RECOMMENDATIONS FOR

LIFE-CYCLE MONITORING PROJECTS

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CHAPTER 1

INTRODUCTION

Experimental pavement sections have been designated or built, and detailed data on materials, traffic, weather, construction, and condition histories have been recorded on each section in a number of research studies for the Department. The effectiveness of different materials, methods of placement and thickness, and how they are influenced by the varying climatic conditions throughout the state can be discovered if these sections are monitored until the end of their life cycle, at which time the monitoring can be discontinued. If this is not done, all of the valuable performance data will be lost.

A recommendation that was made jointly on February 27, 1984 by the Texas Transportation Institute and the Center for Transportation Research to the chairman of the Research and Development Committee suggested the immediate initiation of a Type B study at each of the two institutions to establish detailed recommendations and work plans for the monitoring activity. The recommendation also suggested the formation within the Department of a Pavement Data User Committee which will supervise, review, and prioritize pavement sections to be incorporated into the monitoring effort. The research studies and pavement sections that are suggested in this proposal to be included in the TTI life-cycle monitoring effort will be subject to the approval and prioritization of this committee.

The two studies were initiated in July 1984, and have resulted in this report, which is a combined effort of the two research institutions. The report is separated into chapters covering recommendations on the composition of the Pavement Data Users Committee, life-cycle monitoring projects for both flexible and rigid pavements, standard data collection and coding formats, data management system, and the recommended work plan for the monitoring effort.

The Federal Highway Administration (FHWA) and the new Strategic Transportation Research Study (STRS) have both recommended Long-Term Monitoring as a high priority research effort and several initiatives have been started in the area. These initiatives include the recent publication of the FHWA Long-Term Pavement Monitoring Program Data Collection Guide (1), the two Long-Term Monitoring workshops that are to be held by the FHWA in October 1984 and February 1985, and the anticipated Long-Term Monitoring research effort that is expected to be a part of the Strategic Transportation Research Study.

In this project, the term "Life-Cycle Monitoring" has been used rather than "Long-Term Monitoring" principally to emphasize the need to keep the data collection and storage effort to a manageable minimum, which is an important objective of the FHWA and STRS Long-Term Monitoring efforts as well. The term "Life-Cycle Monitoring" means cutting off the monitoring effort on a particular section of pavement at the end of its life-cycle. Of course, all of the data collected over the life-cycle of the pavement section will be stored in a computer accessible form and the data will be maintained. But by discontinuing the monitoring effort on this pavement section, monitoring can begin on another pavement section which is considered to be important without increasing the overall monitoring effort in time and manpower. In this way, the monitoring effort can be kept to a minimum and thus make possible the efficient management of the effort to collect, code, and enter the data into a computer accessible file.

There are two types of data which must be collected in order to complete the description of a pavement section: inventory data and monitoring data. Inventory data consists of all data that does not change with time such as location, layer thickness, initial material properties, traffic prior to construction, construction history, certain climatic factors, and subgrade properties. Monitoring data are all of those data that change with time such as distress, ride, deflections, traffic, and some material properties.

Both types of data must be collected and stored for each pavement section. However, inventory data only needs to be collected once and is valid from that point on. These are the kind of data that should be collected in the project which initiated the study of a pavement section. Usually, the initiating project will also start collecting monitoring data, determine what data needs to be collected in addition to the standard monitoring data, develop standard data collection forms for recording these data items, and determine the best spacing in time between monitoring observations (say every 3 or 4 years, for example). At the end of the project, if the project meets the criteria set up for the Life-Cycle Monitoring project, and the Pavement Data Users Committee approves it, the pavement sections on which inventory data have been collected will pass over into the Life-Cycle Monitoring project and be monitored until they reach the end of their useful service life cycle.

Conclusions will be drawn and predictive or design equations will be developed from these pavement sections during the course of the Life-Cycle Monitoring project and periodic reports of trends will be generated using the computerized data files on which the data have been entered.

The above description is generally the way in which the Life-Cycle Monitoring project is envisioned to operate once it has been begun. The two Type B studies that were initiated in July 1984 at TTI and CTR were to develop specific recommendations on the details of the Life-Cycle Monitoring project. The objectives of those studies are described below.

OBJECTIVES OF THE STUDIES ON RECOMMENDING LIFE-CYCLE MONITORING PROJECTS

The two Type B studies that were initiated at both TTI and the Center for Transportation Research (CTR) have the following objectives:

a. Prepare a monitoring work plan for a minimum of twenty (20) years.

b. List the projects and pavement sections to be included in the initial monitoring effort.

c. List the dependent and independent variables to be monitored.

d. Establish a standard data collection and coding format.

e. Make recommendations on a data management system to be used by both Texas Transportation Institute and the Center for Transportation Research for consistency between agencies.

f. Suggest the composition of a Pavement Data User Committee and criteria for acceptance of pavement sections into the monitoring effort, to include both experimental pavement selection criteria and cross-sectional pavement selection criteria.

g. Prepare cost estimates for each phase of the work plan.

The standard data collection and coding format that will be established as objective (d) above, will be guided by the most recent version of the Federal Highway Administration's Long-Term Pavement Monitoring Program Data Collection Guide (1), and modified to accommodate the pavement evaluation techniques developed in Study 2-18-71-151 (2). Where required, detailed crack surveys will be performed, as required in the TTI projects on the Evaluation of Fabric Underseals and on Asphalt Rubber Binders. Each of these are described in detail in the following chapters.

CHAPTER 2

RECOMMENDED COMPOSITION OF THE PAVEMENT DATA USER COMMITTEE

It is the recommendation of the Texas Transportation Institute that the Pavement Data Users Committee should have designated representatives of the following:

Division 8 Highway Design

Division 9 Materials and Test

Division 10 Planning and Research

Division 18 Maintenance

Four Districts representing

1. Wet and dry climates
2. Urban and rural environment

Texas Transportation Institute, Texas A&M University

Center for Transportation Research, University of Texas

It will be the duty of this committee to consider and agree upon the pavement sections and research projects that should be incorporated into the Life-Cycle Monitoring efforts at each research institution. The committee will have to develop criteria for accepting pavement sections that are included in the Life-Cycle Monitoring projects suggested criteria given below.

SUGGESTED CRITERIA FOR ACCEPTING PAVEMENTS INTO LIFE-CYCLE MONITORING

Detailed criteria are probably not desirable for the selection process since the kinds of questions that can be answered only by Life-Cycle Monitoring will vary from year to year. However, there are several general criteria that all of the pavement sections should meet, as follows.

1. The subject to be studied with Long-Term Monitoring should be a potentially high payoff item of long term interest to the Department.
2. The inventory data that have been collected on each pavement section should be substantially complete.
3. The total number of pavement sections being actively monitored by both CTR and TTI should never exceed about 500.
4. The pavement sections in a given project should be selected to conform, as much as possible, to an explicit experimental design.
5. The pavement sections accepted into or remaining in the Life-Cycle Monitoring projects should be in accordance with priorities established by the Pavement Data Users Committee.

Despite the fact that these criteria are general, they cover most of the important aspects of the Life-Cycle Monitoring project.

CHAPTER 3

FLEXIBLE PAVEMENT LIFE CYCLE MONITORING PROJECTS

In this chapter, a number of projects that are candidates for the Life-Cycle Monitoring (LCM) effort will be reviewed in light of the criteria in Chapter 2 and recommendations will be made of which of these projects should be included in the LCM project.

REVIEW OF CANDIDATE PROJECTS

Texas Flexible Pavement Data Base

Since 1973, the Texas Transportation Institute (TTI) has maintained a Flexible Pavement Data Base composed of approximately 350 sections of pavement which were selected according to a stratified random statistical sampling procedure. Detailed inventory and monitoring data have been collected, coded, and stored in a computerized data base that has been maintained at TTI. Design and prediction equations have been developed from these data for asphaltic concrete pavements on unstabilized and on bituminous stabilized base courses, overlays on flexible pavements, and surface treated pavements. These equations have been put into FPS (Flexible Pavement System), PES (Pavement Evaluation System), and RENU, and have been used to make accurate projections of oil field truck damage in Study 2-8-81-299, "The Effect of Oil Field Development on Rural Highways," among other uses. Equations and survivor curves from this data base have been incorporated into the district and state optimization programs in the RAMS (Rehabilitation and Maintenance System). There were originally 53 overlaid pavements in the data base and now, over the period of time the data base has been maintained, there are over 90. This gives an excellent chance to determine the effect of the climate and the condition of the pavement prior to overlay upon the subsequent performance of the overlay.

This project meets all five criteria suggested in Chapter 2. The data from this data base have been used in numerous ways to assist the Department in planning, making cost estimates and long-range funding needs projections, and in pavement design in a variety of ways. For example, equations developed from this data base are in the new version of FPS (Flexible Pavement System) which uses the elastic modulus as property for each layer. Data from this data base was used to develop a design procedure for asphalt pavements to resist thermal fatigue cracking, a procedure that was developed and reported in TTI Research Report 284-4. The data were also being used in developing an overlay design procedure to take into account reflection cracking.

The data base and the many uses that have been made of it in the past satisfies the first criterion, that of a high-payoff item of long term interest to the Department. It also satisfies the second criterion since detailed inventory data have been collected and stored. It satisfies the fourth criterion in that all of the sections in the data base were chosen using a random sampling technique. Criterion 3 does not apply to a specific project but is suggested to limit the time and manpower effort that is required to manage the data monitoring effort.

Monitoring of Pavements on Expansive Clay

The monitoring of the performance of pavements on expansive clay in Project 207 and subsequently in Project 284 has led to a design equation for pavements on expansive clay that was presented in TTI Research Report 284-2. The design equation was based on observations of 23 sections of pavement scattered widely across east and central Texas to cover a broad range of climate and soil types. The equation did not consider the effect of vertical or horizontal membranes nor did it consider the effect of cut or fill because all of the original 23 pavements were constructed at ground level. Subsequently, monitoring began on several pavement sections in Districts 1 and 15 to determine the effect of vertical and horizontal membranes on reducing the roughness due to expansive clay subgrade. Moisture measuring instruments have been placed in several locations in San Antonio and have been calibrated for the locations in the Paris district but have not bee placed as yet. Soil samples have been taken from each of the sites in both Districts and laboratory tests of the soil properties have been made on most of them. There are a total of about 20 sites in all. Monitoring consists of periodic runs of the GM profilometer over each section, reducing the data to get several roughness statistics and periodic measurements of the field moisture inside and outside of the moisture barrier.

The effectiveness of vertical moisture barriers in reducing expansive clay roughness has been demonstrated conclusively but several questions remain. Can you make a moisture barrier by pressure-injecting lime or lime-fly-ash slurry? How deep does a moisture barrier have to be in order to be effective? The field experiments are already in place that can answer these questions if the monitoring is continued.

This monitoring project also meets all of the criteria for an LCM project. With another five years of monitoring, the important questions mentioned above can be answered and their answers will have a large, long-term impact on the costs of constructing and rehabilitating pavements on expansive clays, thus meeting the first criterion. The inventory data have already been collected on each pavement section, meeting the second criterion. The sites have been chosen to span a range of soil and climatic variables as well as several different treatments of vertical and horizontal moisture barriers, and thus meet the fourth criterion.

Monitoring of Experimental Projects

Over the past several years, the Texas Transportation Institute has been extensively involved in evaluating new paving materials and construction techniques. Typically, trial sections are laid, the first two or three years of performance data are collected and conclusions are reported. Rarely is any additional performance data collected once the initial project has expired. On several of these studies, valuable information can be gained by continuing the data collection efforts.

As examples of this, thick hot-mix surface or base layer experiments do not usually start exhibiting distress until after 6 or 7 years in service. New materials such as sulflex and fly ash have shown promise in the short term, but their long term performance is largely unknown. Many sections have been placed to investigate techniques of reducing reflection cracking, including the use of fabric and asphalt rubber underseals. The cost effectiveness of these treatments can only be fully determined by extended monitoring, in which it can be established whether a longer pavement life offsets the initially higher cost of the treatment.

Monitoring of Fabric Underseal Sections

Study 2-9-79-261, "Evaluation of Fabric Underseals," has produced a comprehensive research report (3) describing the laboratory and short-term field test results from the four field test pavements. Laboratory work conducted in this study produced the research report entitled, "Laboratory Evaluation of Selected Fabrics for Reinforcement of Asphaltic Concrete Overlays" (4). This document describes the preliminary development of a design method particularly for overlays containing a fabric interlayer.

During the course of this research program, fabrics were installed in five field test projects in Districts 4, 7, 10, 11, and 21 to delay and/or reduce the severity of reflection cracking. These field test projects have been observed for four years or less and show no substantial evidence to indicate any advantage or disadvantages provided by fabrics. In fact, the test project in District 10 is showing no cracking; those in Districts 7, 11, and 21 are showing only a very few isolated cracks; and the one in District 4 is showing moderate cracking. However, there are no quantifiable differences in test sections containing fabrics and the control sections. Typically, realistic evaluations of field test pavements require considerably longer than four years. Annual observations of the test sections should be continued until realistic estimates of the benefits of the different fabrics tested can be established.

Other pavement sections have been placed with and without fabrics to determine the effect of the latter but detailed monitoring has not taken place on these sections. An overlaid section of jointed concrete pavement on US 59 under very high traffic in District 12 has Petromat under the lanes in one direction and no fabric under the lanes in the other direction, and has been in place for five years. The fabric-protected lanes have suffered virtually no distress while the other lanes have had numerous patches near the joints of the old concrete pavement. No inventory data have been collected on this pavement section and it was not placed as part of an overall experiment.

This project meets one of the three technical criteria for the LCM project, i.e., it represents an important long-term interest of the Department in preventing or retarding reflection cracking. Some inventory data have been collected on the sections monitored by TTI but not on most of the others, thus, in general, failing to meet the second criterion. The fourth criterion is not met by these sections since they were not designed or built as part of an overall experiment.

Monitoring of Fly Ash Experimental Projects

In Study 2-9-79-240, "Fly Ash Experimental Projects," over 50 pavement sections have been placed in a variety of climatic zones and under different levels of traffic using several different lime and fly ash mixtures in the sub-base. Only the long-term performance of these pavements will show the most cost effective use of fly ash. TTI Research Report 240-4 has given details of the results of this study up to the present time.

This study meets two of the three technical criteria and possibly the third. The study was conducted in accordance with an experimental plan, and detailed inventory data have been collected on all of the test sections. The third criterion, that of a high payoff item of a long-term interest to the Department is one that is not clearly discernible at present, although it may become important in the future. At that time, these sections can be brought into the LCM effort and monitoring can be initiated.

Monitoring of "Stability" Projects

In Study 2-9-80-285, "Asphalt Concrete Mixture Design and Specification," a total of 45 sections of pavement were designated for a study of the relationships between rutting and material properties that control the in-service stability of mixes. On none of these sections has there been sufficient time to evaluate the effect of the study variables upon pavement performance and serviceable life. TTI Research Report 285-4 has been submitted for review giving the details of the study thus far.

This project meets two of the three technical criteria for the LCM project. The first criterion, that of long-term interest and potentially high payoff and the fourth criterion, conformation to an experimental plan are met by this project. However, the second criterion concerning the collection of all of the relevant inventory data items has not been met up to the present time.

Monitoring of Asphalt Rubber Binders Project

It is expected that Study 2-9-83-347, "Asphalt Rubber Binders," which is due to terminate in this fiscal year and which has been designed and constructed very carefully in accordance with an experimental design, will be an excellent addition to this life-cycle monitoring study.

As with the Fabric Underseals project, the long term interest in retarding reflection cracking is high as is the potential payoff in extending the useful life of overlays. In addition, detailed inventory data have been collected on each site and each section in the study. Because of this, it meets all three technical criteria for the life-cycle monitoring project. A total of 42 test sections are involved on 3 sites in different locations in Texas. There are 10 sections in El Paso; 14 sections in Buffalo which have been placed only recently; and 18 sections in Brownsville; for a total of 42 test sections. Detailed crack maps of each section were made by photologging prior to the placement of the overlays and periodic photologging runs should be made during the monitoring effort in order to determine which cracks, and how many of them, reflect through the overlay.

SUMMARY

It is recommended that the Texas Flexible Pavement Data Base sections, the pavements on expansive clay sections, and the asphalt rubber binder sections should be included in the Life-Cycle Monitoring Project with the Texas Transportation Institute.

CHAPTER 4

RIGID PAVEMENT LIFE-CYCLE MONITORING PROJECTS

CHAPTER 5

STANDARD DATA COLLECTION AND CODING FORMAT

In this chapter, a typical list of variables that should be collected on every section of pavement that enters the Life Cycle Monitoring project. In some cases, it will be unnecessary to collect all of the data in the list and in other cases several additional items of data will need to be collected. The list of inventory data items shown in Table 1 was extracted from the recently published FHWA Long-Term Pavement Monitoring Program Data Collection Guide (1) which is included in this report as Appendix D. This list is regarded as a minimum acceptable list of data items. It is expected that each project will add its own specialized list of inventory data, develop data forms on which the data can be recorded. Lists of such forms are given in a subsequent section of this chapter.

Table 2 is a list of monitoring data that is regarded as a minimum for all LCM projects and is also taken from the FHWA Data Collection Guide (1). It is expected that each project that is accepted into the LCM project will develop data recording forms for specialized data that is unique to the project.

Table 3 is a list of the minimum inventory data that should be collected whenever an overlay, restoration, or other rehabilitation method is part of the Life Cycle Monitoring project.

FEDERAL HIGHWAY ADMINISTRATION LONG-TERM MONITORING DATA COLLECTION GUIDE

A copy of the Data Collection Guide is included in this report as Appendix D. The standard inventory data recording forms that are included in this Data Collection Guide are listed in Table 4. These standard sheets are referred to subsequently in Chapter 6 which is concerned with the computerized data management system. Table 5 gives a list of the standard monitoring data recording forms that are included in the LTM Data Collection Guide. These will also be referred to in Chapter 6.

In addition to these standard data recording forms, there are other inventory and monitoring data recording forms which are appropriate for the projects that have been recommended for the Life-Cycle Monitoring project. These sheets are described in the following sections of this chapter.

Additional Data Recording Sheets for Flexible Pavements

Several additional sheets for recording flexible pavement will be necessary to accommodate the special studies that have been conducted at TTI. Some of these are for inventory data and others are for monitoring data.

Inventory Data Recording Sheets.

Three inventory data sheets appear to be useful; one having to do with the structural design of pavements and overlays, another having

Table 4. Standard Inventory Data Recording Forms From the FHWA-LTM Data Collection Guide

Sheet No.	Data on Sheet
1	Project and Section Identifier
2	Geometric, Shoulder, and Drainage Information
3	Layer Descriptions
4	Age and Major Pavement Improvements
5	Rigid Pavement Layers, Original Surface or Overlay, Joint Data
6	Rigid Pavement Layers, Joint Data (Continued)
7	Rigid Pavement Layers, Reinforcing Steel Data
8	Rigid Pavement Layers, Concrete Data
9	Rigid Pavement Layers, Concrete Data (Continued)
10	Rigid Pavement Layers, Concrete Data (Continued)
11	Asphalt Concrete Layers: Overlay, Original Surface, Binder Course, or Asphalt-Stabilized Base Aggregate Properties
12	Asphalt Concrete Layers: Overlay, Original Surface, Binder Course, or Asphalt-Stabilized Base Asphalt Properties
13	Asphalt Concrete Layers: Overlay, Original Surface, Binder Course, or Asphalt-Stabilized Base In-Place Mixture Properties
14	Asphalt Concrete Layers: Original Surface, Binder Course, or Asphalt-Stabilized Base Dynamic Moduli
15	Asphalt Concrete Layers: Overlay, Original Surface, Binder Course, or Asphalt-Stabilized Base Tensile Strength
16	Unbound or Stabilized Base or Subbase Material Description
17	Subgrade Data
18	Subgrade Soil, Base, or Subbase Resilient Moduli

Table 4. Standard Inventory Data Recording Forms From the FHWA-LTM Data Collection Guide (Cont'd)

Sheet No.	Data on Sheet
19	Environmental Data
20	Environmental Data (Continued)
21	Maintenance Data
22	Traffic Data
23	Traffic Data: Vehicle Classification, Percent of Truck Volume by Truck Type
24	Traffic Data: Typical Axle Loads by Vehicle Class
25	Traffic Data: Summary Axle Load Distributions

Table 5. Standard Monitoring Data Recording Forms From the FHWA-LTM Data Collection Guide

Sheet No.	Data on Sheet
1	Roughness, Skid, and PSI Measurements
2	Distress Survey for Pavements With a Flexible Surface
3	Rutting Surveys for Pavements With a Flexible Surface
4	Distress Survey for Pavements With Jointed Rigid Surfaces
5	Transverse Joint Faulting Survey for Rigid Pavements (JRCP/JCP only)
6	Distress Survey for Rigid Pavements With Continuously Reinforced Rigid Surfaces
7	Data on Deflection Device, Air Temperature, and Date of Measurement
8	Deflection Measurements
9	Maintenance Data
10	Major Pavement Improvement During Monitoring Year
11-22	Rigid Overlay Monitoring Sheets
23	Environmental Data for Monitoring Year
24	Traffic Data
25	Traffic Data: Vehicle Classification, Percent of Truck Volume by Truck Type
26	Traffic Data: Typical Axle Loads by Vehicle Class
27	Traffic Data: Summary Axle Load Distributions

to do with the chemical and compositional characterization of asphalts, and the third related to expansive clay properties.

The structural design sheet will record the mechanical properties of each pavement layer that contributes to rutting, fatigue cracking, and fracture. These include the FHWA VESYS characterization properties: the rutting properties of each layer μ and α; the fatigue properties, K_1 and K_2; the creep compliance curve and its temperature-shift constant, β; and the fracture mechanics properties, A and n.

The chemical and compositional analysis sheet will record the data from gel permeation or high pressure liquid chromatograms giving the ordinates of the chromatograms for various molecular weight fractions of the asphalt; the sheet will also give the composition of each molecular weight fractions between maltenes and volatiles.

The expansive clay inventory sheet would include additional soils and climatic data such as the cation exchange capacity, exchange sodium percentage, percent fine clay, depth of cracks or active zone, depth and type of moisture barrier, range of Thornthwaite Index, probability of drought, and other such climatic variables.

Monitoring Data Recording Sheets.

Three monitoring data recording sheets are suggested by the projects that are recommended for the Life-Cycle Monitoring project. One of these sheets will record pavement texture data, another will record photologged pavement condition data, and the third will record roughness spectral data for pavements on expansive clays.

The pavement texture sheet will record detailed information on tests made of the pavement surface texture including putty and sand patch measurements and other friction measurements.

The photologged pavement condition sheet will record crack length and width statistics and the percent of the original length of crack that has reflected through the overlay.

The expansive clay roughness sheet will include data from both wheel paths from the GM profilometer runs. This includes data points on the relation between amplitude and wave length, mean bump height, auto correlation constant, and decorrelation distance.

