Road Meter had several advantages over the Chloe Profilometer; it was run at normal operating speed on the highway which made it faster, and it also gave the measure of distortion similar to that which a passenger in a car felt.

In order to correlate the pavement performance determined by the AASHO Road Test with the Louisiana in-service pavement performance it was necessary to establish a serviceability determination for the study test sections and then study the serviceability with time and traffic. The terminal level of PSI for design purposes was taken as 2. 5 or 2. 0 depending on the type of road. This followed the AASHO Design Guide Method. A total of four PSI runs were made over each test section throughout the State over a period of four years. Also a rating panel was sent over the State to rate each of these test sections. This rating was done after the fourth run of the PSI's, and it included both a numerical rating from 0 to 5 and a subjective rating as to whether the section had reached a terminal condition.

The variation of Present Serviceability with time or traffic could be used to establish the performance of a test section. The AASHO Design Guide Method established the traffic in terms of 18, 000 pounds equivalent single axle loads. Section V-E describes the Louisiana Method of determining traffic.

It was intended to obtain Present Serviceability Indices once a year on each test section. However, as time progressed and complications arose, Present Serviceability Indices were obtained at irregular intervals. Some sections were run at normal intervals, while others were run at larger intervals of time or, in most cases, obtained at much closer intervals. This situation caused some problems in the data analysis process; however, the researchers had to "live with" the situation because of unforeseen circumstances.

An example of time intervals on Present Serviceability Indices determination is Study Section 72. The first PSI determination was in August 1965, the second in September 1967, the third in March 1969 and the fourth in January 1970. The intervals of time were 25, 18, and 10 months respectively. Wide intervals of time were caused by delays due to equipment breakdown, lack of personnel and built-in slowness of original equipment.

It was felt that a more complete evaluation of a pavement could be obtained if the structural condition of the pavement was considered in addition to the rideability as determined by the PSI. To this end, a deflection testing program was undertaken. This program is shown in the sampling layout in Figure V-1, The first step in the deflection program was a Benkelman Beam - Dynaflect Correlation Study. This study was initiated because of the need to express Dynaflect deflections in terms of Benkelman Beam units which were more universally understood. The Benkelman Beam - Dynaflect Correlation was reported in the Interim Progess Report No. 1 of the AASHO Correlation Study.

Upon completion of this correlation, a regular testing program was set up using the Dynaflect as the deflection determination device. Three sets of data were obtained on all the test sections throughout the State. Again as time progressed and complications arose, the time intervals of these sets of deflection readings became closer and closer, causing difficulties in data analysis.

In addition to the deflection readings, the air and surface temperatures were recorded, a moisture content of the subgrade was obtained on the shoulder at the edge of the pavement and another moisture content was obtained 50 feet out from the pavement either in the right-of-way or, where possible, in a field sampled at a comparable depth. These measurements were taken each time deflection determinations were made on a study. Any remarks pertinent to the weather, condition of the pavement, shoulder, ditches or layers were noted and recorded. A seasonal deflection testing program was not set up as such, but the time element of testing as far as seasons were concerned fitted into that concept. However, in this State, it was and is hard to distinguish differences of seasons for deflection purposes.

Dynaflect deflection readings were taken at 100 foot intervals in alternating wheelpaths as follows: 5 sets of readings in the outside wheelpath of the first 500 feet, 5 sets of readings in the inside wheelpath of the second 500 feet, 5 sets of readings in the inside wheelpath of the third 500 feet and 5 sets of readings in the outside wheelpath of the fourth 500 feet. All five sensor readings were recorded with the maximum single readings noted and the average deflection readings for the section calculated. The operation of the Dynaflect deflection device is described in Section V- B.

A theoretical Radius of Curvature was calculated from a scaled drawing of the bowl of influence from the Dynaflect readings of the five sensors for each test location.

In the beginning of the study, the sampling and testing procedures included a wide range of determinations. These included: measuring thicknesses of each structural layer, gradations, densities, Atterberg Limits and classification and R-values of each layer below the surface layer, moisture contents of each structural layer below the surface layer and compressive strengths of concrete cores and soil cement cores when possible. They also included the asphalt contents, stability, cohesion, gradation and density of the asphaltic concrete flexible surfacing.

Regression analysis showed that only a few of these determinations significantly contributed to traffic performance relationships; therefore, those that did not contribute were dropped. Prime contributors retained were: thickness and type of each structural layer, R-value of the subgrade material (embankment) and moisture contents.

CHAPTER VII
ANALYSIS OF DATA

Evaluation of Performance - General

Basically, the satellite study is geared towards the examination of various relationships between performance and structural design of the pavement using concepts developed at the AASHO Road Test. The basic performance variables are essentially deformation and deterioration which represent undesirable changes in the pavement surface condition. On the other hand, structural variables represent subsurface conditions in terms of thickness, strengths, etc. At the AASHO Road Test, the concept of Present Serviceability Index, PSI, was developed so that measurements of the surface variables could be converted to some numerical scale by use of appropriate mathematical relationships. This PSI concept was discussed in detail in Chapters V and VI. The following paragraphs describe the performance concepts as developed at the Road Test and as used in the Louisiana Satellite Study.

$$p = p_o - (p_o - 1.5) \left[\frac{W}{\rho}\right]^{\beta} \qquad \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Eq. VII-1}$$

where: p = Present Serviceability Index, PSI,
p_o = Initial Serviceability Index,
W = Accumulated axle load applications at the time p was observed,
and β , ρ = functions of design and load.

The serviceability loss is defined by the quantity:

$$\left[\frac{p_o - p}{p_o - 1.5}\right] = G \qquad \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Eq. VII-2}$$

Equation VII-1 then reduces to:

$$G = \left[\frac{W}{\rho}\right]^{\beta}$$

or in Logarithmic form:

$$\text{Log } G = \beta \ (\text{Log } W - \text{Log } \rho) \qquad \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Eq. VII-3}$$

At the Road Test, β and ρ were estimated as the slope and intercept of the plot of equation VII-3 for each section. These parameters were defined by the following two models:

$$\beta = \beta_o + \frac{\beta_o \ (L_1 + L_2)^{\beta_1}}{(a_1 D_1 + a_2 D_2 + a_3 D_3 + a_4)^{\beta_2} \ (L_2)^{\beta_3}} \qquad \text{\_\_\_\_\_\_Eq. VII-4}$$

where:
L_1 = axle weight in kips,
L_2 = axle code 1 for single
2 for tandem,

D_1, D_2 and D_3 = Design thickness of surface, base and subbase,

and β_o, β_1, β_2, β_3, a_1, a_2, a_3 and a_4 are constants determined from the analysis.

Similarly:

$$\rho = \frac{\rho_o \ (SN + a_4)^{\rho_1} \ (L_2)^{\rho_2}}{(L_1 + L_2)^{\rho_3}} \qquad \text{\_\_\_\_\_\_Eq. VII-5}$$

where: $SN = a_1 D_1 + a_2 D_2 + a_3 D_3$,

and ρ_o, ρ_1, ρ_2, and ρ_3 are constants determined

from the analysis.

The analysis gave the following constants in the equations:

$$\beta = 0.4 + \frac{.081 \ (L_1 + L_2)^{3.23}}{(SN+1)^{5.19} \ L_2^{3.23}} \qquad \text{\_\_\_\_\_\_Eq. VII-4A}$$

and $$\rho = \frac{10^{5.93}\,(SN+1)^{9.36}\;L_2^{\;4.33}}{(L_1 + L_2)^{4.79}} \qquad \text{\_\_\_\_\_\_\_\_\_\_\_\_Eq. VII-5A}$$

Rearranging Equation VII-1 gives:

$$\text{Log } W = 9.36 \text{ Log } (SN+1) - .20 - \frac{\text{Log}\left[\frac{po - 1.5}{po - p}\right]}{.40 + \frac{1094}{(SN+1)^{5.93}}} \qquad \text{\_\_\_\_\_\_\_\_\_\_\_\_Eq. VII-6}$$

The left hand side of equation VII-6 is defined as the Performance Index, P, of the pavement section. At the Road Test it was found that most new pavements have serviceability index values in the range from 4.0 to 5.0 and that an average terminal level is in the neighborhood of 2.0 to 2.5.

Substitution of appropriate values in the right hand member of the above equation will give the number of accumulated equivalent 18-kip axle loads corresponding to a terminal serviceability value of 2.0 or 2.5 or any other level of PSI. Performance Index values so calculated can then be examined for their scatter about those observed for the satellite sections that closely approximate the materials and the thickness of the layers used at the Road Test. The direction of the scatter can be used as guidelines for correction and/or modification of the equation for application to Louisiana. However, since the materials encountered in the satellite sections are different from those at the Road Test, the evaluation would be only cursory.

Prediction of Performance - Louisiana Satellite HMAC Sections

The preceding section discussed methods of evaluating performance using concepts developed at the Road Test. This section is concerned with the estimation of P for the satellite sections.

One way to estimate P of the satellite sections is to plot as many points as are available for PSI and ΣL* and draw an arbitrary curve through these points. P is then determined, either by interpolation or extrapolation, as the value of Log ΣL at PSI = 2.5. However, because of close proximity of most of the plotted points and the variation in their trends, the graphical method fails to give a reliable estimate of P. These conditions are indicated in Figure VII-1

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* Same as W in equation VII-6.

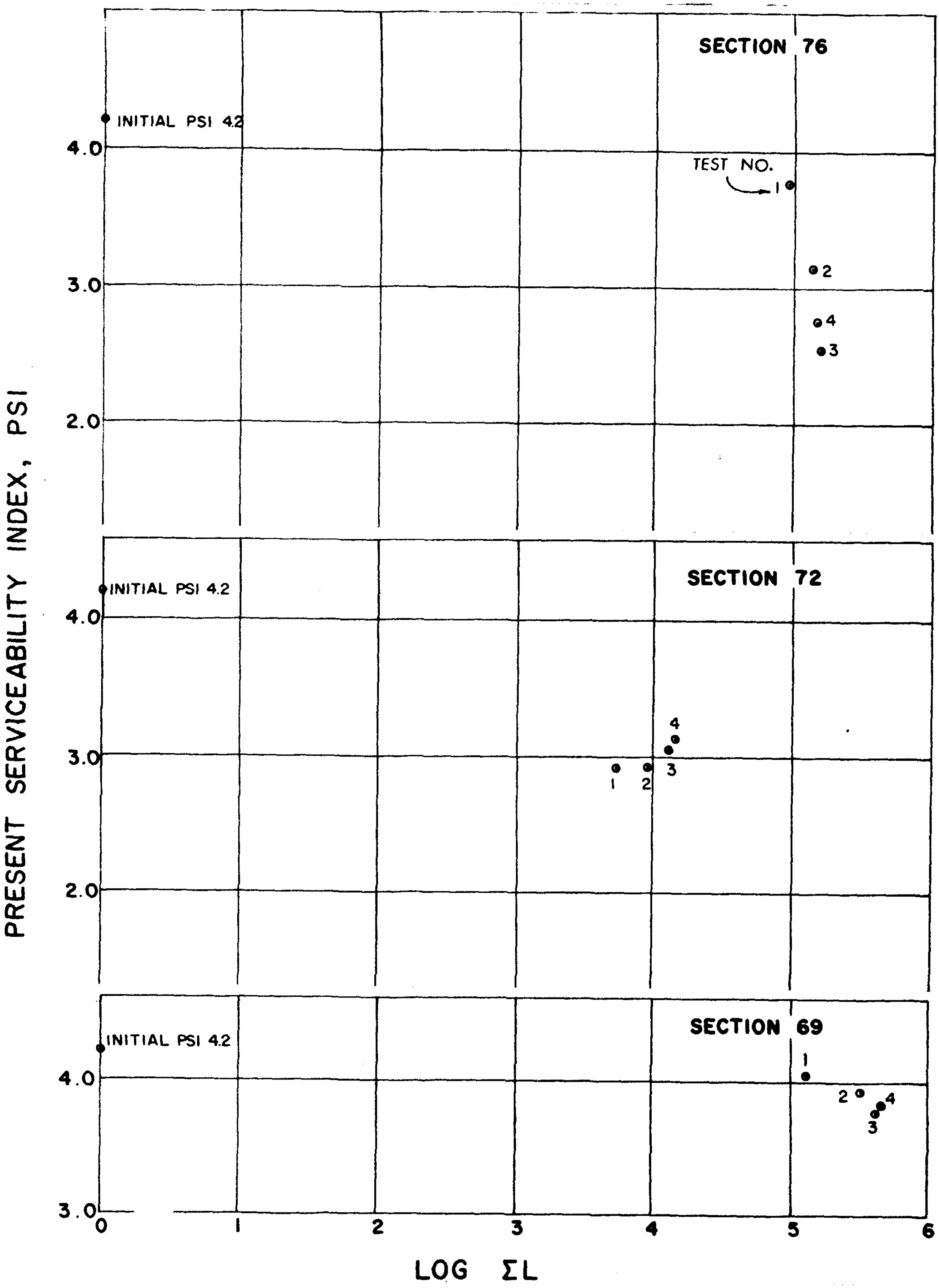

Figure VII-1 - Performance Trends of Sections 69, 72 and 79 for Section Numbers 69, 72 and 76. A more reliable method is to use an algebraic relation of the following form for estimation procedure (5):

$$P = \bar{Y} + B\,(\mathrm{Log\ Log}\,(\frac{p_o}{2.5}) - \bar{X} \qquad \text{Eq. VII-7}$$

where: $\bar{Y}$ = mean of observed values of Log ΣL,

$\bar{X}$ = mean of observed values of

$$\mathrm{LogLog}\,(\frac{p_o}{p}),$$

$$B = \frac{\Sigma(Y - \bar{Y})\,(X - \bar{X})}{\Sigma(X - \bar{X})^2},$$

p_o= Initial serviceability value

and p = PSI values corresponding to ΣL.

For the satellite sections, four separate PSI determinations were made during a five year period along with the total traffic count in terms of accumulated equivalent 18-kip axle loads for the same period. The method of obtaining information on the latter was discussed in Chapters V and VI. The various methods used in the PSI determinations were presented in the same chapters.

Table VII-1 shows a listing of the Performance Indexes of the flexible satellite sections with hot mix surfacing. The asterisk values are observed values of P. The remaining P values represent estimated values. The observed P values are logarithm of ΣL when PSI of 2.5 was observed for that section. The estimated P values were obtained by substitution of the observed values of PSI and ΣL in equation VII-7. Appendix Table 2 gives a complete listing of all the PSI and ΣL values. An initial PSI value of 4.2 was assumed for p_o in equation VII-7.

The data in the table are categorized according to base types. It is also possible to cross reference base type with region; for example, all sand shell sections fall in the poor or wet region while half the soil cement test sections are in the good and the other half in the poor region. The sand clay gravel base course sections, both raw and cement stabilized, are confined to good regions only.

It was not possible to make adequate prediction of the performance indices of the remaining flexible sections with surface treatment and the 49 rigid sections. The reason for this is explained in greater detail in the last two sections of this chapter.

TABLE VII - 1

SUMMARY OF PERFORMANCE FOR LOUISIANA SATELLITE SECTIONS

SECTION NUMBER	STRUCTURAL NUMBER	PERFORMANCE INDEX	AGE YRS.	SOIL SUPPORT	FINAL PSI	CHANGE IN PSI
Sand Clay Gravel Base Course						
55	2.12	5.75	12	2.70	3.14	-0.24
68	1.32	6.58	7	3.90	3.27	0.10
69	2.40	6.45	5	4.30	3.82	0.23
70	1.44	4.34	6	3.40	2.91	0.41
72	1.32	5.14	6	3.20	3.14	-0.20
121	1.44	3.75	6	4.80	2.37	0.96
122	1.40	5.10	6	4.20	2.76	0.44
131	1.44	4.58*	14	2.40	2.42	-0.01
134	2.28	5.25	9	2.80	2.30	0.86
139	1.38	5.43	15	3.90	1.55	0.84
158	1.42	4.62	8	3.90	2.99	0.30
167	2.04	4.34	17	2.40	2.29	0.30
181	1.92	5.94	11	9.30	3.06	-0.14
Algebraic Average			9.4	3.94	2.77	0.30
Sand Shell Base Course						
52	2.32	4.76	8	7.20	3.26	0.64
60	1.77	4.40*	6	2.40	2.40	0.31
67	2.90	5.42	16	2.70	3.07	-0.23
82	2.54	5.69*	6	9.60	1.98	0.98
84	1.67	4.37*	9	3.80	2.53	0.05
85	2.10	5.15	12	4.30	2.39	-0.96
86	1.84	3.94	6	4.80	2.29	-0.13
91	1.69	4.82	14	2.40	3.09	0.41
92	2.46	5.64*	16	3.00	2.51	0.71

* Observed values of log L at PSI of 2.5

TABLE VII - 1 (CONT'D.)

SECTION NUMBER	STRUCTURAL NUMBER	PERFORMANCE INDEX	AGE YRS.	SOIL SUPPORT	FINAL PSI	CHANGE IN PSI
Sand Shell Base Course						
97	1.74	3.91	7	4.40	2.17	-0.18
98	2.82	5.07	15	2.40	3.26	0.06
103	1.08	4.85	11	9.40	2.70	-0.59
104	2.53	5.30	12	2.70	3.10	1.42
105	1.68	4.85*	7	2.80	2.83	-0.33
172	2.69	5.55	4	8.30	1.88	1.34
173	2.40	5.42	4	9.70	1.67	1.32
185	2.24	4.85*	11	8.10	2.56	0.82
Algebraic Average			9.6	5.18	2.57	0.33
Stabilized Sand Clay Gravel Base Course						
54	3.22	5.47*	6	2.70	2.54	1.01
76	2.31	5.17*	9	2.70	2.77	1.01
110	2.58	5.17	6	3.30	2.80	0.44
118	3.10	5.19	4	2.60	2.85	0.61
123	3.19	5.54*	6	3.50	2.54	1.19
126	2.09	4.82	7	8.60	2.74	-0.62
133	3.37	5.33	9	3.00	2.08	0.97
135	2.39	4.84*	8	2.80	2.28	0.03
136	2.68	5.03*	6	3.60	2.38	0.81
138	3.07	5.38	6	4.60	3.29	0.34
152	2.85	5.52	9	3.50	2.80	0.08
156	2.90	6.19	6	8.00	3.68	-0.34
157	3.15	5.07	6	4.50	3.99	-0.04
Algebraic Average			6.8	4.11	2.83	0.42

TABLE VII - 1 (CONT'D.)

SECTION NUMBER	STRUCTURAL NUMBER	PERFORMANCE INDEX	AGE YRS.	SOIL SUPPORT	FINAL PSI	CHANGE IN PSI
Soil Cement Base Course						
65	2.14	4.20*	7	8.10	2.80	-0.39
79	1.85	3.98	6	2.50	2.81	0.10
89	2.26	5.72	11	6.10	2.86	-0.05
96	1.64	4.80*	16	6.10	2.04	0.14
101	1.95	4.30	6	2.80	2.16	-0.31
106	3.84	6.03	13	3.20	3.20	-1.48
109	3.14	5.04	5	3.00	3.16	0.78
111	2.91	4.38	7	3.20	2.80	-0.14
114	3.37	5.49	5	3.80	3.56	0.18
140	1.98	5.51	14	3.30	2.59	-0.48
142	2.05	3.93*	5	5.50	2.27	0.10
162	1.62	4.70	16	7.70	2.92	-0.33
165	2.02	4.03*	7	3.20	2.68	0.23
166	1.90	4.67*	10	2.40	2.59	0.32
Algebraic Average (good region)			9.3	4.24	2.93	-0.20
Algebraic Average (bad region)			9.0	4.46	2.56	0.005

Comparison of Performance with AASHO Interim Guide - HMAC Sections

Figures VII-2 through VII-5 are plots of ΣL, according to base type, for each test section of Table VII-1 against the structural number as defined by the AASHO Road Test equation. In the AASHO Interim Guide (6) these structural numbers are used to establish pavement designs. The design curves are presented for soil support values of 3, 6 and 9. Each plotted point represents the summation of equivalent 18-kip loads through the last PSI determination. According to the Interim Guide design, the section should be at a PSI of 2.5 when the point it represents approaches the line representing the soil support value for the section.

The plotted points in Figures VII-2 through VII-5 and the data in Table VII-1 warrant the following comments:

1. For sand clay gravel base course, Figure VII-2, approximately half of the sections have reached end of life, as indicated by the circled points (PSI 2.5). The average age for these sections is approximately 12 years. Five of the sections that have exceeded the design ΣL have PSI values greater than 3.0 with an average age of 8.2 years. One of these sections (181) has exceeded one million ΣL after 11 years of service.

2. For sand shell base course, Figure VII-3, seven sections with PSI of 2.5 and an average age of 6.5 years have passed the design "number" of equivalent 18-kip axle load.

3. The stabilized SCG sections 54, 123, 133, 135 and 136 are beyond the design ΣL with approximately 7.7 years of traffic (Figure VII-4).

4. Sections 79 and 101 in Figure VII-5, ages 6 and 5 years respectively, on soil cement base course have reached the AASHO Interim design curves. Section 96 with 16 years service has likewise reached the PSI of 2.5. All these are located in wet areas of the State. Section 142 with only 5 years traffic has reached a PSI of 2.3. On the other hand, section 106 after 13 years of service has sustained 1.2 million ΣL to reach a PSI level of 3.2.

All in all, half of the sections have reached the design "number" of the summation of 18-kip equivalent load in less than 10 years of service.

Comparison of Performance with AASHO Interim Guide - Surface Treatment Sections

A total of 72 sections were available for evaluation of performance. However, because of ill-defined serviceability trends, it was not possible to make any meaningful analysis of performance index. In most cases the level of PSI at the end of the fourth and final determination was better than the initial level. This is indicated in Table 4 of the appendix. One of the major deterring factors contributing to such adverse behavior was the frequent maintenance work performed on these sections during the period of data acquisition. Approximately one third of the sections were resealed after the second PSI determination. These sections are marked with an asterisk in Table 4.

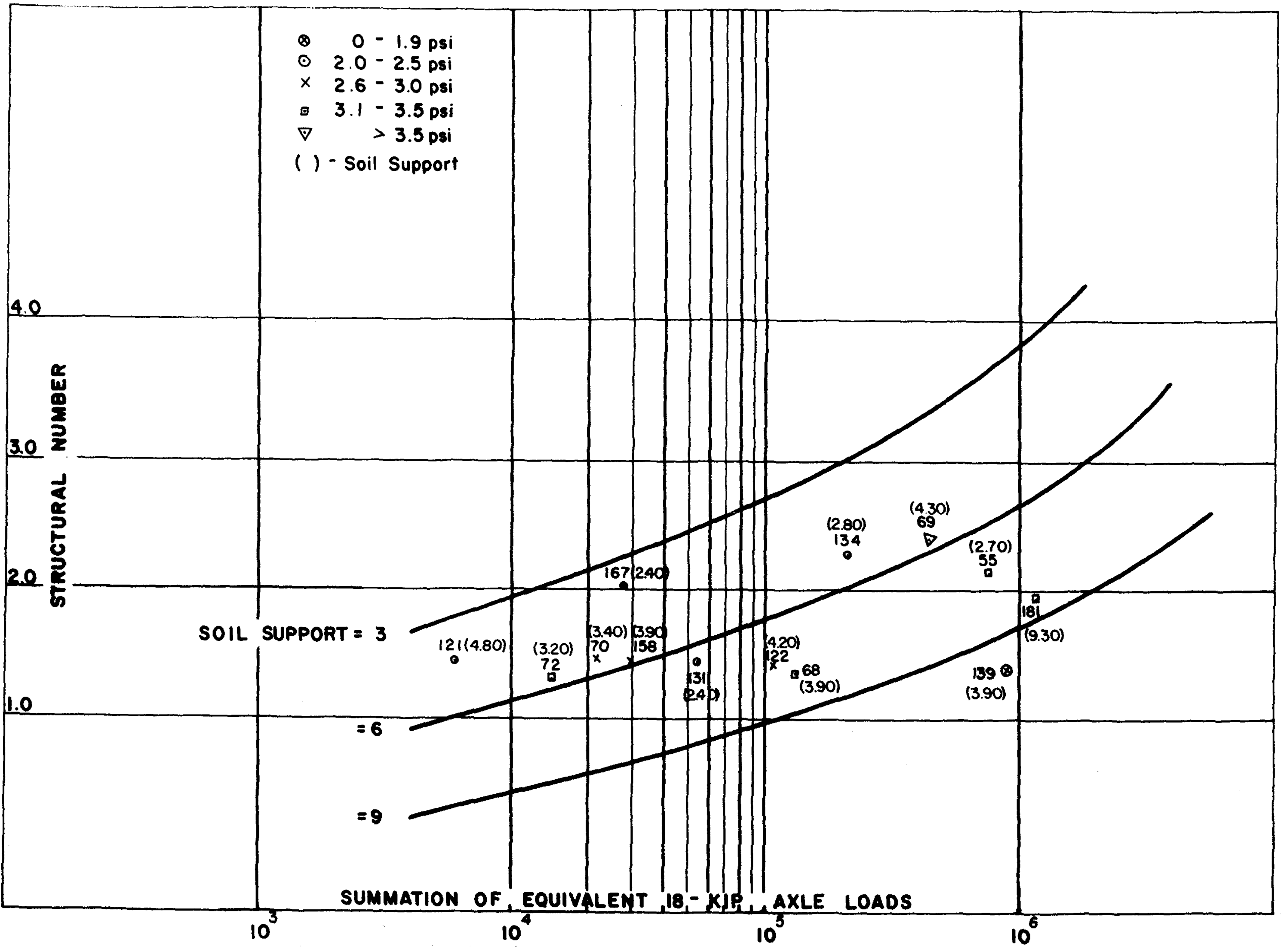

Figure VII-2 - Comparison of Performance of Sand Clay Gravel Sections with AASHO Interim Guide Design Curves

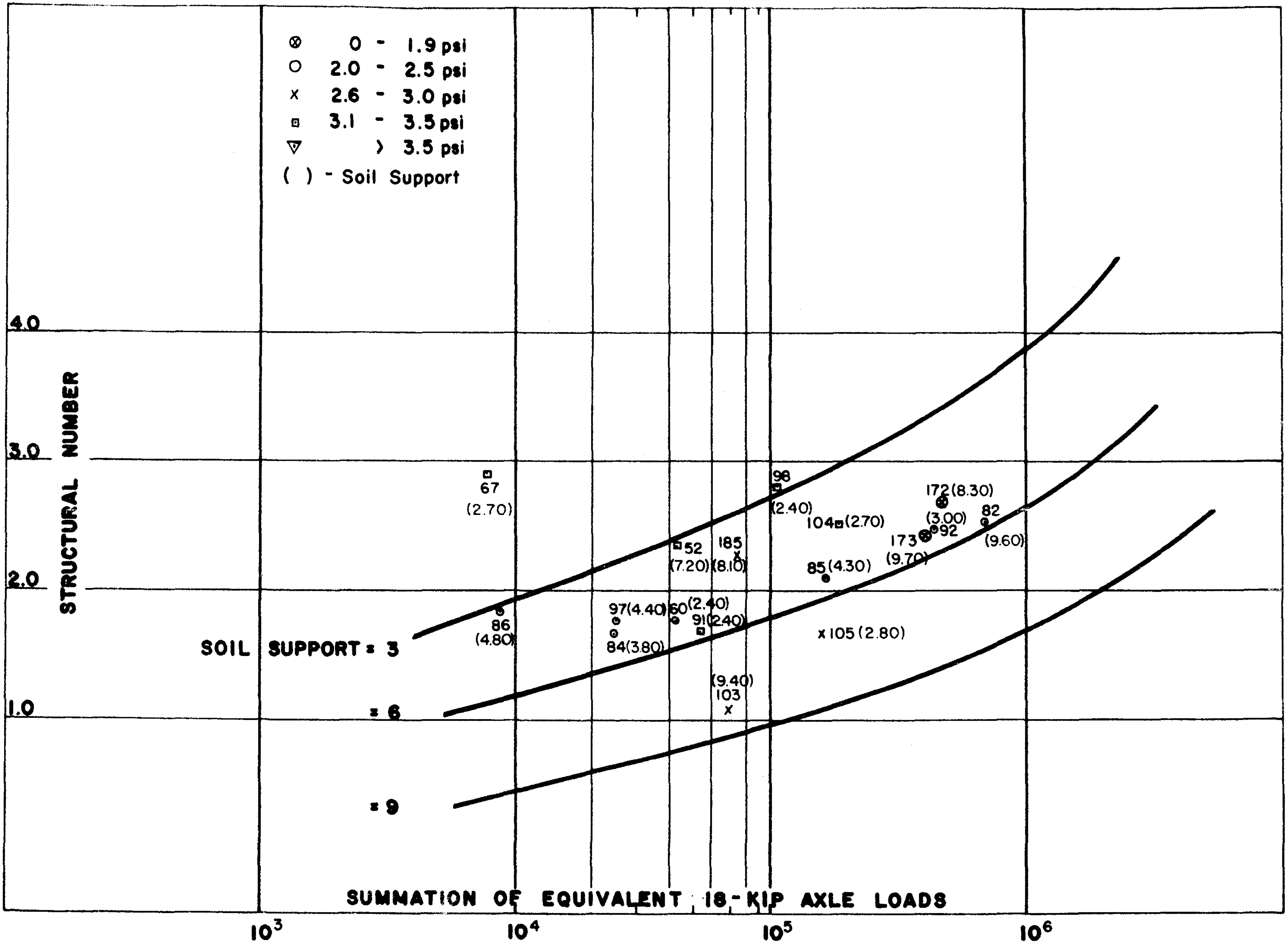

Figure VII-3 - Comparison of Performance of Sand Shell Sections with AASHO Interim Guide Design Curves

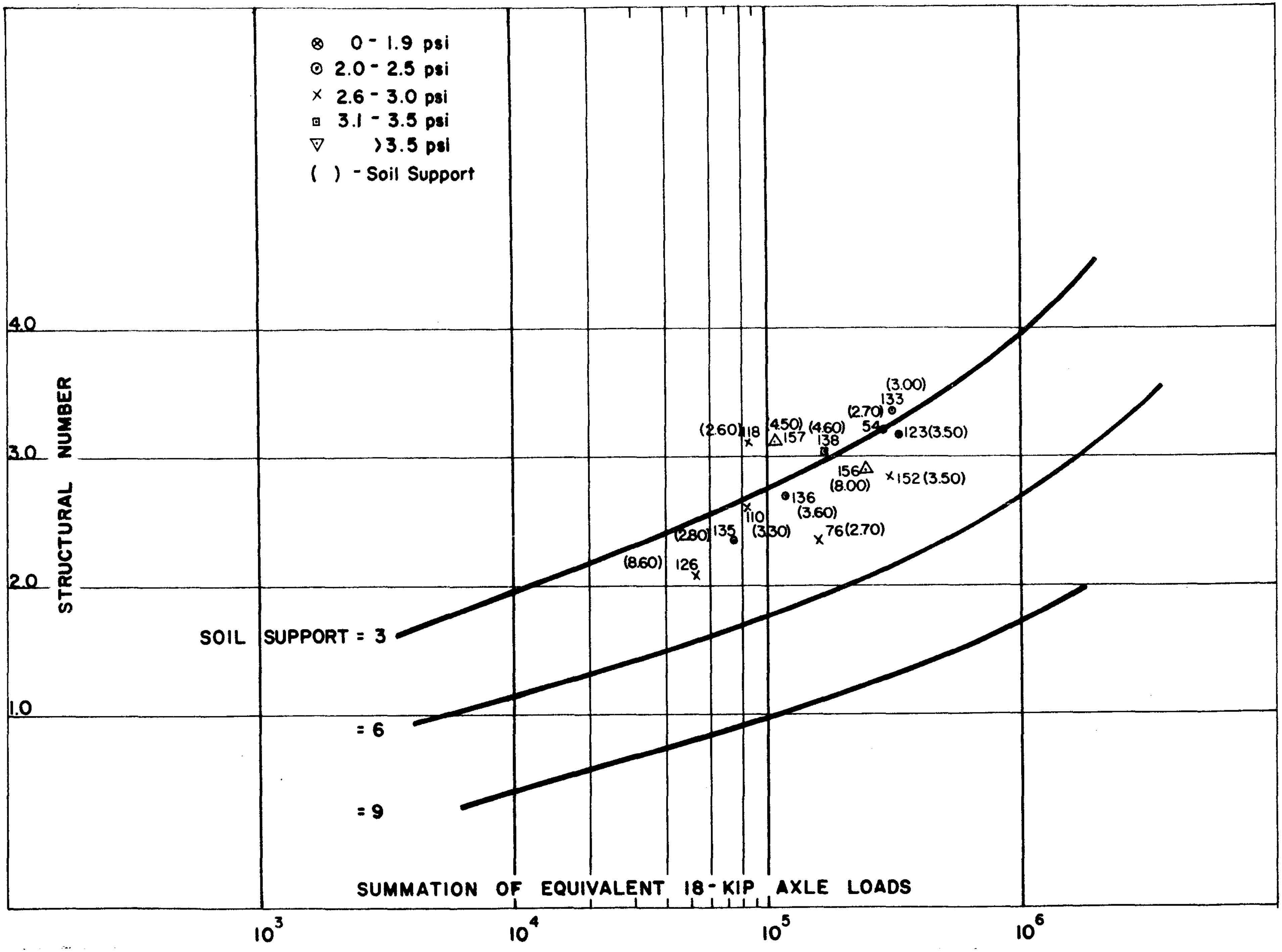

Figure VII-4 - Comparison of Performance of Stabilized SCG Sections with AASHO Interim Guide Design Curves

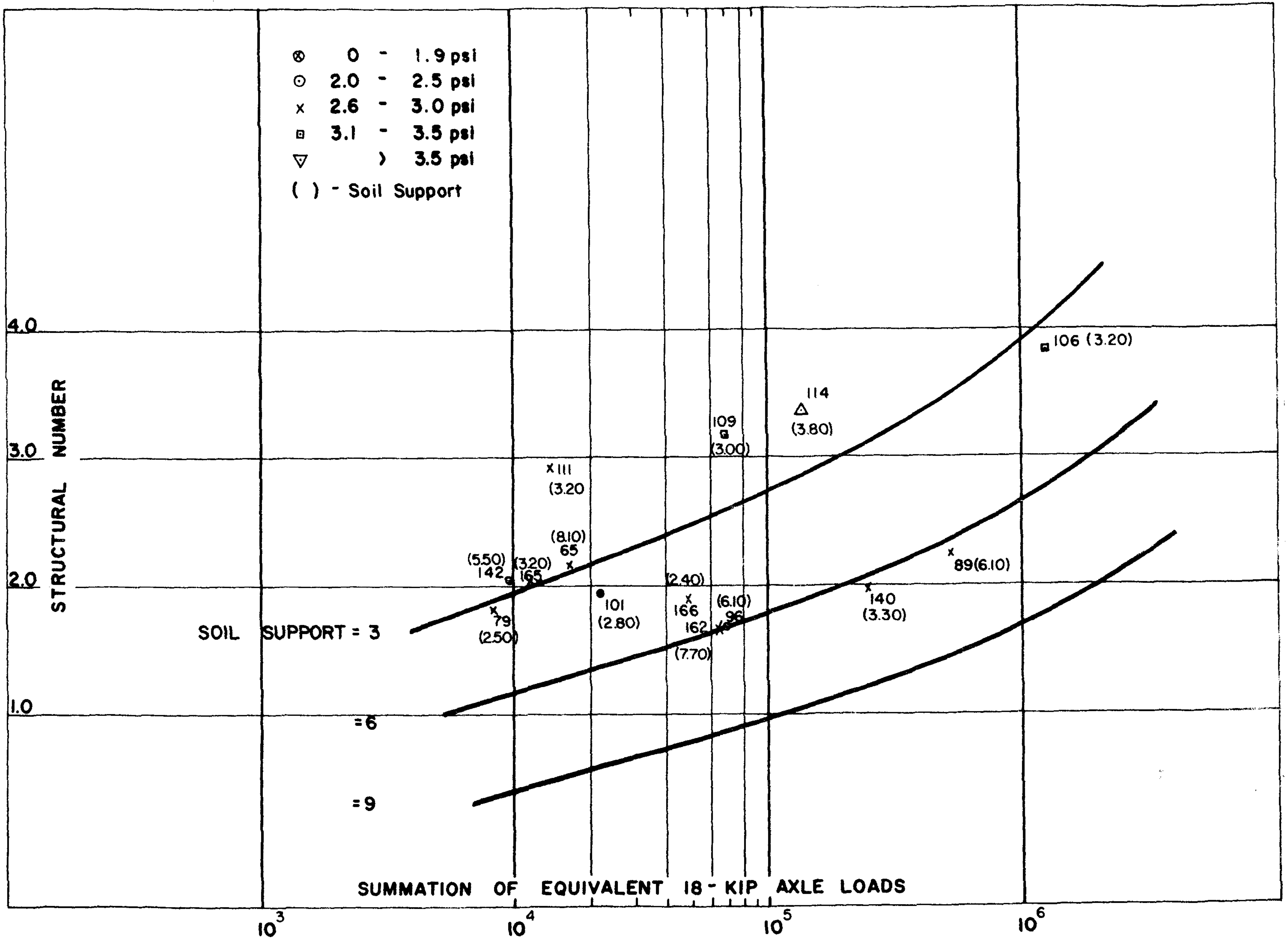

Figure VII-5 - Comparison of Performance of Soil Cement Sections with AASHO Interim Guide Design Curves

As a result of the above, the data were analyzed in their entirety. The data indicated that the average change in PSI, expressed as the algebraic difference between the first and the last PSI determination, was the same for the three base types, sand clay gravel (SCG), sand shell (SS) and cement stabilized soil (SC). This difference was -0.34. Furthermore, most of the sections that suffered a loss in PSI level were in the wetter or poor region of the State. This may be indicative of the susceptibility to damage due to increased moisture and poor drainage.

If it is assumed that the PSI data, through the last determination, represent meaningful trends concerning the behavior of these satellite sections, then it is possible to draw some inference by comparing such trends to the AASHO Interim Guides (6). Figure VII-6 is an aggregate plot of ΣL against the structural number as defined in the AASHO Guide. However, these structural numbers do not reflect the contribution of the surface layer coefficient since it does not add to the structural integrity of the pavement section.

Each plotted point in the figure represents the summation of equivalent 18-kip axle loads through the last PSI determination. The design curves for soil support values of 3, 6 and 9 represent curves to a terminal PSI of 2.0. According to the AASHO design, each section should be at this level when the point it **represents** is in close proximity to the line representing the soil support value for that section. Each point will therefore move to the right with time.

The location of the plotted points with respect to the design curves indicates the following:

1. Approximately 17 percent of the sections have reached the end of life after approximately 12 years of service.

2. Of the remaining sections, twelve have reached the design "number" of ΣL. Their PSI level, however, is above 2.5. Sections 120 and 143 have reached approximately one half million applications of 18-kip axle loads after almost 18 and 20 years of service respectively.

3. Of the twelve sections which are beyond the design axle loads, four have PSI values greater than 3.0. The sections in this category are 78, 141, 144 and 146. However, all but section 141 have been resealed during the study period.

The data in Table 4 and **Figure** VII-6 indicates better performance of these sections than the hot mix flexible sections. **However**, it is believed that the data have been confounded due to frequent maintenance and resealing effort provided on these sections.

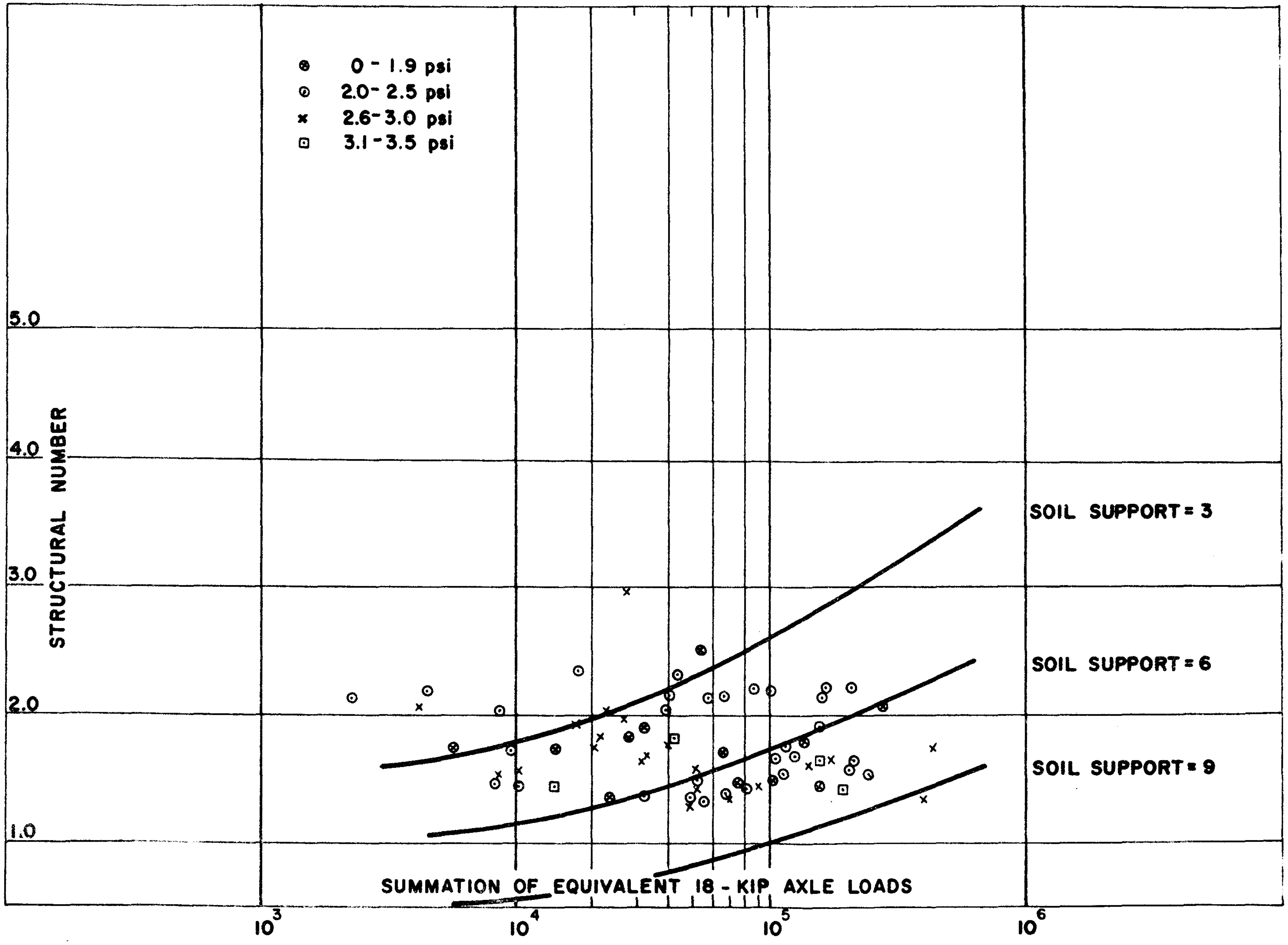

Figure VII-6 - Comparison of Performance of Surface Treatment Sections with AASHO Interim Guide Design Curves

Evaluation of Performance of Rigid Sections

As was observed for flexible surface treatment sections, most of the 49 concrete and rigid sections exhibited continuous increase in the PSI level during the four periods of measurements. This can be seen in Table 5 of the Appendix. As a result of this adverse trend, it was not possible to estimate the performance index of these sections to a terminal PSI level of 2. 5.

The relationships expressed in the Road Test equation were developed from the pavements having a number of design factors held constant (1). In the satellite study it was not possible to study the effect of some of these variables for various reasons. For example, none of the satellite sections had slab reinforcement. The modulus of subgrade reaction K could not be determined due to lack of proper instrumentation. As a result of these misgivings, no meaningful analysis can be presented at this stage of the study. An extended evaluation of a few selected sections is a necessary prerequisite for adequate evaluation of performance and the association of this performance with the indicator of composite strength.

A cursory evaluation of the data in Table 7 in the Appendix warrants the following comments:

1. Fifty percent of the sections had sustained more than one million summation of 18-kip axle loads in approximately 10 years. The average PSI level of these sections at the end of the last determination was 3. 5. This represents a drop of 0. 7 from the initial PSI of 4. 2. If these trends are extrapolated, then the years of service left to a PSI of 2. 5 would be approximately eight.