Additional Data Collection Sheets for Rigid Pavements

CHAPTER 6

PROPOSED AUTOMATED SYSTEM

In order to maintain and effectively utilize the data collected for life-cycle pavement monitoring, the data must be automated in a form that is consistent and easily accessible to the three agencies involved in this long-term study. A national standard for data elements required for pavement inventory and life-cycle monitoring has been developed for FHWA by Rauhut, Lytton, and Darter (1). In order to be consistent with these standards, the Texas pavement life-cycle monitoring (PLM) system has been designed to incorporate these data elements (Appendix D), as well as location identification specific to the State of Texas.

PLM SYSTEM OVERVIEW

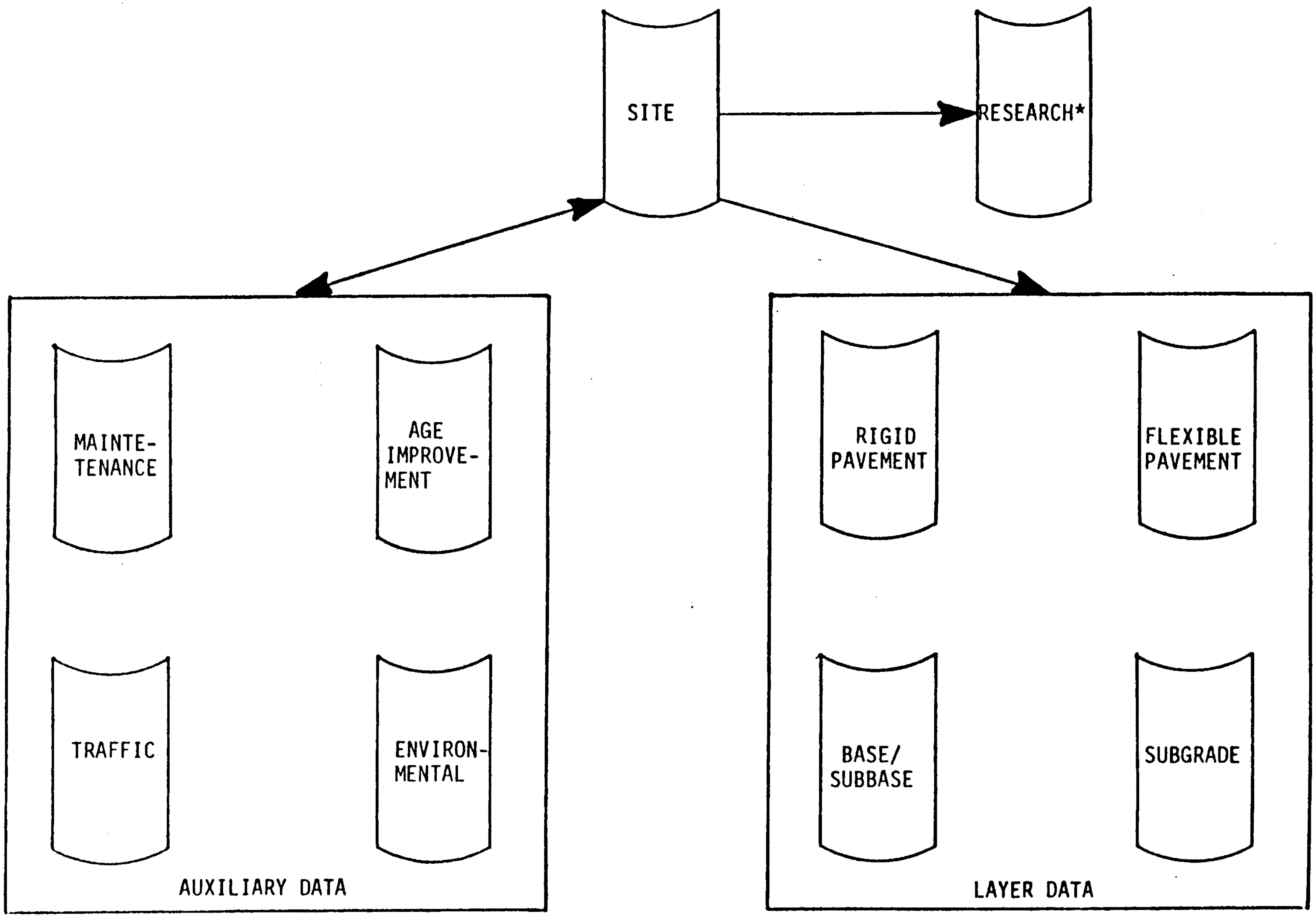
The proposed automated system for pavement life-cycle monitoring (PLM) system will meet the following major requirements:

1. The Department and the two research agencies will be able to enter, maintain, and access pavement inventory and monitoring data as needed.
2. All three agencies will have available the hardware and software required for PLM.
3. The PLM system will be flexible enough to add and delete special research files, as required, using the basic database structure.

Although each user of this system has specific needs, these requirements represent the general concerns of all three agencies.

Figure illustrates the conceptual database design for PLM. As designed, this is a stand alone system without interfaces to existing automated files. As Departmental files are designed in the future with sufficient detail, interface with other automated systems can be added to PLM. All the data elements to be used in PLM have been defined in the previously mentioned study for FHWA. Definitions of each record type that will be incorporated into the database are provided in Table 6. The following assumptions have been made about the system structure and the relationship of the record types to each other:

1. Segments of pavement to be monitored, known as sites, will be 200 feet in length and only one lane. There may be three or more such sites in each 2-mile section of pavement. The 200 ft. length will be centered on a milepost.
2. The traffic record may be related to more than one site, if the sites are in close proximity.
3. The maintenance record may be related to more than one site, if the sites are in close proximity.
4. The age/improvement record may be related to more than one site, if the sites are in close proximity.
5. The environmental record may relate to more than one site, if more than one site exists in a single county.
6. More than one layer of the site may be rigid pavement.
7. More than one layer of the site may be base or subbase.
8. Only one layer of a site will be subgrade.



——▶ Denotes data for one site

◀——▶ Denotes data that may apply to more than one site

* Specialized Research files to be defined as required

FIGURE PLM DATABASE STRUCTURE

Record Type	Description	Data Entry Sheets from Data Collection Guide for Long-Term Monitoring ( ) — Inventory Sheet	Monitoring Sheet
Site	Description, location, and site specific data for 200-foot, 1-lane monitoring section	1,2	N/A
Age/Improvement	Construction data and both inventory and monitoring record of major pavement improvements	4	10
Rigid Pavement	Data specific to rigid pavement layers, (inventory and monitoring)	3,5,6,7,8, 9,10	1,4,5,6,11,12, 13,14,15,16
Flexible Pavement	Data specific to flexible pavement layers, (inventory and monitoring)	3,11,12,13, 14,15	1,2,3,7,8,17, 18,19,20,21
Base/Subbase	Data specific to base or subbase layers (inventory and monitoring)	3,16,18	22
Subgrade	Data specific to subgrade level	3,17,18	N/A
Environmental	Annual climate data	19,20	23
Maintenance	Data pertaining to maintenance activities	21	9
Traffic	Data pertaining to vehicle count and classification	22,23,24,25	24,25,26,27
Research	Specialized data to be determined for specific experimental projects		

Table 6. PLM File Description

9. Inventory and monitoring data will exist on the same record type when the data is essentially the same for both activities.

10. Research records will be defined as needed for a particular purpose.

Hardware

Funding restrictions for collection of data will necessarily restrict the size of the PLM system to a relatively few number of sites at any one time. For this reason, use of microcomputers at all three agencies is the most cost effective and flexible alternative of hardware for managing the PLM data. Specifications for a suitable microcomputer are presented in Appendix E.

Examples of currently available microcomputers that will meet the general specifications include, among others, the following:

1. IBM/XT
2. COLUMBIA MPC
3. COMPAQ DESKTOP
4. Texas Instruments/PC

The requirements for microcomputers which meet the provided specifications is as follows:

Agency	Number of Microcomputers	Process
SDHPT	2	data entry & reporting
CTR	2	data entry & research
TTI	2	data entry & research
TTI	1	system development and maintenance

Software

In order to combine the ten record types into a logical format that can easily be used by all three agencies, it will be necessary to use a database management system that will establish the data relationships in a manner that is "transparent" to the user of the system. The relationships of the various record types precludes the use of a hierarchical database structure, so only network and relational database structures were evaluated for this study. All three types of database software are available on mainframe computers, mini-computers, and microcomputers. Even though use of microcomputers is recommended, the conceptual design presented will apply to any size machine depending on the specific software package selected.

Several commercially available database software packages for network or relational file structures were evaluated for this study. The three that show the most potential for this application are:

1. OMNIBASE - a relational database structure with a statistical processing language based on SAS
2. PC/FOCUS - a relational database structure with English-type reporting language for the non-programmer
3. MDBS III - a network database structure with powerful capabilities for handling complex data relationships

All three of these software packages are suitable for this application and all three will run on the recommended microcomputer. The primary advantage of OMNIBASE is the statistical capability of the package which is based on the Statistical Analysis System (SAS). The primary advantage of PC/FOCUS is the ease of ad hoc reporting for the non-programmer. The primary advantage of MDBS III is the powerful data base capabilities to handle the complex data required for the PLM system. Evaluation packages of these three database management systems have been ordered. A test database will be developed to verify the capabilities of each system in the second phase of this study. At that time a final choice can be made.

Source of Information

In order to meet the requirement of a responsive life-cycle monitoring system, all categories of data must be collected and maintained for the selected sites (Figure). While sites to be monitored can be recommended by all three agencies, approval to add a site to the PLM system must come from the Pavement Data Users Committee. Once a site has been approved by the Committee, a team of technicians assigned to life-cycle pavement monitoring activities will begin assembling the required data. It is anticipated that some data will be available in project files, some will be available in Departmental files, and other data must be obtained from the site itself.

A basic data entry program has been developed by Brent Rauhut, Engineering, Inc. for the coding sheets used for the standard data elements required for pavement life-cycle monitoring. This program will be modified to include extensive edits of the data, and will be used by the pavement monitoring team to enter the initial data to the PLM system. Copies of all data available in the PLM system will be

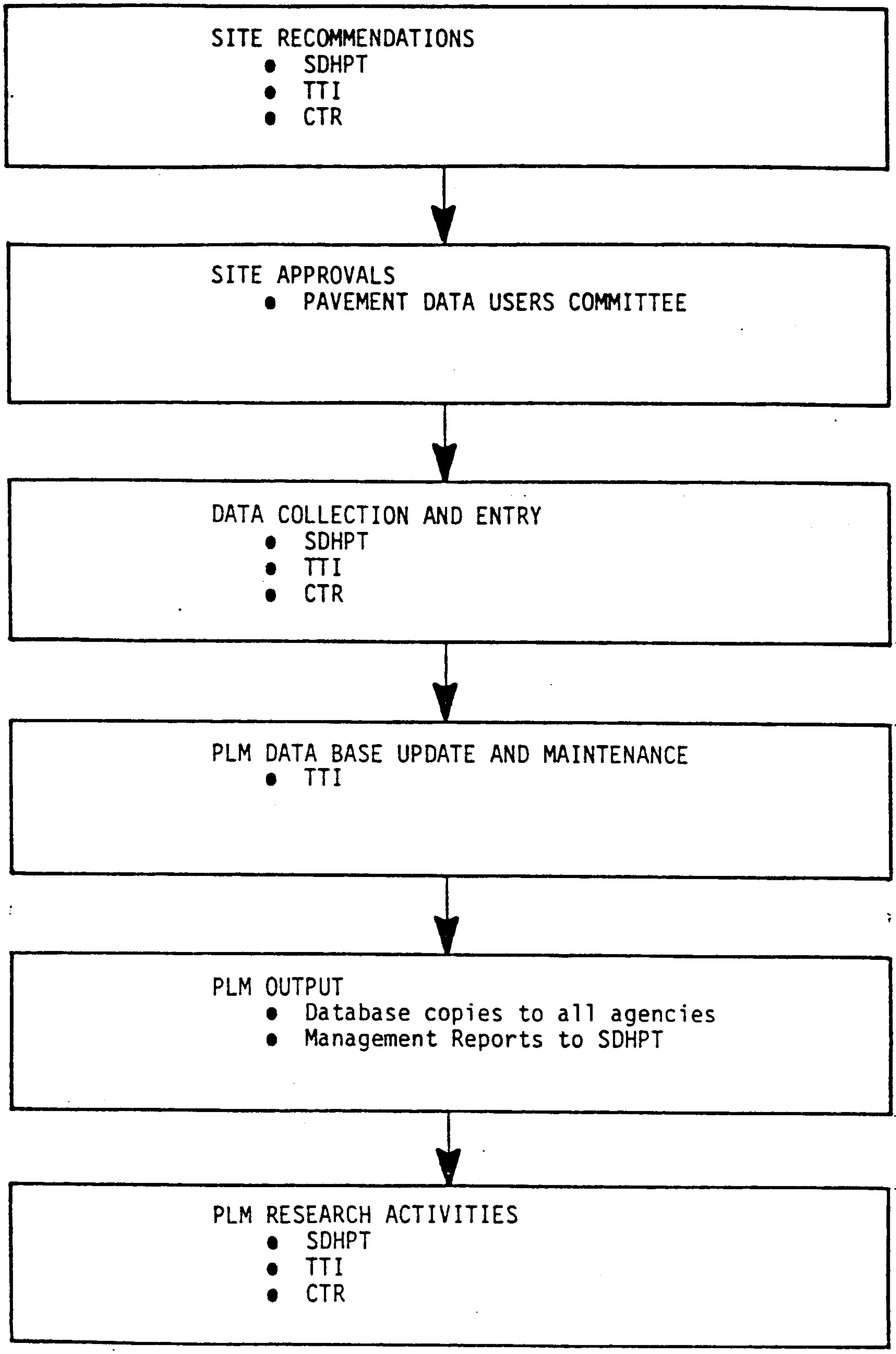


FIGURE . CONCEPTUAL DATA FLOW.

transmitted on a routine basis to all three agencies.

PLM Reporting

There will be many research uses of the data in the PLM system, such as modeling, that will require ad hoc reporting. There are, however, standard reports that will be produced to manage the system.

Control Reports.

Control reports for the PLM system are divided into two categories: rejected and accepted. These reports, to be designed during the second phase of this study, are produced during the process to update the PLM database.

The rejected report will show any inventory or monitoring data that could not be added to the PLM system due to errors. Corrections of any errors indicated on the rejected report can then be made on-line. The accepted report will list all updates made correctly and applied to the database file.

Status Reports.

The status reports will provide at the user's request, a detailed or summary report of all or selected sites on the PLM system. These reports, to be defined in the second phase of this study, will also indicate when a site is due for an update of the monitoring data or when a site is due to be removed from the monitoring process.

Exception Report.

An exception report will be produced when a monitoring site is significantly overdue for new measurements to be taken. This report will provide a control mechanism to ensure that appropriate monitoring data is collected for all selected sites.

Ad Hoc Reports.

The PLM system has been designed to provide the capability for the user to produce ad hoc reports, as needed using the database query language or other microcomputer languages of preference to the user. In addition, the capability for creating a file to be used on the mainframe computer will be included for those users who prefer to use SAS or another language available on a larger machine.

Data Processing Requirements

The Pavement Life-Cycle Monitoring System will require an MS/DOS or PC/DOS operating system. This environment is available on hardware that meets the specifications provided in Appendix E. In addition, it is anticipated that specified research projects will also require the use of a mini-computer or mainframe computer that handles SAS software.

Processing.

Collection of data for the selected sites will continue throughout the year. At a minimum of once a month, copies of the updated PLM database will be provided to all three agencies.

Disk Storage Requirements.

The requirement for disk storage is anticipated to be approximately thirty megabytes, which is available in hard disks for the specified microcomputers. This storage requirement is for each of the three agencies involved in this system.

Communication Requirements.

Communication between the three agencies' systems will be in two forms. The 1600 bpi tape drive system specified for each agency can be used to load, transfer, and unload the updated database at the new location. In addition, auto-answer modems attached to each system will allow communications to be performed by telephone lines. Since the second method is slower and will lock out other users of the system, it is recommended that the first method be used unless an emergency arises that requires immediate transmission of an updated PLM database.

The requirement for 1600 bpi magnetic tapes is as follows:

Agency	Number of Tapes	Process
SDHPT	2	monthly file backup
SDHPT	4	data transfer
TTI	2	monthly file backup
TTI	2	data transfer
CTR	2	monthly file backup
CTR	2	data transfer

Only one tape drive will be required for each agency, regardless of the number of microcomputers required.

CHAPTER 7

MONITORING WORK PLAN

Four separate studies are envisioned as part of the overall Life-Cycle Monitoring project, as follows:

1. Design and creation of a data management system
2. Monitoring of flexible pavement projects and updating design and predictive equations and trends
3. Monitoring of rigid pavement projects and updating design and predictive equations and trends
4. Monitoring traffic data.

Summary work plans for each of these separate studies have been prepared and are presented in this chapter.

DATA MANAGEMENT SYSTEM

The design and creation of a data management system to meet the requirements described in Chapter 6 is estimated to require a total of three years. Actually, most of the work could be accomplished in about one year, but it is considered wiser to stage the development of the data management system over a three year period in order to keep the expenditures for the Life-Cycle Monitoring projects to a reasonable level. Two tasks have been described for this Data Management System project, as described below.

Task 1.0 Create the Pavement Research Information File

This task will be to design and create the pavement research information file that will be used by the Department, TTI, and CTR. This task will use the results of the two Type B studies performed by TTI and CTR and will be concluded in the first year of this study.

Subtask 1.1 Design the File Structure. This subtask will use the recommendations made under the two Type B studies to design an automated file structure to store the required pavement research information. The system design specifications will document the proposed Pavement Research Information File that will be used by all three agencies to store data for life-cycle pavement monitoring.

Subtask 1.2 Design Programs to Access the File. This subtask will design and document the program specifications for the file structure designed under Subtask 1.1. The required programs will include methods to enter and edit the data to be collected, as well as detailed and summary reports of the data that is stored in the file.

Subtask 1.3 Programming for the Pavement Research Information File. Based on the detailed design and program specifications documented in Subtask 1.1 and 1.2, the required file structure will be created and the necessary computer programs to manage the data will be written and documented.

Task 2.0 Code Data into Pavement Research Information File

A separate task, Task 1.0, will design a file structure that can be used by the Department, TTI, and CTR and will develop input and edit programs to enter the collected pavement information into the file, and will also develop report routines to provide detailed or summary information from the Pavement Research Information File. This task will make use of the results of Task 1.0 in the following two subtasks.

Subtask 2.1 Code and Enter Existing Data. This subtask is to enter all pavement data that have been collected through August 1984, into the Pavement Research Information File. This includes converting the existing TTI Flexible Pavement Data Base into a form that is suitable for the new Pavement Research Information File, as well as coding in the data that have been tabulated in any other studies that are designated by the Pavement Data Users Committee. The data to be coded will include both inventory and monitoring data.

Subtask 2.2 Code and Enter Monitoring Data. This subtask is to enter all data that are collected in the monitoring effort into the Pavement Research Information File. This includes deflection, distress, traffic, measured material properties for cores, and others.

The second task of this study will require a two-year period to complete after Task 1.0 has been finished.

LIFE CYCLE MONITORING OF FLEXIBLE PAVEMENT PROJECTS

A detailed work plan of this project must await a decision by the Pavement Data Users Committee on which of the pavement projects are to be monitored during the fiscal year 1984-85. However, the four tasks to be accomplished will be the same, regardless of the designations made by the Committee. These tasks are described below.

Task 1.0 Experimental Design of Experimental Projects

This task is to set up a statistical experimental design for the more important types of pavements in the State and to select pavement sections that fit into the experimental design so as to represent as unbiased a cross-section of these types of pavement as possible. Major variables that will be considered in developing the experimental design are the level of traffic, the thickness of the pavement, and the climatic zones, of which there are four in Texas differentiated by moisture availability and freeze-thaw activity. This experimental design will be developed so as to be able to recommend to the Pavement Data Users Committee what types of pavements and in what locations should be selected for being included in the life-cycle monitoring effort. It is expected that among the first types of pavement that will be subjected to the experimental design will be asphalt overlays over flexible pavements. This task will be completed in the first year of the study.

Task 2.0 Data Collection

This task will require a major part of the effort in this project. As the project proceeds, subtasks will be identified by number to designate each of the studies that have been incorporated into the life-cycle monitoring effort. Thus, each year there will be a data collection plan for each subtask which corresponds to each study that has been adopted. Data collection will include distress condition surveys, measurement of serviceability index, deflection measurements, detailed crack maps, and other measurements as required by the nature of the project. The specific subtasks that will be performed during fiscal year 1984-85 must await a decision by the Pavement Data Users Committee. The following list of subtasks is subject to revision in light of that decision.

Subtask 2.1 (284). This subtask will collect distress and serviceability index data on 120 pavement sections of the original 350 sections in the Texas Flexible Pavement data base in Study 284, "Flexible Pavement Data Base and Design." The construction records on each of these pavements will be updated. To the extent possible, all pavements in the original Flexible Pavement data base that are to be overlayed will be tested with the Dynaflect or preferably with the Falling Weight Deflectometer. Emphasis this next year will be on overlays and pavements about to be overlayed and on monitoring the test sections on expansive clays in Districts 1 and 15.

Subtask 2.2 (347). This subtask will collect distress and serviceability index data and arrange for photologging to be done on each of the asphalt rubber binder test sections. The photologging runs will be converted into detailed reflection crack maps. There will be no need to collect any of these data until fiscal year 1985-86, and thereafter once every two years until the test sections have either reached 60 percent reflection cracking or ten years, whichever comes earlier.

Even though the following subtasks are not recommended for the Life-Cycle Monitoring project, they are listed here in case the Pavement Data Users Committee decides that some of them should be included in the LCM project.

Subtask 2.3 (240). This subtask will collect distress and serviceability index data on 20 of the 50 pavement sections that were originally in Study 240, "Fly Ash Experimental Projects." The time spacing on all observations should be three years and a new set of deflections with temperature measurements needs to be made in fiscal year 1985-86.

Subtask 2.4 (261). This subtask will collect distress and serviceability index data of pavements in all five sites of the original Study 261, "Evaluation of Fabric Underseals," and make detailed crack maps of those overlays which have suffered reflection cracking. Observations of cracks on these sections should be made each year until the percent of reflected cracks equals 60 percent or more.

Subtask 2.5 (285). This subtask will collect distress and serviceability index data on all of the 48 pavement sections on which stability is being studied. Observations should be made on each section once every three years. Detailed inventory data on construction history, layer thickness and properties, climatic data, and traffic data will need to be collected as well.

Task 3.0 Updating Pavement Design and Prediction Capabilities

This task will be a continuing effort to update pavement prediction and design equations as new sets of data are added, to incorporate these equations into appropriate network (RENU, PES, RAMS) and project level (FPS) programs which estimate costs, service life, funding needs, special use truck traffic impacts, and operational planning needs.

In this first year of the monitoring effort, it is expected that overlay design equations will be updated and incorporated into the FPS (Flexible Pavement System). It is also expected that a design equation for pavements on expansive clays which takes into account the effect of moisture barriers will be completed.

Updating these equations and predictive capabilities is an essential element of the Life-Cycle Monitoring project and can only be accomplished satisfactorily when sufficient high quality data have accumulated.