2. There were six sections that had suffered a loss of 0. 9 in PSI (assuming an initial value of 4. 2) after approximately 14 years and 2. 5 million 18-kip axle loads. Extrapolation of the years left to p=2. 5 would give 10 additional years, according to AASHO Guide, before structural failure might occur. All these sections had only 8 inches of slab thickness.

3. There was no indication of the difference in performance between the good and the poor region.

4. The level of PSI observed through the fall of 1969 indicates that the satellite sections are generally performing as would be expected considering the AASHO design procedures.

In view of the above, it would be of interest to continue observation of a few selected sections for a more realistic evaluation of performance and its association with some of the structural and strength design features. Evaluation of the latter, in the form of deflections, is presented in the next chapter.

CHAPTER VIII
LEAST SQUARES ANALYSIS

General

In Chapter IV the desirability of a factorial design to study the pavement performance response to various structural factors was discussed. The Louisiana study falls short of this desirable design. The main drawback pursuing further analysis of such a design is the presence of unequal subclasses. If conventional analysis of variance approach is applied, a bias due to these unequal classes and subclasses is introduced in the sum of squares. However, this bias can be eliminated by using Least Squares Analysis of Variance Technique (LSANOV).

In this chapter an attempt is made to present a multifactor analysis of data using the method of LSANOV. The independent factors and their levels were defined in the previous chapter. The response variables are Performance Index and Deflections.

Performance Index Analysis - HMAC Sections

Table VIII-1 shows Performance Index of test sections according to their location in the experimental design. Table VIII-2 is a Least Squares Analysis of Variance table for the data of Table VIII-1. The factors A through F are main factors and represent Regional, ADL, Base Type, Base Thickness, Surface Thickness and Subgrade Strength Variables respectively. Only the first order interaction terms are included in the analysis. The second and higher order interaction terms, therefore, appear in the remainder or error term.

The first line of the table shows the total sum of squared deviations from the overall mean. Of this, approximately 17 percent are attributable to the six main factors. The first order interaction terms account for 54 percent of the total variation and the remaining 29 percent are contributed by the second and higher order interaction terms.

The mean squares are the sum of squares per degree of freedom and are used to infer the significance of the factor effect relative to unexplained variation. The reference for appraising any of the mean squares is provided by the remainder term.

Of the six main factors, only ADL is statistically significant at 95 percent probability level. The surface thickness factor almost approaches the level of significance. Of the 15 two-factor terms, the base type base thickness mean square is significant. By significance, it is meant that the effects of the factors on the measured response are real. The analysis shows that it is possible to have the effect of main factors be insignificant and yet interact significantly. This is indicated by C and D which were insignificant when considered separately and yet highly significant when they interacted. When the factors interact, the effect of one factor is markedly dependent on the level of the other.

In order to compare the magnitude of the mean response to each main factor and to their interaction, Tables VIII-3 and VIII-4 were prepared. The values listed are least squares means. The overall mean is 4. 90. The difference in Performance Index between the high ADL and low ADL is equal to 0. 79, a highly significant difference as was indicated by the LSANOV. The regional difference is 0. 18, with region A showing better performance than region B. The magnitude of Performance Index is much higher for sections on thick surface course than on thin ones, the difference between the two being 0. 29.

The least squares means for base type, base thickness and subgrade strength are almost the same for both levels. This observation agrees with the results of the AASHO Test wherein the influences of the various pavement layers diminished with distance from the surface. However, this does not hold true when the factors interact.

Table VIII-4 shows least squares means for all the two-factor interactions. The means show normal expected trends with a few surprises. For example, contrary to expectations, the mean performance index for stabilized base course with greater than 8 inch thickness is the least of all the other levels.

One of the major drawbacks in this study is the reliability of some of the data. For example, traffic data represent projected rather than actual loadometer values. One of the major variables, and one of paramount importance, is the construction practices. The effect of this, however, is difficult to delineate from other factors. Furthermore, some of the information is lost (or confounded) due to dichotomization. Defining the levels on a continuous scale would have been a more desirable approach. In spite of these misgivings, the analysis has isolated the effects of some structural variables on the performance of the pavement sections. The inference drawn from this analysis can be used to develop a mathematical model that will explain the behavior of the pavement performance in terms of some of the significant variables. For example, a model can be formulated to include such factors as surface thickness, base thickness, base type and ADL, all of which have been shown to be significant, or nearly so, in the above analysis. This concept is developed in greater detail in the next chapter.

Deflection Analysis - HMAC Sections

This section is concerned with the analysis of data using deflection as the dependent or response variable. The same LSANOV technique described above was used to evaluate the collected data on deflection.

TABLE VIII-1
OBSERVED OR ESTIMATED PERFORMANCE INDEX FOR HMAC SATELLITE SECTIONS

REGION		GOOD								POOR							
ADL		HIGH				LOW				HIGH				LOW			
BASE TYPE		RAW		STAB		RAW		STAB		RAW		STAB		RAW		STAB	
BASE THICKNESS		<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"
SURFACE THICKNESS	SOIL SUPPORT																
THICK > 2"	POOR	5.75	5.25	5.51	5.04 6.18 5.19 5.35 5.47				4.84	5.64	5.30 5.07 5.55			4.34	5.42	4.67	
	GOOD	5.43	6.39	5.43 6.19 5.07	5.54 5.52 5.29						5.42 5.69	5.72		4.76	4.85 5.15	4.19	4.22 4.20
THIN ≤ 2"	POOR < 3.4			5.17	5.17	4.31	5.14		4.38	4.85			3.98	4.82	4.40 4.58		4.30 4.89 4.03
	GOOD ≥ 3.4	5.10	6.58		5.03		3.75 4.34 4.59	4.70	3.93 4.82					4.85	3.91 3.94	4.88 4.80	

TABLE VIII-2
LEAST-SQUARES ANALYSIS OF VARIANCE

PI

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F
TOTAL	59	283635.000000		
TOTAL REDUCTION	22	200960.307044	9134.559411	4.038
MJ-YM	1	2611.675430	2611.675430	1.169
A	1	1960.689731	1960.689731	0.877
B	1	38107.010646	38107.010646	17.054*
C	1	979.207100	979.207100	0.438
D	1	18.916336	18.916336	0.008
E	1	8568.022177	8568.022177	3.835
F	1	28.774072	28.774072	0.013
A X B	1	5013.856082	5013.856082	2.244
A X C	1	423.940378	423.940378	0.190
A X D	1	2580.608172	2580.608172	1.155
A X E	1	47.993536	47.993536	0.021
A X F	1	917.955319	917.955319	0.411
B X C	1	3684.737027	3684.737027	1.649
B X D	1	346.570535	346.570535	0.155
B X E	1	6.215648	6.215648	0.003
B X F	1	7554.297738	7554.297738	3.381
C X D	1	15882.997800	15882.997800	7.108*
C X E	1	989.336675	989.336675	0.443
C X F	1	97.372897	97.372897	0.044
D X E	1	304.836654	304.836654	0.136
D X F	1	86.039451	86.039451	0.039
E X F	1	265.071028	265.071028	0.119
REMAINDER	37	82674.692956	2234.451161	

* Significant at .05 level

TABLE VIII - 3

LEAST SQUARES MEANS FOR MAIN FACTORS (PERFORMANCE INDEX ON HMAC SECTIONS)

FACTOR	LEVEL		MEAN PERFORMANCE INDEX
REGION	A_1	GOOD	4.99
	A_2	POOR	4.81
ADL	B_1	HIGH	5.30
	B_2	LOW	4.51
BASE TYPE	C_1	RAW	4.96
	C_2	STAB.	4.85
BASE THICKNESS	D_1	$< 8''$	4.90
	D_2	$\geq 8''$	4.91
SURFACE THICKNESS	E_1	THIN	4.76
	E_2	THICKNESS	5.05
SUBGRADE STRENGTH	F_1	GOOD	4.90
	F_2	POOR	4.91
OVERALL MEAN			4.90

TABLE VIII - 4

LEAST SQUARES MEANS FOR FIRST ORDER INTERACTIONS (PERFORMANCE INDEX ON HMAC SECTIONS)

	A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E_1	E_2
B_1	5.53	5.08								
B_2	4.46	4.55								
C_1	5.01	4.90	5.49	4.43						
C_2	4.98	4.72	5.12	4.58						
D_1	4.90	4.90	5.33	4.46	4.75	5.04				
D_2	5.09	4.73	5.27	4.55	5.16	4.66				
E_1	4.86	4.65	5.16	4.35	4.76	4.76	4.78	4.73		
E_2	5.13	4.97	5.45	4.66	5.16	4.95	5.01	5.09		
F_1	4.93	4.86	5.46	4.33	4.96	4.83	4.87	4.92	4.78	5.01
F_2	5.06	4.77	5.14	4.68	4.95	4.88	4.92	4.90	4.74	5.09

For the satellite sections, three separate deflection determinations were made using the Dynaflect equipment. The method is discussed in detail in Chapter V and VI. The first determination was not confined to any specific months of the year. The second and third determinations were made in late spring and late fall of 1969 respectively. Tables VIII-5, VIII-6 and VIII-7 show the three deflection determinations according to their location in the experimental design. Table VIII-8 is the LSANOV for deflection determination.

Two main factors, Region and Subgrade Strength in terms of soil support show significant mean square terms. Their interaction is also highly significant. This indicates a strong influence of these two factors on the response studied. The mean square for the two-factor CE and DE, although not significant statistically, are quite large and approaching significance.

If deflection is considered a measure of composite strength of the pavement section, then the significant contribution of the above factors to the overall variation in the response seems to follow the expected trend.

Table VIII-9 and VIII-10 show the least squares means for the six main factors and their interactions respectively. These data warrant the following comments:

1. For region B, the deflections are approximately twice those for region A.

2. Base type and base thickness show almost the same magnitude of deflection for both levels. Furthermore, for base type category, deflections on sand shell sections were almost twice as much as on the remaining three types.

3. Because of the strong regional influence, the subgrade strength factor show adverse conditions for all three deflection determinations. However, when the factors interact, the least deflections are indicated by A_1F_1. The strong influence of region is further indicated by factor A_1F_2 which shows smaller deflection measurements than factor A_2F_1.

4. The lower deflections during the fall months may be due to the favorable moisture condition underneath the surface layers. The moisture content data for the spring and fall periods indicated optimum conditions during the latter period. It is possible that such conditions contribute more to reducing deflections because of the increased load carrying capacity of the supporting medium.

Deflections on Surface Treatment Section

The analysis presented in this section does not follow the statistical technique used in the previous sections. This was unavoidable because of lack of adequate experimental design. The circumstances surrounding this was covered in the last portion of Chapter IV. However, rather then ignore the data in its entirety, it was decided to pursue the analysis by comparing raw means using one factor at a time. The major disadvantage in using this

TABLE VIII-5
DYNAFLECT DEFLECTIONS FOR SATELLITE HMAC SECTIONS

REGION		GOOD								POOR							
ADL		HIGH				LOW				HIGH				LOW			
BASE TYPE		RAW		STAB		RAW		STAB		RAW		STAB		RAW		STAB	
BASE THICKNESS		<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"
SURFACE THICKNESS	SOIL SUPPORT																
THICK > 2"	POOR	1.03*	1.26	1.54	0.84 1.28 1.42 0.80 1.07				1.23	2.21	1.97 1.31 1.42			1.43	2.92	1.95	
	GOOD	1.43	1.04	0.81 0.72 0.70	1.03 1.09 0.72						1.45 1.75	1.88		2.03	4.12 6.03	3.30	3.03 1.66
THIN ≤2"	POOR < 3.4			2.27	1.11	1.17	1.88		0.94	1.49			2.18	3.19	1.20 1.50		1.31 1.78 1.74
	GOOD ≥ 3.4	1.88	0.80		0.78		1.76 1.30 1.12	1.74	1.43 1.29					2.77	4.19 5.41	2.31 4.07	

*(Mean + 2σ) x 10^{-3}

TABLE VIII-6
DYNAFLECT DEFLECTIONS FOR SATELLITE HMAC SECTIONS
(Spring 1969)

REGION		GOOD								POOR							
ADL		HIGH				LOW				HIGH				LOW			
BASE TYPE		RAW		STAB		RAW		STAB		RAW		STAB		RAW		STAB	
BASE THICKNESS		<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"
SURFACE THICKNESS	SOIL SUPPORT																
THICK > 2"	POOR	1.23*	1.82	1.53	1.13 1.18 1.40 1.27 1.07				1.71	2.18	2.07 1.37 1.43			2.29	2.45	3.92	
	GOOD	1.57	0.96	0.82 0.96 0.92	1.09 1.04 0.72						1.55 2.37	2.01		2.43	4.12 7.40	4.86	3.46 1.86
THIN ≤ 2"	POOR < 3.4			1.93	1.36	1.56	1.97		1.17	1.50			2.63	4.32	3.37 2.23		1.35 2.89 2.12
	GOOD ≥ 3.4	2.17	0.82		1.10		1.80 1.40 1.59	2.60	1.76 1.63					3.34	6.82 6.66	1.55 4.50	

* (Mean + 2σ) x 10^{-3}

TABLE VIII-7
DYNAFLECT DEFLECTIONS FOR SATELLITE HMAC SECTIONS
(FALL 1969)

REGION		GOOD								POOR							
ADL		HIGH				LOW				HIGH				LOW			
BASE TYPE		RAW		STAB		RAW		STAB		RAW		STAB		RAW		STAB	
BASE THICKNESS		<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"	<8"	≥8"
SURFACE THICKNESS	SOIL SUPPORT																
THICK > 2"	POOR	1.09	1.33	1.56	1.80 1.63 1.27 1.03 1.22				1.60	3.81	1.61 1.21 1.41			2.25	2.35	2.94	
	GOOD	1.58	1.00	0.88 0.86 0.90	1.20 0.98 0.76						1.68 1.60	1.90		1.82	3.62 6.92	4.47	3.76 1.76
THIN ≤ 2"	POOR < 3.4			2.19	1.46	1.29	1.51		1.16	1.31			2.20	3.60	2.87 1.75		1.20 2.44 1.61
	GOOD ≥ 3.4	1.58	0.68		0.97		1.82 1.18 1.23	1.67	1.47 1.21					2.82	4.06 5.61	1.31 3.82	

*(Mean + 2σ) x 10^{-3}

TABLE VIII-8
LEAST-SQUARES ANALYSIS OF VARIANCE

D1

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F
TOTAL	60	746522.000000		
TOTAL REDUCTION	22	567392.205457	25790.554794	5.471
MU-YM	1	24826.753596	24826.753596	5.267
A	1	73611.464814	73611.464814	15.616*
B	1	1385.508437	1385.508437	0.294
C	1	28.237992	28.237992	0.006
D	1	41.037007	41.037007	0.009
E	1	8356.541680	8356.541680	1.773
F	1	24452.696903	24452.696903	5.187*
A X B	1	9156.885933	9156.885933	1.943
A X C	1	12.253248	12.253248	0.003
A X D	1	1812.622089	1812.622089	0.385
A X E	1	556.325923	556.325923	0.118
A X F	1	29173.453388	29173.453388	6.189*
B X C	1	13732.511800	13732.511800	2.913
B X D	1	25963.992398	25963.992398	5.508*
B X E	1	61.894358	61.894358	0.013
B X F	1	1534.610068	1534.610068	0.326
C X D	1	5402.811636	5402.811636	1.146
C X E	1	16122.206067	16122.206067	3.420
C X F	1	5434.634079	5434.634079	1.153
D X E	1	20605.679731	20605.679731	4.371
D X F	1	5131.593154	5131.593154	1.089
E X F	1	13464.908241	13464.908241	2.856
REMAINDER	38	179129.794543	4713.941962	

* Significant at .05 level

TABLE VIII - 9

LEAST SQUARES MEANS FOR MAIN FACTORS (DEFLECTIONS ON HMAC SECTIONS)

FACTOR	LEVEL		MEAN DEFLECTION		
			I	II*	III**
REGION	A_1	GOOD	1.16	1.49	1.19
	A_2	POOR	2.27	2.56	2.40
ADL	B_1	HIGH	1.64	1.59	1.62
	B_2	LOW	1.79	2.46	1.97
BASE TYPE	C_1	RAW	1.72	2.15	1.80
	C_2	STAB.	1.71	1.90	1.79
BASE THICKNESS	D_1	$< 8''$	1.73	2.00	1.80
	D_2	$\geq 8''$	1.71	2.05	1.80
SURFACE THICKNESS	E_1	THIN	1.86	2.16	1.83
	E_2	THICK	1.57	1.89	1.76
SUBGRADE STRENGTH	F_1	GOOD	1.95	2.23	1.90
	F_2	POOR	1.48	1.83	1.69
OVERALL MEAN			1.72	2.03	1.80

* spring and summer deflections
** fall and winter deflections

TABLE VIII - 10
LEAST SQUARES MEANS FOR FIRST ORDER INTERACTIONS
(DEFLECTIONS FOR HMAC SECTIONS)

		A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E_1	E_2
B_1	I	1.26	2.02								
	II	1.34	1.85								
	III	1.27	1.97								
B_2	I	1.06	2.52								
	II	1.64	3.28								
	III	1.12	2.82								
C_1	I	1.16	2.29	1.40	2.05						
	II	1.43	2.86	1.62	2.68						
	III	1.11	2.50	1.45	2.16						
C_2	I	1.16	2.26	1.88	1.54						
	II	1.54	2.26	1.57	2.23						
	III	1.28	2.29	1.79	1.78						
D_1	I	1.24	2.21	1.96	1.49	1.62	1.83				
	II	1.70	2.30	1.67	2.32	2.02	1.97				
	III	1.27	2.32	1.91	1.68	1.80	1.79				
D_2	I	1.08	2.34	1.32	2.09	1.83	1.59				
	II	1.28	2.83	1.51	2.59	2.28	1.83				
	III	1.12	2.47	1.33	2.26	1.81	1.78				
E_1	I	1.34	2.38	1.77	1.95	1.66	2.06	2.12	1.60		
	II	1.52	2.81	1.76	2.56	2.21	2.12	2.15	2.18		
	III	1.28	2.39	1.59	2.07	1.71	1.95	1.94	1.73		
E_2	I	0.97	2.17	1.51	1.63	1.79	1.35	1.33	1.81		
	II	1.45	2.32	1.42	2.35	2.09	1.69	1.85	1.92		
	III	1.11	2.41	1.65	1.88	1.90	1.62	1.65	1.87		
F_1	I	1.12	2.78	1.80	2.10	2.07	1.83	1.85	2.05	2.30	1.60
	II	1.44	3.01	1.64	2.81	2.51	1.95	2.00	2.45	2.56	1.89
	III	1.08	2.73	1.61	2.20	2.02	1.78	1.67	2.14	2.12	1.69
F_2	I	1.20	1.77	1.48	1.49	1.38	1.58	1.60	1.36	1.42	1.54
	II	1.54	2.11	1.55	2.10	1.79	1.86	1.99	1.66	1.77	1.88
	III	1.31	2.06	1.63	1.75	1.59	1.79	1.92	1.46	1.55	1.83

approach is that is precludes statistical interpretation of the observed data.

Tables VIII-11 and VIII-12 show comparisons of raw means for each of the main factors and their interactions, respectively. The deflection values represent the mean plus twice the standard deviation of the data for each section. A summary of all section deflections appears in Table 5 of the Appendix. The following trends are apparent from the data in these tables:

1. Sections in wet areas indicate less resistance to deflections than those in the areas having better drainage characteristics. The numerical difference between the two areas is of the order of .001 inch.

2. The different levels of factors for base thickness and subgrade strength seem to follow the expected trend. However, the deflections on sections with raw base course are lower than those on the stabilized base course sections.

3. The strong influence of the regional factor is evident in the mean for factor A_1F_2 which is the lowest of the AF block.

4. The spring deflections follow the same trend as those on hot mix asphaltic concrete surfacing.

5. Comparison of these deflections with those in Tables VIII-9 and VIII-10 indicates the effectiveness of surface thickness and hence surface strength in reducing deflections, regardless of seasonal variations.

Deflections on Concrete and Rigid Sections

Following the approach presented in the preceding section, the analysis of deflection data on concrete sections provided raw means categorized according to region and slab thickness of concrete. These are presented in Table VIII-13. It is possible to make the following comments on the basis of these data:

1. There is no indication of any strong regional influence on the deflections of these rigid sections.

2. There is some reduction in deflections with increasing slab thickness in both region A and region B.

3. The seasonal variation is not as pronounced as was observed for flexible sections.

4. In general, comparison with flexible sections data indicates half as much deflection as that on HMAC sections and almost a third as much as the surface treatment sections.

TABLE VIII - 11

COMPARISON OR RAW MEANS FOR MAIN FACTORS (DEFLECTIONS ON SURFACE TREATMENT SECTIONS)

FACTOR	LEVEL		MEAN DEFLECTION	
			II*	III**
REGION	A_1	GOOD	2.18	1.80
	A_2	POOR	3.39	2.81
BASE TYPE	C_1	RAW	2.79	2.24
	C_2	STAB.	2.92	2.58
BASE THICKNESS	D_1	$< 7''$	2.79	2.87
	D_2	$\geq 7''$	2.27	2.40
SUBGRADE STRENGTH	F_1	GOOD	2.61	1.83
	F_2	POOR	3.07	2.90
GRAND MEAN			2.84	2.35

* spring and summer deflections
** fall and winter deflections

TABLE VIII - 12

RAW MEANS FOR FIRST ORDER INTERACTION (DEFLECTIONS ON SURFACE TREATMENT SECTIONS)

		A_1	A_2	C_1	C_2	D_1	D_2
C_1	II*	2.13	3.55				
	III**	1.76	2.78				
C_2	II	2.35	3.17				
	III	1.97	2.85				
D_1	II	2.43	3.18	2.69	3.21		
	III	2.04	2.51	2.11	2.91		
D_2	II	1.88	3.55	2.93	2.80		
	III	1.52	3.00	2.36	2.44		
F_1	II	2.50	3.51	3.12	2.94	2.75	2.79
	III	2.15	2.94	2.59	2.63	2.34	2.24
F_2	II	1.91	3.27	2.43	2.91	3.36	2.46
	III	1.52	2.68	1.84	2.55	2.87	2.00

* spring and summer deflections
** fall and winter deflections

TABLE VIII-13
SUMMARY OF DEFLECTION DATA ON CONCRETE SECTIONS

FACTOR		LEVEL					
REGION		GOOD			POOR		
	I	.90			1.08		
	II	1.05			1.30		
SLAB THICKNESS, IN.		8	9	10	8	9	10
	II	1.17	1.01	.70	1.25	.99	.78
	III	1.14	1.51	.73	1.34	1.34	.90
GRAND MEAN	II	.99					
	III	1.17					

The basic purpose of this satellite study is to examine the effects of various factors on the behavior of pavements subjected to design traffic loads. The inference drawn from the above analysis can be used to advantage for postulation of model or models defining the performance, strength and structural relationships of the pavement sections. Furthermore, if an index of performance is available, then it is possible to develop a relationship between performance and deflection. In the next chapter an attempt is made to formulate various mathematical models relating pavement performance to various structural design and strength variables by using information obtained from the above analysis and that advanced at the AASHO Road Test.