Task 4.0 Reports

Reports will be produced annually as inspections are conducted and will include the long-term trends and assessments of the performance of the various types of pavements that have been expected. The person who will be responsible for producing the trend reports for particular types of pavements will be, as much as possible, the original Study Supervisor of the study which made the initial investigation of that type of pavement.

LIFE CYCLE MONITORING OF RIGID PAVEMENT PROJECTS

COLLECTION OF TRAFFIC DATA

CHAPTER 8

CONCLUSION

There are several important objectives of the Life-Cycle Monitoring projects at the Texas Transportation Institute and the Center for Transportation Research, some of which are listed below. The objectives of LCM are to:

a. Design and create a file structure to accomodate the dependent and independent variables defined under the Type B studies.

b. Collect and code monitoring data on sections of pavement in experimental projects that are due to terminate in August 1984, or have previously terminated.

c. Collect and code monitoring data on a cross-section of pavement types and influential variables.

d. Collect and code monitoring data for experimental and cross-sectional pavement sections that meet the selection criteria established under the Type B studies and are approved by the Pavement Data Users Committee.

e. Update pavement prediction and design equations as new sets of data are added; incorporate these equations into appropriate network and project level programs which estimate costs, service life, etc.

The implementation of the results of this study requires close coordination between the Study Supervisor, the Study contact personnel, and the Pavement Data Users Committee.

The programs that are written to generate reports from the Data Management System will be written to provide current and useful information from this project. An annual report will be prepared showing the trends of the data for each type of pavement section included in the monitoring effort. A report summarizing long term performance of experimental treatments will be of immediate use to the State's Pavement Management activities.

Updated design and prediction equations will be inserted into the appropriate network and project level programs in use by the Department.

Numerous benefits are expected to come from the LCM projects at TTI and CTR including some of the following.

1. Reports of long-term trends in experimental pavement performance will be available to the Department.
2. Standardized procedures for assessing and coding the performance of experimental pavement sections will be developed. This will make the data available and usable by the Department for future purposes, some of which are still unknown or only dimly foreseen.
3. Network and project level programs that assist in pavement design, funding estimates, operational planning, estimating special use truck impacts, and so on will be updated systematically.
4. The investment of the construction and research funds that have been expended on experimental projects will be preserved, and useful information about new materials construction and performance will be available to the Department.

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APPENDIX A

COST ESTIMATES - LIFE-CYCLE MONITORING OF FLEXIBLE PAVEMENTS

The estimates are made in constant dollars, not taking into account the rate of inflation.

The basis of the cost estimate is the collection of distress and ride data on 150 pavement sections per year. The cost of photologging and making deflection measurements is calculated separately.

Year	Monitoring Activity (No. of Pavement Sections) Distress	Ride	Photolog	Deflect	Update (No. of Equations)	Estimated Cost
1984-85	150	150			2	100,000
85-86	150	150	30	50		125,000
86-87	150	150		50	3	115,000
87-88	150	150	30	50		125,000
88-89	150	150		50	3	115,000
89-90	150	150	30	50		125,000
90-91	150	150		50	3	115,000
91-92	150	150	30	50		125,000
92-93	150	150		50	3	115,000
93-94	150	150	30	50		125,000
94-95	150	150			3	110,000
95-96	150	150		50		110,000
96-97	150	150			3	110,000
97-98	150	150		50		110,000
98-99	150	150			3	110,000
1999-2000	150	150		50		110,000
2000-01	150	150			3	110,000
01-02	150	150		50		110,000
02-03	150	150			3	110,000
03-04	150	150		50		110,000

APPENDIX C

COST ESTIMATES - DATA MANAGEMENT SYSTEM

This estimate is made based on a three-year study, the first year of which will be involved in designing and programming the system including data entry and reporting programs, and the second and third year of which will involve coding and entering data from existing sources.

Year	Tasks	Estimated Costs
1984-85	Task 1.0	40,000
85-86	Task 2.0	50,000
86-87	Task 2.0	50,000

Appendix D

Long-Term Pavement Monitoring Program

Data Collection Guide

U.S. Department of Transportation
Federal Highway Administration

1984

NOTICE

PREFACE

This work was accomplished by Drs. J. Brent Rauhut and Peter R. Jordahl with Brent Rauhut Engineering Inc. of Austin, Texas; Dr. Michael I. Darter with ERES Consultants, Inc. of Champaign, Illinois; and Dr. Robert L. Lytton with the Texas Transportation Institute. The FHWA had already developed a preliminary data collection guide, entitled "Long-Term Pavement Monitoring Program, Data Collection Guide" for use by selected state highway agencies in the LTM pilot studies. This new data collection guide reflects the current state of LTM program planning as advanced cooperatively by the FHWA; the AASHTO Joint Task Force on Pavement, Pavement Management Task Group; and the authors.

The data collection guide was developed primarily for the LTM Program, but was made sufficiently broad for use as a guide for other data collection activities as well. It is expected that this data collection guide will be further revised and improved to reflect the results from continuing development of the LTM program over the next two years.

Significant portions of this data collection guide were adapted from the COPES system (References 3, 4, and 20).

Support for this research effort was provided by the Federal Highway Administration, Contract No. DTFH61-80-C-00175. We are grateful for the valuable ideas and technical coordination provided by Mr. William J. Kenis, FHWA Contract Manager, Office of Research and Development, and Mr. Roger G. Petzold with the FHWA Office of Highway Planning.

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CHAPTER 1

INTRODUCTION

Section 506 of the Surface Transportation Assistance Act of 1978 (P.L. 95-599) directed the Secretary of Transportation to study and investigate, ". . . the need for long-term or continuous monitoring of roadway deterioration to determine the relative damage attributable to traffic and environmental factors."

The Highway Cost Allocation Study (1982) examined the available data that have been collected by the States for the purpose of determining causal relationships among traffic use, the environment, construction materials, soils, etc., and highway deterioration and costs. It was determined that the available information upon which cost allocation, investment decisions, and highway design are based is generally quite inadequate. Very limited pavement monitoring data has been collected in a uniform manner since the American Association of State Highway and Transportation Officials (AASHTO) road tests of the late 1950's and early 1960's, and its use leads to a number of problems. The typical problems that occur when trying to develop a common data base are:

1. Historical data are frequently not available over a sufficient time period or have been collected sporadically.

2. Significant data are often omitted.

3. Apparently identical items of data are recorded in totally different units or have varying definitions.

4. Inadequate traffic volume or loading data.

5. Differing definitions of pavement present serviceability index (PSI).

6. Different types of equipment used to measure data items.

INITIAL LTM PILOT STUDIES

In response to the congressional request, an initial pilot study has been established by the FHWA, in cooperation with the AASHTO and selected states, to assess the problems in building a data base that can be used to improve existing design procedures, evaluate 4R rehabilitation techniques, examine quality of construction techniques and maintenance procedures, and respond to questions asked by Congress on pavement issues. The initial pilot study has been structured as a cooperative program between the FHWA, AASHTO, and eight selected States (see Figure 1) to demonstrate and share information on innovative pavement monitoring techniques and to establish a core number of case study sites (minimum of 10 sites per State) to be monitored over at least 10 years. If this pilot study shows sufficient promise, the study will be placed on a firm statistical basis and State participation expanded to establish a broad-based Long-Term Monitoring (LTM) program to develop a national data base.

LONG-TERM MONITORING PROGRAM

The primary purpose of an LTM Program would be to produce an adequate data base for the evaluation of existing design methods and the development of design procedures for pavement rehabilitation, however, meaningful project and network level information for State DOT use would be an objective of high priority. The long-term pavement monitoring data base would then be structured to include:

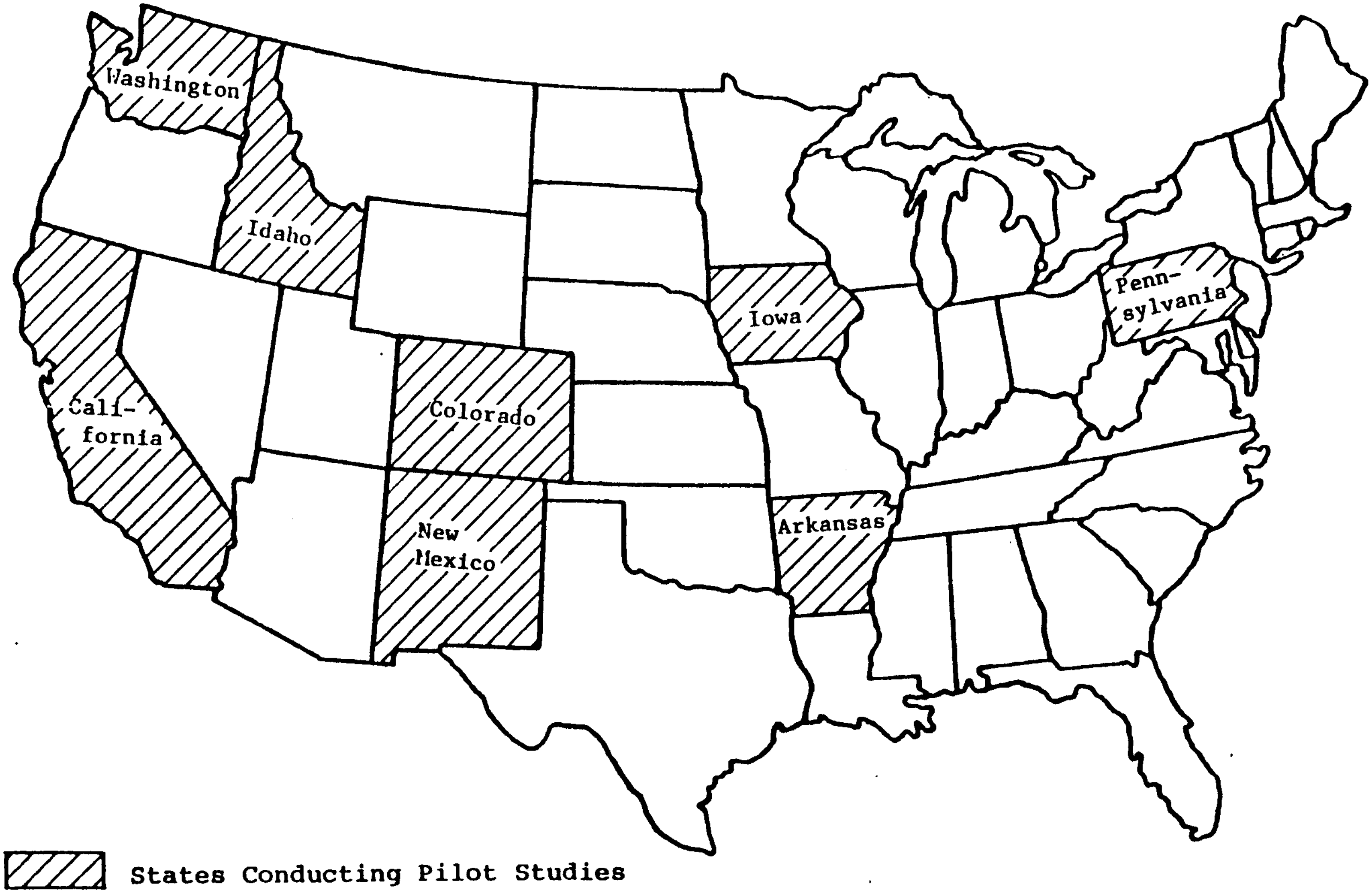


Figure 1. U.S. Map Indicating States Conducting LTM Pilot Studies

1. All variables that are significant to predicting pavement distress or performance, and maintenance or rehabilitation requirements. These variables include:

   a. Pavement structure (layers and their thicknesses)

   b. Engineering properties of the materials

   c. Traffic and load distribution

   d. Environmental conditions

   e. Time and type of initial construction and maintenance activities

   f. Costs

2. A sufficient number of States to be representative of the United States and its environmental regions.

3. A sufficient number of test sections to include a representative sample of pavement types, ages, and traffic distributions.

4. A data collection procedure that is reliable and uniform from State to State.

5. Sufficient data to attain statistical reliability.

6. Other data to satisfy specific State agency needs.

The expected results of LTM would be improved information on pavement condition at the State level for making both program and project decisions, and a data base that may be used to develop improved analytical capabilities and design procedures for both new and rehabilitated pavements.

The future of LTM will depend heavily on the results from the first year of full operation of the pilot studies. At the end of the first year, each participating State will evaluate the monitoring program and submit a report. These reports will include details of the data obtained and its apparent value, costs to obtain the data, identification of problems arising in such a monitoring activity, and recommendations concerning the best methods for performing long-term monitoring of pavements.

These reports will be reviewed by the AASHTO Joint Task Force on Pavement, Pavement Management Task Group, which is serving as an advisory panel on LTM to the FHWA. The panel will then advise the FHWA if this type of long-term monitoring approach is considered by them to be appropriate, and offer suggested modifications in approach where deemed advantageous. If long-term monitoring of pavements still appears advantageous, planning will continue for the expanded program to develop a national data base.

PURPOSES FOR LTM DATA COLLECTION GUIDE

One of the primary difficulties in utilization of data already collected by various agencies around the nation is lack of uniformity in the data. The items of data collected differ and significant data are often omitted, apparently identical items of data are recorded in totally different units or have varying definitions, and traffic and axle load data are frequently inadequate. Examples of lack of uniformity include: 1) differing definitions of Present Serviceability Index - different States use the AASHO relationship, modified AASHO relationships, rating panels, their own regression relationships, simple equipment measurements correlated to regression relationships, simple equipment measurements correlated through the GM Profilometer to rating panels, etc.; 2) cracking is measured by various States in square feet or square yards cracked in some area or length interval, lineal feet of cracks, percent of total cracked, percent slabs cracked, etc.; and 3) rutting varies in definition and in lengths of straight edges used to measure it.

The primary purpose for this data collection guide is to ensure that the national pavement data base to be obtained from a long-term monitoring program is adequate to support the development of the desired mathematical equations or models to explain the relationships between significant parameters (or independent variables) and the occurrence of distress and deterioration in pavements. This data base should have as a minimum the following characteristics:

1. It must include data for all variables that are significant to predictions of distress or performance, the maintenance or rehabilitation requirements that they generate, and the costs for that maintenance and/or rehabilitation. These variables will generally include: a) those required to define the pavement structure, b) the engineering properties of the materials within the pavement structure, c) the traffic and axle-load distribution imposed on the pavement, d) the environmental conditions in which the pavement exists, e) time since initial construction and significant rehabilitation (such as an overlay), f) maintenance and rehabilitation histories, including identification of the distresses or other parameters that generated the maintenance or rehabilitation, and g) the costs.

2. A representative sampling of the various environmental and geographic regions, and a selection of test sections within a region or state to include a representative sampling of: a) urban and rural areas, b) highway functional classes, c) traffic levels, d) types of pavements, and e) distribution of ages since construction or last major overlay.

3. The data collected should be reliable and uniform from state to state. Reliability may be promoted by

a) use of carefully developed procedures described in sufficient detail that individual biases are hard to introduce, b) sufficient training of survey crews to gain consistency in data gathering, and c) maintaining equipment and keeping it calibrated (for the same reason).

4. Sufficient data should be gathered to satisfactorily "explain" the relationships to be developed from these statistical analyses. Decisions to determine sufficiency of data must consider numbers of test sections, lengths of pavements to be included in test sections and the numbers of measurements to be made within these lengths.

Other purposes for this data collection guide are to provide:

1. An organized basis for collecting data on pavements in support of pavement management systems at the project and network levels, and to a more limited extent for project design purposes.

2. Recommendations for selecting data items to collect for various purposes; i.e., long-term monitoring, research studies, pavement management at the network level, etc.

3. Useful forms to use in data collection or recording the results of material testing.

4. References that include procedures for conducting materials tests not presently specified by ASTM or AASHTO standards.

This is a transitional data collection guide intended to offer improvements to the preliminary guide used for initial collection of data for the pilot studies, but expected itself to be further improved as data from the pilot studies are analyzed and resulting revisions to data collection requirements implemented.

DATA ITEMS TO BE COLLECTED

The general data requirements for an adequate data base have been previously described, drawing heavily on similar descriptions in References 1 and 2 (condensed versions of these references appear in Research Record 846, 1982). Reference 1 also reported results of studies conducted to select specific data items for collection to support the development of models to accurately predict pavement damage, as well as cost data aimed at relating maintenance and rehabilitation costs to other design, construction, and environmental variables. The approach taken in these studies was to list all potential data items that could reasonably be expected to have statistical significance to the development of the relationships, and then to carefully reduce this list on the basis of past experience to those items of data expected to exhibit statistical importance. Where possible, data items such as resilient moduli and fatigue life potential (that would prove both costly and difficult for State DOT's to produce) were eliminated in favor of more conventional material properties such as asphalt content, initial air voids, original stability, and viscosity or penetration of asphalt cement. The resulting list of data items for collection was presented to the AASHTO advisory panel and the FHWA in June, 1981 and appear in final form in Tables 1, 2, and 3.

It may be seen that the data items recommended for collection appeared in two broad categories (Tables 1 and 2). The first is basic inventory data, which includes those items that remain constant over the monitoring period. The second is monitoring data, which includes those items that will change with

Table 1. Items of Inventory Data to be Collected

1. Test Section Identification:

Highway Number	Functional Class
Urban or Rural	Location of Test Section
Lanes Included	

2. Geometric Details and General Information

Width of Highway	Width of Shoulders
Number of Lanes	Year Originally Constructed
Thickness of Layers	Identification of Layer Materials
Years When Overlays or Reconstruction Occurred	Thicknesses of Overlays or Final Layer Thicknesses After Reconstruction
Identification of Materials Used in Overlay or Reconstruction	Year and Details if Roadway Widened
Adequacy of Drainage	Joint Spacing
Underdrains Provided	Dowel Bar Diameter
Extent and Severity of Rigid Slab Cracking Prior to Overlay	Type of Load Transfer (Aggregate Interlock or Dowels)
Extent and Severity of Flexible Pavement Cracking Prior to Overlay	Dowel Bar Spacing

3. Environmental Data:

General Type of Environment (Dry-Freeze, Wet-No Freeze, etc.)	Thornthwaite Index
Number of Freeze-Thaw Cycles Per Year	Lowest Mean Solar Radiation
Highest Mean Monthly Temperature	Highest Mean Solar Radiation
Lowest Mean Monthly Temperature	Annual Precipitation
	Freeze Index

4. Accumulated Traffic and Axle-Load Data Prior to Long-Term Monitoring Effort:

Mean of AADT for Prior Years	Accumulated Number and Distribution of Tandem Axles
Accumulated 18-Kip ESAL (AASHO Equivalencies)	Accumulated Number and Distribution of Single Axles
Weighted Mean of % Trucks for Prior Years	

5. Material Properties:

a. Subgrade Soil:

Soil Type and Classification	Plasticity Index
% Passing No. 200 Sieve	Dry Density
CBR (Estimate from Other Data if Not Available)	

b. Base and Subbase Layers (Unbound)

Soil Type and Classification	Percent Modified AASHO Compaction
Dry Density	Percent Binder (Passing No. 40 Sieve)

Table 1. Items of Inventory Data to be Collected (continued)

(5. continued)

c. <u>Base and Subbase Layers (Stabilized)</u>:

Type of Treatment (Cement, Lime, etc.)	Dry Density
Untreated Soil Type and Classification	Percent of Stabilizing Agent
	Percent Modified AASHO Compaction

d. <u>Asphalt Concrete Layers</u>:

Asphalt Grade	Penetration of Asphalt*
Asphalt Content	Initial Air Voids
Viscosity of Asphalt*	Type of Coarse Aggregate
Original Stability	Dynamic Modulus

e. <u>Rigid Layers</u>:

Percent of Steel in Longitudinal Direction	Modulus of Rupture**
	Type of Coarse Aggregate

6. <u>Construction Costs Prior to Long-Term Monitoring Effort</u>:

Cost of Initial Construction	Accumulated Pavement Maintenance Costs (If Available Separated from Routine Maintenance)
Cost of Each Past Overlay	
Cost for Each Restoration or Rehabilitation Project	

* Viscosity and penetration of asphalt cement at time of basic inventory data collection

** Compute from compressive strength if not available

Table 2. Items of Monitoring Data to be Collected

1. Distress and Performance Measurements:

   a. Flexible Pavements (With or Without Overlays):

      - Alligator Cracking (Fatigue)
      - Rut Depth
      - Roughness
      - Raveling
      - Lane/Shoulder Separation
      - Low-Temperature Transverse or Longitudinal Cracking
      - Low-Temperature Block Cracking
      - Skid-Resistance (To Monitor Reductions)
      - Flushing

   b. Rigid Pavements:

      - Slab Cracking
      - D-Cracking
      - Joint Faulting
      - Pumping
      - Lane/Shoulder Separation
      - Skid-Resistance (To Monitor Reductions)
      - Roughness
      - Blow-ups
      - Deterioration of Transverse Joints

   c. Rigid Pavements with Flexible Overlays:

      - Reflection Cracking
      - Rut Depth
      - Pot Holes in Overlays
      - Raveling
      - Skid-Resistance (To Monitor Reductions)
      - Roughness
      - Flushing
      - Lane/Shoulder Separation

2. Traffic and Axle Loads:

   - AADT
   - Number and Distribution of Single Axle Loads
   - Number and Distribution of Tandem Axle Loads
   - 18-KIP ESAL for Year
   - Accumulated 18-Kip ESAL
   - Percent Trucks
   - Truck Lane Distribution

3. Deflection Testing Results:

   - Mean Maximum Deflection Under Load
   - Basin Parameters
   - Coefficient of Variation of Maximum Deflection

4. Pavement Maintenance Costs per Square Yard of Test Section (Exclusive of Routine Maintenance Such as Mowing, Salting, Snow Removal, etc.)

Table 3. Additional Data to be Collected if Resurfacing, Restoration, or Rehabilitation Occur During Monitoring Year

1. <u>Cost of Overlay per Square Yard</u>:

2. <u>Description of Overlay for Addition to Basic Inventory Data</u>:

Thickness of Overlay	Cost of Overlay (Per Sq.Yd.)
Material in Overlay	Asphalt Content
Asphalt Grade	Stability of Mix
Viscosity of Asphalt	Initial Air Voids
Penetration of Asphalt	Initial Skid Number
Type of Coarse Aggregate	

3. <u>Cost of Restoration or Rehabilitation per Square Yard</u>:

4. <u>Description of Pavement Structure Resulting From Restoration or Rehabilitation</u>:

Identification of Layer Materials	Thicknesses of Layers
Joint Spacing	Dowel Bar Diameter
	Width of Joint at Dowel Level

Same data appearing in Items 5b, 5c, and 5d in Table 1 for material properties of new or revised layers above the subgrade level.

time and will require periodic measurements or updating during the monitoring period.

The basic inventory data includes that data necessary to: 1) identify the test section, 2) describe the geometric details of its construction and the material properties of its structural constituents, 3) describe the environment in which the pavement test section exists, 4) identify the accumulated traffic and axle-load data prior to the long-term monitoring effort, and 5) to identify construction costs and costs of subsequent maintenance and repair prior to the long-term monitoring effort. All of this data should remain constant throughout the monitoring period unless the pavement is resurfaced or rehabilitated during the monitoring period. In the latter case, the test section becomes for practical purposes a new pavement structure with new surface conditions, so the basic inventory data must be revised to describe these new conditions, while retaining the original data for reference in long-term cost analyses and studies of the effects of rehabilitation on deterioration rates. Table 3 indicates additional data recommended for collection in the event this occurs during the monitoring period.