CHAPTER IX
DEVELOPMENT OF EQUATIONS FOR HMAC FLEXIBLE SECTIONS

Prediction of Performance using Deflections - General

At the AASHO Road Test it was determined that the strength of the pavement measured in the field could be used to predict the performance of the pavement sections. The Benkelman beam deflection tests were used as criteria of strength measurement. These measurements were made at periodic intervals to determine the variation in strength characteristics. As a result of these analyses, four equations were developed relating deflection to performance. The derived equations related the number of applications of a given load to fall and spring deflections. In each case the terminal PSI level was set at 2.5 and 1.5. The equation for spring deflection predicting performance to a PSI level of 2.5 is as follows:

$$P = \log(\Sigma L)_{2.5} = 11.10 - 3.25 \log d_{sn} \qquad \text{Eq. IX-1}$$

$$R^2 = .78 \qquad S_E = 0.21$$

where: d_{sn} = normal spring Benkelman beam deflections, .001 in.

R^2 = an expression of the goodness of fit to the observed data.

S_E = the average discrepancy between log ΣL as observed and as calculated from the equation. The lower this value, the better the fit.

At the Road Test it was found that the mean residuals for log ΣL were about the same whether log ΣL was predicted from the performance equation (Eq. VII-6) with given pavement design and load or predicted from the equations involving performance and deflections.

The relationship described above may be used to indicate the magnitude of deflection, measure seasonally, that could be considered safe for any specified number of summation of load applications before reaching $p = 2.5$ or 1.5.

Prediction of Performance Using Louisiana Deflections - HMAC Sections

In Chapter VII the method of predicting performance from load - design equations was presented in the form of equation VII-6. The values of the performance index using this equation were compared with those observed or estimated for each of the satellite sections. The difference between these two, expressed as the mean absolute difference, is given on the next page for each base type.

Base Type	Residual
Sand Clay Gravel	1.44
Sand Shell	.59
Cement Stabilized Sand Clay Gravel	.30
Cement Stabilized Soil	.53

The above values are much larger than that observed at the Road Test which was approximately 0.25. However, such a comparison may be misleading since none of the materials represent those encountered at the Road Test. Therefore, it was decided to use deflection criteria for prediction of performance.

The deflection measurements were obtained with the Dynaflect method as described in Chapters V and VI. The analyses were performed on the last two deflection determinations (spring and fall of 1969).

The spring deflections were generally greater than the fall deflections in all the sections. This was emphasized in the previous chapter under Deflection Analysis. The results of these analyses are presented in the form of the following equations:

Sand Clay Gravel Base Course

$P = 6.27 - 4.74 \log d_s$ $R^2 = .79$ $S_E = .31$ ——— Eq. IX-2

$P = 6.02 - 4.92 \log d_f$ $R^2 = .59$ $S_E = .46$ ——— Eq. IX-2(a)

Sand Shell Base Course

$P = 5.72 - 1.78 \log d_s$ $R^2 = .46$ $S_E = .42$ ——— Eq. IX-3

$P = 5.47 - 1.24 \log d_f$ $R^2 = .20$ $S_E = .52$ ——— Eq. IX-3(a)

Cement Stabilized Sand Clay Gravel Base Course

$P = 5.60 - 2.24 \log d_s$ $R^2 = .59$ $S_E = .28$ ——— Eq. IX-4

$P = 5.51 - 1.99 \log d_f$ $R^2 = .42$ $S_E = .33$ ——— Eq. IX-4(a)

Cement Stabilized Soil Base Course

$P = 4.95 - 3.00 \log d_s$ $R^2 = .78$ $S_E = .29$ ——— Eq. IX-5

$P = 4.82 - 2.78 \log d_f$ $R^2 = .32$ $S_E = .50$ ——— Eq. IX-5(a)

$P = 6.09 - 2.29 \log d_s$ $R^2 = .78$ $S_E = .30$ ——— Eq. IX-6

$P = 5.96 - 2.22 \log d_f$ $R^2 = .37$ $S_E = .52$ ——— Eq. IX-6(a)

where: d_s and d_f are the spring and fall deflections respectively in .001 in.

and R^2 and S_E are as defined for equation IX-1.

The values of R^2 and mean residuals for the above equations show that log ΣL predictions are closer to the observations when spring deflections are used rather than fall deflections. Furthermore, the spring deflections are more critical than the fall deflections because the former months are generally the wettest months in the State.

The soil cement base course data gave two separate equations for each deflection period. This was observed from the scatter of points on the P versus log deflection plot. The equations do represent two separate populations as is evident from the slope-intercept values. There is a difference of almost one-tenth in performance (ΣL) between the two predicting equations. The effect of regional factor cannot be overruled since there were five data points from poor region included in equation IX-5 and IX-5(a). However, it will be necessary to observe these sections for an extended period to verify the observed trends.

The mean residual was the largest for sand shell sections. The residual for the other three base course sections was about nine percent higher than that observed for the Road Test spring deflection data. Also, comparison with the residuals obtained using design and load equation (Eq. VII-6) indicated better prediction with the load deflection equations. The curves computed from equations IX-2 through IX-6 for spring deflections are shown in Figures IX-1 and IX-4 respectively. It is possible to use these relationships to determine the magnitude of the "safe" spring deflections for any specified number of load applications to a PSI of 2. 5. For example, a line drawn approximately two standard errors below the computed line (five percent risk that the pavement life will fall below this value) would indicate the safe deflection value for a pavement expected to carry any design ΣL without dropping below $p = 2.5$. In Figure IX-1 this safe deflection for spring period would be . 001 in. if the pavement is expected to carry approximately one million 18-kip axle loads.

Although there is some error involved with estimating safe deflections using these equations, it is felt that they are appropriate for predictive purpose. This is because the deflections used for determining the strength parameter are the average value plus two standard deviations, and this represents a value close to the weakest condition of the pavement.

Deflection as a Function of Structural Design

At the AASHO Road Test, deflections of the pavement sections were measured periodically in order to evaluate the contribution of each layer to the total deflection of the section. As a result of these analyses, it was possible to determine the relative effect of the thickness of individual layers on deflections. The magnitude of these coefficients for surfacing, base and subbase thickness disclosed that the surfacing was much more effective in reducing pavement deflection than the base or subbase was, particularly during the spring period of the year.

In Louisiana, the spring and fall deflections were correlated with the pavement layers and the strength of the embankment material using the model shown on the next page.

$$\log d_s = a_0 - a_1D_1 - a_2D_2 - a_3\log R$$

where: d_s = spring Dynaflect deflection, .001 in.

D_1, D_2 = design thickness of surface and base, in.

R = an expression of subgrade strength

and a_0, a_1, a_2, a_3 = constants to be determined from the analysis

Since R has been shown to correlate well with the soil support value of the embankment or subgrade soil (7), log of soil support (SS) was used rather than log R.

Equations IX-7 through IX-10 represent the results of the analyses of the deflection data for each base type category through the summer of 1969.

Sand Clay Gravel Base Course

$$\log d_s = .92 - .052D_1 - .048D_2 - .35 \log SS \qquad \text{Eq. IX-7}$$

$$S_E = .13$$

Sand Shell Base Course

$$\log d_s = .84 - .052D_1 - .029D_2 + .033 \log SS \qquad \text{Eq. IX-8}$$

$$S_E = .24$$

Cement Stabilized Sand Clay Gravel Base Course

$$\log d_s = .64 - .097D_1 - .015D_2 - .28 \log SS \qquad \text{Eq. IX-9}$$

$$S_E = .098$$

Cement Stabilized Soil Base Course

$$\log d_s = 1.27 - .090D_1 - .089D_2 - .089 \log SS \qquad \text{Eq. IX-10}$$

$$S_E = .15$$

Examination of the above equations reveals that for the range of soil support values generally used in Louisiana for section design, the thickness of the surfacing is more effective in reducing deflections than the embankment strength parameter. Furthermore, the confounding of the data due to saturated moisture contents is evident from the coefficient a_3 for sand shell sections which are all located in the wet areas of the State. This effect is additive as indicated by the positive sign of the coefficient.

In order to check how well the above equations relate to the presently used AASHO design procedures, section designs were made for soil support values of 3.5, 5.0 and 7.5 using the AASHO design procedures. The resulting thickness (as manipulated from $\overline{SN}$) of the layers were then substituted in the above equations to arrive at Performance Index P. These comparative values for P or Log ΣL are given below for cement stabilized sand clay gravel and soil bases.

SS	D_1	D_2	Log ΣL	
			AASHO Design	Eq. IX-4 & IX-9
Stabilized Sand Clay Gravel				
3.5	4"	9"	5.70	5.68
3.5	5"	8 1/2"	6.00	5.89
5.0	3 1/2"	7"	5.70	5.61
5.0	4"	7 1/2"	6.00	5.74
7.5	2 1/2"	5"	5.70	5.48
7.5	3"	5"	6.00	5.55
7.5	3 1/2"	6 1/2"	6.48	5.72
Stabilized Soil				Eq. IX-6 & IX-10
3.5	5"	9"	5.70	6.16
3.5	6"	9"	6.00	6.36
5.0	4"	8"	5.70	5.78
5.0	4 1/2"	9"	6.00	6.09
7.5	2 1/2"	6"	5.70	5.10
7.5	3"	6 1/2"	6.00	5.30
7.5	3 1/2"	8 1/2"	6.48	5.81

The difference in the Performance Index at high soil support values stems from the fact that the soil support value in the AASHO design is a linear function where as it is Logarithmic in the Louisiana equations. However, the comparison does provide the magnitude of the residuals over some range of soil support values.

As a result of the above, it is suggested that the previous equations be verified before using as design equations. This may necessitate acquisition of additional data for further analysis and evaluation.

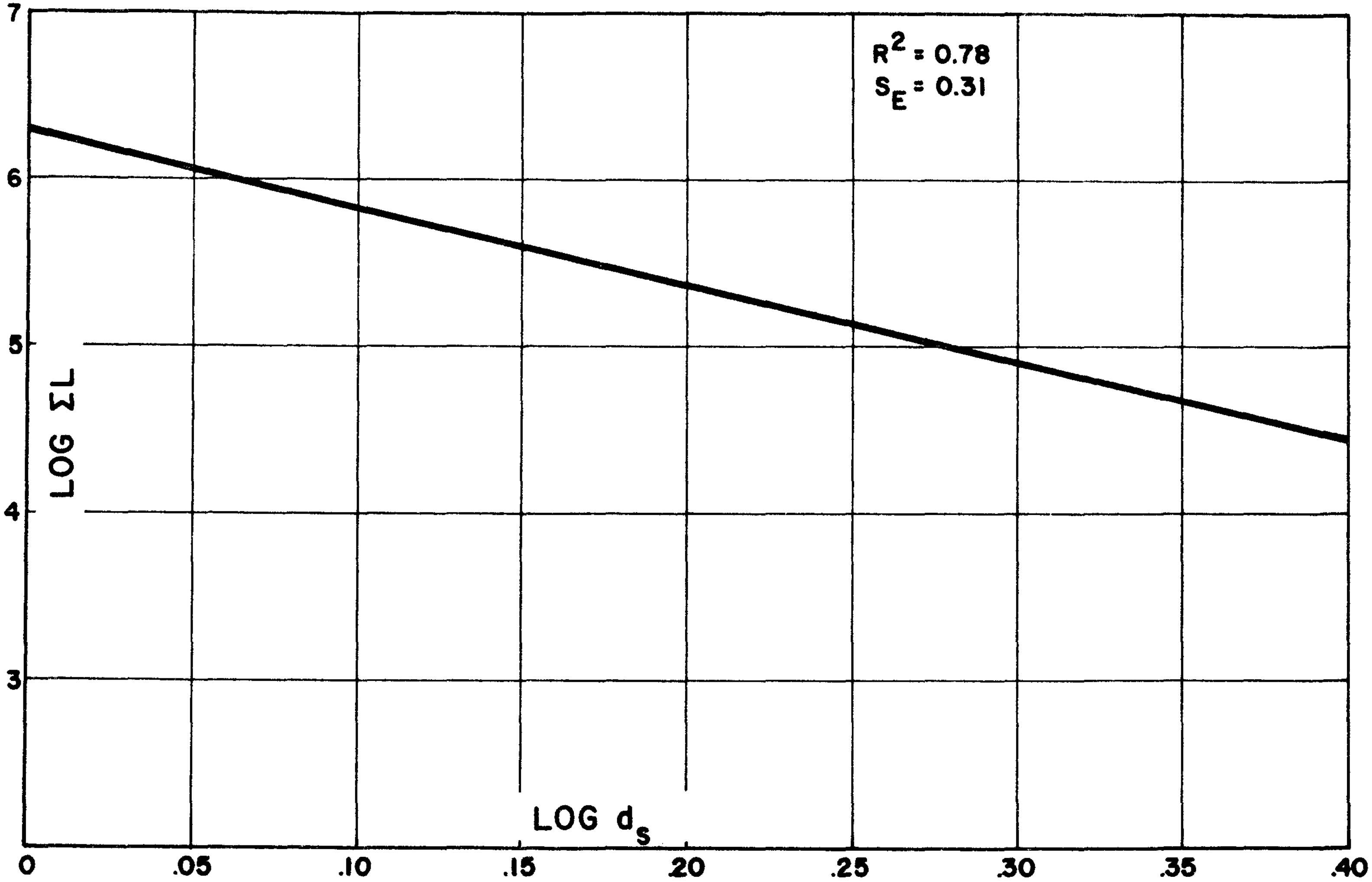

Figure X-1 - Variation in Spring Deflections with Log ΣL - Sand Clay Gravel Sections

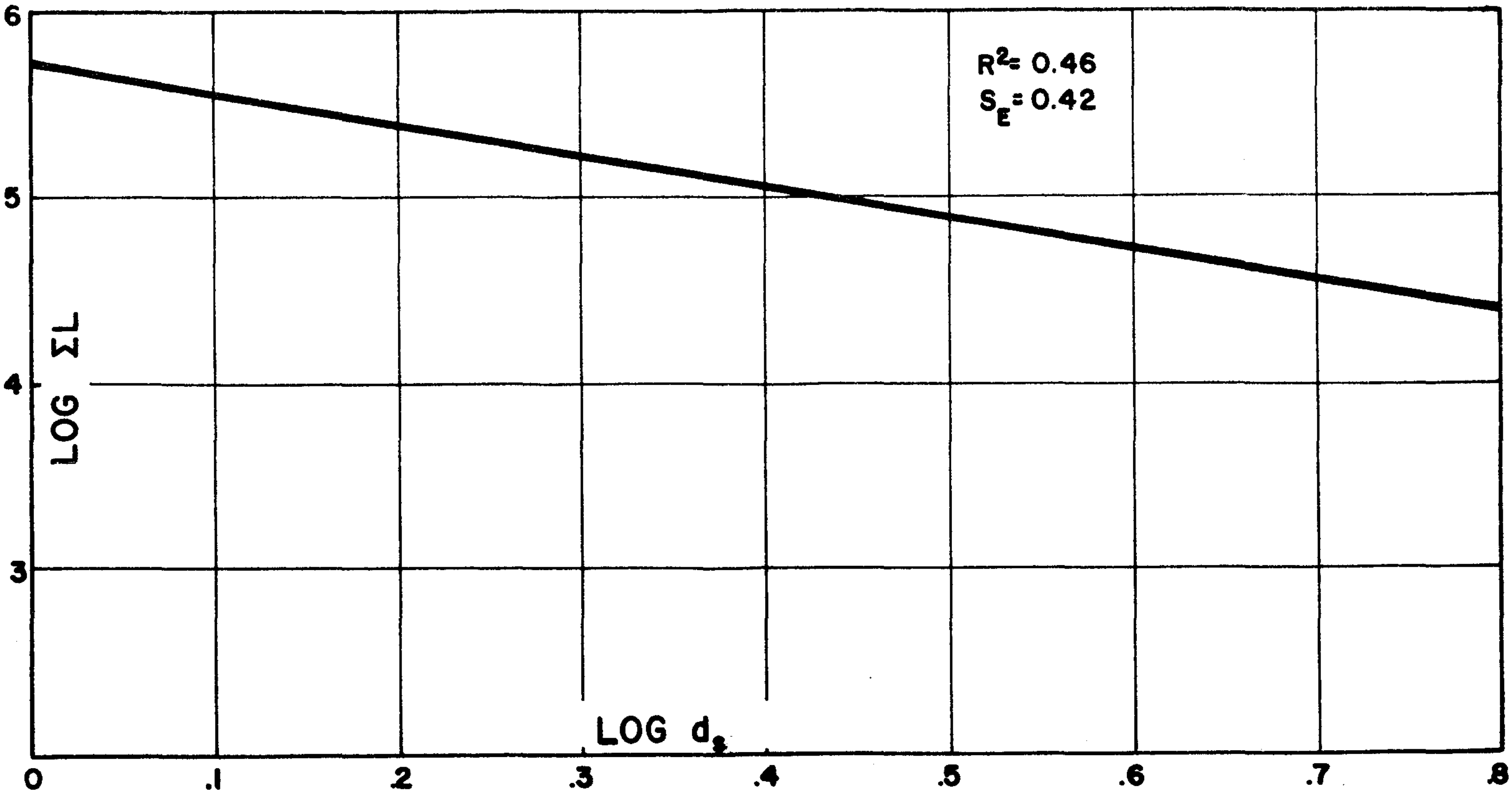

Figure X-2 - Variation in Spring Deflections with Log ΣL - Sand Shell Sections

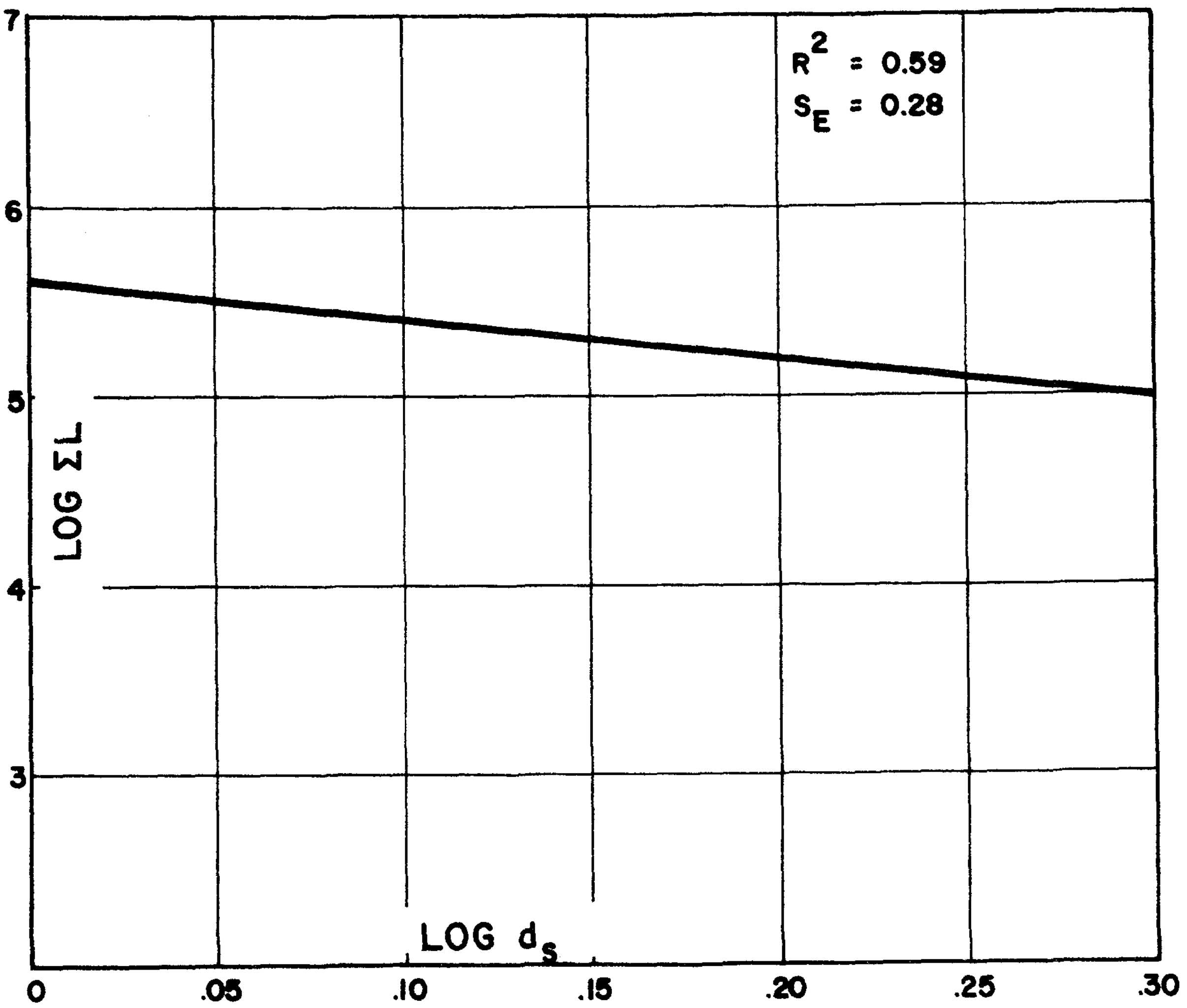

Figure X-3 - Variation in Spring Deflections with Log ΣL Cement Stabilized Sand Clay Gravel Sections

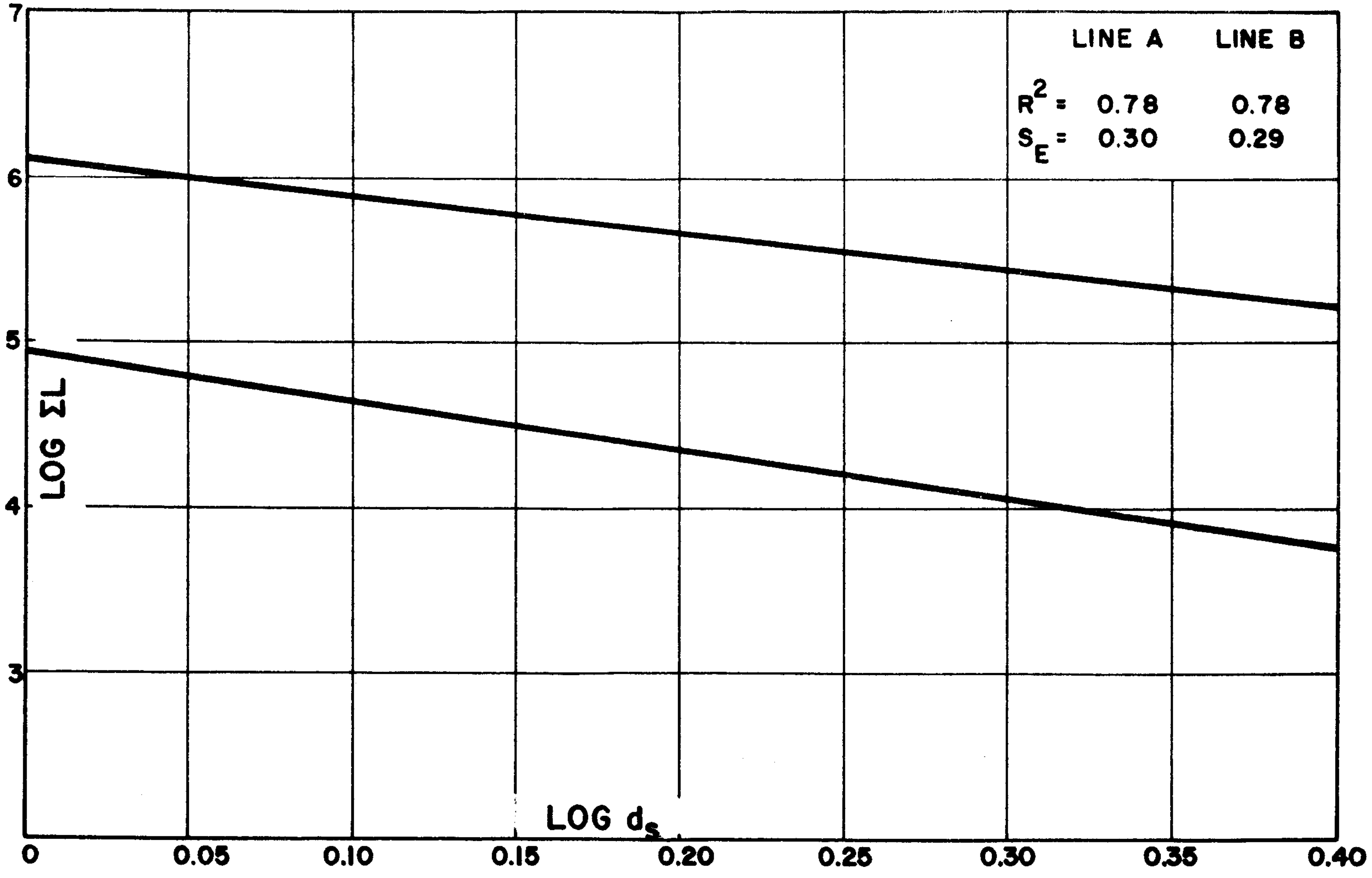

Figure X-4 - Variation in Spring Deflections with Log ΣL - Cement Stabilized Soil Sections

CHAPTER X

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In the preceding chapters an attempt was made to present more than five years of effort that was expended in order to correlate the level of performance determined at the AASHO Road Test with that of in-service Louisiana Pavements. Although the findings have fallen short of the desired objectives in a few instances, the effort has, nevertheless, been rewarding. Some of the shortcomings can be attributed to the nature of the experimental design which precluded adequate statistical evaluation. Furthermore, there were too many sections with low volume traffic included in the study. This required considerable time and effort for data acquisition. Additionally, most of these low **ADL** sections had experienced some type of maintenance work during the course of the study. In spite of these shortcomings, the study has provided valuable data on the performance of Louisiana pavements with regional and material differences and the association of performance to structural and strength variables.

The comments and conclusions have already been presented in a number of previous chapters. This chapter is intended to summarize those considered the most important.

1. The PSI concept developed at the AASHO Road Test seems to be an adequate parameter for evaluation of performance of pavements in Louisiana. The proposed method of determining performance to some terminal level of PSI offers early prediction of the useful life of the pavement provided a drop of at least one unit in PSI is observed on the p versus log ΣL plot.

2. The above PSI concept when applied to Louisiana Satellite Study indicates that 50 percent of the flexible sections with HMAC surfacing have reached the end of life in about half the time period indicated by the AASHO Interim Guide (6). Comparison of surface treatment flexible sections (low ADL) with AASHO Guide indicates better performance largely due to the resealing of surface course during the performance evaluation. Since these pavements generally receive surface maintenance within five years after construction, the prediction of performance does not lend itself to realistic values.

3. Most of the concrete and rigid sections have exhibited smoother rather than rougher trends with the passage of time. Projection of such trends for prediction of useful life remaining indicates that these sections should provide adequate service for more than the design life before structural failure may occur.

4. Although better performance has been indicated by HMAC sections in regions with better soil and drainage characteristics than otherwise, this difference is not statistically significant.

5. The pavement strength, as measured by deflection criteria, is very much dependent upon the seasonal and regional variations. This was quite pronounced for flexible sections. Furthermore, the effectiveness of surface thickness in reducing deflections on flexible sections was evidenced by larger deflection values for surface treatment sections.

6. Equations X-2 through X-6 can be used to adequately predict the Performance Index (log ΣL to $p = 2.5$) of Louisiana flexible section with HMAC surfacing. These predictions are closer to observations for the spring months which are more critical than fall months.

7. The surfacing seems to be the major factor in reducing deflections on HMAC Sections. This is indicated by the deflection - structural - design relationships as defined by equations X-7 through X-10. With additional evaluation, these equations can be used for the design of high type flexible pavements.

On the basis of the conclusions listed above, the following recommendations are presented for continuation of the Louisiana Satellite Study:

1. Performance determination of a few selected sections that have not yet suffered a loss in PSI level below 2.5 should be continued on a yearly basis. Concurrently, traffic evaluation should be accomplished for the same period.

2. Strength determination using Dynaflect method of test should be accomplished twice a year, once during the early part of the year and once during the latter part of the same year. This phase should continue on the same sections used for phase One above.

3. The relationships shown in equations IX-2 through IX-10 should be continually checked for verification using the data from the above two phases.

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APPENDIX

TABLE 3

STRUCTURAL VARIABLES FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS SURFACE	BASE	SUBBASE	SN	SOIL SUPPORT
1690ST	1963	(1)	2.25	7.25		1.09	2.40
1700ST	1959	(8)	1.50	5.50		0.33	2.40
1710ST	1955	(8)	1.50	6.00		0.36	7.40
1720HM	1964	(6)	2.50	13.00	4.50	2.69	8.30
1730HM	1964	(6)	2.50	18.50	7.00	3.40	9.70
1740ST	1956	(5)	1.50	10.00		0.75	2.80
1750HM	1956	(5)	3.00	7.50		1.32	3.80
1760ST	1958	(5)	1.00	9.25		1.11	5.80
1770ST	1957	(5)	1.13	6.88	3.00	0.71	8.60
1780HM	1959	(2)	2.00	5.00		1.95	8.90
1790ST	1959	(5)	1.50	9.00		0.68	4.90
1810HM	1958	(3)	3.50	6.50		1.92	9.30
1820ST	1957	(5)	1.50	5.75	1.75	0.43	6.30
1830HM	1957	(5)	4.50	8.00		2.34	5.40
1840ST	1955	(3)	1.38	6.50		0.52	3.30
1850HM	1958	(6)	3.50	8.00		2.24	8.10
1860ST	1959	(5)	1.25	8.50		0.64	2.50
1880ST	1956	(5)	2.75	5.25		0.85	3.70

TABLE 3

STRUCTURAL VARIABLES FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS SURFACE	BASE	SUBBASE	SN	SOIL SUPPORT
1400HM	1955	(1)	2.25	6.50		1.98	3.30
1410ST	1954	(3)	2.00	8.00		0.64	5.00
1420HM	1964	(1)	1.75	9.00		2.05	5.50
1430ST	1951	(3)	1.50	9.00		0.72	6.30
1440ST	1954	(3)	2.00	5.38		0.43	7.90
1450ST	1952	(3)	1.25	5.25		0.42	2.80
1460ST	1959	(3)	1.00	5.63		0.45	2.70
1470ST	1951	(3)	1.00	6.00		0.48	2.40
1480ST	1948	(3)	1.50	7.38		0.59	3.00
1490ST	1960	(3)	1.00	5.50		0.44	2.60
1500ST	1960	(3)	1.00	8.00		0.64	3.90
1510ST	1955	(3)	1.00	5.75		0.46	4.40
1520HM	1960	(2)	3.00	9.75		2.85	3.50
1530ST	1949	(3)	1.00	5.75		0.46	3.20
1540ST	1962	(1)	1.00	8.00		1.20	3.10
1550ST	1958	(3)	2.50	5.50		0.44	8.30
1560HM	1963	(2)	3.00	7.50	5.25	2.90	8.00
1570HM	1963	(2)	3.75	7.25	5.25	3.15	4.50
1580HM	1961	(3)	1.50	10.25	2.75	1.42	3.90
1590ST	1954	(8)	2.00	5.75	3.75	0.75	2.80
1600HM	1962	(8)	2.00	7.00		1.22	3.30
1610ST	1955	(8)	1.50	6.50		0.39	5.90
1620HM	1953	(1)	2.00	5.50		1.62	7.70
1630ST	1959	(1)	1.00	6.00		0.90	2.60
1640ST	1963	(1)	1.25	7.75	1.25	1.16	3.50
1650HM	1962	(1)	1.50	9.50		2.02	3.20
1660HM	1959	(1)	2.50	6.00		1.90	2.40
1670HM	1952	(3)	4.00	5.50		2.04	2.40
1680ST	1954	(8)	1.25	6.00		0.36	2.40

TABLE 3

STRUCTURAL VARIABLES FOR FLEXIBLE SECTIONS

CT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS SURFACE	BASE	SUBBASE	SN	SOIL SUPPORT
1100HM	1963	(2)	2.00	8.25		2.58	3.30
1110HM	1962	(1)	2.00	9.50	6.25	2.91	3.20
1120ST	1958	(8)	1.50	9.75	9.50	0.68	3.40
1130ST	1958	(8)	1.00	7.50		0.45	2.90
1140HM	1964	(1)	4.50	7.50	4.50	3.37	3.80
1150ST	1954	(8)	1.25	6.75	5.00	0.68	2.90
1170ST	1962	(1)	1.50	7.00		1.05	7.40
1180HM	1965	(2)	3.00	8.00	4.88	3.10	2.60
1190ST	1950	(3)	1.50	7.50		0.60	7.90
1200ST	1949	(3)	2.00	4.38		0.35	6.10
1210HM	1963	(3)	2.00	8.00		1.44	4.80
1220HM	1963	(3)	2.00	7.50		1.40	4.20
1230HM	1963	(2)	3.00	8.50	5.00	3.19	3.50
1240ST	1953	(8)	1.50	5.00		0.30	8.90
1250ST	1960	(8)	1.75	6.00		0.36	9.40
1260HM	1962	(2)	1.75	9.25		2.09	8.60
1270ST	1956	(8)	1.50	5.50		0.38	2.40
1280ST	1953	(8)	2.50	5.50		0.33	7.60
1290ST	1948	(1)	1.50	6.00		0.90	4.50
1300ST	1951	(1)	1.38	5.13		0.77	9.30
1310HM	1955	(3)	2.00	8.00		1.44	2.40
1320ST	1962	(8)	1.13	7.63		0.46	7.10
1330HM	1960	(2)	3.75	11.00		3.37	3.00
1340HM	1960	(3)	3.75	9.75		2.28	2.80
1350HM	1961	(2)	2.25	8.75		2.39	2.80
1360HM	1963	(2)	2.00	8.50	4.00	2.68	3.60
1370ST	1957	(8)	1.50	13.13		0.79	7.70
1380HM	1963	(2)	3.00	11.00	3.00	3.07	4.60
1390HM	1954	(3)	6.50	3.50		1.38	3.90

TABLE 3

STRUCTURAL VARIABLES FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS SURFACE	BASE	SUBBASE	SN	SOIL SUPPORT
810ST	1950	(6)	3.13	9.25		2.05	3.28
820HM	1963	(6)	3.50	8.75		2.54	9.60
830ST	1951	(6)	1.38	9.88	9.00	1.50	2.60
840HM	1960	(6)	2.44	8.63		1.67	3.80
850HM	1957	(6)	3.50	8.50	8.50	2.10	4.30
860HM	1963	(6)	1.50	9.50		1.84	4.80
870ST	1952	(6)	1.25	4.00		0.52	3.00
880ST	1956	(6)	1.75	8.88		1.15	5.10
89CHM	1958	(1)	2.75	7.75		2.26	6.10
900ST	1954	(6)	1.50	4.50		0.58	6.00
910HM	1955	(6)	1.88	7.25		1.69	2.40
920HM	1953	(6)	4.25	5.88		2.46	3.00
930ST	1957	(6)	1.50	7.75		1.01	2.80
940ST	1951	(3)	1.63	4.50		0.36	3.90
950HM	1962	(2)	2.00	9.50		2.98	3.20
960HM	1953	(1)	1.75	6.25		1.64	6.10
97CHM	1962	(6)	1.75	8.00		1.74	4.40
980HM	1954	(6)	3.00	12.50		2.82	2.40
990ST	1962	(1)	1.38	8.00		1.20	2.60
1000ST	1961	(6)	1.50	5.50		0.72	3.20
1010HM	1963	(1)	1.50	9.00		1.95	2.80
1020ST	1963	(1)	1.00	7.00		1.05	4.20
1030HM	1958	(6)	1.00	3.75	1.75	1.08	9.40
1040HM	1957	(6)	2.75	11.00		2.53	2.70
1050HM	1962	(6)	1.75	7.50		1.68	2.80
1060HM	1956	(1)	6.50	8.25		3.84	3.20
1070ST	1962	(1)	1.50	8.00		1.20	5.30
1080ST	1962	(3)	1.50	7.00		0.56	3.60
1090HM	1964	(1)	4.75	8.25		3.14	3.00

TABLE 3

STRUCTURAL VARIABLES FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS SURFACE	BASE	SUBBASE	SN	SOIL SUPPORT
520HM	1961	(6)	4.00	5.00		2.32	7.20
530ST	1958	(6)	1.50	7.00		0.91	3.50
540HM	1963	(2)	4.00	9.50		3.22	2.70
550HM	1957	(3)	4.00	6.50		2.12	2.70
560ST	1954	(3)	1.50	7.00		0.56	3.00
570ST	1963	(2)	1.00	11.70		1.98	2.80
580ST	1958	(1)	1.50	8.00		1.20	7.10
590ST	1959	(6)	1.25	5.00		0.65	8.70
600HM	1963	(6)	1.50	9.00		1.77	2.40
610ST	1957	(6)	2.50	7.75		1.01	2.40
620ST	1952	(6)	1.00	2.25	3.75	0.70	2.70
630ST	1960	(6)	1.00	7.50		0.98	2.80
640ST	1960	(1)	1.00	9.00		1.35	3.40
650HM	1962	(1)	2.25	8.25		2.14	8.10
660ST	1960	(6)	1.00	6.50		0.84	2.70
670HM	1953	(6)	3.75	10.75		2.90	2.70
680HM	1962	(3)	1.25	10.25		1.32	3.90
690HM	1964	(3)	4.00	10.00		2.40	4.30
700HM	1963	(3)	1.88	8.63		1.44	3.40
710ST	1956	(3)	1.50	9.50		0.76	4.40
720HM	1963	(3)	1.50	9.00		1.32	3.20
730ST	1948	(1)	1.25	7.50		1.12	2.40
740ST	1957	(1)	1.50	6.00		1.02	2.80
750ST	1959	(3)	1.88	5.00		0.40	2.40
760HM	1960	(2)	2.00	7.50	2.13	2.31	2.70
770ST	1952	(1)	1.75	7.50		1.12	4.10
780ST	1959	(3)	1.88	10.00		0.80	2.80
790HM	1963	(1)	1.25	9.00		1.85	2.50
800ST	1957	(6)	1.38	10.00		1.30	2.70

***Base Type Code as follows:**

(1) Soil-Cement
(2) Stabilized SCG
(3) SCG
(4), (5) Soil-Lime
(6), (7) Sand-Shell
(8) Iron-ore
(9) Miscellanous Granular

TABLE 2

TRAFFIC SUMMARY

VEHICLE TYPE	4 - 8 Hr. Classification Count	Percent	18 Kip Equivalent Factor	1966 A. D. T.	18 Kip Equivalent
Passenger Cars	639	72. 20	. 0004	957	0. 38
Buses					
2 axle					
4 axle					
Single Axle Trucks					
Pickups & Panels	154	17. 40	. 0021	231	0. 49
2 axle, 4 tire	5	0. 57	. 0073	8	0. 06
3 axle, 6 tire	41	4. 63	. 1644	61	10. 03
3 axle	5	0. 57	. 3027	8	2. 42
Tractor Semi-Trailer					
3 axle	2	0. 23	. 5299	3	1. 59
4 axle	17	1. 92	. 9262	25	25. 16
5 axle	17	1. 92	1. 1600	25	29. 00
6 axle	5	0. 56	3. 7933	7	26. 55
Truck Trailer					
3 axle					
4 axle					
5 axle					
6 axle					
TOTAL	885	100. 00		1325	95. 68
Average Daily Traffic				$\frac{2650}{2}$	
Annual Daily Volume				483625	

Note: Manual Count Time will be circled.
Total summation of loads (18 Kip Equivalent Daily) are not included in this table; however, it can be obtained by multiplying the ADL by the total number of days the highway has been open to traffic since construction for a particular period. This traffic information is for a flexible pavement design with p = 2. 5 and SN = 5. 0 and the Louisiana Department of Highways 18 Kip Equivalencies used.

TABLE 1 (continued)

LIST OF TEST SECTIONS

Section No.	Pavement Type	Route No.	Location	Control No.
150	ST	La. 8	Southwest of Harrisonburg	39-03
151	ST	La. 460	East of Nebo	152-01
152	HM	La. 8 & US 84	Northwest of Whitehall	22-05
153	ST	La. 127	South of Olla	127-02
154	ST	La. 127	North of Olla	127-04
155	ST	La. 124	West of Olla	125-01
156	HM	US 84	Northwest of Tullos	22-03
157	HM	US 84	Northwest of Tullos	22-03
158	HM	La. 1232	Northwest of Winnfield	864-06
159	ST	La. 505	Northwest of Tannehill	321-01
160	HM	La. 811	Northeast of Jonesboro	713-10
161	ST	La. 147	Southeast of Jonesboro	320-02
162	HM	La. 133	South of Oak Ridge	163-02
163	ST	La. 134	East of Oak Ridge	161-03
164	ST	La. 588	Southeast of Pioneer	862-04
165	HM	La. 589	Southeast of Oak Grove	862-14
166	HM	La. 134	Southwest of Lake Providence	161-09
167	HM	La. 134	Southwest of Lake Providence	161-08
168	ST	La. 527	Northeast of Taylortown	121-01
169	ST	La. 511	South of Shreveport	102-01
170	ST	La. 177	South of Evelyn	106-02
171	ST	La. 1217	North of Many	113-01
172	HM	US 90	West of Morgan City	424-05
173	HM	US 90	West of Morgan City	424-05
174	ST	La. 405	South of White Castle	231-01
175	HM	La. 308	South of Napoleonville	407-07
176	ST	La. 343	Northwest of Abbeville	393-01
177	ST	La. 678	South of Polkville	850-04
178	HM	La. 14	East of Holmwood	196-01
179	ST	La. 14	South of Hayes	196-02
180	HM	US 167	South of Packton	23-03
181	HM	US 165	South of Alexandria	14-06
182	ST	La. 575	Northwest of Newellton	351-01
183	HM	La. 2	East of Oak Grove	37-04
184	ST	La. 594	Northeast of Monroe	326-02
185	HM	La. 24	Southeast of Bourg	65-01
186	ST	La. 22	South of Whitehall	260-03
187 Omit	ST	La. 126	West of Grayson	91-09
188	ST	La. 554	Southwest of Collinston	160-02

TABLE 1 (continued)

LIST OF TEST SECTIONS

Section	Pavement Type	Route No.	Location	Control No.
98	HM	La. 35	North of Rayne	207-07
99	ST	La. 92	Northwest of Morse	385-02
100	ST	La. 97	South of Redich	201-02
101	HM	La. 374	West of Fenris	820-01
102	ST	La. 99	Southeast of Kinder	827-20
103	HM	La. 27 & 82	East of Holly Beach	31-01
104	HM	La. 27	South of Sulphur	31-04
105	HM	La. 27	North of Sulphur	31-06
106	HM	La. 12	Northeast of Starks	12-02
107	ST	La. 109	Northeast of Fields	372-02
108	ST	La. 113	North of Reeves	139-02
109	HM	La. 190	West of DeRidder	28-03
110	HM	La. 117	South of Kurthwood	114-01
111	HM	La. 117	South of Kisatchie	114-02
112	ST	La. 117	South of Bellewood	114-02
113	ST	La. 117	North of Bellewood	114-03
114	HM	La. 6	West of Hagewood	34-05
115	ST	La. 485	East of Allen	115-02
116 Omit	ST	La. 105	South of Odenburg	141-04
118	HM	La. 1	West of Simmesport	52-05
119	ST	La. 107	Southeast of Cottonport	147-04
120	ST	La. 114	East of Hessmer	145-02
121	HM	La. 1206	Southeast of Holloway	840-01
122	HM	Parish Road	Road on North Side of LSU(Alex)	
123	HM	La. 1-S	North of Boyce	53-02
124	ST	La. 174	Northeast of Mitchell	112-03
125	ST	La. 174	South of Hunter	99-02
126	HM	La. 763	Southeast of Logansport	99-03
127	ST	La. 509	Northwest of Abington	105-03
128	ST	La. 177	North of Evelyn	106-03
129	ST	La. 155	Northeast of Coushatta	91-01
130	ST	La. 9	South of Bienville	89-04
131	HM	La. 349	North of Belcher	79-01
132	ST	La. 157	North of Rocky Mount	286-01
133	HM	La. 7	South of Cotton Valley	86-01
134	HM	La. 7	North of Minden	86-01
135	HM	La. 2	Southeast of Leton	85-07
136	HM	La. 2	West of Homer	85-07
137	ST	La. 152	Northwest of Hico	110-01
138	HM	La. 33 & 15	South of Farmerville	69-02
139	HM	La. 2	Northwest of Sterlington	70-05
140	HM	La. 15	Northwest of Farmerville	154-02
141	ST	La. 15	Northwest of Monroe	156-02
142	HM	La. 861	Northeast of Crowville	821-01
143	ST	La. 557	South of Monroe	159-03
144	ST	La. 132	West of Mangham	166-04
145	ST	La. 4	South of Winnsboro	36-03
146	ST	La. 562	Southwest of Wisner	165-02
147	ST	La. 15	South of Ferriday	177-05
148	ST	La. 107	Northwest of Effie	142-01
149	ST	La. 124	South of Jonesville	143-05