The monitoring data includes distress and serviceability measurements, traffic and axle load data, deflection testing results, pavement maintenance costs, resurfacing costs, and restoration and rehabilitation costs during the monitoring year. This data is to be collected on an annual or other periodic basis to provide a historical data base for developing relationships between distress, performance, traffic and axle loads, age, maintenance costs, and repair costs.

The data identified for collection by this guide is not entirely consistent with Tables 1, 2, and 3, as additional items are included in some cases for other data originally identified for the pilot studies and included in the preliminary guide.

While the data items identified in Tables 1 through 3 are expected to represent very closely those required for statistical adequacy, it may be expected that the results of the pilot studies will indicate that some of these items may be omitted and that others should be added on the basis of experience. Although this upgraded data collection handbook will be based primarily on the data requirements established initially for the pilot studies, an additional update is planned by the Federal Highway Administration as a portion of their continued development of the long-term pavement monitoring program and should reflect the experience from the pilot studies.

While the primary thrust of this data collection guide is support of the LTM program, it is also intended to provide guidance for collecting other data for network and project level activities at the state level and for research purposes. Consequently, data collection procedures and data collection sheets have been organized in this guide by data use type for clarity; so that the data items may be clearly identified and confusion avoided, each data sheet will be identified as to the applicability of its data for these various uses:

DATA USE TYPE IDENTIFICATION	DATA USE
A	Development of Multiple Regression Equations to explain the relationships between data items
B	Network level pavement management
C	Project Level pavement management and design
D	Research or other Special Studies

Each data form will be identified with one or more of the letter codes identified above, and the additional data items included in this data collection guide for these additional purposes will be discussed in Chapters 4 and 5.

SELECTION OF SAMPLE SIZES AND SPECIFIC TEST SECTIONS

It will be very important to select the smallest sample size possible that will still provide sufficient information of suitable quality to support the multiple regression analysis requirements. Otherwise, the costs for collection will become prohibitive or funds may be wasted that could fulfill other critical needs.

It will also be very important to select test sections for which sufficient historical data collected in a satisfactory manner is available to service the data needs. Consideration should be given to proximity to traffic count and weigh stations so that representative traffic counts and axle-load distributions may be expected.

ORGANIZATION OF PROCEDURES AND DATA SHEETS

It was necessary to organize the remainder of this data collection guide in some logical manner so that it can be readily followed with minimal confusion and without duplication of essentially identical forms. The approach selected was to organize the procedures and data sheets as follows:

1. By data use; i.e., development of multiple regression relationships to predict distress and performance of pavements, relations between maintenance, rehabilitation, costs, and other data items, and other data useful for future design and construction (Data Use A).

2. Additional data items for network project management (Data Use B).

3. Additional data items for project level planning and/or design (Data Use C).

4. Additional data items for research or special studies (Data Use D).

Within each of the categories of data use identified above, the data is broken down by inventory and monitoring data. The data sheets and instructions are then organized so that sheets independent of pavement type are first, followed by data sheets specific to pavement type.

This organizational approach will allow those generally interested in the primary goals of the LTM program to enter only the portion of this guide identified for Data Use A. Those interested in network or project level activities would need to collect the data identified on the data sheets for Data Uses B or C in the Data Use A portion of the report, plus the additional items in the separate Data Use sections. Those interested in research or other special studies might do the same plus other data items of interest in the Data Use D section.

CHAPTER 2

INVENTORY DATA COLLECTION PROCEDURES FOR LTM (TYPE A DATA USE)

This chapter provides data sheets and instructions for their use in collecting inventory data that should remain constant over the monitoring period (unless the pavement is rehabilitated). Much of this data will be useful for all four data uses described in Chapter 1, so the data sheets used for collection will be identified by the letter designations indicating their potential uses (i.e., A, B, C, and D - see Chapter 1). Data sheets will appear in numerical sequence at the rear of the chapter.

Whenever possible, data sheets and procedures from the COPES system (References 3, 4 and 20) have been used directly or modified to fit the needs for LTM data collection. This was done to take advantage of the work already accomplished for NCHRP Project 1-19 by Darter et al at the University of Illinois.

The small letters at the right of most data sheets (below or inside tables in others) have been included to indicate where data is to be entered on a line in the "schema" adopted for the initial LTM pilot study data bank. The "State Code" and "Project ID" are the same for a test section and are entered in the first six columns of each line of data in the data bank relating to a specific test section. The sheet type ("I" for inventory data and "M" for monitoring data) is entered in Column 8 and sheet number in Columns 9 and 10 for all lines of data entered in the data bank. Columns 79 and 80 of each line are reserved for entry of line numbers, which are sequential for a specific sheet (i.e., if all data on a sheet is entered on one line, the line number is always 01. If data is entered on say three lines as for Sheet 19, the line numbers will be 01, 02, and 03).

DATA SECTION COMMON FOR ALL DATA SHEETS

A common set of project identification data appears in the upper right hand corner of every data sheet. These data items are described below.

State Code: A two-digit code number used to identify the state in which the pavement section is located (see Table A.1, Appendix A).

Project ID: A four-digit identification number set by the agency. This number is used solely to facilitate the computer filing of the projects, and is cross-referenced with the construction project number.

Date: A four-digit code for entering date when data was collected. The first two digits represent the numerical sequence of the month as it occurs during the year (March-03, November-11, etc.), and the second two digits are the day of the month when data was collected (may vary from sheet to sheet).

Year: A two-digit code representing last two digits of year (83 for 1983, etc.) when data was collected.

PROJECT AND SECTION IDENTIFICATION (SHEET 1)

State Code: Repeated on this data sheet (described in previous section).

Project ID: Repeated on this data sheet (described in previous section).

State Highway Department (SHD) District Number: A two-digit number used to identify the SHD district in which the pavement section is located.

County: A three-digit number used to identify the county where the pavement section is located. County codes may be found in Federal Information Processing Standards Publications 6, "Counties of the States of the United States".

Section/Grouped Data Identification: This is the twelve-digit "Section/Grouped Data Identification" assigned to any section of highway in the Highway Performance Monitoring System (HPMS). It provides a unique identification for a test section and may be obtained from those State DOT personnel servicing the HPMS.

Functional Class: A two-digit number used to identify the functional classification of the highway for which the pavement section is a sample (see Appendix, Table A.2).

Highway Letter Designation: A one-digit code to identify the letter designation that precedes the number of the highway where the SHD project is located. The number that corresponds to the appropriate letter designation is:

Interstate	1	State	3
U.S.	2	Other	4

Highway Number: This is a four-digit number assigned to the highway where the SHD project is located (e.g.,I-280).

Pavement Type: Two-digit code indicating type of pavement structure (See Table A.3 for code).

Direction of Survey: The field survey proceeds in one direction of traffic flow along the section. The code that corresponds to the direction appears on the form.

Case Study Section Location: The "Start Point Milemark" is the reading on the mile post where the section begins (e.g., 115.29). The end-point milemark is similarly the reading on the mile post where the test section ends. The start point station number is the reading of the station number at which this section begins, as determined from the project layout plans (e.g., 833 + 57). The end-point station number is similarly the station number at the end of the test section.

GEOMETRIC, SHOULDER AND DRAINAGE INFORMATION (SHEET 2)

Type of Pavement: A two-digit code number identifying the general type of pavement structure (such as flexible pavement, jointed plain concrete pavement (JPCP), jointed reinforced concrete pavement (JRCP), continuously reinforced concrete pavement (CRCP), JPCP with flexible overlay, etc.). The pavement type codes are listed in the appendix, Table A.3.

Number of Through Lanes: A one-digit number indicating total of through lanes (exclusive of access lanes) in direction of survey.

Lane Width: Two-digit number indicating the width of a lane to the nearest whole number of feet (assumes that survey lanes are the same width).

Lanes Included in Monitoring Section: Two single-digit numbers to identify which lane or lanes (maximum of two) are to be monitored. Lanes are identified as indicated on the data sheet. If only one lane is being monitored, enter its number as the "right lane" and leave the "left lane" blank. If two lanes, enter as the left lane the lane farthest from the outside edge of the pavement. Enter the number of the lane nearest the outside edge as the right lane. Any two lanes in one direction with the same pavement structure may be selected for monitoring (if the pavement structure differs between lanes, only one should be used or they should be considered as separate test sections). Data is to be collected separately for each of the lanes identified. Traffic will be divided between the lanes by entering lane distribution of trucks in percent on Sheet 22.

Shoulder Width: A two-digit number indicating width of the shoulder to the nearest whole number of feet.

Shoulder Surface Type: A one-digit code indicating the type of shoulder surface (codes appear on the data sheet). A space is provided for describing another type of shoulder surface if different from those for which codes are provided.

Shoulder Base Type: A two-digit number identifying the type of base material used in the shoulder (See Table A.5, Appendix A).

Shoulder Surface Thickness: A two-digit number identifying the thickness of the shoulder surface to the nearest tenth of an inch.

Subsurface Drainage Type: A one-digit code indicating the type of subsurface drainage provided (codes appear on the data sheet). A space is provided for describing another type of subsurface drainage if different from those for which codes are provided.

Diameter of Longitudinal Drainpipes: The inside diameter to the nearest tenth of an inch of the longitudinal drainpipes used for subsurface drainage. If no longitudinal drainage, leave blank.

Subsurface Drainage Location: A one-digit code indicating whether the subsurface drainage is continuous along the section monitored or was provided at intermittent locations using code designations indicated on the data sheet. Leave blank if no subsurface drainage provided.

LAYER DESCRIPTIONS (SHEET 3)

Layer Numbers: Ten or less layer numbers may be identified with Number 1 as the surface layer and the last number identifying the subgrade.

Layer Description: A single-digit layer description code is to be entered for each of the layer numbers in the system. These layer description codes appear on the data sheet.

Thickness: A three-digit code to provide the thickness of each specific layer in inches (enter to the nearest tenth of an inch). (Detailed data is not to be filled out on subsequent data sheets for layers 0.5 inches or less in thickness).

Material Type Classification: A two-digit code identifying the type of materials in each layer of the pavement structure including the subgrade. The data sheet refers to the tables where these codes may be found.

AGE AND MAJOR PAVEMENT IMPROVEMENTS (SHEET 4)

Year Constructed: A four-digit number to indicate the month and year in which construction of the pavement to be monitored was completed. The first two digits represent the numerical sequence of the month as it occurs during the year and the second two digits are the last two digits in the year (84 for 1984, etc.).

Opened to Traffic: A four-digit number indicating the month and year that the pavement was originally opened to traffic. The first two digits represent the numerical sequence of the month as it occurs during the year and the second two digits are the last two digits in the year (83 for 1983, etc.).

Years When Major Improvements Occurred and Types of Improvements: Two-digit codes under "YEAR" representing the last two digits in a year when a major improvement to the pavement (does not include bridges, etc.) occurred. Two-digit codes under "TYPE" to identify the types of major improvements for which years of occurrence were given. Space is provided for up to six different major improvements. The "TYPE" codes appear on the data sheet.

Year When Roadway Widened: A two-digit number identifying the last two digits in the year when the roadway was widened. If the roadway has not been widened, leave blank.

Original Number of Lanes: A two-digit number to indicate the original number of lanes in the survey direction prior to roadway widening. If the roadway has not been widened, leave this blank.

Final Number of Lanes: A two-digit number to indicate the final number of lanes after the roadway has been widened. If the roadway has not been widened, leave this blank.

RIGID PAVEMENT LAYERS, ORIGINAL SURFACE OR OVERLAY, JOINT DATA (SHEET 5)

Layer Number: A single-digit number to identify the portland cement concrete layer for which a description is being provided. (This sheet is to be filled out for each PCC layer identified on Sheet 3).

Average Contraction Joint Spacing: A four-digit number to identify the spacing in feet (to the nearest tenth of a foot) between consecutive contraction joints (length of the concrete slab) of the pavement under survey. A space is provided to write in a description of any random joint spacing.

Built-in Expansion Joint Spacing: A four-digit number to identify the spacing in feet between consecutive expansion joints of the pavement under survey. If there are no expansion joints in the original construction, leave blank.

Skewness of Joint: A two-digit number to record the deviation of the contraction joint across the slab from a right angle with the edge. This is measured in feet per lane. If not skewed, leave blank.

Transverse Contraction Joint Load Transfer System: A one-digit code to identify the mechanism by which a portion of the moving load is transferred across the transverse contraction joint to the adjacent slab (codes appear on the data sheet). A space is provided to write in a description of another load transfer system if different from those for which codes are provided.

Dowel Diameter: A three-digit number to identify the outer diameter of the dowel bar used as the load transfer device across a contraction joint of the pavement under survey. This number is entered to the nearest one hundredth of an inch.

Dowel Spacing in Inches: A two-digit number reporting the center-to-center distance in inches between any two consecutive dowel bars across the contraction joint of the PCC layer being described.

Dowel Length: A two-digit number identifying the length in inches of the dowel bars across the contraction joint in the PCC layer being described.

Dowel Coating: A one-digit code identifying the material covering the dowel bar surfaces when installed in the concrete slab (codes appear on the data sheet). A space is provided to write in a description if some dowel coating was used other than those for which codes are provided.

Method Used to Install Dowels: A one-digit code to indicate whether the dowels were installed by preplacing them on baskets, installing them mechanically with special equipment, or other means of installation (codes appear on the data sheet). A space is provided for describing some method of installing dowels if the method used differs from those for which codes are provided.

RIGID PAVEMENT LAYERS, JOINT DATA CONTINUED (SHEET 6)

This sheet is a continuation of Sheet 5 to provide additional information on the joints in a PCC layer. These additional data items are described below.

Methods Used to Form Transverse Joints: A one-digit code to indicate whether the contraction joints were constructed by sawing the hardened slab at the proper time, or by placing an insert in the slab surface while the concrete is plastic, or by any other construction method used to form the joint (codes appear on the data sheet). Space is provided for describing another method if none of those for which codes were provided was used.

Transverse Joint Sealant Type: A one-digit code to indicate the type of joint sealant used in the transverse joints (codes appear on the data sheet). Space is provided for describing another type of sealant if none of those for which codes were provided was used.

Transverse Joint Sealant Reservoir: A three-digit code to identify the width of the transverse joint sealant reservoir to the nearest one hundredth of an inch, and a two digit number to identify the depth of the transverse joint sealant reservoir to the nearest tenth of an inch.

Type of Longitudinal Joint: A one-digit code to indicate how the longitudinal joint between the lanes was formed (codes appear on the data sheet). Space is provided for describing another way of forming the joints if none of those for which codes are provided was used.

Tie Bar Diameter: A three-digit number to identify the outer diameter to the nearest one hundredth of an inch of the tie bars used across longitudinal joints between lanes to keep the joint closed through resisting horizontal movements in the subgrade or subbase when the slab is contracting.

Tie Bar Length: A two-digit number identifying the length in inches of the tie bars used across the longitudinal joint between the lanes.

Tie Bar Spacing: A two-digit number identifying the center-to-center distance in inches between consecutive tie bars across the longitudinal joint between the lanes.

Type of Shoulder-Traffic Lane Joint: A one-digit code to indicate how the joint between the concrete shoulder and the traffic lane was formed (codes appear on the data sheet). Space is provided for describing another way of forming the joints if none of those for which codes are provided was used.

Shoulder-Traffic Lane Joint Tie Bar: A three-digit number identifying the outer diameter of the tie bars across the joint between the shoulder and the traffic lane to the nearest one hundredth of an inch. A two-digit number to identify the length of the tie bars to the nearest inch. A two-digit number to identify the center-to-center distance in inches between consecutive tie bars across the concrete shoulder-traffic lane joint. If no concrete shoulder exists, leave these data entry spaces blank.

RIGID PAVEMENT LAYERS, REINFORCING STEEL DATA (SHEET 7)

Layer Number: A single-digit number to identify the portland cement concrete layer for which a description is being provided. (This sheet is to be filled out for each PCC layer identified on Sheet 3).

Type of Reinforcing: A one-digit code to indicate the type of reinforcing used in the PCC layer being described (codes appear on the data sheet). A space is provided for entering a written description of a reinforcing type other than deformed bars or welded wire fabric.

Transverse Bar Diameter: A three-digit number to record the outer diameter of the transverse bars to the nearest one hundredth of an inch.

Transverse Bar Spacing: A three-digit number to record the center-to-center spacing between transverse bars to the nearest tenth of an inch.

Longitudinal Bar Diameter: A three-digit number to record the outer diameter of the longitudinal bars to the nearest hundredth of an inch.

Longitudinal Bar Spacing: A three-digit number to record the spacing between longitudinal bars to the nearest tenth of an inch.

Yield Strength of Reinforcing: A three-digit number to record the yield strength of the reinforcing steel in the bars to the nearest tenth of a kip per square inch.

Depth to Reinforcement From Slab Surface: A two-digit number for the depth to the nearest tenth of an inch of the concrete cover over the reinforcing steel of the concrete pavement.

Method Used to Place Rebar: A one-digit code to indicate the method used to install reinforcing steel bars or wire fabric during pavement construction. These methods include presetting the reinforcement on chairs, placing it mechanically by means of special equipment used for that purpose, or by placing them between layers of concrete. A space is also provided for a verbal description of some other method of placement that might have been used.

Length of Steel Lap at Construction Joint: A two-digit code providing the length to the nearest inch of the longitudinal reinforcing steel overlap at a CRCP construction joint. If the rigid pavement is not CRCP, leave this entry blank.

RIGID PAVEMENT LAYERS, CONCRETE DATA (SHEET 8)

Mix Design: Four four-digit codes to identify in pounds the weights of coarse aggregate, fine aggregate, cement, and water provided by the mix design for a cubic yard of concrete.

Strength (28-Day Modulus of Rupture): Two four-digit numbers for entry of the mean value and range of values measured for the 28-day modulus of rupture of the concrete. This strength is based on beam specimens tested in simple third-point loading as described in ASTM C78 or AASHTO T97 specifications. If center point loading was used, the strength should be appropriately modified on the basis of a suitable correlation relationship to third-point loading. If the only data available is for shorter periods of curing such as 7 or 14 days, an appropriate correlative relationship should be used to increase the strength to 28 days. If only compressive strength data is available, an appropriate relationship should be used to transform that strength to a modulus of rupture based on third-point loading. If no strength data is available, leave these spaces blank. The value for range to be entered is the difference between the maximum and minimum values of the moduli of rupture measured for the concrete used in the pavement.

Slump: Two two-digit numbers to record the mean of the slump measurements made and their range to the nearest tenth of an inch. The slump test is described in ASTM C143. The range is the difference between the maximum and minimum values of slump measured during construction.

Type Cement Used: A two-digit number for entering a code indicating which of the different types of cement normally used in concrete mix design was used in the slab concrete. These cement type codes appear in Table A.9 in the appendix.

Alkali Content of Cement: A three-digit number for entering the alkali content of the cement to the nearest tenth of one percent.

Entrained Air: Two two-digit numbers for entering the mean of the values of entrained air measured during construction and the range of these values to the nearest tenth of one percent.

Additives Other Than Air-Entrainers: A two-digit code for indicating the type for one additional additive other than the additive to produce entrained air. The codes for cement additives appear in Table A.10 in the appendix.

Maximum Size of Coarse Aggregate: A two-digit code for entering the maximum size of the coarse aggregate to the nearest tenth of an inch.

Type of Coarse Aggregate: A one-digit code for indicating the type of coarse aggregate (that portion of an aggregate retained on the No. 4 sieve) used in the concrete mix (codes appear on the data sheet). Space is provided for description of another type if none of the types for which codes are provided were used.

RIGID PAVEMENT LAYERS, CONCRETE DATA CONTINUED (SHEET 9)

Layer Number: A single-digit number to identify the portland cement concrete layer for which a description is being provided. (This sheet is to be filled out for each PCC layer identified on Sheet 3).

Sources of Coarse Aggregate: A number with up to six digits to indicate each source where the State contractor obtained aggregates for use in the concrete pavement. A list of sources of coarse aggregate for a given state is typically tabulated with source numbers assigned for each source where the State contractors obtain their aggregates. If for a particular state this is not done, a source identification list can either be established or this data field left blank.

Type of Fine Aggregate: A one-digit code to identify the type of fine aggregate passing the No. 4 (4.75mm) and retained on the No. 200 (75mm) sieve. The codes appear on the data sheet. Space is provided for identifying another type if none of those for which codes are provided was used.

Sources of Fine Aggregate: Source numbers with up to six digits to identify sources of fine aggregate used in the concrete slabs. Comments above for coarse aggregate apply to the assignment of source numbers for fine aggregates also.

Type of Aggregate Durability Test Used: A two-digit code to identify the type of durability test used. The durability test type codes appear in Table A.11.

Result of Durability Test: A three-digit code to give the results of durability testing in tenths. These results are to be recorded in the units specified for the test.

Type of Paver Used: A one-digit code to record whether a slip-form or side-form paver was used to place the concrete. The codes appear on the data sheet.

Method Used to Cure Concrete: A one-digit code to identify the method used to cure the concrete. The codes appear on the data sheet. Space is provided for identifying another curing method if none of those with codes was used.

RIGID PAVEMENT LAYERS, CONCRETE DATA CONTINUED (SHEET 10)

This data sheet is a continuation of the data on Sheet 9. These additional data entries are discussed below.

Method Used to Finish Concrete: A one-digit code to identify how the concrete surface was finished, which greatly affects the texture at the surface. The codes appear on the data sheet. Space is provided for identifying another finishing method if none of those with codes was used.

Geologic Classification of Coarse Crushed Stone Concrete Aggregate: A two-digit code to identify the geologic classification of the crushed stone used as coarse aggregate in the concrete. These codes appear in Table A.8 and provide identification as to which of the three major classes of rock the coarse aggregate belongs to and the type of rock within those classes.

Elastic Modulus: A four digit code to record the mean elastic modulus of the concrete in kips per square inch. The elastic modulus can either be obtained through compression testing of cylindrical samples collected and tested during construction, compression or indirect tensile testing of cores from the existing pavement in place, or through relationships published by the ACI and others relating elastic modulus to compressive strength. Although no ASTM standard has been established for indirect tensile testing of PCC cores, the general procedures for asphalt concrete cores (ASTM D4123) may be applied without consideration of temperature. The ACI formula in general use is:

$$E_c = 57{,}000 \sqrt{f'_c}$$

Where:

E_c = Modulus of Elasticity in psi

f'_c = Compressive Strength in psi

Test Method for Elastic Modulus: A one-digit code to identify test method used for measuring the elastic modulus of the mix, and whether the test was conducted upon a sample of the concrete prepared during construction or a core removed from the PCC layer in place. The codes appear on the data sheet. Testing on cores is preferred. Sufficient cores should be obtained at the beginning of data collection to support a test program for elastic modulus, compressive strength, and/or indirect tensile strength (probably a minimum of nine).

Compressive Strength of In-Place Concrete: A four digit code to record the mean compressive strength in psi of cores removed from the in-place PCC layer as measured according to ASTM C39.

Indirect Tensile Strength of In-Place Concrete: A three digit code to record the mean indirect tensile strength in psi of cores removed from the in-place PCC Layer as measured according to ASTM C496.

ASPHALT CONCRETE LAYERS - OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE AGGREGATE PROPERTIES (SHEET 11)

Layer Number: A one-digit number to identify the asphalt concrete layer for which a description is being provided (this sheet is to be filled out for each asphalt concrete layer identified on Sheet 3).

Percent Passing No. 200 Sieve: A three-digit number for entering the percent of the aggregate by dry weight that passes the No. 200 sieve in tenths of a percent.

Type of Coarse Aggregate: A one-digit code to identify the type of coarse aggregate used in the asphalt concrete mix.

The codes appear on the data sheet. Space is provided for identifying a type of coarse aggregate other than those with codes.

<u>Source of Coarse Aggregate</u>: A number with up to six digits to indicate each source where the State contractor obtained aggregates for use in the concrete pavement. A list of sources of coarse aggregate for a given state is typically tabulated with source numbers assigned for each source where the State contractors obtain their aggregates. If for a particular state this has not been done, a source identification list can either be established or this data field left blank.

<u>Type of Fine Aggregate</u>: A one-digit code to identify the type of fine aggregate passing the No. 4 (4.75mm) and retained on the No. 200 (75mm) sieve. The codes appear on the data sheet. Space is provided for identifying a type of fine aggregate other than those with codes.

<u>Sources of Fine Aggregate</u>: Source numbers with up to six digits to identify sources of fine aggregate used in the concrete slabs. Comments above for coarse aggregate apply to the assignment of source numbers for fine aggregates also.

ASPHALT CONCRETE LAYERS - OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE ASPHALT PROPERTIES (SHEET 12)

<u>Layer Number</u>: A one-digit number to identify the asphalt concrete layer to be described on this sheet. (This sheet is to be filled out for each asphalt concrete layer identified on Sheet 3).

<u>Asphalt Grade</u>: A two-digit code to identify the asphalt cement used in terms of its viscosity grade (in hundredths of poise). Where it has been documented by penetration grade, it

should be converted to viscosity grade using approximate tables that have been developed for this conversion. As an example, the numbers "20" should be entered if the asphalt cement used in the mix was "AC-20".

Source: A two-digit code for identification of the source for the asphalt cement. A list of asphalt sources for a given state is typically tabulated with a source number assigned for each asphalt source used by state contractors. If for a particular state this has not been done, a source identification list can either be established or this data field left blank.

Asphalt Content: A three-digit number to record the asphalt content by percent of mixture weight to the nearest tenth of a percent.

Viscosity of Asphalt at 140 F: A six-digit number providing the results in poise of viscosity testing using Test Method ASTM D2171 on cores removed from the pavement at the beginning of the data collection effort.

Viscosity of Asphalt at 275 F: A six-digit number providing the results in poise of viscosity testing using Test Method ASTM D2171 on cores removed from the pavement at the beginning of the data collection effort.

Ductility Measured by ASTM D113 Test Method: A four-digit number providing the ductility in centimeters as measured by Test Method ASTM D113.

Test Temperature for Ductility Measurement: A three-digit number for recording the test temperature (usually 77°F) for the ductility measurement.

Penetration at 77 F: A three-digit number for identification of the current penetration value for the asphalt cement in the mixture, using Test Method ASTM D5 on asphalt cement extracted from cores removed at the time the data collection effort was initiated.

Softening Point: A three-digit number to report the softening point of the asphalt cement in °F as measured with the ring-and-ball apparatus used in ASTM D36.

ASPHALT CONCRETE LAYERS - OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE IN-PLACE MIXTURE PROPERTIES (SHEET 13)

Density (PCF): A three-digit number for recording the mean of the measured densities of the asphalt cores removed at the time the data collection effort was initiated. Such methods as ASTM D1188 using paraffin-coated specimens should be used to establish the bulk specific gravity rather than simply weighing the specimen and measuring it to get an approximate density.

Marshall Stability: A four-digit number to identify the original Marshall Stability (average of measured results) in pounds for the mixture during laboratory mix design.

Hveem Stability: A three-digit number to record the Hveem Stability or "stabilometer value" as measured with the Hveem apparatus using Test Method D1560.

Percent Air Voids: A three-digit number for entry of calculated air voids (to the nearest tenth of a percent) as a percent of the material volume. This data is frequently not available, but can be calculated using other available data from reports on mix design and density measurements on samples from the pavement.

Marshall Flow: A four-digit number for recording.the Marshall Flow (average of measured results) in hundredths of an inch as measured by Test Method ASTM D1559 for the mixture during the laboratory mix design.

ASPHALT CONCRETE LAYERS, OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE DYNAMIC MODULI (SHEET 14)

Layer Number A one-digit number to identify the asphalt concrete layer to be described on this sheet. (This sheet is to be filled out for each asphalt concrete layer identified on Sheet 3).

Dynamic Moduli for Selected Temperatures: Space is provided for three sets of temperatures in °F and dynamic moduli in kips per square inch (KSI). Three sets are usually sufficient to identify the relationship between the asphalt concrete stiffness (dynamic modulus) and temperature. The dynamic moduli are to be obtained through resilient modulus testing on cores removed from the pavement at the beginning of data collection. As the cores for a specific layer are rarely long enough for testing as cylindrical specimens (ASTM D3497-79), it will probably be necessary to test them in indirect tension (ASTM D4123--82). However, studies reported in Reference 8 indicate that similar results may be obtained from either of these test methods, except that testing on cylindrical samples without confinement leads to unrealistically low moduli at the higher temperatures. A confinement of say 10 psi is preferable. If the State DOT does not have a capability for repetitive load testing such as that required to produce dynamic moduli, estimates of the dynamic moduli may be obtained from regression equations developed by Witczak, et.al. reported in References 8 and 9.

Test Load Duration: A three-digit number to identify the load duration for the repetitive-load dynamic modulus testing in hundredths of a second. A load duration of 0.10 seconds is common, but shorter and longer durations are sometimes used.

Frequency of Load Repetitions: A three-digit number to record the frequency of the repetitive loads applied to the specimen in hertz to the nearest tenth.

Test Method: A one-digit code to identify the test method used for measuring the dynamic moduli of the mix at different temperatures. The codes appear on the data sheet.

Confining Pressure: A two-digit number to record the confining pressure in psi used during the confined compression test. If no confining pressure was applied or if some other test procedure was used, leave this space blank.

ASPHALT CONCRETE LAYERS - OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE TENSILE STRENGTH (SHEET 15)

Tensile Strength for Selected Temperatures: Space is provided for three sets of temperatures in °F and tensile strengths in psi. Three sets are usually sufficient to identify the relationship between the asphalt concrete tensile strength and temperature. The usual method for measuring the tensile strength of an asphalt concrete core is the indirect tension test. Although there are no ASTM or AASHTO test methods for the indirect tensile test, this test has been in fairly common use in the United States for a number of years and is described in Reference 21.

Tensile Strain Rate: A three-digit number for reporting the strain rate used in the indirect tensile test in inches per minute to the nearest tenth of an inch.

Test Method: A one-digit code for identifying the type of tension test used to measure the tensile strengths. Codes are provided on the data sheet for the indirect tensile test and for space to specify what other test was used. It is possible to measure tensile strength through direct tension, but this is very difficult and very rarely done. The Hveem Cohesiometer Test also measures a cohesiometer value related to load necessary to produce a tensile failure of an asphalt core in bending, but cohesiometer values would not be of use for this purpose unless some relationship had been developed to relate tensile strengths to cohesiometer values for regional mixes.

UNBOUND OR STABILIZED BASE OR SUBBASE MATERIAL DESCRIPTION (SHEET 16)

Layer Number: A one-digit number to identify the base or subbase layer to be described on this sheet. (This sheet is to be filled out for each base or subbase layer identified on Sheet 3).

AASHTO Soil Classification: A two-digit code indicating the AASHTO soil classification for the base or subbase material (before stabilization). The code numbers appear in appendix, Table A.7.

Optimum Lab Dry Density: A three-digit number for entry of the optimum laboratory dry density in pounds per cubic foot for the base or subbase material in the layer of interest.

Optimum Lab Moisture Content: A three-digit number for recording the optimum moisture content obtained in the laboratory to the nearest one-tenth of a percent for the base or subbase layer.

Test Used to Measure Optimum Dry Density: A one-digit code to identify whether standard proctor, modified proctor, or some other test method was used to establish the optimum dry density and moisture content. Space is provided for identifying the other test method used. These codes appear on the data sheet.

Compactive Energy for "Other" Method: A three-digit code to report the compactive energy in foot-pounds per cubic inch applied if some test method was used other than standard proctor or modified proctor. If standard or modified proctor were used, these spaces are to be left blank.

In Situ Dry Density (Percent of Optimum): A three-digit code for reporting the average of field measurements of dry density for the base or subbase in place as a percent of the optimum lab dry density.

In Situ Moisture Content: A three-digit number for reporting the average of field measurements of moisture content as a percent of the optimum laboratory moisture content for the base or subbase layer.

In Situ Dry Density (PCF): A three-digit number for reporting the average of field measurements of dry density in pcf for the base or subbase layer. This need not be entered if both the optimum laboratory dry density and the in situ dry density as a percent of optimum have been reported.

Percent Binder: A two-digit number for entry of the average value from available sieve test results for percent of the material passing the No. 40 sieve.

Percent Passing No. 200 Sieve: A two-digit number for entry of the average value from available sieve test results for percent of the material passing the No. 200 sieve.

Percent Stabilizing Agent: A two-digit number to identify the percent by weight of stabilizing agent mixed into the base or subbase material in the layer of interest. An average figure of measured percentages should be used where available. If percentages have not been measured, the specified percentage should be entered. If neither measured nor specified data are available, a percentage should be estimated based on practice at the time a stabilized base or subbase layer was constructed. If the base or subbase material was not stabilized, leave these spaces blank.

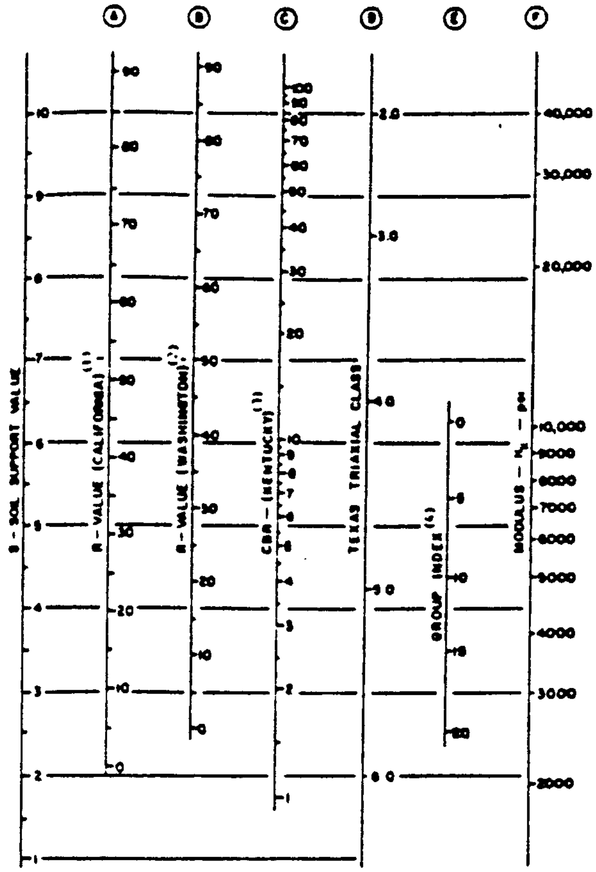
SUBGRADE DATA (SHEET 17)

Layer Number: A two-digit number to identify the subgrade (from Sheet 3).

AASHTO Soil Classification: A two-digit code identifying the AASHTO Soil Classification for the subgrade material. These codes are to be found in the appendix, Table A.7.

CBR: A three-digit number identifying the California Bearing Ratio (CBR) for the subgrade soil. If a value of CBR is not available, one can be obtained from suitable relationships with other soil properties or from Figure 2 (extracted from Reference 11).

Resistance R-Value: A three-digit number for entering the resistance R-value as determined by test method AASHTO T-190 (ASTM D2844). Leave blank if an R-value is not available.



(1) The correlation is with the design curves used by California; AASHO designation is T-173-60, and exudation pressure is 240 psi. See Hveem, F.M., and Carmany, R.M., "The Factors Underlying the Rational Design of Pavements." Proc. HRB, Vol. 28 (1948) pp. 101-136.

(2) The correlation is with the design curves used by Washington Dept. of Highways; exudation pressure is 300 psi. See "Flexible Pavement Design Correlation Study." HRB Bull. 133 (1956).

(3) The correlation is with the CBR design curves developed by Kentucky. See Drake, W.B., and Havens, J.H., "Re-Evaluation of Kentucky Flexible Pavement Design Criterion." HRB Bull. 233 (1959) pp. 33-56. The following conditions apply to the laboratory-modified CBR: Specimen is to be molded at or near the optimum moisture content as determined by AASHO T-99; dynamic compaction is to be used with a hammer weight of 10 lb dropped from a height of 18 in.; specimen is to be compacted in five equal layers with each layer receiving 10 blows; specimen is to be soaked for 4 days.

(4) This scale has been developed by comparison between the California R-value and the Group Index determined by the procedure in Proc. HRB Vol. 25 (1945) pp. 376-392.

Figure 2. Correlation Chart for Estimating CBR (from Ref. 11)

Modulus of Subgrade Reaction (K-Value): A three-digit number for entering the modulus of subgrade reaction in pci (pounds per square inch per inch of deflection) for the in situ subgrade. The modulus of subgrade reaction is usually obtained from plate load bearing tests using test methods ASTM D1195 or D1196.

Percent Passing No. 200 Sieve: A three-digit number identifying the average of percentages passing the No. 200 sieve from available sieve test results for samples from the first five feet of subgrade. Enter to the nearest tenth of one percent.

Plasticity Index: A two-digit number identifying the average of plasticity indices measured for samples from the first five feet of the subgrade.

Liquid Limit: A two-digit number identifying the average of the liquid limits measured for samples from the first five feet of subgrade.

Optimum Lab Dry Density: A three-digit number for entry of the optimum laboratory dry density in pounds per cubic foot for the subgrade material.

Optimum Lab Moisture Content: A three-digit number for recording the optimum moisture content obtained in the laboratory to the nearest one-tenth of a percent for the subgrade.

Test Used to Measure Optimum Dry Density: A one-digit code to identify whether standard proctor, modified proctor, or some other test method was used to establish the optimum dry density and moisture content. Space is provided for identifying the other test method used. These codes appear on the data sheet. Description of a test method other than standard or modified proctor must include the compactive energy applied in foot-pounds per cubic inch.

Average In Situ Dry Density: A three-digit number for reporting the average of field measurements of dry density in place for the subgrade as a percent of the optimum lab dry density.

Mean Measured Moisture Content: A three-digit number for recording the average of field measurements of subgrade moisture content as a percent of the optimum moisture content obtained in the laboratory to the nearest one-tenth of a percent.

In Situ Dry Density: A three-digit number for reporting the average of field measurements of dry density in pcf for the subgrade. This need not be entered if both the optimum laboratory dry density and the in situ dry density as a percent of optimum have been reported.

Swell Potential: A two-digit space and a four-digit space are included for a test code and a test value, respectively. The test codes are to be found in Table A.11 in the appendix. The test values should be reported to tenths in units appropriate to the type of test used to measure swell potential.

Frost Susceptibility: Two-digit and four-digit spaces are provided for a test code and test value, respectively. The test codes appear in Table A.11 in the appendix. The test value should be entered to the nearest tenth in units consistent with the test method used.

SUBGRADE SOIL, BASE, OR SUBBASE RESILIENT MODULI (SHEET 18)

Layer Number: A two-digit number to identify the subgrade soil, base, or subbase layer to be described on this sheet.

(This sheet is to be filled out for the subgrade and for each base or subbase layer identified on Sheet 3).

<u>AASHTO Soil Classification</u>: A two-digit code identifying the AASHTO Soil Classification for the subgrade, base, or subbase layer. These codes are to be found in the appendix, Table A.7.

<u>Code for Stress Type Used as Variable</u>: A one-digit code to indicate whether bulk stress or deviator stress from the triaxial compression stress state applied was used as a variable in the regression relationship developed for the resilient modulus. The bulk stress, the sum of the vertical stress applied and twice the confining stress or pressure applied, is usually used for base or subbase materials. The deviator stress, the difference between the vertical stress and the lateral stress or confining pressure applied to the triaxial compression specimen, is usually used for subgrade materials. The codes appear on the data sheet.

<u>Confining Pressure</u>: A two-digit number to identify the confining pressure in psi applied to the specimen in the triaxial cell.

<u>Resilient Moduli for Selected Stress States</u>: The resilient moduli are generally obtained from a single sample tested sequentially under differing stress states, starting with the least severe and progressing to the most severe stress states to minimize potential damage. Stress state may be increased by increasing vertical stress or decreasing lateral pressure. Space is provided for sample moisture content and sample density, and for four sets of stress level in psi and resilient modulus in kips per square inch (thousands of psi). Three digits are available for recording the moisture content of the sample or samples when tested to the nearest tenth of a percent, and three digits are also available for recording the

dry density of the sample tested in pcf. Two digits are available for entering stress level in psi and five digits for entering resilient modulus to the nearest tenth of a ksi.

In the event of variation in material types, density, or moisture content, the most typical resilient modulus data should be reported. If more than one sample is tested, moisture content and density should be approximately equivalent and the average entered.

<u>Constants A and B in the Resilient Modulus Relationship</u>: Four-digit numbers for entering the constants of regression A in thousands (to nearest tenth of a thousand) and B to the nearest hundredth. These coefficients of regression are for the relationship below:

$$\text{Log } E = \text{Log } A + B * \text{Log(Stress)}$$

The stress in this case is either the bulk stress or the deviator stress as specified above.

It is not uncommon for the constant B to be negative. In this case, the negative sign should be entered in column 65.

ENVIRONMENTAL DATA (SHEET 19)

Space has been provided for entering average data for each month of the year, as well as other general information relating to the environment in which a test section exists. Each of the four data items to be entered are described individually below as are the other data items to be entered. This data is to represent average data of all such monthly information available prior to the year in which the monitoring activity was initiated.

Average Monthly Temperature: A three-digit number for entering the average of the air temperatures in °C that have been measured in the vicinity of the site in past years during a given month.

Average Maximum Daily Temperature: A three-digit number for recording the average of the maximum daily air temperatures in °C that have been measured in the vicinity of the site in past years during a given month.

Average Minimum Daily Temperature: A three-digit number for recording the average of the minimum daily air temperatures in °C that have been measured in the vicinity of the site in past years during a given month.

Average Monthly Precipitation: A three-digit number for entering the average amount of precipitation in centimeters of water that fell at the site in past years during the given month. If part of the precipitation was in the form of snow, it should be converted to equivalent inches of water and added in to obtain the total precipitation.

General Type of Environment: A one-digit code for identifying the climatic zone in which the test section is located. The climatic zone and the codes assigned appear on Figure 3.

Latitude: A two-digit number to express the degrees of latitude at which the test section is located.

Freezing Index: A four-digit number for recording the freezing index (time and temperature) by degree days over a one year period. One degree day represents one day with a mean air temperature of one degree below freezing. A distribution of mean freezing index values in the continental United States is shown as contour lines in Figure 4.

Average Number of Annual Freeze-Thaw Cycles: A three-digit number for entering the average number of annual freeze-thaw cycles experienced at the project site during past years at approximately the bottom of the rigid slab or asphalt concrete pavement prior to the year that monitoring was initiated. This information is difficult to obtain and may need to be estimated by experienced persons. If not available from State or regional climatic data, approximate data may be obtained in appropriate climatological publications for the area under survey by writing or calling:

National Climatic Center, Federal Building,
Ashville, North Carolina 28801
Telephone: (704) 258-2850, ext. 683

Elevation: A five-digit number for entering the elevation of the test section in feet above sea level.

Average Annual Deicing Salt Application: A two-digit number for recording the average tons of deicing salt spread per lane mile annually for the years prior to the year in which monitoring was initiated.

ENVIRONMENTAL DATA CONTINUED (SHEET 20)

This sheet is a continuation of Sheet 19. The additional environmental data to be entered are described below.

Highest Monthly Mean Solar Radiation: A four-digit number identifying the average of the maximum daily measurements of solar radiation in the vicinity of the test section in langleys per day for the month experiencing the greatest solar radiation measured in previous years. If no data is available, Table 5.11 of Reference 12 gives approximate mean values (not mean highest) in terms of environmental regions (only four environmental regions considered) and mean annual air temperatures (MAAT).

Lowest Monthly Mean Solar Radiation: A four-digit number identifying the average of the daily measurements of solar radiation in langleys per day in the vicinity of the test section for the month experiencing the least solar radiation during the year measured in previous years. If no data is available, Table 5.11 of Reference 12 gives approximate mean annual values (not mean lowest) in terms of environmental regions (only four environmental regions considered) and mean annual air temperatures (MAAT).

Thornthwaite Index: A three-digit number to record the Thornthwaite Moisture Index, which reflects the potential evapotranspiration. Values of the Thornthwaite Moisture Index may be calculated as described in Reference 5 or obtained from the map of the United States with approximate index values in Figure 5.

MAINTENANCE DATA (SHEET 21)

Space is provided for identifying a maximum of six maintenance activities by year in which they were accomplished. If more than six maintenance activities need to be recorded, this sheet must be repeated. Each of the seven data items for each maintenance case are discussed separately below.

Year: A two-digit number for identifying the year in which the maintenance occurred. Enter the last two digits of the year (83 for 1983, etc.).

Maintenance Case Number: A three-digit number to identify the case number assigned for the specific maintenance being reported.

Work Type Code: A two-digit code to identify the type of maintenance work accomplished. The work type codes appear in Table A.12 in the appendix.

Location on Pavement Code: A two-digit code to identify where on the pavement the maintenance was conducted. These codes appear in Table A.13 in the appendix.

Maintenance Material Code: A two-digit code for identifying the maintenance materials used (such as "preformed joint fillers", "surface treatment, single layer", etc.). These codes appear in Table A.14 in the appendix.

Work Quantity: A five-digit number for entering the number of appropriate units of work accomplished.

Thickness: A three-digit number for entering thickness to the nearest tenth of an inch for those maintenance activities that increase the thickness of the pavement structure (such as "surface treatment, single layer" or a "surface treatment, double layer", etc.).

TRAFFIC DATA (SHEET 22)

Space is provided for entering traffic data for a maximum of six years on this sheet. If more than six years of data are to be entered, additional data sheets must be used. All the dependable data available on an annual basis should be entered. Each of the five items of traffic data reported by year in which traffic counts were made are discussed separately below.

Year: A two-digit code for entering the year for which the traffic data was obtained. Enter the last two digits of the year (83 for 1983, etc.).

One Way AADT: A five-digit number to enter the average annual daily traffic for the year reported. Data on AADT is usually available within SHA files as the result of traffic counts at various locations within the state. If properly selected, the test sections to be monitored should be located where traffic data is available either for the specific highway or one in the vicinity such that traffic could be reasonably extrapolated. Although the AADT data available may not be especially accurate, its importance requires as accurate an estimate as possible.