TABLE 1 (continued)

LIST OF TEST SECTIONS

Section No.	Pavement Type	Route No.	Location	Control No.
47	PCC	US 79 & 80	West of Minden	1-04
48	PCC	US 79 & 80	East of Shreveport	1-03
49	PCC	US 171	South of Shreveport	25-08
50	PCC	La. 173	Northwest of Shreveport	94-01
51	PCC	I-55	North of Ponchatoula	421-01
52	HM	La. 30	South of Baton Rouge	414-61
53	ST	La. 431	South of Gonzales	267-01
54	HM	US 61	North of Port Hudson	19-05
55	HM	La. 61	North of Bains	60-04
56	ST	La. 67	North of Clinton	60-04
57	ST	La. 10 & 77	West of Morganza	219-30
58	ST	La. 415	South of Chamberlain	225-01
59	ST	La. 105	South of Krotz Springs	849-34
60	HM	La. 989 & 1	West of Brusly	861-08
61	ST	La. 989 & 1	West of Brusly	861-08
62	ST	La. 75	North of Bayou Sorrel	230-02
63	ST	La. 75	South of Plaquemine	824-03
64	ST	La. 405	South of Plaquemine	824-06
65	HM	La. 405	South of Plaquemine	824-06
66	ST	La. 401	South of Napoleonville	233-01
67	HM	La. 398	South of Labadieville	804-15
68	HM	La. 1083	North of Waldheim	825-30
69	HM	La. 25	South of Franklinton	59-03
70	HM	La. 442	West of Tickfaw	269-04
71	ST	La. 441	North of Albany	260-09
72	HM	La. 448	North of Grangeville	254-31
73	ST	La. 429	East of Gonzales	264-04
74	ST	La. 22	South of Killian	260-04
75	ST	La. 107	West of Big Cane	147-01
76	HM	La. 10	Southwest of LeBeau	32-04
77	ST	La. 31	South of Opelousas	56-07
78	ST	La. 93	West of Arnaudville	221-01
79	HM	La. 726	Northeast of Arnaudville	391-04
80	ST	La. 301	West of Lafitte	826-06
81	ST	La. 46	Northwest of Yscloskey	284-01
82	HM	Veterans Hwy.	In New Orleans	714-07
83	ST	La. 46	Northwest of Yscloskey	284-02
84	ST	La. 665	South of Bourg	855-09
85	HM	La. 24	Southwest of Larose	65-01
86	HM	La. 657	Northeast of Delta Farm	829-11
87	ST	La. 654	West of Gheens	829-10
88	ST	La. 307	Northeast of Thibodaux	829-15
89	HM	La. 674	South of New Iberia	823-29
90	ST	La. 88	Northwest of New Iberia	397-05
91	HM	La. 82	South of Kaplan	207-01
92	ST	La. 82	South of Abbeville	194-07
93	ST	La. 82	South of Abbeville	215-01
94	ST	La. 339	North of Delcambre	216-01
95	HM	La. 31	South of Breaux Bridge	56-03
96	HM	La. 342	South of Duson	218-01
97	HM	La. 724	South of Duson	218-30

TABLE 1

LIST OF TEST SECTIONS

Section No.	Pavement Type	Route No.	Location	Control No.
1	PCC	La. 1	North of Plaquemine	450-06
2	PCC	US 61	North of Baton Rouge	252-01
3	PCC	La. 19	State Route in Baker	250-01
4	PCC	US 190	East of US 61 in Baton Rouge	13-05
5	PCC	US 190	East of US 61 in Baton Rouge	13-05
6	PCC	US 61	South of Prairieville	7-07
7	PCC	US 61	North of Sorrento	7-07
8	PCC	US 61	South of Sorrento	7-06
9 Omit	PCC	US 51	South of Hammond	17-04
10	PCC	I-55	South of Hammond	421-01
11	PCC	I-59	North of Pearl River	740-00
12	PCC	I-59	North of Pearl River	740-00
13	PCC	US 61	North of Gramercy	7-05
14 Omit	PCC	US 90	West of Marrero	283-09
15	PCC	La. 660	North of Houma	855-07
16	PCC	La. 57	North of Dulac	246-01
17	PCC	La. 83	East of Cypremort	239-02
18	PCC	La. 83	East of Cypremort	239-02
19	PCC	La. 3052	South of Lafayette	424-02
20	PCC	La. 3052	South of Lafayette	424-02
21	PCC	US 190	West of Port Barre	12-13
22	PCC	La. 3052	South of Opelousas	424-01
23	PCC	La. 3052	South of Opelousas	424-01
24	PCC	I-10	West of Crowley	450-04
25	PCC	I-10	West of Crowley	450-04
26	PCC	US 190	East of Lake Charles	3-04
27	PCC	I-10	West of Lake Charles	740-00
28	PCC	US 64 & 84	West of Vidalia	26-02
29	PCC	US 64 & 84	West of Vidalia	26-02
30	PCC	US 165	South of Tullos	15-04
31	PCC	US 65	North of Clayton	20-02
32	PCC	US 65	North of Clayton	20-02
33	PCC	US 65	North of Somerset	20-04
34	PCC	US 165	North of Columbia	15-07
35	PCC	US 65	South of Tallulah	20-06
36	PCC	ByPass US 165	South of Monroe	15-31
37	PCC	ByPass US 165	South of Monroe	15-31
38	PCC	I-20	East of Arcadia	451-04
39	PCC	I-20	East of Arcadia	451-05
40	PCC	I-20	West of Ruston	451-05
41	PCC	I-20	East of Ruston	740-00
42	PCC	I-20	East of Ruston	740-00
43	PCC	I-20	East of Ruston	740-00
44	PCC	I-20	East of Minden	740-00
45	PCC	I-20	West of Minden	451-03
46	PCC	I-20	West of Minden	451-03

TABLE 4

PERFORMANCE AND LOADING HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
520HM	1961	(6)	2/66	3.90	19.00	6/67	3.78	28.00	1/69	3.07	40.00	6/69	3.26	43.00	3.37
530ST	1958	(6)	3/66	2.19	10.00	6/67	2.27	12.50	1/69	2.69	16.50	6/69	2.82	17.50	2.17
540HM	1963	(2)	2/66	3.55	125.00	6/67	3.37	190.00	1/69	2.37	270.00	1/70	2.54	288.00	2.95
550HM	1957	(3)	2/66	2.90	500.00	6/67	2.30	590.00	1/69	2.96	655.00	6/69	3.14	725.00	2.62
560ST*	1954	(3)	3/66	2.30	163.00	5/67	2.38	195.00	1/69	2.41	235.00	6/69	2.50	245.00	2.70
570ST*	1963	(2)	2/66	1.93	13.00	6/67	1.99	18.50	1/69	3.05	25.10	6/69	2.98	27.00	2.78
580ST*	1958	(1)	2/66	2.18	102.00	6/67	1.98	123.00	1/69	2.37	151.00	8/69	2.17	161.00	2.70
590ST	1959	(6)	10/65	2.53	120.00	9/67	2.46	160.00	3/69	2.35	195.00	8/69	2.43	210.00	2.45
600HM	1963	(6)	2/66	2.71	14.50	8/67	2.44	25.00	1/69	2.15	37.50	6/69	2.40	41.00	2.58
610ST*	1957	(6)	2/66	1.87	5.00	8/67	1.71	6.40	1/69	2.03	8.00	6/69	2.28	8.60	2.50
620ST*	1952	(6)	3/66	2.02	47.00	6/67	2.25	52.50	1/69	2.26	62.50	6/69	2.42	66.00	2.88
630ST	1960	(6)	3/66	2.49	14.80	6/67	2.62	18.80	1/69	2.64	24.80	6/69	2.80	26.90	2.75
640ST	1960	(1)	3/66	2.09	8.60	8/67	2.07	12.20	1/69	1.99	16.10	6/69	2.30	17.20	2.32
650HM	1962	(1)	3/66	2.41	5.20	8/67	2.84	10.00	1/69	2.47	15.90	6/69	2.80	16.40	3.08
660ST*	1960	(6)	2/66	2.32	9.90	9/67	2.22	14.60	1/69	2.90	19.50	7/69	2.95	21.50	2.62
670HM	1953	(6)	2/66	2.84	1.80	9/67	3.16	2.45	1/69	3.17	3.50	7/69	3.07	7.50	3.15
680HM	1962	(3)	8/65	3.37	60.00	9/67	3.36	96.00	1/69	3.47	124.00	6/69	3.27	128.00	3.20
690HM	1964	(3)	8/65	4.05	125.00	9/67	3.92	300.00	1/69	3.77	405.00	6/69	3.82	440.00	3.65
700HM	1963	(3)	8/65	3.32	5.20	9/67	3.68	12.00	1/69	2.75	18.20	6/69	2.91	21.20	2.82
710ST	1956	(3)	8/65	2.56	25.80	9/67	2.55	33.50	1/69	2.66	39.00	6/69	2.91	41.00	3.30
720HM	1963	(3)	8/65	2.94	5.50	9/67	2.94	9.50	3/69	3.06	13.30	6/69	3.14	14.20	2.85
730ST*	1948	(1)	2/66	1.76	50.00	6/67	1.83	56.00	1/69	1.86	63.20	6/69	2.12	65.50	2.23
740ST	1957	(1)	8/65	1.92	25.50	9/67	1.89	32.50	1/69	2.02	37.50	6/69	2.23	39.50	2.33
750ST	1959	(3)	10/65	3.02	33.00	9/67	2.72	44.00	1/69	2.47	50.30	6/69	2.69	52.00	2.58
760HM	1960	(2)	10/65	3.78	95.00	5/68	3.15	140.00	1/69	2.54	149.00	6/69	2.77	155.00	2.75
770ST	1952	(1)	10/65	2.22	125.00	5/68	2.23	150.00	1/69	1.90	157.00	6/69	2.06	160.00	2.25
780ST*	1959	(3)	10/65	1.87	23.00	5/68	2.80	36.50	1/69	2.78	40.00	6/69	3.10	42.00	2.90
790HM	1963	(1)	10/65	2.91	3.00	10/67	3.30	5.60	1/69	2.81	7.60	6/69	2.81	8.30	2.82
800ST	1957	(6)	8/65	1.63	9.50	3/69	2.23	36.00	7/69	2.42	40.00	10/69	2.16	44.00	

*Resealed during study period.

TABLE 4

PERFORMANCE AND LOADING HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
810ST*	1950	(6)	8/65	2.14	145.00	1/69	2.72	197.00	7/69	2.80	203.00	10/69	2.55	208.00	3.15
820HM	1963	(6)	8/65	2.96	250.00	9/67	2.54	490.00	3/69	1.96	660.00	8/69	1.98	698.00	2.70
830ST	1951	(6)	8/65	1.19	37.00	1/69	1.93	49.50	7/69	2.15	51.40	10/69	1.81	52.40	2.08
840HM	1960	(6)	9/65	2.58	12.50	1/69	2.75	21.70	7/69	2.55	23.20	9/69	2.53	23.70	3.12
850HM	1957	(6)	9/65	1.43	95.00	1/69	2.32	156.00	7/69	2.27	160.00	9/69	2.39	161.00	2.38
860HM	1963	(6)	9/65	2.16	3.30	1/69	2.09	7.00	7/69	2.07	8.30	9/69	2.29	8.70	2.02
870ST	1952	(6)	9/65	1.93	74.00	1/69	1.81	99.00	7/69	2.19	108.00	9/69	2.30	112.00	1.85
880ST	1956	(6)	8/65	2.34	25.00	1/69	2.09	38.20	7/69	2.16	40.10	9/69	2.38	41.00	2.45
890HM	1958	(1)	10/65	2.81	310.00	10/67	2.59	420.00	1/69	2.59	500.00	6/69	2.86	525.00	2.85
900ST	1954	(6)	10/65	2.44	35.50	10/67	2.57	44.00	1/69	2.26	50.00	6/69	2.63	52.00	2.45
910HM	1955	(6)	10/65	3.50	33.50	5/68	3.45	46.00	2/69	3.49	49.50	6/69	3.09	51.50	3.05
920HM	1953	(6)	10/65	3.22	290.00	2/69	2.79	420.00	6/69	2.79	438.00	9/69	2.51	448.00	2.45
930ST*	1957	(6)	10/65	2.63	15.30	5/68	2.41	20.50	2/69	2.90	22.20	6/69	2.87	23.00	2.82
940ST	1951	(3)	10/65	2.61	52.00	10/67	2.58	61.00	1/69	2.38	67.00	6/69	2.86	69.00	2.65
950HM	1962	(2)	10/65	2.70	38.00	10/67	2.81	60.00	1/69	2.38	75.00	6/69	2.50	78.50	2.72
960HM	1953	(1)	10/65	2.18	48.00	2/69	2.06	62.50	6/69	2.50	63.50	9/69	2.04	64.50	2.40
970HM	1962	(6)	10/65	1.99	8.30	2/69	1.97	21.50	6/69	2.28	23.00	1/70	2.17	24.20	2.35
980HM	1954	(6)	10/65	3.32	21.00	7/68	3.88	80.00	2/69	3.42	95.00	6/69	3.26	103.00	3.13
990ST	1962	(1)	10/65	2.02	2.15	2/69	2.35	4.08	6/69	2.61	4.30	9/69	2.46	4.50	2.30
1000ST*	1961	(6)	10/65	2.49	8.60	2/69	1.93	19.00	6/69	2.54	20.00	9/69	2.69	20.70	3.20
1010HM	1963	(1)	10/65	1.85	7.60	3/69	2.11	18.50	7/69	2.31	19.90	11/69	2.16	21.30	2.53
1020ST*	1963	(1)	10/65	1.44	1.40	3/69	2.45	3.95	7/69	2.85	4.15	11/69	2.88	4.40	2.50
1030HM	1958	(6)	10/65	2.11	40.00	3/69	2.64	62.20	7/69	2.82	64.20	11/69	2.70	66.50	2.73
1040HM	1957	(6)	10/65	1.68	110.00	3/69	3.11	108.00	7/69	3.03	173.00	11/69	3.10	179.00	3.03
1050HM	1962	(6)	10/65	2.50	70.00	3/69	2.61	143.00	7/69	2.79	151.00	11/69	2.83	159.00	2.93
1060HM	1956	(1)	10/65	1.72	930.00	3/69	3.16	1190.00	7/69	3.12	1210.00	11/69	3.20	1230.00	3.30
1070ST	1962	(1)	10/65	1.40	35.50	3/69	2.18	87.00	7/69	2.19	93.00	11/69	2.24	100.00	2.57
1080ST	1962	(3)	10/65	2.70	4.30	3/69	2.99	9.40	7/69	3.07	9.98	11/69	3.08	10.50	3.17
1090HM	1964	(1)	10/65	3.94	20.00	3/69	3.24	61.00	7/69	3.18	65.80	11/69	3.16	70.00	3.43

TABLE 4

PERFORMANCE AND LOADING HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
1100HM	1963	(2)	12/65	3.24	27.00	9/67	3.53	52.00	3/69	2.76	78.00	7/69	2.80	83.00	3.00
1110HM	1962	(1)	8/65	2.66	4.60	9/67	2.84	9.10	3/69	2.72	13.20	7/69	2.80	14.00	2.87
1120ST	1958	(8)	12/65	2.44	53.00	9/67	2.18	77.00	3/69	1.72	102.00	7/69	2.06	107.00	1.93
1130ST	1958	(8)	12/65	2.49	50.00	9/67	2.21	68.00	3/69	2.41	84.50	7/69	2.69	90.00	2.47
1140HM	1964	(1)	12/65	3.74	42.00	9/67	4.31	86.00	3/69	3.16	128.00	7/69	3.56	138.00	3.67
1150ST	1954	(8)	11/65	2.24	26.50	9/67	2.41	31.50	3/69	2.82	35.20	7/69	2.96	36.00	2.37
1170ST	1962	(1)	3/66	2.13	19.50	1/69	2.04	35.90	6/69	2.31	37.50	9/69	2.80	38.80	2.52
1180HM	1965	(2)	3/66	3.46	19.50	1/69	2.94	69.80	6/69	2.87	79.00	9/69	2.85	86.00	3.50
1190ST	1950	(3)	3/66	2.44	113.00	1/69	2.58	136.00	6/69	2.98	140.50	9/69	2.92	141.00	2.85
1200ST*	1949	(3)	12/65	1.85	305.00	1/69	2.25	400.00	6/69	2.57	415.00	9/69	2.69	419.00	2.70
1210HM	1963	(3)	3/66	3.33	2.30	1/69	2.16	5.20	6/69	2.59	5.50	9/69	2.37	5.70	3.13
1220HM	1963	(3)	12/65	3.20	43.00	10/67	3.12	75.00	1/69	2.64	97.50	6/69	2.76	105.00	3.00
1230HM	1963	(2)	12/65	3.73	140.00	9/67	3.71	230.00	3/69	2.72	323.00	8/69	2.54	344.00	3.53
1240ST	1953	(8)	11/65	2.06	32.50	9/67	2.43	38.50	3/69	2.71	47.10	7/69	2.73	49.30	2.60
1250ST	1960	(8)	11/65	2.10	27.50	9/67	2.44	39.00	3/69	2.31	47.20	7/69	2.54	49.10	2.53
1260HM	1962	(2)	11/65	2.12	24.00	9/67	2.81	37.00	3/69	2.66	48.00	7/69	2.74	51.00	3.00
1270ST	1956	(8)	11/65	2.14	50.00	9/67	2.21	58.00	3/69	2.32	66.10	7/69	2.50	68.00	2.50
1280ST*	1953	(8)	11/65	1.67	20.00	9/67	2.38	22.00	3/69	2.21	24.30	7/69	2.40	24.80	2.57
1290ST	1948	(1)	11/65	1.43	123.00	9/67	1.96	140.00	3/69	1.78	154.00	7/69	2.13	157.00	2.47
1300ST*	1951	(1)	11/65	2.14	89.00	3/69	2.24	110.00	8/69	2.13	113.00	12/69	2.14	115.00	2.70
1310HM	1955	(3)	11/65	2.41	38.00	10/67	1.96	45.00	3/69	2.36	50.80	8/69	2.42	52.50	2.77
1320ST*	1962	(8)	11/65	1.67	3.60	3/69	2.52	7.39	8/69	2.49	7.85	10/69	2.46	8.10	2.70
1330HM	1960	(2)	11/65	3.05	135.00	3/69	1.98	267.00	8/69	2.16	287.00	12/69	2.08	302.00	2.57
1340HM	1960	(3)	11/65	3.16	95.00	3/69	2.38	186.00	8/69	2.47	198.00	12/69	2.30	208.00	2.80
1350HM	1961	(2)	11/65	2.31	34.00	3/69	2.40	64.30	8/69	2.47	68.50	12/69	2.28	72.00	2.70
1360HM	1963	(2)	11/65	3.19	50.00	3/69	2.51	105.00	8/69	2.47	112.00	12/69	2.38	116.00	2.67
1370ST	1957	(8)	5/66	1.91	94.00	2/69	1.96	121.00	7/69	2.23	127.00	12/69	1.64	131.00	2.20
1380HM	1963	(2)	5/66	3.63	74.00	2/69	2.97	143.00	7/69	3.18	154.00	12/69	3.29	164.00	3.33
1390HM	1954	(3)	5/66	2.39	610.00	2/69	1.61	798.00	7/69	1.94	837.00	12/69	1.55	872.00	2.43