One Way Percent Trucks: A two-digit number indicating what the mean percent of the total traffic flow comprised of trucks has been in the years being reported. This information will usually be available from traffic count data in SHA files.

One Way Lane Distribution of Trucks: Three-digit spaces are provided for both the left and right lanes for entering the percent of the total trucks using that specific lane, so that trucks using each lane included in the test section being monitored (identified also on Sheet 2) may be accounted for separately. Lane distribution factors may or may not be available from SHA data, but estimates may be made from current counts, past research studies, or other such sources. If the distribution is unknown, Table A.16 may be used for a reasonable estimate, or as guidance for an estimate.

TRAFFIC DATA - VEHICLE CLASSIFICATION, PERCENT OF TRUCK VOLUME BY TRUCK TYPE (SHEET 23)

Space is provided for entering percent of truck volume by each of eight types of trucks for each of a maximum of seven years. If data for more than seven years is available, additional sheets may be filled out. It should be noted that the percentage figures entered for a year under the eight truck types must total 100%.

The year is entered in each case as a two-digit number as described previously for other sheets. The truck types for which percentages of total truck volume must be calculated are described briefly below:

1. Two-Axle, Six-Tire Single Unit Trucks - This category includes all trucks, camping and recreation vehicles, motor homes, etc., having two axles and dual rear wheels.

2. Three or More Axle Single Unit Trucks - All vehicles on a single frame with three or more axles in any configuration. This category includes concrete mixer trucks, heavy dump trucks, large motor homes, etc., having three axles or more.

3. Three-Axle Combination Trucks - All vehicles consisting of two units (one of which is a power unit) with a total of three axles. This category includes all 2-axle tractors with 1-axle semi-trailers (2S1) and all 2-axle single unit trucks with 1-axle trailers (2-1).

4. Two-Axle Tractor With Two-Axle Semi-Trailer Trucks (2S2) - Only those vehicles consisting of a 2-axle tractor and a 2-axle semi-trailer. All other 4-axle combination trucks are included in Category 5.

5. Other Four-Axle Combination Trucks - All vehicles consisting of two or more units having a total of four axles in any configuration, except the 2S2 (which is independently classified as Category 4). This category includes 2-axle trucks with 2-axle trailers (2-2), 3-axle trucks with 1-axle trailers (3-1), 3-axle tractors with 1-axle semi-trailers (3S1), and 2-axle tractors with a 1-axle semi-trailer and a 1-axle trailer (2S1-1).

6. Three-Axle Tractor with Two-Axle Semi-Trailer Trucks (3S2) - Only those vehicles consisting of a 3-axle tractor with a 2-axle semi-trailer. All other 5-axle combination trucks are included in Category 7.

7. Other Five-Axle Combination Trucks - All vehicles consisting of two or more units with five axles in any configuration, except the 3S2 (which is independently classified as Category 6).

8. Six or More Axle Combination Trucks - All vehicles consisting of two or more units with six or more axles in any configuration.

Additional information as to identification of truck types is included in the HPMS Vehicle Classification Case Study Manual and in the Truck Weight Study Manual issued by the Federal Highway Administration. As most test sections selected are near a vehicle count and weigh station to insure availability of traffic data, the required traffic data may usually be found in the "W-Tables".

TRAFFIC DATA, TYPICAL AXLE LOADS BY VEHICLE CLASS (SHEET 24)

This sheet is filled out in its entirety for each year for which annual data is available. The year is entered in two digits as previously described and there is a one-digit code for axle type and a three-digit code for entering the axle loads in hundreds of pounds. The truck classifications on this data sheet are consistent with those on the previous data sheet 23.

It should be remembered that all axles are considered to be single axles for truck classification, but the two axles in a "tandem" axle are weighed as a single tandem axle. As an example, consider the "other 5-axle combinations". It is possible to have a combination with five single axles, in which case there would be entries in all five of the spaces provided. However, it would be more likely to have a single axle on the front of the drive unit, a tandem axle on the rear of the driver unit, and another tandem axle at the rear of the semi-trailer. In this case, the code 1 would be entered for axle type at the left column and a typical weight for the single axle entered under the load. For the next two sets of entries, the axle type code would be 2 and typical loads entered for each of these tandem axle sets. This would leave two sets of entries blank. This is typical of how entries are to be made in terms of single and tandem axles for other truck types.

If there are triple axles (tridems) present, they are to be indicated by entering a 3 for the axle type.

It is probable that there will be more than one subtype of truck under a specific truck classification such as "other 5-axle combinations". As there is only going to be room in the data bank for one set of entries for each truck classification, the most typical (i.e., the one with the greatest count) will be considered and the typical axle load data entered for it. The assumption is that all of the trucks in this classification are the most typical subtype. This will, of course, introduce some error, but it is believed to be acceptable as unusual truck types do not often occur in great numbers and there will be some compensation.

This traffic data may also usually be extracted from the "W-Tables".

TRAFFIC DATA, SUMMARY AXLE LOAD DISTRIBUTIONS (SHEET 25)

It can be seen that the data to be entered on this data sheet is that appearing as "Total All Trucks and Combinations, Probable No." in Part 5 of the W-4 tables. This data may be entered as number of axles under each single or tandem axle load group in the six-digit spaces provided. The year is entered as two digits as previously described, and this data sheet is to be repeated for each year for which W-Tables are available prior to the year in which monitoring was initiated.

Although most test sections were specifically selected to be in the vicinity of a weigh station or weigh-in-motion system, this may not always be the case. In this case, judgement must be applied to best represent the traffic data for the test section.

DATA USES: A,B,C,D

SHEET 1	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

PROJECT AND SECTION IDENTIFICATION

STATE CODE	__ __.	12-13
PROJECT ID	__ __ __ __.	14-17
STATE HIGHWAY DEPARTMENT (SHD) DISTRICT NUMBER	__ __.	19-20
COUNTY	__ __ __.	22-24
SECTION/GROUPED DATA IDENTIFICATION	__ __ __ __ __ __. __ __ __ __ __ __.	26-37
FUNCTIONAL CLASS	__ __.	39-40
HIGHWAY LETTER DESIGNATION (NUMERIC CODE)	__.	42
HIGHWAY NUMBER	__ __ __ __.	44-47
DIRECTION OF SURVEY	__.	49

EAST - 1   NORTH - 3
WEST - 2   SOUTH - 4

CASE STUDY SECTION LOCATION

START POINT MILEMARK	__ __ __.__ __	51-55
END POINT MILEMARK	__ __ __.__ __	57-61
START POINT STATION NO.	__ __ __ __ __.__ __	63-69
END POINT STATION NO.	__ __ __ __ __.__ __	71-77

DATA USES: A,B,C,D

SHEET 2	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

GEOMETRIC SHOULDER AND DRAINAGE INFORMATION

TYPE OF PAVEMENT (SEE CODE, Table A.3) __ __. 12-13

NUMBER OF THROUGH LANES (ONE DIRECTION) __. 15

LANE WIDTH (FEET) __ __. 17-18

LANES (BY NUMBER) INCLUDED IN MONITORING SECTION
(Lane 1 is Outside Lane, Lane 2 is next to Lane 1,etc)
LEFT __. 20
RIGHT __. 22

SHOULDER WIDTH IN FEET __ __. 24-25

SHOULDER SURFACE TYPE __. 27
- Turf............1
- Granular........2
- Asphalt Concrete..3
- Concrete..........4
- Other (Specify)________________________5 29-40

SHOULDER BASE TYPE (See Base Type Code, Table A.5) __ __. 42-43

SHOULDER SURFACE THICKNESS IN INCHES __.__ 45-46

SHOULDER BASE THICKNESS IN INCHES __ __.__ 48-50

SUBSURFACE DRAINAGE TYPE __. 52
- No subsurface drainage................1
- Longitudinal drains...................2
- Transverse drains.....................3
- Drainage blanket......................4
- Well system...........................5
- Drainage blanket with longitudinal drains.................6
- Other (Specify)________________________7 54-65

DIAMETER OF LONGITUDINAL DRAINPIPES, IN INCHES __.__ 67-68

SUBSURFACE DRAINAGE LOCATION __. 70
- Continuous along project..............1
- Intermittent..........................2

DATA USES: A,B,C,D

SHEET 3

INVENTORY DATA

LTM PROGRAM

STATE CODE __ __ 1-2

PROJECT ID __ __ __ __ 3-6

DATE (MONTH/DAY) __ __ / __ __

YEAR __ __

LAYER DESCRIPTIONS

LAYER NUMBER[1]	LAYER DESCRIPTION[2]	THICKNESS (INCHES)	MATERIAL TYPE CLASSIFICATION[3]
1	__ 12	__ __.__ 14-16	__ __ 18-19
2	__ 21	__ __.__ 23-25	__ __ 27-28
3	__ 30	__ __.__ 32-34	__ __ 36-37
4	__ 39	__ __.__ 41-43	__ __ 45-46
5	__ 48	__ __.__ 50-52	__ __ 54-55
6	__ 57	__ __.__ 59-61	__ __ 63-64
7	__ 66	__ __.__ 68-70	__ __ 72-73
8	__ 12	__ __.__ 14-16	__ __ 18-19
9	__ 21	__ __.__ 23-25	__ __ 27-28
10	__ 30	__ __.__ 32-34	__ __ 36-37

NOTES:

1. LAYER 1 IS EXISTING SURFACE LAYER, LAST LAYER IS SUBGRADE.
2. LAYER DESCRIPTION CODES:
   - OVERLAY............1
   - PREVIOUS OVERLAY...2
   - ORIGINAL SURFACE...3
   - BASE LAYER.........4
   - SUBBASE LAYER..........5
   - SECOND SUBBASE LAYER...6
   - SUBGRADE...............7
   - SEAL COAT..............8
   - INTERLAYER.............9
3. THE MATERIAL TYPE CLASSIFICATION CODES FOR SURFACE, BASE OR SUBBASE, SUBGRADE, AND SEAL COAT OR INTERLAYER MATERIALS APPEAR IN TABLES A.4, A.5, A.6, AND A.15 RESPECTIVELY.
4. DETAILED DATA ON SUBSEQUENT SHEETS NOT REQUIRED FOR THIN LAYERS 1/2-INCH OR LESS IN THICKNESS.
5. DATA ON THIS SHEET MUST BE ENTERED INTO DATA BANK ON TWO LINES. 'HEADER DATA' IN FIRST TEN COLUMNS MUST BE REPEATED ON SECOND LINE.

DATA USES: A,B,C,D

SHEET 4	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

AGE AND MAJOR PAVEMENT IMPROVEMENTS

DATE CONSTRUCTED (MONTH/YEAR)	__ __/__ __	12-15
OPENED TO TRAFFIC (MONTH/YEAR)	__ __/__ __	17-20

YEARS WHEN MAJOR IMPROVEMENTS OCCURRED AND TYPES OF IMPROVEMENTS

IMPROVEMENT TYPE CODES	YEAR		TYPE	
OVERLAY....................01	__ __	22-23	__ __	25-26
SLAB JACKING..............02	__ __	28-29	__ __	31-32
JOINT REPAIR..............03	__ __	34-35	__ __	37-38
IMPROVED SHOULDER.........04	__ __	40-41	__ __	43-44
RECYCLED..................05	__ __	46-47	__ __	49-50
UNDERDRAINS...............06	__ __	52-53	__ __	55-56
REMOVED AND RECONSTRUCTED.07				
OTHER, SPECIFY____________08				58-69

YEAR WHEN ROADWAY WIDENED	__ __	71-72
ORIGINAL NUMBER OF LANES (ONE DIRECTION)	__	74
FINAL NUMBER OF LANES (ONE DIRECTION)	__	76

NOTES:

1. IF A MONITORING LANE WAS CREATED BY ROADWAY WIDENING, IT SHOULD BE AN INDEPENDENT MONITORING SECTION WITH ONLY THAT LANE.
2. MAJOR IMPROVEMENTS TO PAVEMENTS ONLY. DOES NOT INCLUDE BRIDGES.

DATA USES: A,B,C,D

SHEET 5	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

RIGID PAVEMENT LAYERS
ORIGINAL SURFACE OR OVERLAY
JOINT DATA

LAYER NUMBER (FROM SHEET 3) __ 12

AVERAGE CONTRACTION JOINT SPACING IN FEET __ __ __.__ 14-17

(RANDOM JOINT SPACING, IF ANY: ____________________)

BUILT-IN EXPANSION JOINT SPACING IN FEET __ __ __ __. 19-22

SKEWNESS OF JOINT IN FT/LANE __.__ 24-25

TRANSVERSE CONTRACTION JOINT LOAD TRANSFER SYSTEM __ 27
- Dowels................................1
- No mechanical load transfer device....2
- Other (Specify)____________________3

DOWEL DIAMETER IN INCHES __.__ __ 30-32

DOWEL SPACING IN INCHES __ __. 34-35

DOWEL LENGTH IN INCHES __ __. 37-38

DOWEL COATING __ 40
- Paint and/or Grease..................1
- Plastic..............................2
- Monel................................3
- Stainless Steel......................4
- Epoxy................................5
- Other (Specify)____________________6

METHOD USED TO INSTALL DOWELS __ 41
- Preplaced on baskets.................1
- Mechanically installed...............2
- Other (Specify)____________________3

NOTE: THIS SHEET AND SHEET 6 ARE TO BE FILLED OUT FOR EACH RIGID LAYER WITH JOINTS IDENTIFIED ON SHEET 3. DATA FROM BOTH SHEETS ARE ENTERED ON SAME LINE IN DATA BANK.

DATA USES: A,B,C,D

SHEET 6 — STATE CODE __ __

INVENTORY DATA — PROJECT ID __ __ __ __

LTM PROGRAM — DATE (MONTH/DAY) __ __ / __ __

YEAR __ __

RIGID PAVEMENT LAYERS
JOINT DATA CONTINUED

METHOD USED TO FORM TRANSVERSE JOINTS __ 43

- Sawed............................1
- Plastic Insert...................2
- Metal Insert (i.e., Uni-Tube)...3
- Other (Specify)________________4

TRANSVERSE JOINT SEALANT TYPE (AS BUILT) __ 45

- Preformed (open web)............1
- Asphalt.........................2
- Rubberized Asphalt (old type)...3
- Rubberized Asphalt (new type)...4
- Low-Modulus Silicone............5
- Other (i.e., closed neoprene or specify)________________6

TRANSVERSE JOINT SEALANT RESERVOIR (AS BUILT)

(A) WIDTH, (IN.) __.__ __ 47-49

(B) DEPTH, (IN.) __.__ 51-52

TYPE OF LONGITUDINAL JOINT (BETWEEN LANES) __ 54

- Butt..................1
- Keyed.................2
- Sawed Weakened Plane.3
- Insert Weakened Plane..4
- Other________________5 (Specify)

TIE BAR DIAMETER IN INCHES __.__ __ 56-58

TIE BAR LENGTH IN INCHES __ __. 60-61

TIE BAR SPACING IN INCHES __ __. 63-64

TYPE OF SHOULDER-TRAFFIC LANE JOINT __ 66

- Butt..................1
- Keyed.................2
- Sawed Weakened Plane.3
- Insert Weakened Plane..4
- Tied Concrete Curb.....5
- Other________________6 (Specify)

SHOULDER-TRAFFIC LANE JOINT TIE BAR (FOR CONCRETE SHOULDER)

DIAMETER IN INCHES __.__ __ 68-[illegible]

LENGTH IN INCHES __ __. 72-73

SPACING IN INCHES __ __. 75-76

DATA USES: A,B,C,D

SHEET 7	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

RIGID PAVEMENT LAYERS
REINFORCING STEEL DATA

LAYER NUMBER (FROM SHEET 3) __ 12

TYPE OF REINFORCING __ 14

Deformed Bars.........................1
Welded Wire Fabric....................2
Other (specify)______________________3

TRANSVERSE BAR DIAMETER IN INCHES __.__ __ 15-17

TRANSVERSE BAR SPACING IN INCHES __ __.__ 18-20

LONGITUDINAL BAR DIAMETER IN INCHES __.__ __ 21-23

LONGITUDINAL BAR SPACING IN INCHES __ __.__ 24-26

YIELD STRENGTH OF REINFORCING (KSI) __ __.__ 27-29

DEPTH TO REINFORCEMENT FROM SLAB SURFACE, INCHES __.__ 30-31

METHOD USED TO PLACE REBAR __ 32

Preset on Chairs......................1
Mechanically..........................2
Between Layers of Concrete............3
Other (Specify)______________________4

LENGTH OF STEEL LAP AT CONSTRUCTION JOINT, INCHES __ __. 33-34
(CRCP ONLY)

DATA USES: A,B,C,D

SHEET 8	STATE CODE	__ __
INVENTORY DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

RIGID PAVEMENT LAYERS
CONCRETE DATA

MIX DESIGN (lb./yd^3)	(A) Coarse Aggregate	__ __ __ __.	36-39
	(B) Fine Aggregate	__ __ __ __.	40-43
	(C) Cement	__ __ __ __.	44-47
	(D) Water	__ __ __ __.	48-51
STRENGTH (28-day Modulus of Rupture) (psi)(based on 3rd point loading)	(A) Mean	__ __ __ __.	52-55
	(B) Range	__ __ __ __.	56-59
SLUMP (inches)	(A) Mean	__.__	60-61
	(B) Range	__.__	62-63
TYPE CEMENT USED (See Cement Type Codes, Table A.9)		__ __	64-65
ALKALI CONTENT OF CEMENT, %		__ __.__	66-68
ENTRAINED AIR, %	(A) Mean	__.__	70-71
	(B) Range	__.__	72-73
ADDITIVE OTHER THAN AIR-ENTRAINER (See Cement Additive Codes, Table A.10)		__ __	74-75
MAXIMUM SIZE OF COARSE AGGREGATE, INCHES		__.__	76-77
TYPE OF COARSE AGGREGATE		__	78

Crushed Stone...............1
Gravel or Crushed Gravel....2
Crushed Slag................3
Blend Crushed Stone/Gravel..4
Blend Crushed Stone/Slag....5
Blend Gravel/Slag...........6
Other (specify)______________7

NOTE: DATA ON THIS SHEET IS ENTERED FOR DATA BANK ON THE SAME LINE AS DATA FROM SHEET 7

DATA USES: A,B,C,D

SHEET 9	STATE CODE	_ _	1-2
INVENTORY DATA	PROJECT ID	_ _ _ _	3-6
LTM PROGRAM	DATE (MONTH/DAY)	_ _ / _ _	
	YEAR	_ _	

RIGID PAVEMENT LAYERS
CONCRETE DATA CONTINUED

LAYER NUMBER (From Sheet 3) _ 12

SOURCES OF COARSE AGGREGATE
Source Code Number Obtained From a State List of Sources and Producers of Aggregates for Highway Construction
(A) Source I _ _ _ _ _ _ 14-19
(B) Source II _ _ _ _ _ _ 20-25
(C) Source III _ _ _ _ _ _ 26-31

TYPE OF FINE AGGREGATE _ 33
Natural or Crushed Sand..........................1
Manufactured Sand (From Crushed Gravel or Stone)..2
Other (Specify)________________________________3

SOURCES OF FINE AGGREGATE
Source Code Number Obtained From a State List of Sources and Producers of Aggregates for Highway Construction
(A) Source I _ _ _ _ _ _ 35-40
(B) Source II _ _ _ _ _ _ 41-46
(C) Source III _ _ _ _ _ _ 47-52

TYPE OF AGGREGATE DURABILITY TEST USED _ _ 54-55
(See Durability Test Type Codes, Table A.11)

RESULT OF DURABILITY TEST _ _._ 57-59

TYPE OF PAVER USED _ 61
Slip-Form..........1 Side-Form..........2

METHOD USED TO CURE CONCRETE _ 62

Membrane Curing Compound....1
Burlap Curing Blankets......2
Waterproof Paper Blankets...3
White Polyethylene Sheeting.4
Burlap-Polyethylene Blanket..5
Cotton Mat Curing............6
Hay..........................7
Other________________________8
(Specify)

DATA USES: A,B,C,D

SHEET 10	STATE CODE	__ __
INVENTORY DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

RIGID PAVEMENT LAYERS
CONCRETE DATA CONTINUED

METHOD USED TO FINISH CONCRETE __ 63

- Tine............1
- Broom...........2
- Burlap Drag......3
- Grooved Float.........4
- Astro Turf............5
- Other ________________ 6 (Specify)

GEOLOGIC CLASSIFICATION OF COARSE CRUSHED STONE CONCRETE AGGREGATE (See Geologic Classification Codes, Table A.8) __ __ 64-65

ELASTIC MODULUS (KSI) __ __ __ __ __. 66-70

TEST METHOD FOR ELASTIC MODULUS __ 71

- Indirect Tensile Test on Cores..................1
- Compression Test on Cores (ASTM C469)...........2
- Compression Test on Cylinders During Initial Construction (ASTM C469)..............3
- Calculated Using ACI Relation Between Elastic Modulus and Compressive Strength......4
- Other (Specify) ________________________ 5

COMPRESSIVE STRENGTH OF IN-PLACE CONCRETE IN PSI __ __ __ __. 72-75

INDIRECT TENSILE STRENGTH OF IN-PLACE CONCRETE IN PSI __ __ __. 76-78

NOTE: DATA ON THIS SHEET IS ENTERED FOR DATA BANK ON THE SAME LINE AS DATA FROM SHEET 9.

DATA USES: A,B,C,D

SHEET 11	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

ASPHALT CONCRETE LAYERS
OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE
AGGREGATE PROPERTIES

LAYER NUMBER (From Sheet 3) __ 12

PERCENT PASSING NO. 200 SIEVE __ __.__ 14-16

TYPE OF COARSE AGGREGATE __ 18

- Crushed Stone....................1
- Gravel or Crushed Gravel.........2
- Crushed Slag.....................3
- Blend Crushed Stone/Gravel.......4
- Blend Crushed Stone/Slag.........5
- Blend Gravel/Slag................6
- Other (Specify)__________________7

SOURCE OF COURSE AGGREGATE (Source code number obtained from a State list of sources and producers of aggregates for highway construction)

- (A) Source I __ __ __ __ __ __ 20-25
- (B) Source II __ __ __ __ __ __ 26-31
- (C) Source III __ __ __ __ __ __ 32-37

TYPE OF FINE AGGREGATE __ 39

- Natural or Crushed Sand..........1
- Manufactured Sand................2
- Other (Specify)__________________3

SOURCE OF FINE AGGREGATE (Source code number obtained from a State list of sources and producers of aggregates for highway construction)

- (A) Source I __ __ __ __ __ __ 41-46
- (B) Source II __ __ __ __ __ __ 47-52
- (C) Source III __ __ __ __ __ __ 53-58

DATA USES: A,B,C,D

SHEET 12	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

ASPHALT CONCRETE LAYERS
OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE
ASPHALT PROPERTIES

LAYER NUMBER (FROM SHEET 3)	__	12
ASPHALT GRADE AC -	__ __	14-15
SOURCE (CODE NUMBER ASSIGNED BY STATE DOT)	__ __	17-18
ASPHALT CONTENT (PERCENT WEIGHT OF TOTAL MIX)	__ __.__	20-22
VISCOSITY OF ASPHALT AT 140°F (ASTM D2171)	__ __ __ __ __ __.	24-29
VISCOSITY OF ASPHALT AT 275°F	__ __ __ __ __ __.	31-36
DUCTILITY MEASURED BY ASTM D113 TEST METHOD	__ __ __ __.	38-41
TEST TEMPERATURE FOR DUCTILITY MEASUREMENT(°F)	__ __ __.	43-45
PENETRATION AT 77°F (ASTM D5)	__ __ __.	47-49
SOFTENING POINT (ASTM D36)	__ __ __.	51-53

NOTE: DATA FROM THIS SHEET AND SHEET 13 ARE ENTERED ON SAME LINE FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 13

INVENTORY DATA

LTM PROGRAM

STATE CODE __ __

PROJECT ID __ __ __ __

DATE (MONTH/DAY) __ __ / __ __

YEAR __ __

ASPHALT CONCRETE LAYERS
OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE
IN-PLACE MIXTURE PROPERTIES

DENSITY (PCF)	__ __ __.	55-57
MARSHALL STABILITY (LBS)	__ __ __ __.__	59-63
HVEEM STABILITY	__ __ __.	65-67
PERCENT AIR VOIDS	__ __.__	69-71
MARSHALL FLOW (0.01 IN.)	__ __ __ __.	73-76

NOTE: DATA ON THIS SHEET ARE TO BE ENTERED ON THE SAME LINE AS THAT ON SHEET 12 FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 14	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

ASPHALT CONCRETE LAYERS
OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE
DYNAMIC MODULI

LAYER NUMBER (SEE SHEET 3) __ 12

DYNAMIC MODULI FOR SELECTED TEMPERATURES:

TEMPERATURE (^{0}F)		DYNAMIC MODULUS (KSI)	
__ __ __.	14-16	__ __ __ __.	17-20
__ __ __.	22-24	__ __ __ __.	25-28
__ __ __.	30-32	__ __ __ __.	33-36

TEST LOAD DURATION IN HUNDREDTHS OF A SECOND __ __ __. 37-39

FREQUENCY OF LOAD REPETITIONS (HERTZ) __ __.__ 40-42

TEST METHOD __ 43

Indirect Tensile Test (ASTM D4123)........1
Unconfined Compression Test (ASTM D3497)..2
Confined Compression Test.................3
Witczak Regression Equations..............4

CONFINING PRESSURE, PSI __ __. 45-46
(IF CONFINING PRESSURE APPLIED)

NOTE: DATA FROM THIS SHEET AND SHEET 15 ARE ENTERED ON SAME LINE FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 15	STATE CODE	__ __
INVENTORY DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

ASPHALT CONCRETE LAYERS
OVERLAY, ORIGINAL SURFACE, BINDER COURSE, OR ASPHALT-STABILIZED BASE
TENSILE STRENGTH

TENSILE STRENGTH FOR SELECTED TEMPERATURES:

TEMPERATURE (°F)		TENSILE STRENGTH, PSI)	
__ __ __.	48-50	__ __ __.	52-54
__ __ __.	56-58	__ __ __.	60-62
__ __ __.	64-66	__ __ __.	68-70

TENSILE STRAIN RATE (INCHES PER MINUTE) __ __.__ 72-74

TEST METHOD __ 77

Indirect Tensile Test 1

Other (Specify)______________________________2

NOTE: DATA ON THIS SHEET ARE TO BE ENTERED ON THE SAME LINE AS THAT ON SHEET 14 FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 16	STATE CODE __ __ 1-2
INVENTORY DATA	PROJECT ID __ __ __ __ 3-6
LTM PROGRAM	DATE (MONTH/DAY) __ __ / __ __
	YEAR __ __

UNBOUND OR STABILIZED BASE OR SUBBASE MATERIAL DESCRIPTION

LAYER NUMBER (FROM SHEET 3)	__	12
AASHTO SOIL CLASSIFICATION (SEE CODE, TABLE A.7)	__ __	14-15
OPTIMUM LAB DRY DENSITY, PCF	__ __ __.	17-19
OPTIMUM LAB MOISTURE CONTENT (%)	__ __.__	21-23
TEST USED TO MEASURE OPTIMUM DRY DENSITY	__	25
STANDARD PROCTOR (T-99).........................1		
MODIFIED PROCTOR (T-180)........................2		
OTHER (SPECIFY)________________________3		27-40
COMPACTIVE ENERGY FOR 'OTHER' METHOD (FT.-LBS./CU.IN.)	__ __.__	42-44
IN SITU DRY DENSITY, (PERCENT OF OPTIMUM) (AVERAGE OF DATA AVAILABLE)	__ __ __.	46-48
IN SITU MOISTURE CONTENT (PERCENT OF OPTIMUM)	__ __ __.	50-52
IN SITU DRY DENSITY (PCF)	__ __ __.	54-56
PERCENT BINDER (PASSING NO. 40 SIEVE)	__ __.	58-59
PERCENT PASSING NO. 200 SIEVE	__ __.	61-62
PERCENT STABILIZING AGENT (FOR STABILIZED LAYERS)	__ __.	64-65

NOTE: THIS SHEET IS TO BE FILLED OUT FOR EACH BOUND OR UNBOUND BASE OR SUBBASE LAYER IDENTIFIED ON SHEET 3.

DATA USES: A,B,C,D

SHEET 17	STATE CODE	__ __	1-2
INVENTORY DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	

SUBGRADE DATA

LAYER NUMBER (FROM SHEET 3)	__ __	11-12
AASHTO SOIL CLASSIFICATION (SEE CODE, TABLE A.7)	__ __	14-15
CBR (ESTIMATE FROM OTHER DATA IF NOT AVAILABLE)	__ __ __.	17-19
RESISTANCE (R-VALUE)	__ __ __.	21-23
MODULUS OF SUBGRADE REACTION (K-VALUE), PCI	__ __ __.	25-27
PERCENT PASSING NO. 200 SIEVE	__ __.__	29-31
PLASTICITY INDEX	__ __.	33-34
LIQUID LIMIT	__ __.	36-37
OPTIMUM LAB DRY DENSITY, PCF	__ __ __.	39-41
OPTIMUM LAB MOISTURE CONTENT (%)	__ __.__	43-45
TEST USED TO MEASURE OPTIMUM DRY DENSITY	__	47
STANDARD PROCTOR (T-99)...............1		
MODIFIED PROCTOR (T-180)..............2		
OTHER (SPECIFY)____________________3		
AVERAGE IN SITU DRY DENSITY, PERCENT OF OPTIMUM	__ __ __.	49-51
MEAN MEASURED MOISTURE CONTENT, PERCENT OF OPTIMUM	__ __ __.	53-55
IN SITU DRY DENSITY, PCF	__ __ __.	57-59
SWELL POTENTIAL		
TEST CODE (TABLE A.11)	__ __	61-62
TEST VALUE	__ __ __.__	64-67
FROST SUSCEPTIBILITY		
TEST CODE (TABLE A.11)	__ __	69-70
TEST VALUE	__ __ __.__	72-75

DATA USES: A,B,C,D

SHEET 18	STATE CODE __ __	1-2
INVENTORY DATA	PROJECT ID __ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY) __ __ / __ __	
	YEAR __ __	

SUBGRADE SOIL, BASE, OR SUBBASE RESILIENT MODULI

LAYER NUMBER (FROM SHEET 3) __ __ 11-12

AASHTO SOIL CLASSIFICATION (SEE CODE, TABLE A.7) __ __ 13-14

CODE FOR STRESS TYPE USED AS VARIABLE __ 15

BULK STRESS...............1
DEVIATOR STRESS...........2

CONFINING PRESSURE, PSI __ __. 16-17

RESILIENT MODULI FOR SELECTED STRESS STATES

MOISTURE CONTENT(%)	DENSITY (PCF)	STRESS LEVEL (PSI)	RESILIENT MODULUS (KSI)
__ __.__ 18-20	__ __ __. 21-23	__ __. 24-25	__ __ __ __.__ 27-31
		__ __. 33-34	__ __ __ __.__ 36-40
		__ __. 42-43	__ __ __ __.__ 45-49
		__ __. 51-52	__ __ __ __.__ 54-58

IN THE RELATION LOG E = LOG A + B * LOG(STRESS)

A (THOUSANDS) __ __ __.__ 60-63

B (MAY BE <0) __ __.__ __ 65-68

NOTE: IF B IS NEGATIVE, ADD NEGATIVE SIGN IN COLUMN 65

DATA USES: A,B,C,D

SHEET 19
INVENTORY DATA
LTM PROGRAM

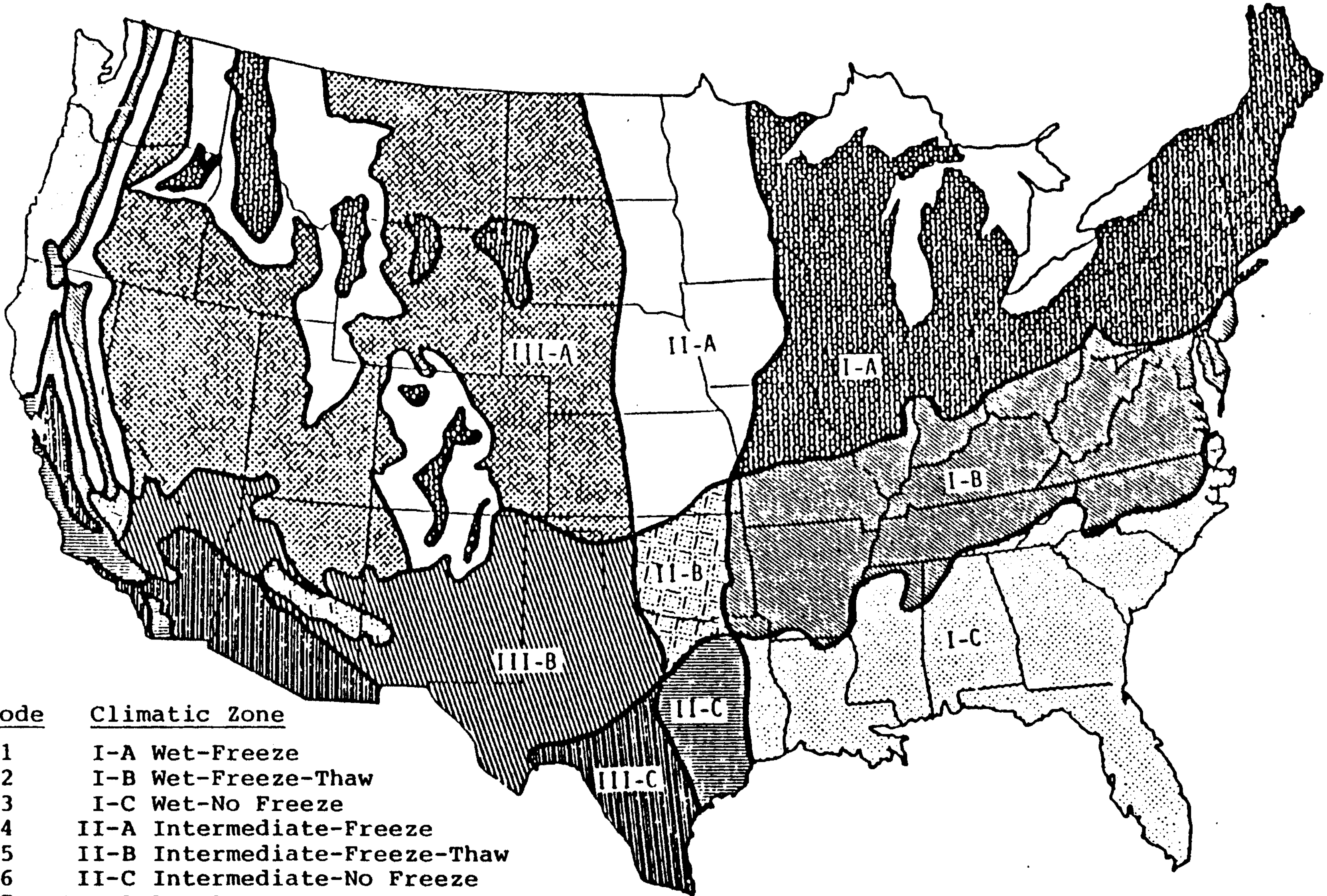
STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

ENVIRONMENTAL DATA

	AVG. MONTHLY TEMP., °C	AVG. MAX. DAILY TEMP., °C	AVG. MIN. DAILY TEMP., °C	AVG. MONTHLY PRECIP., CMS. OF WATER
JANUARY	__ __ __. 12-14	__ __ __. 15-17	__ __ __. 18-20	__ __.__ 21-23
FEBRUARY	__ __ __. 25-27	__ __ __. 28-30	__ __ __. 31-33	__ __.__ 34-36
MARCH	__ __ __. 38-40	__ __ __. 41-43	__ __ __. 44-46	__ __.__ 47-49
APRIL	__ __ __. 51-53	__ __ __. 54-56	__ __ __. 57-59	__ __.__ 60-62
MAY	__ __ __. 64-66	__ __ __. 67-69	__ __ __. 70-72	__ __.__ 73-75
JUNE	__ __ __. 12-14	__ __ __. 15-17	__ __ __. 18-20	__ __.__ 21-23
JULY	__ __ __. 25-27	__ __ __. 28-30	__ __ __. 31-33	__ __.__ 34-36
AUGUST	__ __ __. 38-40	__ __ __. 41-43	__ __ __. 44-46	__ __.__ 47-49
SEPTEMBER	__ __ __. 51-53	__ __ __. 54-56	__ __ __. 57-59	__ __.__ 60-62
OCTOBER	__ __ __. 64-66	__ __ __. 67-69	__ __ __. 70-72	__ __.__ 73-75
NOVEMBER	__ __ __. 12-14	__ __ __. 15-17	__ __ __. 18-20	__ __.__ 21-23
DECEMBER	__ __ __. 25-27	__ __ __. 28-30	__ __ __. 31-33	__ __.__ 34-36

GENERAL TYPE OF ENVIRONMENT (SEE FIGURE 3)	__.	38
LATITUDE (DEGREES)	__ __.	40-41
FREEZING INDEX (32°F - CE METHOD)(SEE FIGURE 4)	__ __ __ __.	43-46
AVERAGE NO. OF ANNUAL FREEZE-THAW CYCLES	__ __ __.	48-50
ELEVATION (FEET ABOVE SEA LEVEL)	__ __ __ __ __.	52-56
AVG. ANNUAL DEICING SALT ($CaCl_2$) APPLICATION (TON/LANE MILE/YEAR)	__ __.	58-59

NOTE: THE DATA ON THIS SHEET AND SHEET 20 IS ENTERED ON THREE LINES IN THE DATA BANK. REPEAT COLUMNS 1-10 ON EACH OF THE 3 LINES.



Code	Climatic Zone
1	I-A Wet-Freeze
2	I-B Wet-Freeze-Thaw
3	I-C Wet-No Freeze
4	II-A Intermediate-Freeze
5	II-B Intermediate-Freeze-Thaw
6	II-C Intermediate-No Freeze
7	III-A Dry-Freeze
8	III-B Dry-Freeze-Thaw
9	III-C Dry-No Freeze

Figure 3. Climatic Zones for the United States (Refs. 5 and 6)

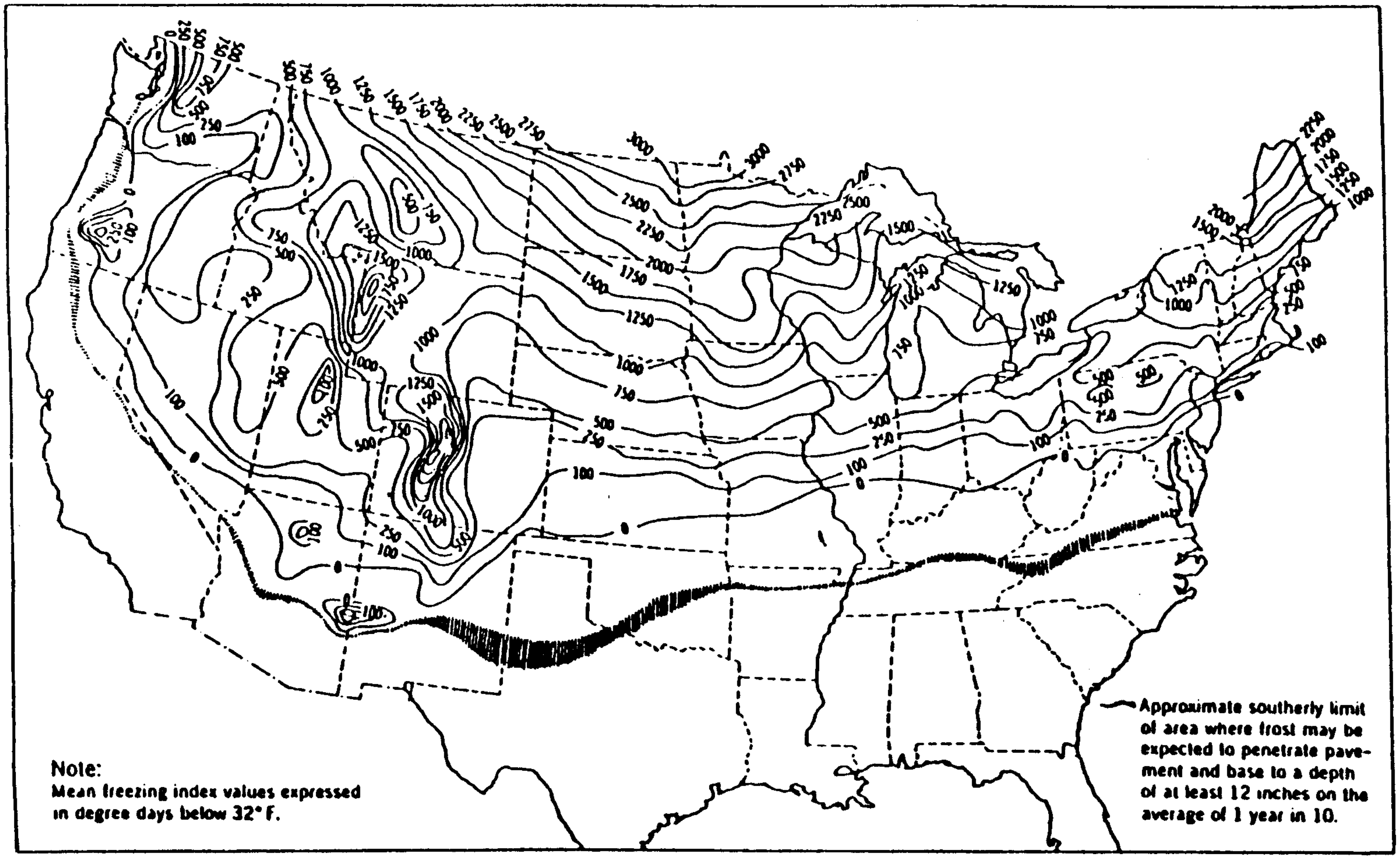


Figure 4. Distribution of Mean Freezing-Index Values in Continental United States (From Corps of Engineers EM 1110-345-306)

DATA USES: A,B,C,D

SHEET 20

INVENTORY DATA

LTM PROGRAM

STATE CODE __ __

PROJECT ID __ __ __ __

DATE (MONTH/DAY) __ __ / __ __

YEAR __ __

ENVIRONMENTAL DATA CONTINUED

HIGHEST MONTHLY MEAN SOLAR RADIATION (LANGLEYS/DAY) __ __ __ __. 61-64

LOWEST MONTHLY MEAN SOLAR RADIATION (LANGLEYS/DAY) __ __ __ __. 66-69

THORNTHWAITE INDEX (SEE FIGURE 5) __ __ __. 71-73

NOTE: DATA ON THIS PAGE IS ENTERED IN THE DATA BANK AS A PART OF THIRD LINE OF DATA STARTING ON PREVIOUS SHEET 19.

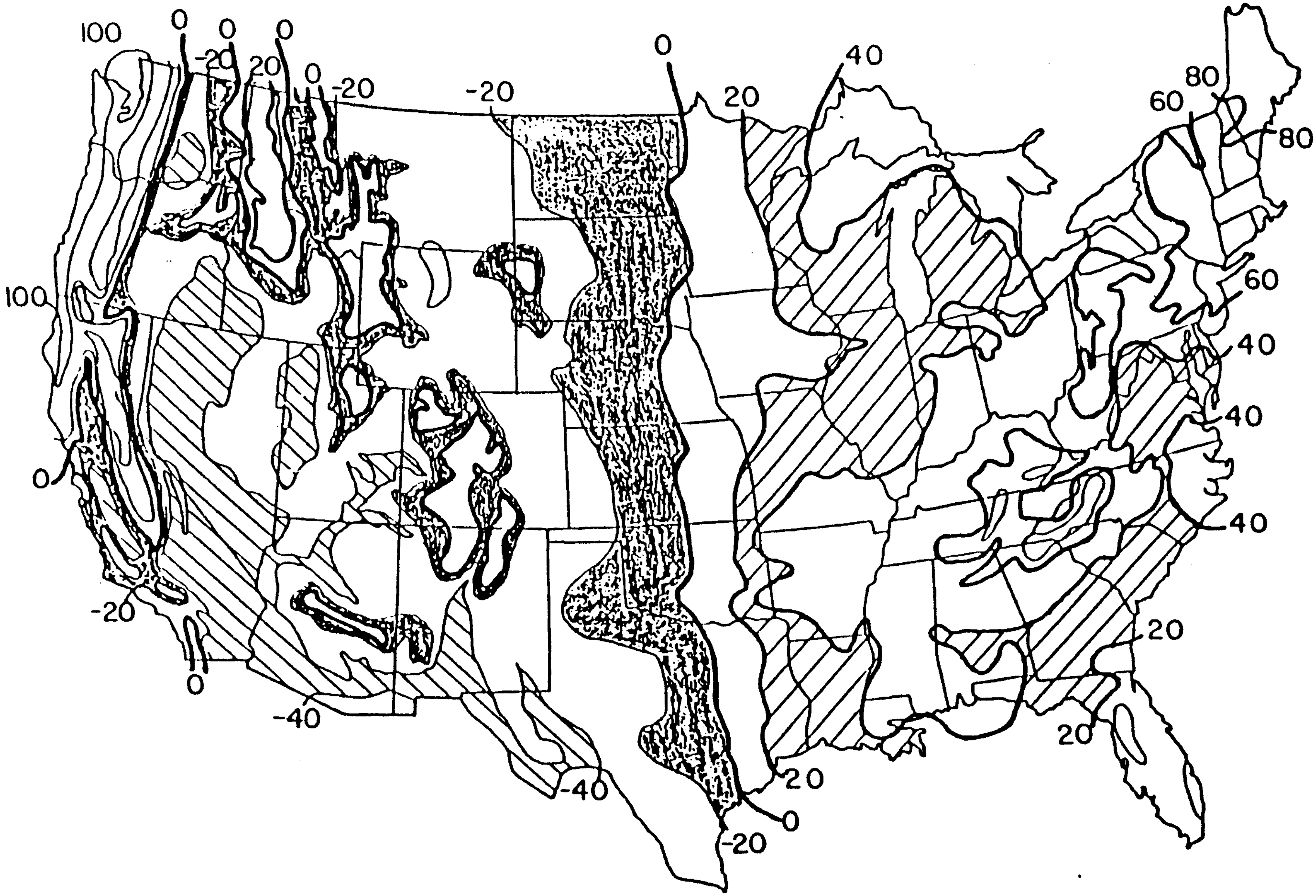


Figure 5. Distribution of Thornthwaite Moisture Index in the United States (Refs. 5 and 7)

DATA USES: A,B,C,D

SHEET 21
INVENTORY DATA
LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

MAINTENANCE DATA

YEAR (YEAR)	MAINTENANCE CASE NO. (CASE)	WORK TYPE CODE (Table A.12)	LOCATION ON PAVEMENT CODE (Table A.13)	MAINTENANCE MATERIAL CODE (Table A.14)	WORK QUANTITY	THICKNESS (INCHES)
__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
14-15	17-19	21-22	24-25	27-28	30-34	36-38

NOTE: EACH LINE OF DATA ABOVE IS ENTERED IN THE DATA BANK AS ONE LINE IN THE POSITIONS INDICATED BELOW THE DATA TABLE.