TABLE 4

PERFORMANCE AND LOADING HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
1400HM	1955	(1)	5/66	2.11	180.00	2/69	2.58	232.00	7/69	2.60	242.00	12/69	2.59	250.00	3.26
1410ST	1954	(3)	5/66	2.27	105.00	2/69	2.97	145.00	7/69	2.98	150.00	12/69	3.13	154.00	3.07
1420HM	1964	(1)	4/66	2.37	2.85	2/69	2.29	7.85	7/69	2.47	8.60	11/69	2.27	9.30	2.85
1430ST*	1951	(3)	5/66	2.22	350.00	2/69	2.00	435.00	12/69	2.56	460.00	2/70	2.81	470.00	2.75
1440ST*	1954	(3)	4/66	2.21	140.00	2/69	2.20	183.00	7/69	3.10	190.00	11/69	3.31	194.00	2.85
1450ST*	1952	(3)	4/66	1.95	61.00	2/69	2.26	77.00	7/69	2.57	79.00	11/69	2.23	80.40	2.85
1460ST*	1959	(3)	5/66	2.14	9.40	2/69	2.79	13.60	7/69	2.82	14.40	11/69	3.16	14.80	3.60
1470ST	1951	(3)	4/66	2.31	28.00	2/69	1.70	64.00	7/69	1.95	69.00	11/69	1.70	73.20	1.98
1480ST*	1948	(3)	3/66	1.49	130.00	1/69	1.39	195.00	6/69	2.15	200.00	9/69	2.41	203.00	1.80
1490ST	1960	(3)	4/66	1.90	67.00	2/69	2.46	140.00	7/69	2.75	150.00	11/69	2.38	157.00	2.72
1500ST	1960	(3)	4/66	1.94	125.00	2/69	1.68	166.00	7/69	2.00	171.00	11/69	1.46	177.00	1.82
1510ST	1955	(3)	4/66	2.21	35.50	3/69	2.25	48.00	8/69	2.27	50.00	11/69	2.29	51.00	2.68
1520HM	1960	(2)	3/66	2.88	185.00	3/69	2.74	280.00	8/69	2.55	292.00	11/69	2.80	300.00	2.92
1530ST	1949	(3)	4/66	1.05	82.00	3/69	1.82	98.00	8/69	2.05	102.00	11/69	1.89	104.00	2.08
1540ST*	1962	(1)	4/66	1.43	29.50	3/69	2.54	73.00	8/69	2.39	80.00	11/69	2.56	85.00	3.08
1550ST	1958	(3)	4/66	1.81	68.00	3/69	1.63	95.00	8/69	2.02	100.00	11/69	1.49	103.00	2.02
1560HM	1963	(2)	4/66	3.34	125.00	3/69	3.29	223.00	8/69	3.18	237.00	11/69	3.68	247.00	3.42
1570HM	1963	(2)	4/66	3.95	50.00	3/69	3.36	97.50	8/69	2.65	103.00	11/69	3.99	107.00	3.32
1580HM	1961	(3)	4/66	3.29	16.50	9/67	3.38	22.00	3/69	3.21	27.50	8/69	2.99	29.00	3.45
1590ST	1954	(8)	4/66	1.43	10.00	9/67	1.39	12.00	3/69	1.43	14.20	8/69	1.94	14.80	1.68
1600HM	1962	(8)	5/66	3.02	9.40	3/69	2.75	14.40	8/69	2.78	15.70	11/69	2.77	16.50	2.90
1610ST	1955	(8)	5/66	1.86	26.00	3/69	1.98	32.80	8/69	2.24	33.80	11/69	1.99	34.20	2.20
1620HM	1953	(1)	5/66	2.59	46.00	2/69	2.32	58.50	7/69	2.38	60.80	11/69	2.92	62.60	2.68
1630ST	1959	(1)	5/66	1.52	19.00	2/69	2.44	30.00	7/69	2.59	31.50	11/69	1.51	32.70	2.35
1640ST	1963	(1)	5/66	1.52	1.05	2/69	2.44	1.98	7/69	2.59	2.13	11/69	2.48	2.28	2.82
1650HM	1962	(1)	5/66	2.91	5.80	2/69	2.42	10.20	7/69	2.57	10.80	11/69	2.68	11.40	2.82
1660HM	1959	(1)	5/66	2.91	30.50	2/69	2.41	44.50	7/69	2.52	47.30	11/69	2.59	49.50	2.82
1670HM	1952	(3)	5/66	2.59	20.00	2/69	2.34	25.00	7/69	2.30	26.10	11/69	2.29	26.90	2.58
1680ST*	1954	(8)	11/65	2.08	15.20	10/67	1.55	19.50	3/69	2.68	22.80	8/69	2.01	23.60	2.50

TABLE 4

PERFORMANCE AND LOADING HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
1690ST	1963	(1)	11/65	1.28	62.50	10/67	1.26	150.00	3/69	1.45	260.00	8/69	1.80	277.00	1.90
1700ST	1959	(8)	11/65	1.44	33.50	9/67	1.27	43.00	3/69	1.92	52.30	7/69	2.23	54.30	2.13
1710ST	1955	(8)	12/65	2.04	19.00	9/67	2.12	25.50	3/69	2.13	31.00	7/69	2.25	32.20	2.47
1720HM	1964	(6)	5/67	3.22	225.00	2/69	2.07	425.00	7/69	2.01	468.00	9/69	1.88	485.00	2.82
1730HM	1964	(6)	5/67	2.99	200.50	2/69	1.73	377.00	7/69	1.84	418.00	9/69	1.67	435.00	3.32
1740ST	1956	(5)	4/67	1.95	4.20	1/69	2.09	5.38	8/69	2.22	5.60	12/69	1.84	5.75	1.88
1750HM	1956	(5)	5/67	2.08	11.10	1/69	2.85	13.80	7/69	2.75	14.70	9/69	2.58	15.00	2.72
1760ST	1958	(5)	5/67	2.33	45.00	2/69	2.08	54.00	6/69	2.45	56.00	9/69	2.11	57.50	2.40
1770ST	1957	(5)	5/67	2.61	7.40	1/69	2.20	9.10	6/69	2.44	9.50	9/69	2.21	9.80	2.80
1780HM	1959	(2)	5/67	3.26	57.00	2/69	3.47	71.00	7/69	2.67	74.30	11/69	2.65	77.50	2.80
1790ST	1959	(5)	5/67	2.15	89.00	2/69	2.39	112.00	7/69	2.65	118.00	11/69	2.47	124.00	2.30
1800HM	1958	(5)	5/67	3.13	470.00	3/69	2.31	570.00	8/69	2.40	600.00	11/69	2.33	620.00	2.37
1810HM	1958	(3)	5/67	2.92	810.00	1/69	2.18	973.00	6/69	2.34	1015.00	9/69	3.06	1035.00	3.67
1820ST	1957	(5)	5/67	1.83	7.70	2/69	2.16	9.45	7/69	2.29	9.80	11/69	2.12	10.20	2.45
1830HM	1957	(5)	5/67	2.11	25.00	2/69	1.84	31.50	7/69	2.13	32.80	11/69	1.79	34.20	1.95
1840ST	1955	(3)	5/67	1.84	6.50	2/69	2.60	7.70	7/69	2.80	8.20	11/69	2.77	8.60	2.62
1850HM	1958	(6)	4/67	3.38	52.00	1/69	2.73	66.30	7/69	2.54	71.00	11/69	2.56	72.30	2.90
1860ST	1959	(5)	1/69	2.45	28.50	6/69	2.47	30.30	9/69	2.45	31.50	2/70	2.68	33.70	2.60
1880ST	1956	(5)	2/69	1.73	26.00	7/69	2.00	27.00	11/69	1.50	27.80	2/70	1.92	28.50	2.20

TABLE 5

DEFLECTION AND MOISTURE CONTENT HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
520HM	1961	(6)	1/67	2.03	13.30	24.50	4/69	2.43	20.70	42.00	8/69	1.82	23.50	44.50
530ST	1958	(6)	5/68	3.94	13.80	14.80	4/69	3.63	26.20	17.00	7/69	2.79	26.00	17.50
540HM	1963	(2)	7/66	1.07	15.10	145.00	3/69	1.07	14.00	280.00	7/69	1.22	21.80	300.00
550HM	1957	(3)	7/66	1.03	15.10	520.00	3/69	1.23	14.30	720.00	7/69	1.09	19.10	730.00
560ST	1954	(3)	2/68	1.31	13.90	215.00	4/69	1.95	16.90	242.00	7/69	1.62	20.50	247.00
570ST	1963	(2)	3/69	2.39	15.70	26.00	6/69	2.27	10.80	27.00	9/69	2.41	11.90	28.10
580ST	1938	(1)	6/68	2.72	27.90	142.00	3/69	2.55	15.50	157.00	7/69	2.08	19.00	160.00
590ST	1959	(6)	2/69	2.89	31.50	192.00	6/69	2.94	35.80	204.00	9/69	2.12	23.00	215.00
600HM	1963	(6)	7/66	1.2C	18.60	17.00	4/69	3.37	38.40	39.80	8/69	2.87	8.90	43.00
610ST	1957	(6)	6/68	4.74	22.30	7.30	4/69	6.75	25.60	8.40	8/69	3.95	19.10	8.60
620ST	1952	(6)	2/69	3.82	20.70	64.00	6/69	4.09	20.20	66.00	9/69	3.38	20.90	69.00
630ST	1960	(6)	2/69	2.96	29.70	25.30	6/69	3.50	24.50	26.90	9/69	3.40	14.40	28.00
640ST	1960	(1)	6/68	4.86	19.40	14.30	4/69	4.04	23.40	16.70	8/69	3.84	18.60	17.70
650HM	1962	(1)	7/66	1.66	16.20	6.20	4/69	1.86	12.20	15.90	8/69	1.76	19.70	17.00
660ST	1960	(6)	3/69	2.5C	17.50	20.10	7/69	2.31	20.20	21.50	11/69	2.10	18.30	23.00
670HM	1953	(6)	8/66	2.92	20.50	3.60	5/69	2.45	33.20	11.30	8/69	2.35	20.00	12.70
680HM	1962	(3)	7/66	0.88	9.50	74.00	5/69	0.82	22.30	127.00	8/69	0.68	20.40	130.00
690HM	1964	(3)	7/66	1.04	13.90	200.00	5/69	0.96	22.20	430.00	8/69	1.00	18.00	460.00
700HM	1963	(3)	7/66	1.30	11.80	7.70	4/69	1.40	21.80	20.00	7/69	1.18	19.40	22.00
710ST	1956	(3)	5/68	1.77	14.40	36.50	4/69	1.91	8.90	40.50	7/69	1.65	19.80	41.20
720HM	1963	(3)	8/66	1.88	9.90	7.20	4/69	1.97	18.70	13.60	7/69	1.51	17.40	14.50
730ST	1948	(1)	5/68	4.54	19.70	60.00	4/69	3.46	21.40	68.00	7/69	2.94	25.40	72.00
740ST	1957	(1)	5/68	3.88	16.00	35.00	4/69	2.68	19.30	38.50	7/69	2.12	17.80	39.80
750ST	1959	(3)	3/69	1.68	23.50	51.10	6/69	2.01	23.90	52.0C	10/69	1.50	7.50	53.00
760HM	1960	(2)	8/66	2.27	18.60	110.00	5/69	1.93	31.60	153.00	8/69	2.19	6.60	158.00
770ST	1952	(1)	6/68	4.70	18.40	152.00	4/69	3.60	24.90	159.0C	8/69	2.79	17.00	162.00
780ST	1959	(3)	6/66	3.06	15.90	37.00	4/69	2.17	26.20	41.50	8/69	1.95	19.40	43.00
790HM	1963	(1)	7/66	2.18	21.00	3.70	6/69	2.63	23.00	8.00	8/69	2.20	22.50	8.40
800ST	1957	(6)	1/69	4.14	32.40	34.20	6/69	5.15	34.50	39.50	9/69	4.63	34.40	43.00

TABLE 5

DEFLECTION AND MOISTURE CONTENT HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
810ST	1950	(6)	1/69	2.28	34.00	197.00	6/69	3.34	36.50	202.00	9/69	2.82	24.10	206.00
820HM	1963	(6)	8/66	1.75	15.90	360.00	5/69	2.37	57.00	680.00	9/69	1.60	27.10	705.00
830ST	1951	(6)	1/69	3.69	29.20	49.50	6/69	5.75	33.60	51.00	9/69	5.02	26.70	52.00
840HM	1960	(6)	1/69	3.21	22.00	21.70	6/69	3.23	25.80	23.00	9/69	3.29	15.80	23.70
850HM	1957	(6)	9/66	6.03	28.00	110.00	5/69	7.40	36.60	158.00	9/69	6.92	37.40	161.00
860HM	1963	(6)	8/66	5.41	7.60	4.20	5/69	6.66	44.60	7.90	9/69	5.61	56.40	8.70
870ST	1952	(6)	1/69	3.82	28.40	99.00	6/69	4.39	33.20	107.00	9/69	4.19	20.00	112.00
880ST	1956	(6)	1/69	5.20	30.60	38.20	6/69	4.89	33.20	40.00	9/69	4.23	22.40	41.00
890HM	1958	(1)	9/66	1.88	9.00	355.00	4/69	2.01	27.20	512.00	8/69	1.90	28.80	535.00
900ST	1954	(6)	3/68	4.38	16.90	46.20	4/69	4.23	27.70	52.00	8/69	3.30	20.50	53.00
910HM	1955	(6)	9/66	3.19	22.20	37.00	4/69	4.32	24.40	50.50	8/69	3.60	14.40	52.50
920HM	1953	(6)	2/69	2.21	23.80	420.00	6/69	2.18	25.80	438.00	9/69	3.81	14.60	448.00
930ST	1957	(6)	3/68	3.95	14.10	20.00	4/69	4.40	23.10	22.80	8/69	3.37	22.10	23.50
940ST	1951	(3)	3/68	3.37	12.20	63.00	4/69	3.65	25.00	68.00	8/69	2.43	20.20	69.50
950HM	1962	(2)	7/66	1.78	22.40	47.00	4/69	2.89	43.40	77.00	8/69	2.44	32.00	80.00
960HM	1953	(1)	7/66	4.07	16.90	52.00	4/69	4.50	25.40	63.00	8/69	3.82	18.30	64.00
970HM	1962	(6)	7/66	4.19	20.20	10.50	4/69	6.82	28.90	22.50	8/69	4.06	20.20	23.80
980HM	1954	(6)	7/66	1.31	15.90	35.50	4/69	1.37	28.90	99.00	8/69	1.21	14.90	105.00
990ST	1962	(1)	6/68	4.04	21.20	3.70	4/69	2.88	22.10	4.20	8/69	3.40	17.20	4.40
1000ST	1961	(6)	6/68	3.36	23.20	16.80	4/69	2.68	17.00	19.50	8/69	1.86	12.80	20.40
1010HM	1963	(1)	8/66	1.31	14.50	10.50	4/69	1.35	18.10	18.80	8/69	1.20	11.20	20.20
1020ST	1963	(1)	6/68	1.25	12.80	3.40	4/69	1.15	20.60	4.00	8/69	0.96	6.60	4.21
1030HM	1958	(6)	8/66	2.77	7.60	44.00	4/69	3.34	30.60	62.50	8/69	2.82	37.40	65.00
1040HM	1957	(6)	9/66	1.97	14.80	125.00	4/69	2.07	14.20	169.00	8/69	1.61	11.20	175.00
1050HM	1962	(6)	9/66	1.49	17.50	85.00	4/69	1.50	20.70	145.00	8/69	1.31	10.80	153.00
1060HM	1956	(1)	9/66	1.28	14.70	1020.00	4/69	1.18	23.00	1195.00	8/69	1.63	7.00	1220.00
1070ST	1962	(1)	6/68	1.21	12.50	74.00	4/69	1.14	19.70	88.00	8/69	0.94	8.60	95.00
1080ST	1962	(3)	6/68	1.49	13.40	8.40	4/69	1.36	18.80	9.50	8/69	1.31	9.50	10.30
1090HM	1964	(1)	1/67	0.84	14.80	33.50	4/69	1.13	19.50	62.30	8/69	1.80	1.50	67.50

TABLE 5

DEFLECTION AND MOISTURE CONTENT HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
1100HM	1963	(2)	9/66	1.11	12.00	37.50	4/69	1.36	26.20	79.00	8/69	1.46	17.00	85.00
1110HM	1962	(1)	9/66	0.94	29.00	6.50	4/69	1.17	25.00	13.30	8/69	1.16	5.00	14.20
1120ST	1958	(8)	3/68	1.48	19.60	85.00	4/69	1.71	31.10	103.00	8/69	1.49	15.50	109.00
1130ST	1958	(8)	3/68	1.82	22.10	73.00	4/69	2.01	27.60	86.00	8/69	1.93	16.40	91.50
1140HM	1964	(1)	9/66	0.81	17.70	60.00	4/69	0.82	29.60	131.00	8/69	0.88	16.60	141.00
1150ST	1954	(8)	3/68	4.40	14.00	33.00	5/69	3.31	15.50	35.70	8/69	2.67	6.80	96.30
1170ST	1962	(1)	3/69	3.15	21.70	36.50	6/69	3.31	11.60	37.50	9/69	3.19	13.90	38.80
1180HM	1965	(2)	8/66	1.42	22.60	26.50	5/69	1.40	22.60	77.00	9/69	1.27	17.60	86.00
1190ST	1950	(3)	3/69	2.65	15.00	139.00	6/69	2.52	5.20	140.50	10/69	2.17	15.20	142.00
1200ST	1949	(3)	3/69	3.29	20.60	405.00	6/69	3.52	21.70	415.00	10/69	2.55	8.40	423.00
1210HM	1963	(3)	8/66	1.76	10.60	2.75	4/69	1.80	24.90	5.40	8/69	1.82	19.60	5.60
1220HM	1963	(3)	8/66	1.88	16.70	53.00	5/69	2.17	27.40	105.00	8/69	1.58	5.20	110.00
1230HM	1963	(2)	9/66	1.03	24.10	175.00	5/69	1.09	27.20	330.00	8/69	1.20	6.70	344.00
1240ST	1953	(8)	3/68	2.26	12.10	41.00	4/69	2.03	19.80	48.00	8/69	1.68	5.50	50.00
1250ST	1960	(8)	6/68	2.36	12.40	43.00	5/69	2.27	19.90	48.00	8/69	1.71	7.20	49.50
1260HM	1962	(2)	1/67	1.29	12.30	33.00	5/69	1.63	21.00	49.50	8/69	1.21	3.60	52.00
1270ST	1956	(8)	6/68	3.19	14.00	62.00	5/69	3.19	24.10	67.20	8/69	2.61	17.90	68.70
1280ST	1953	(8)	6/68	3.57	10.00	23.50	5/69	2.76	16.50	24.50	8/69	2.37	24.00	24.90
1290ST	1948	(1)	6/68	3.02	17.10	147.00	5/69	2.32	16.00	156.00	8/69	2.80	7.40	160.00
1300ST	1951	(1)	3/69	2.24	12.90	110.00	7/69	1.72	4.20	112.00	10/69	1.57	11.00	114.00
1310HM	1955	(3)	1/67	1.50	25.60	42.00	5/69	2.23	16.70	51.50	8/69	1.75	11.40	52.50
1320ST	1962	(8)	3/69	1.76	22.00	7.39	7/69	1.76	19.40	7.73	10/69	1.16	12.90	8.10
1330HM	1960	(2)	2/67	0.80	15.70	180.00	5/69	1.27	19.40	275.00	8/69	1.03	22.90	287.00
1340HM	1960	(3)	2/67	1.26	12.40	125.00	5/69	1.82	17.00	191.00	8/69	1.33	12.40	198.00
1350HM	1961	(2)	1/67	1.23	20.50	43.00	5/69	1.71	18.80	66.00	8/69	1.60	20.90	68.50
1360HM	1963	(2)	1/67	0.78	18.60	72.00	5/69	1.10	28.50	107.00	8/69	0.97	7.90	112.00
1370ST	1957	(8)	2/69	1.14	13.40	121.00	6/69	1.06	18.80	125.00	9/69	0.73	6.20	129.00
1380HM	1963	(2)	10/66	0.72	14.00	85.00	4/69	0.72	22.90	148.00	8/69	0.76	11.60	157.00
1390HM	1954	(3)	10/66	1.43	16.60	640.00	4/69	1.57	22.20	820.00	8/69	1.58	13.90	842.00

TABLE 5

DEFLECTION AND MOISTURE CONTENT HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
1400HM	1955	(1)	12/67	1.54	12.20	190.00	2/69	1.53	16.80	232.00	6/69	1.56	14.00	240.00
1410ST	1954	(3)	2/69	1.52	18.80	145.00	6/69	1.51	16.60	149.00	9/69	1.06	13.90	151.00
1420HM	1964	(1)	12/66	1.43	21.60	3.90	4/69	1.76	23.70	8.15	8/69	1.47	10.20	8.75
1430ST	1951	(3)	2/69	1.88	18.40	435.00	6/69	1.98	16.80	448.00	9/69	1.08	3.40	459.00
1440ST	1954	(3)	2/69	2.83	27.00	183.00	6/69	2.82	24.50	188.00	9/69	1.39	14.50	191.00
1450ST	1952	(3)	3/69	3.07	17.20	77.30	7/69	3.63	25.00	79.00	10/69	2.61	13.40	80.00
1460ST	1959	(3)	3/69	1.26	25.90	13.80	7/69	1.37	16.20	14.40	10/69	0.82	19.50	14.70
1470ST	1951	(3)	3/69	2.85	3.40	65.00	7/69	3.75	26.00	69.00	10/69	3.09	4.50	72.00
1480ST	1948	(3)	3/69	2.34	21.40	196.00	6/69	2.13	18.30	200.00	10/69	1.91	17.90	204.00
1490ST	1960	(3)	3/69	1.66	23.50	142.00	7/69	2.06	24.20	150.00	10/69	1.46	11.10	157.00
1500ST	1960	(3)	3/69	2.02	14.80	167.00	7/69	2.13	26.40	171.00	10/69	1.38	16.10	177.00
1510ST	1955	(3)	3/69	2.34	16.80	48.00	7/69	2.17	24.40	49.50	10/69	1.63	11.50	50.50
1520HM	1960	(2)	10/66	1.09	12.20	205.00	4/69	1.04	20.50	282.00	8/69	0.98	16.60	292.00
1530ST	1949	(3)	3/69	2.38	15.60	98.00	7/69	2.72	19.70	101.00	10/69	1.76	19.20	103.00
1540ST	1962	(1)	3/69	1.76	12.60	73.00	7/69	1.53	25.80	79.00	10/69	1.47	9.30	83.00
1550ST	1958	(3)	3/69	1.72	13.60	95.00	7/69	1.42	24.20	99.50	10/69	0.96	12.50	102.00
1560HM	1963	(2)	10/66	0.72	9.80	142.00	4/69	0.96	25.50	225.00	8/69	0.86	7.70	237.00
1570HM	1963	(2)	10/66	0.70	7.40	59.00	4/69	0.92	22.30	96.50	8/69	0.90	11.40	103.00
1580HM	1961	(3)	10/66	1.12	15.30	18.50	4/69	1.59	18.00	27.80	8/69	1.23	11.60	29.00
1590ST	1954	(8)	3/69	2.30	9.80	14.20	7/69	2.05	13.80	14.70	10/69	2.53	15.60	15.00
1600HM	1962	(8)	10/66	1.17	27.40	10.00	4/69	1.56	24.80	14.70	8/69	1.29	11.00	15.70
1610ST	1955	(8)	3/69	2.04	23.10	33.80	7/69	1.38	10.60	33.50	10/69	1.52	12.40	34.00
1620HM	1953	(1)	12/66	1.74	13.80	49.00	4/69	2.60	23.30	59.30	8/69	1.67	3.60	61.00
1630ST	1959	(1)	4/68	3.66	23.60	27.00	4/69	3.84	25.00	30.80	8/69	3.43	9.60	31.90
1640ST	1963	(1)	4/68	1.85	24.30	1.70	4/69	1.65	23.00	2.04	8/69	1.19	6.20	2.18
1650HM	1962	(1)	12/67	1.74	21.20	7.00	4/69	2.12	25.20	10.40	8/69	1.61	7.80	11.00
1660HM	1959	(1)	12/67	1.95	31.30	34.00	4/69	3.92	22.20	45.50	8/69	2.94	12.70	48.00
1670HM	1952	(3)	2/69	1.43	29.40	21.50	4/69	2.29	34.40	25.40	8/69	2.25	24.40	26.30
1680ST	1954	(8)	6/68	1.83	14.10	21.00	5/69	1.70	16.10	23.20	8/69	1.43	7.60	23.60

TABLE 5

DEFLECTION AND MOISTURE CONTENT HISTORY FOR FLEXIBLE SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
1690ST	1963	(1)	6/68	2.39	20.80	205.00	5/69	2.14	23.00	267.00	8/69	1.75	12.80	277.00
1700ST	1959	(8)	6/68	3.25	18.10	48.00	5/69	2.33	12.80	53.50	8/69	2.94	7.90	55.00
1710ST	1955	(8)	3/68	2.75	12.40	27.50	4/69	2.58	25.40	31.40	8/69	2.16	6.50	32.50
1720HM	1964	(6)	2/68	1.42	14.40	310.00	5/69	1.43	29.80	467.00	9/69	1.41	16.90	485.00
1730HM	1964	(6)	2/68	1.45	13.30	280.00	5/69	1.55	31.20	402.00	9/69	1.68	37.40	435.00
1740ST	1956	(5)	6/68	4.30	19.60	4.90	5/69	4.24	30.40	5.50	8/69	3.62	13.80	5.60
1750HM	1956	(5)	7/67	3.30	19.10	11.20	5/69	4.86	20.90	14.40	8/69	4.47	10.20	14.80
1760ST	1958	(5)	3/68	4.19	17.10	49.00	4/69	4.96	22.60	55.00	8/69	3.92	8.20	57.00
1770ST	1957	(5)	3/68	6.40	18.90	8.40	4/69	5.25	24.80	9.35	8/69	4.46	14.50	9.65
1780HM	1959	(2)	3/69	2.31	16.60	72.00	7/69	1.55	23.60	74.30	10/69	1.31	11.00	76.50
1790ST	1959	(5)	3/69	3.07	21.30	113.00	7/69	2.38	22.80	118.00	10/69	2.01	8.30	122.00
1800HM	1958	(5)	8/67	1.12	22.40	480.00	4/69	1.38	22.40	578.00	8/69	1.33	10.40	600.00
1810HM	1958	(3)	8/67	1.33	27.00	840.00	5/69	1.30	27.00	1005.00	8/69	1.31	16.50	1025.00
1820ST	1957	(5)	3/69	3.91	21.80	9.55	7/69	3.53	19.80	9.80	10/69	4.14	12.10	10.10
1830HM	1957	(5)	5/67	3.03	21.30	25.00	4/69	3.46	21.80	32.00	8/69	3.76	10.60	33.20
1840ST	1955	(3)	2/69	2.38	21.20	7.70	6/69	2.35	19.80	8.05	9/69	1.68	7.50	8.40
1850HM	1958	(6)	8/67	3.54	32.60	55.00	5/69	4.12	32.60	69.20	9/69	3.62	39.80	72.30
1860ST	1959	(5)	5/68	4.38	16.70	26.00	4/69	3.42	24.10	29.50	7/69	2.54	20.40	30.70
1880ST	1956	(5)	4/68	3.32	19.90	24.50	4/69	3.16	21.60	26.40	8/69	1.84	9.20	27.20

TABLE 6

STRUCTURAL VARIABLES FOR RIGID SECTIONS

SECT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS			SN	SOIL SUPPORT
			SURFACE	BASE	SUBBASE		
10C	1962	(9)	10.00	7.00			3.10
20C	1960	(9)	9.50	3.50			3.10
30C	1962	(3)	9.50	5.50			5.00
40C	1959	(4)	9.00	5.00			2.70
50C	1959	(4)	9.50	5.50			3.30
60C	1956	(9)	8.00	12.50			2.60
70C	1956	(0)	8.00	12.50			1.60
80C	1955	(7)	8.00	12.00			1.60
100C	1960	(5)	10.00	4.13	4.50		3.70
110C	1961	(5)	10.50	4.75			2.90
120C	1961	(5)	10.25	5.13	5.50		3.10
130C	1955	(7)	8.00	6.50			2.60
150C	1958	(9)	8.00	3.50			2.60
160C	1958	(9)	8.00	9.00			3.10
170C	1958	(6)	8.25	10.00			3.30
180C	1958	(6)	7.89	9.38			2.50
190C	1963	(6)	9.50	7.38	6.00		4.50
200C	1963	(6)	9.63	6.00	6.00		5.20
210C	1960	(9)	8.75	6.00			2.20
220C	1962	(1)	8.88	7.13			4.10
230C	1962	(1)	9.88	6.75			4.10
240C	1963	(6)	9.75	8.50	6.00		2.20
250C	1963	(6)	10.00	6.00	6.00		3.10
260C	1958	(9)	9.11				1.60
270C	1961	(1)	10.50	6.00	6.00		9.30
280C	1962	(1)	9.33	6.25			3.30
290C	1962	(1)	8.75	6.50			7.70
300C	1957	(9)	8.00	23.00			2.60
310C	1957	(9)	8.25	12.00			2.60

TABLE 6

STRUCTURAL VARIABLES FOR RIGID SECTIONS

SECT NO	YEAR CONST	BASE TYPE	ACTUAL THICKNESS SURFACE	BASE	SUBBASE	SN	SOIL SUPPORT
320C	1959	(9)	7.60	26.50			8.80
330C	1963	(9)	9.25	7.50			2.70
340C	1958	(9)	9.00	12.00			1.60
350C	1963	(9)	9.00	6.75			2.40
360C	1964	(9)	9.00	6.38			9.10
370C	1964	(9)	9.00	4.38			7.90
38CC	1963	(1)	10.25	6.50	4.25		3.20
390C	1963	(1)	10.50	6.75	6.63		8.40
400C	1963	(1)	10.13	6.38	7.00		8.60
410C	1960	(1)	10.13	6.50	6.75		6.40
420C	1960	(1)	10.13	6.38	6.75		3.60
430C	1959	(1)	10.38	6.38	6.75		3.50
440C	1960	(1)	10.13	6.50	5.75		2.80
450C	1960	(1)	10.06	8.50	7.38		8.50
460C	1960	(1)	10.25	7.50	8.00		8.10
470C	1955	(9)	8.00	6.25			5.70
480C	1955	(9)	8.13	14.00			2.90
490C	1962	(9)	9.00	6.00	5.50		3.00
500C	1960	(9)	8.88	11.88			3.60
510C	1960	(5)	9.88	4.75			2.70

TABLE 7

PERFORMANCE AND LOADING HISTORY FOR RIGID SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
10C	1962	(9)	2/66	3.49	348.00	10/67	3.51	530.00	1/69	3.24	710.00	6/69	3.22	788.00	3.25
20C	1960	(9)	2/66	3.35	408.00	10/67	3.34	580.00	1/69	3.36	720.00	6/69	3.39	775.00	3.20
30C	1962	(3)	2/66	3.30	110.00	10/67	3.22	153.00	1/69	3.32	204.00	6/69	3.39	217.00	3.20
40C	1959	(4)	2/66	3.40	1200.00	10/67	3.37	1580.00	3/69	3.35	1930.00	8/69	3.28	2050.00	3.22
50C	1959	(4)	2/66	3.21	925.00	10/67	3.25	1290.00	1/69	3.24	1580.00	6/69	3.40	1680.00	3.08
60C	1956	(9)	2/66	3.23	2100.00	10/67	3.10	2650.00	1/69	3.36	3110.00	6/69	3.43	3300.00	2.95
70C	1956	(C)	2/66	3.06	1980.00	10/67	3.17	2410.00	1/69	3.42	2800.00	8/69	3.35	3000.00	2.90
80C	1955	(7)	2/66	3.11	1970.00	10/67	3.03	2385.00	1/69	3.30	2720.00	8/69	3.23	2870.00	2.85
100C	1960	(5)	8/65	3.05	568.00	10/67	3.04	975.00	1/69	3.34	1260.00	6/69	3.53	1320.00	3.05
110C	1961	(5)	8/65	3.10	490.00	10/67	3.09	830.00	1/69	3.32	1120.00	6/69	3.37	1230.00	2.85
120C	1961	(5)	8/65	3.42	430.00	10/67	3.43	827.00	1/69	3.39	1110.00	6/69	3.40	1230.00	2.80
130C	1955	(7)	8/65	3.09	1590.00	9/67	3.20	2100.00	1/69	3.50	2250.00	7/69	3.44	2380.00	3.02
150C	1958	(9)	8/65	3.28	192.00	2/69	3.68	275.00	7/69	3.64	295.00	9/69	3.49	303.00	3.35
160C	1958	(9)	8/65	3.58	36.00	1/69	3.66	58.30	7/69	3.62	61.00	9/69	3.49	62.00	3.20
170C	1958	(6)	10/65	2.68	53.50	10/67	3.50	69.00	2/69	3.59	77.00	6/69	3.45	79.50	3.15
180C	1958	(6)	10/65	2.65	52.30	5/67	3.74	66.00	2/69	3.68	77.00	6/69	3.53	79.50	3.15
190C	1963	(6)	10/65	3.38	166.00	10/67	3.44	333.00	1/69	3.31	450.00	6/69	3.40	490.00	3.18
200C	1963	(6)	10/65	3.24	166.00	10/67	3.16	333.00	1/69	3.27	450.00	6/69	3.36	490.00	3.20
210C	1960	(9)	10/65	2.99	930.00	10/67	3.39	1370.00	1/69	3.42	1660.00	6/69	3.38	1730.00	3.22
220C	1962	(1)	10/65	3.26	338.00	1/69	3.39	930.00	6/69	3.45	1000.00	9/69	3.39	1050.00	3.22
230C	1962	(1)	10/65	3.46	338.00	1/69	3.52	930.00	6/69	3.54	1000.00	9/69	3.49	1050.00	3.48
240C	1963	(6)	10/65	3.75	141.00	2/69	3.81	670.00	6/69	3.56	745.00	9/69	3.62	804.00	3.57
250C	1963	(6)	10/65	3.76	161.00	2/69	3.57	670.00	6/69	3.54	745.00	9/69	3.51	800.00	3.33
260C	1958	(9)	10/65	2.44	162.00	3/69	3.43	760.00	7/69	3.52	770.00	11/69	3.44	780.00	3.07
270C	1961	(1)	10/65	3.41	312.00	3/69	3.67	810.00	7/69	3.71	865.00	11/69	3.72	920.00	3.23
280C	1962	(1)	4/66	3.62	503.00	2/69	3.36	970.00	7/69	3.40	1030.00	11/69	3.37	1095.00	3.20
290C	1962	(1)	4/66	3.19	443.00	2/69	3.28	890.00	7/69	3.33	950.00	11/69	3.26	1010.00	3.08
300C	1957	(9)	4/66	3.24	357.00	3/69	2.83	498.00	11/69	3.40	525.00	2/70	3.77	540.00	3.70
310C	1957	(9)	4/66	3.26	164.00	2/69	3.36	228.00	7/69	3.43	240.00	11/69	3.32	249.00	3.28

TABLE 7

PERFORMANCE AND LOADING HISTORY FOR RIGID SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE (1)	PSI (1)	LOAD (1)	DATE (2)	PSI (2)	LOAD (2)	DATE (3)	PSI (3)	LOAD (3)	DATE (4)	PSI (4)	LOAD (4)	PSR
320C	1959	(9)	4/66	3.23	164.00	2/69	3.30	228.00	7/69	3.39	239.00	11/69	3.28	248.00	3.12
330C	1963	(9)	5/66	3.50	81.00	2/69	3.54	151.00	7/69	3.51	161.00	11/69	3.63	168.00	3.48
340C	1958	(9)	4/66	3.12	458.00	3/69	3.39	678.00	8/69	3.27	718.00	11/69	3.34	740.00	3.10
350C	1963	(9)	5/66	3.61	39.00	2/69	3.49	78.00	7/69	3.47	85.00	11/69	3.57	91.00	3.42
360C	1964	(9)	5/66	3.73	104.00	2/69	3.77	269.00	7/69	3.73	325.00	11/69	3.58	335.00	3.45
370C	1964	(9)	5/66	3.93	104.00	2/69	3.70	269.00	7/69	3.72	325.00	11/69	3.62	335.00	3.48
380C	1963	(1)	5/66	3.76	247.00	2/69	3.69	570.00	7/69	3.64	625.00	12/69	3.66	680.00	3.47
390C	1963	(1)	3/66	3.57	400.00	2/69	3.44	992.00	7/69	3.47	1100.00	12/69	3.35	1185.00	3.37
400C	1963	(1)	3/66	3.73	247.00	2/69	3.42	700.00	7/69	3.51	762.00	12/69	3.40	842.00	3.43
410C	1960	(1)	3/66	3.62	595.00	2/69	3.46	1110.00	7/69	3.53	1185.00	12/69	3.48	1275.00	3.30
420C	1960	(1)	3/66	3.78	595.00	2/69	3.44	1110.00	7/69	3.44	1185.00	12/69	3.32	1275.00	3.17
430C	1959	(1)	3/66	3.34	530.00	2/69	3.28	967.00	7/69	3.42	1035.00	12/69	3.20	1110.00	3.37
440C	1960	(1)	11/65	3.10	573.00	3/69	3.40	1120.00	8/69	3.43	1200.00	12/69	3.35	1270.00	3.30
450C	1960	(1)	11/65	3.63	478.00	10/67	3.43	758.00	3/69	3.30	1002.00	8/69	3.36	1090.00	3.17
460C	1960	(1)	11/65	2.92	478.00	10/67	3.15	758.00	3/69	3.30	1002.00	8/69	3.34	1090.00	3.03
470C	1955	(9)	11/65	3.03	722.00	10/67	3.49	940.00	3/69	3.13	1120.00	8/69	3.22	1175.00	2.93
480C	1955	(9)	11/65	3.29	2125.00	3/69	3.39	3130.00	8/69	3.35	3300.00	12/69	3.56	3450.00	3.43
490C	1962	(9)	11/65	2.69	333.00	10/67	2.92	550.00	3/69	3.20	742.00	8/69	3.11	805.00	3.00
500C	1960	(9)	11/65	3.13	258.00	10/67	3.63	360.00	3/69	3.28	445.00	8/69	3.30	468.00	2.97
510C	1960	(5)	8/65	3.39	600.00	10/67	3.13	1020.00	1/69	3.41	1280.00	6/69	3.50	1350.00	3.12

TABLE 8

DEFLECTION AND MOISTURE CONTENT HISTORY FOR RIGID SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
10C	1962	(9)	2/69	1.19	25.60	740.00	6/69	0.92	20.60	760.00	9/69	0.95	10.10	822.00
20C	1960	(9)	3/69	0.93	19.40	740.00	6/69	0.89	7.80	766.00	9/69	1.99	11.00	804.00
30C	1962	(3)	3/69	0.96	16.20	208.00	6/69	0.83	15.20	217.00	9/69	2.02	18.50	226.00
40C	1959	(4)	1/69	1.48	10.40	1890.00	6/69	1.30	13.90	2000.00	9/69	1.50	15.40	2060.00
50C	1959	(4)	1/69	1.43	17.40	1580.00	6/69	1.06	18.90	1680.00	10/69	2.02	13.80	1770.00
60C	1956	(9)	1/69	1.44	11.20	3100.00	6/69	1.49	18.40	3300.00	9/69	1.32	10.00	3390.00
70C	1956	(C)	3/69	2.19	17.70	2850.00	6/69	1.60	19.30	2940.00	9/69	1.95	17.60	3030.00
80C	1955	(7)	3/69	1.38	16.60	2770.00	6/69	1.58	22.20	2820.00	10/69	1.31	22.60	2900.00
100C	1960	(5)	1/69	0.90	20.80	1260.00	6/69	1.10	42.30	1320.00	9/69	0.94	13.80	1370.00
110C	1961	(5)	1/69	1.03	17.90	1120.00	6/69	1.00	26.80	1230.00	9/69	0.76	15.40	1320.00
120C	1961	(5)	1/69	0.84	16.80	1110.00	6/69	0.83	17.10	1230.00	9/69	0.62	14.90	1320.00
130C	1955	(7)	3/69	1.70	15.00	2300.00	6/69	1.22	30.20	2340.00	10/69	1.22	23.20	2420.00
150C	1958	(9)	1/69	1.90	18.60	273.00	6/69	1.47	19.20	290.00	9/69	1.56	11.40	303.00
160C	1958	(9)	1/69	1.38	24.80	58.30	6/69	1.37	25.80	60.50	9/69	1.41	25.80	62.00
170C	1958	(6)	2/69	0.85	16.20	77.00	6/69	0.85	18.80	79.50	9/69	1.25	17.90	81.00
180C	1958	(6)	2/69	0.86	22.80	77.00	6/69	0.86	20.30	79.50	9/69	1.18	18.60	81.00
190C	1963	(6)	2/69	0.87	25.80	460.00	6/69	0.67	25.60	490.00	9/69	1.05	17.30	510.00
200C	1963	(6)	2/69	1.17	22.80	460.00	6/69	0.72	26.40	490.00	9/69	1.12	20.10	510.00
210C	1960	(9)	2/69	1.19	37.20	1670.00	6/69	1.14	39.20	1730.00	9/69	1.11	29.00	1780.00
220C	1962	(1)	2/69	0.68	23.10	940.00	6/69	0.71	23.70	1000.00	9/69	0.66	19.30	1050.00
230C	1962	(1)	2/69	0.70	24.20	940.00	6/69	0.82	23.60	1000.00	9/69	0.69	15.20	1050.00
240C	1963	(6)	3/69	0.95	26.50	690.00	7/69	0.78	18.60	765.00	10/69	0.87	25.80	830.00
250C	1963	(6)	3/69	0.74	21.70	690.00	7/69	0.67	22.70	765.00	10/69	0.75	21.90	830.00
260C	1958	(9)	3/69	0.88	17.90	760.00	7/69	0.88	21.20	770.00	10/69	1.38	17.40	779.00
270C	1961	(1)	3/69	0.72	22.30	810.00	7/69	0.74	26.20	865.00	10/69	0.99	13.60	910.00
280C	1962	(1)	3/69	1.17	20.90	980.00	7/69	1.40	19.30	1030.00	10/69	1.21	21.30	1080.00
290C	1962	(1)	3/69	1.47	23.00	900.00	7/69	1.31	23.50	950.00	10/69	1.51	19.20	998.00
300C	1957	(9)	3/69	1.61	37.40	498.00	7/69	1.14	25.10	510.00	10/69	1.25	18.90	520.00
310C	1957	(9)	3/69	1.23	57.00	232.00	7/69	1.15	21.00	240.00	10/69	1.23	35.60	247.00

TABLE 8

DEFLECTION AND MOISTURE CONTENT HISTORY FOR RIGID SECTIONS

SECT NO	YEAR CONST	BASE TYPE	DATE 1	DEFL 1	MC 1	LOAD 1	DATE 2	DEFL 2	MC 2	LOAD 2	DATE 3	DEFL 3	MC 3	LOAD 3
320C	1959	(9)	3/69	1.12	24.50	230.00	7/69	1.52	25.40	239.00	10/69	1.69	27.80	245.00
330C	1963	(9)	3/69	0.95	19.80	153.00	7/69	1.06	17.10	161.00	10/69	1.40	32.90	166.00
340C	1958	(9)	3/69	1.11	13.40	678.00	7/69	0.92	25.00	707.00	10/69	1.19	9.80	737.00
350C	1963	(9)	3/69	1.19	23.80	79.00	7/69	1.14	19.30	85.00	10/69	3.53	38.60	89.00
360C	1964	(9)	2/69	1.66	29.90	269.00	6/69	1.56	12.00	297.00	9/69	1.15	3.80	321.00
370C	1964	(9)	2/69	1.05	35.30	269.00	6/69	0.90	20.00	297.00	9/69	1.03	4.00	321.00
380C	1963	(1)	2/69	0.63	18.80	570.00	6/69	0.63	17.40	610.00	9/69	0.59	8.40	643.00
390C	1963	(1)	2/69	0.56	27.00	992.00	6/69	0.56	26.40	1065.00	9/69	0.59	1.70	1125.00
400C	1963	(1)	2/69	0.66	15.80	700.00	6/69	0.63	13.80	753.00	9/69	0.60	7.00	799.00
410C	1960	(1)	2/69	0.58	21.30	1110.00	6/69	0.55	22.20	1175.00	9/69	0.62	7.60	1220.00
420C	1960	(1)	2/69	0.66	19.90	1110.00	6/69	0.65	14.80	1175.00	9/69	0.69	4.80	1220.00
430C	1959	(1)	2/69	0.58	28.80	967.00	6/69	0.60	22.20	1020.00	9/69	0.66	14.40	1065.00
440C	1960	(1)	3/69	0.64	19.40	1120.00	7/69	0.58	9.30	1180.00	10/69	0.77	13.60	1225.00
450C	1960	(1)	3/69	0.76	19.10	1002.00	7/69	0.63	27.80	1070.00	10/69	0.89	10.40	1125.00
460C	1960	(1)	3/69	0.82	15.70	1002.00	7/69	0.62	12.00	1070.00	10/69	1.01	16.20	1125.00
470C	1955	(9)	5/69	1.10	19.00	1145.00	7/69	1.01	8.40	1170.00	10/69	1.09	16.00	1205.00
480C	1955	(9)	3/69	0.93	27.20	3130.00	7/69	1.22	14.40	3280.00	10/69	1.10	16.20	3380.00
490C	1962	(9)	3/69	0.68	26.20	742.00	7/69	0.88	28.80	795.00	10/69	0.85	9.40	830.00
500C	1960	(9)	3/69	0.65	31.40	445.00	7/69	0.99	8.80	463.00	10/69	0.96	17.40	482.00
510C	1960	(5)	1/69	1.08	19.20	1280.00	6/69	1.16	26.60	1350.00	9/69	1.01	11.30	1390.00