DATA USES: A,B,C,D

SHEET 22
INVENTORY DATA
LTM PROGRAM

STATE CODE	_ _	1-2
PROJECT ID	_ _ _ _	3-6
DATE (MONTH/DAY)	_ _ / _ _	
YEAR	_ _	

TRAFFIC DATA

YEAR	ONE WAY AADT	ONE WAY % TRUCKS	ONE WAY LANE DISTRIBUTION OF TRUCKS (%)	
			LEFT LANE	RIGHT LANE
_ _	_ _ _ _ _.	_ _.	_ _ _.	_ _ _.
_ _	_ _ _ _ _.	_ _.	_ _ _.	_ _ _.
_ _	_ _ _ _ _.	_ _.	_ _ _.	_ _ _.
_ _	_ _ _ _ _.	_ _.	_ _ _.	_ _ _.
_ _	_ _ _ _ _.	_ _.	_ _ _.	_ _ _.
_ _	_ _ _ _ _.	_ _.	_ _ _.	_ _ _.
12-13	15-19	21-22	24-26	28-30

*Excluding pickups and panels.

NOTE: EACH LINE OF DATA ABOVE IS ENTERED IN THE DATA BANK AS ONE LINE IN THE POSITIONS INDICATED BELOW THE DATA TABLE.

DATA USES: A,B,C,D

SHEET 23
INVENTORY DATA
LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

TRAFFIC DATA

VEHICLE CLASSIFICATION

(PERCENT OF TRUCK VOLUME BY TRUCK TYPE)

YEAR	2-AXLE, 6-TIRED S.U. TRUCKS	3^+-AXLE S.U. TRUCKS	3-AXLE COMB.	2S2	4-AXLE COMB.	3S2	OTHER 5-AXLE COMB.	6^+-AXLE COMB.	TOTAL
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%
__ __ 14-15	__ __ 17-18	__ __ 20-21	__ __ 23-24	__ __ 26-27	__ __ 29-30	__ __ 32-33	__ __.__ 35-37	__ __.__ 39-41	100%

NOTE: USE AS MANY SHEETS AS NEEDED TO INCLUDE AVAILABLE DATA SINCE THE SECTION WAS OPENED

DATA USES: A,B,C,D

SHEET 24
INVENTORY DATA
LTM PROGRAM

STATE CODE __ __ 1-2
PROJECT ID __ __ __ __ 3-6
DATE (MONTH/DAY) __ __ / __ __
YEAR __ __

TRAFFIC DATA
TYPICAL AXLE LOADS BY VEHICLE CLASS

YEAR.. __ __ 12-13

TRUCK CLASSIFICATION	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]
2-AXLE, 6-TIRED S.U. TRUCKS	__ 15	__ __ __. 16-18	__ 19	__ __ __. 20-22								
3+-AXLE S.U. TRUCKS	__ 23	__ __ __. 24-26	__ 27	__ __ __. 28-30	__ 31	__ __ __. 32-34	__ 35	__ __ __. 36-38				
3-AXLE COMB.	__ 39	__ __ __. 40-42	__ 43	__ __ __. 44-46	__ 47	__ __ __. 48-50						
2S2	__ 51	__ __ __. 52-54	__ 55	__ __ __. 56-58	__ 59	__ __ __. 60-62						
4-AXLE COMB.	__ 63	__ __ __. 64-66	__ 67	__ __ __. 68-70	__ 71	__ __ __. 72-74	__ 75	__ __ __. 76-78				
3S2	__ 15	__ __ __. 16-18	__ 19	__ __ __. 20-22	__ 23	__ __ __. 24-26						
OTHER 5-AXLE COMB.	__ 27	__ __ __. 28-30	__ 31	__ __ __. 32-34	__ 35	__ __ __. 36-38	__ 39	__ __ __. 40-42	__ 43	__ __ __. 44-46		
6+-AXLE COMB.	__ 47	__ __ __. 48-50	__ 51	__ __ __. 52-54	__ 55	__ __ __. 56-58	__ 59	__ __ __. 60-62	__ 63	__ __ __. 64-66	__ 67	__ __ __. 68-70

[1]AXLE TYPE CODE: SINGLE AXLE..1 TANDEM AXLE..2 TRIPLE (TRIDEM) AXLE..3 [2]ALL LOADS IN HUNDREDS OF POUNDS.

NOTE: DATA ON THIS SHEET IS ENTERED ON TWO LINES IN DATA BANK IN THE COLUMNS INDICATED BY SMALL NUMBERS UNDER DATA ENTRY SPACES. THE 'HEADER DATA' IN COLUMNS 1-13 ON LINE 1 MUST BE REPEATED ON LINE 2.

DATA USES: A,B,C,D

SHEET 25

INVENTORY DATA

LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

TRAFFIC DATA
SUMMARY AXLE LOAD DISTRIBUTIONS

YEAR.. __ __.12-13

SINGLE AXLE LOAD (SA)	NUMBER OF AXLES	TANDEM AXLE LOAD (TA)	NUMBER OF AXLES
UNDER 3,000	__ __ __ __ __ __.15-20	Under 6,000	__ __ __ __ __ __.33-38
3,000 - 6,999	__ __ __ __ __ __.21-26	6,000 - 11,999	__ __ __ __ __ __.39-44
7,000 - 7,999	__ __ __ __ __ __.27-32	12,000 - 17,999	__ __ __ __ __ __.45-50
8,000 - 11,999	__ __ __ __ __ __.33-38	18,000 - 23,999	__ __ __ __ __ __.51-56
12,000 - 15,999	__ __ __ __ __ __.39-44	24,000 - 29,999	__ __ __ __ __ __.57-62
16,000 - 17,999	__ __ __ __ __ __.45-50	30,000 - 31,999	__ __ __ __ __ __.63-68
18,000 - 18,499	__ __ __ __ __ __.51-56	32,000 - 32,499	__ __ __ __ __ __.69-74
18,500 - 19,999	__ __ __ __ __ __.57-62	32,500 - 33,999	__ __ __ __ __ __.15-20
20,000 - 21,999	__ __ __ __ __ __.63-68	34,000 - 35,999	__ __ __ __ __ __.21-26
22,000 - 23,999	__ __ __ __ __ __.69-74	36,000 - 37,999	__ __ __ __ __ __.27-32
24,000 - 25,999	__ __ __ __ __ __.15-20	38,000 - 39,999	__ __ __ __ __ __.33-38
26,000 - 29,999	__ __ __ __ __ __.21-26	40,000 - 41,999	__ __ __ __ __ __.39-44
30,000 or Over	__ __ __ __ __ __.27-32	42,000 - 43,999	__ __ __ __ __ __.45-50
TOTAL SINGLE AXLES	__ __ __ __ __ __.	44,000 - 45,999	__ __ __ __ __ __.51-56
		46,000 - 49,999	__ __ __ __ __ __.57-62
		50,000 or Over	__ __ __ __ __ __.63-68
		TOTAL TANDEM AXLES	__ __ __ __ __ __.

NOTE: THE DATA FROM THE W-4 TABLE IS ENTERED IN THE DATA BANK AS THREE LINES. IDENTIFICATION AND YEAR MUST BE REPEATED ON EACH LINE.

CHAPTER 3

MONITORING DATA COLLECTION PROCEDURES FOR LTM (TYPE A DATA USE)

This chapter provides data sheets and instructions for their use in collecting monitoring data that may be expected to change over the monitoring period. Much of this data will be useful for all four data uses described in Chapter 1, so the data uses will be identified in the upper right corner of the data sheets by the letter designations in the same manner as for the data sheets for inventory data. Data sheets and procedures from the COPES system have also been used wherever possible as for the inventory data sheets.

The common data section appearing in the right hand corner of each of the inventory data sheets previously described will also appear in the upper right hand corner of each of the monitoring data sheets. This data section is described under the section entitled, "Data Section Common for all Data Sheets" in Chapter 2.

ROUGHNESS, SKID, AND PSI MEASUREMENTS (SHEET 1)

Lane Numbers: One single-digit number each to identify the left and right lane numbers for which these measurements are made, which must be consistent with lane numbers appearing on Sheet 2 of the inventory data. The outer lane is Lane 1, the lane next to it is Lane 2, etc.

Pavement Serviceability Index: One two-digit number each for entering the Pavement Serviceability Index (PSI) to the nearest tenth for the lane or lanes measured. These PSI-values should be calculated based on HPMS procedures from data obtained from roughness and distress measurements.

Measurement Date (Month/Day/Year) for PSI: A set of three two-digit numbers for each lane to identify the month, day, and year when the roughness measurements were made. The number to identify the month is in numerical sequence of the months as they occur during the year (enter "03" for March, etc.). The two digits identifying the year are the last two digits of the year (83 for 1983, etc.).

Skid Number (SN)(Wet): A two-digit number identifying the coefficient of friction between the vehicle wheel tire and the pavement surface. Coefficient of friction or "friction factor" is the ratio of the frictional force to the wheel load. The skid number SN is the friction factor multiplied by 100. These skid resistance measurements are made with a calibrated locked-wheel skid tester as specified by ASTM E274 and supplemental procedures described in Appendix B of FHWA Technical Advisory T 5040.17, December 23, 1980. Tests are taken ten times per mile and the arithmetic average of all determinations is the number entered on this data sheet.

Measurement Date (Month/Day/Year) for SN: Date or dates entered the same as for Measurement Date for PSI.

Roughness Index: A three-digit number for each lane measured by a Roughometer, Ridemeter, Profilograph, or Profilometer. The units for the numbers entered are dependent on the type of measurement device used (identified on the data sheet).

Measurement Date for Roughness Index: Date entered in the same manner as for PSI.

Speed at Which Roughness Index Obtained: A two-digit number for each lane to indicate the speed in miles per hour at which the roughness was measured.

Speed at Which SN Obtained: A two-digit number for entering the speed in miles per hour at which the skid numbers were obtained (assumed to be standard for all tests).

Equipment Used to Measure SN: A single-digit code to identify the type of skid measurement device used. The codes appear on the data sheet.

Equipment Used to Measure Roughness: A single-digit code used to identify the roughness measurement device used. The codes appear on the data sheet.

DISTRESS SURVEY FOR PAVEMENTS WITH A FLEXIBLE SURFACE (SHEET 2)

Lane Number: A one-digit number to identify the lane number as identified on Sheet 2 of the inventory data. Where two lanes are monitored, two sets of sheets should be filled out.

Subsection Number: A one-digit number to identify which of the ten subsections of the test section the distress data represents. The first subsection from the start of the test section (one mile in length) is called "0" and extends from 0 to 0.1 of a mile along the test section. The second is called "0.1" and extends from 0.1 to 0.2 of a mile along the test section, and so forth. The last subsection is called "0.9" and extends from a point 0.9 miles from the start of the test section to its end. The number "0" is entered to identify the first subsection, "1" for the second subsection, "2" the third, and so forth. As can be seen, ten copies of this data sheet are to be filled out for each lane in a test section.

Extent and Severity of Distress: The data sheet includes space for recording ten types of distress identified in the left column. The extent of the distress in terms of the units indicated are to be entered for the particular lane and sub-section numbers in columns identified by level of severity as low, moderate, or high; with the exceptions that 1) bleeding is entered only as extent in square feet, and 2) only the mean severity is entered for "Lane/Shoulder Dropoff or Heave" and "Lane/Shoulder Separation". Spaces are left blank for distresses and severities not noted.

These distresses and severities must be identified using 1) Report No. FHWA/RD-81/080, "A Pavement Moisture Accelerated Distress Identification System User's Manual, Volume 2" (Ref. 6) or 2) Report No. FHWA/RD-79-66, "Highway Pavement Distress Identification Manual" (Ref. 18). The distress identifications in these two documents are essentially identical.

RUTTING SURVEY FOR PAVEMENTS WITH A FLEXIBLE SURFACE (SHEET 3)

Lane Numbers: Instructions for lane identification provided for Sheet 2 apply also for Sheet 3.

Rutting: Space is provided on this one data sheet for entering all rutting measurements in square feet of rutting within each of the ten subsections of a test section by lane. A four-digit space was provided for low severities of rutting and three-digit spaces for moderate and high severity rutting, respectively. This is because more low severity rutting is usually apparent than either moderate or high severity rutting. Definitions of the severity levels appear in Reference 6.

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED RIGID SURFACES (SHEET 4)

This data sheet is filled out essentially as described above for Sheet 2. The data sheet includes space for recording thirteen types of distress identified in the left column. The extent of the distress in terms of the units indicated are to be entered for the particular lane and subsection numbers in columns identified by level of severity as low, moderate, or high; with the exceptions that 1) bleeding is entered only as extent in square feet, and 2) only the mean severity is entered for "Lane/Shoulder Dropoff or Heave" and "Lane/Shoulder Separation". Spaces are left blank for distresses and severities not noted. Reference 18 must be used in the identification of distresses for rigid pavements.

TRANSVERSE JOINT FAULTING SURVEY FOR RIGID PAVEMENTS (JRCP/JCP ONLY) (SHEET 5)

The mean transverse joint faulting in inches to the nearest hundredth may be entered on this sheet for each subsection of a test section by lane. Three-digit spaces are provided for each entry. Lane numbers are identified as previously described.

DISTRESS SURVEY FOR RIGID PAVEMENTS WITH CONTINUOUSLY REINFORCED RIGID SURFACES (SHEET 6)

The lane number and subsection number are entered as described for Sheet 2.

The data sheet includes space for recording fifteen types of distress identified in the left column. The extent of the distress in terms of the units indicated are to be entered for the particular lane and subsection numbers in columns identified by level of severity as low, moderate, or high; with the exceptions that 1) only the highest severity is indicated by a one-digit code for four of the distresses and 2) only the number of corner breaks and the percent area with reactive aggregates are entered in single three-digit and two-digit spaces, respectively. Spaces are left blank for distresses and severities not noted. The descriptions for "Punchouts" and "Construction Joint Deterioration" appear only in Reference 18 as continuously reinforced concrete pavements were omitted from Reference 6.

DATA ON DEFLECTION DEVICE, AIR TEMPERATURE, AND DATE OF MEASUREMENT (SHEET 7)

Type of Deflection Device: A one-digit code identifying the type of deflection device. The codes are provided on the data sheet.

Load: A five-digit number indicating the load applied to the pavement by the deflection device. For a Dynaflect trailer, this will always be 1000 pounds. For the other devices, this may vary.

Frequency: A two-digit number indicating the frequency of loading for those devices such as the Dynaflect trailer and Road Rater that apply continuous repetitive loadings. For the Dynaflect trailer, this will always be 8 Hz., while the frequency for the Road Rater may be varied.

Location of Sensors: Two-digit codes identifying the distance in feet to the nearest tenth from the center of load (equidistant between load wheels for the Dynaflect trailer) to the various sensors. Sensor 1 will generally be located at the center of load, while the other four sensors are at increasing distances with increasing sensor number. The Falling Weight Deflectometer sometimes is operated with more than five sensors, but the first five sensors should be utilized for data entry. Dynaflect sensors are usually located at one-foot intervals such that the entry for Sensor 1 would be 0.0, 1.0 for Sensor 2, 2.0 for Sensor 3, etc.

Date of Measurement and Air and/or Pavement Temperature: The dates measurements were made and the average air and/or pavement temperatures in degrees Fahrenheit recorded while the measurement series was in progress. Pavement temperatures are often measured for asphalt concrete surfaces by drilling holes into the pavement and measuring the temperature of glycerin or other liquids poured in the holes and allowed to stabilize in temperature. When available, pavement temperatures should be entered. If not available, leave blank. The dates are to be entered as previously described. These data are entered for the left and right lanes separately.

DEFLECTION MEASUREMENTS (SHEET 8)

This data sheet provides space for the entry of the measured deflections for one lane from each of five sensors in mils at each of four test locations per 0.1 mile subsection.

Decimal Code: Deflection measurements are generally entered in hundredths of mils (i.e., "1.04 mils" would be entered as "104"). However, heavy loads on weak pavements sometimes produce measurements of ten mils or more, so a decimal code has been included to allow specified measurements to be entered in tenths of a mil. As Sensor 1 should always measure the largest deflection, a single-digit code may be entered to indicate if only Sensor 1, Sensors 1 and 2, the first three sensors, etc. are to be entered in tenths (i.e., "10.4" mils is entered as "104"). An entry of "1" means only Sensor 1 is entered in tenths of a mil, "3" means the first three sensors, etc.

Test Location: Four test locations are defined for each subsection. These measurements vary for pavements with flexible surfaces and rigid pavements with joints. Measurements for continuously reinforced concrete pavements may be conducted as for flexible pavements. Each of these test locations is defined below.

The test locations are indicated as A, B, C, and D on the data sheet. For flexible and continuously reinforced concrete pavements, test location A will be the first measurement made in the outer wheel path. Test measurement B will be made five feet away from test location A in the direction of travel.

Test location C will be ten feet away from test location A in the direction of travel, and test location B will be 20 feet away from test location A in the direction of travel.

For jointed concrete pavements, the tests are located differently. Test location A will be at mid slab in the outer wheel path. Test location B will be on the same slab as test location A, but located adjacent to the next transverse joint in the direction of traffic. The first two sensors should be located on opposite sides of the joint. Test location C will be adjacent to the same joint, but Sensor 1 will be located just on the other side on the next slab. Test location D will be at mid slab in the outer wheel path of the same slab occupied for test location C. As wheel paths are difficult to locate on rigid pavements, the center of load may be placed between 18 and 24 inches from the edge of the pavement or the edge of the lane.

The instructions above are correct for most deflection devices with sensors "leading" the applied load in the direction of traffic, but some devices (notably Road Raters) have sensors that "trail" the load. For these devices, the same procedure is followed, but the sensors will be located on either side of the joint for Location C rather than Location B.

MAINTENANCE DATA (SHEET 9)

The instructions in Chapter 2 for entering data on Inventory Data Sheet 21 apply for this data sheet, except that space was provided for the month (as well as the year) when the maintenance occurred during the monitoring year.

MAJOR PAVEMENT IMPROVEMENT DURING MONITORING YEAR (SHEET 10)

It should be remembered that combining more than one lane in a test section implies that the lanes have essentially identical pavement structures. If a major pavement improvement alters this similarity, one of the lanes must be renumbered as a separate test section. This should be provided for in a computer program yet to be written.

Type of Major Improvement: A one-digit code to identify the type of major improvement that has occurred during the monitoring year. The codes appear on the data sheet.

Cost for Major Improvement: A four-digit number for entering the cost for the major improvement in thousands of dollars per mile.

Overlay Data: A three-digit number to enter the thickness of a new overlay in tenths of an inch and a two-digit code for entering the material type classification from Table A.4, Pavement Surface Material Type Codes. If the major improvement was not an overlay, these two data fields are left blank.

Replacement Data: A three-digit number to enter thickness in tenths of an inch and a two-digit code for entering material type classification from either Table A.4 or A.5 where Layer 1, Layers 1 and 2, or Layers 1, 2, and 3 have been replaced or recycled (includes tearing out and recompacting base or subbase layers). These six fields are left blank if no layers were replaced or recycled. Layers 2 and 3 are left blank if only Layer 1 was replaced or recycled, etc.

SHEETS 11 THROUGH 22

Sheets 11 through 16 are filled out only in the event of a rigid pavement overlay or replacement of the surface layer with a rigid layer. If the pavement is continuously reinforced without joints, Sheets 11 and 12 for entering joint data are also omitted. Sheets 17 through 21 would also be omitted because they are for asphalt concrete.

If the overlay or layer replacement is asphalt concrete, only Sheets 17 through 21 are filled out.

Sheet 22 is only filled out when a layer has been replaced or recycled with unbound or stabilized base or subbase material.

None of these sheets are filled out unless there is a major improvement and only then if it is an overlay or one or more layers is recycled or replaced.

The instructions for these data sheets are identical to those for identical Inventory Data Sheets 5 through 16 (see Chapter 2), except that:

1. The layer number is either 1, 2, or 3. If an overlay, it is Layer Number 1 and the computer program (to be developed) must reassign layer numbers for previously existing layers. If a replacement, the layer number entered will be that for the layer, but the thicknesses and types of material may vary from those replaced. (Note - removal of a layer by planing and then adding an overlay is a replacement if all of the layer is removed. If only partially removed, enter the overlay and also the new reduced thickness for the layer partially replaced, using its new layer number now that the overlay is Layer 1).

2. The material properties are those for the new material as conventionally measured during construction, or from cores removed from the completed layer.

ENVIRONMENTAL DATA FOR MONITORING YEAR (SHEET 23)

<u>Temperature and Precipitation Data</u>: Three-digit numbers for entering average monthly temperature, average maximum daily temperature, average minimum daily temperature, and precipita-

tion for each month during the monitoring year. Entries for temperature are in degrees Centigrade and entries for precipitation are in inches of water to the nearest tenth of an inch.

Deicing Salt ($CaCl_2$) Applications During Year: A two-digit number for entering the tons of deicing salt spread per lane mile during the monitoring year.

Number of Freeze-Thaw Cycles: A three-digit number identifying the number of ambient freeze-thaw cycles that occur during the monitoring year.

Highest Mean Solar Radiation: A four-digit number identifying the average of the daily measurements of solar radiation in Langleys per day for the month experiencing the greatest solar radiation during the monitoring year. Use best data available in vicinity of monitoring section. If no measurements are made during monitoring year, leave blank.

Lowest Mean Solar Radiation: A four-digit number identifying the average of the daily measurements of solar radiation in Langleys per day for the month experiencing the least solar radiation during the monitoring year. Use best data available in vicinity of monitoring section. If no measurements are made during monitoring year, leave blank.

TRAFFIC DATA (SHEET 24)

Space is provided on this sheet for entering traffic data from a maximum of four counts during the monitoring year. If more than four counts are to be entered, they should be averaged together on a seasonal basis to restrict to four counts. Each of the five items of traffic data reported by month in which traffic counts were made are discussed separately below.

Month: A two-digit code for entering the month during which the traffic count was conducted. Enter the number of the month in numerical sequence during the year ("03" for March, etc.).

One Way ADT: A five-digit number to enter the average daily traffic from the count reported. If at all possible, the count should be made for the specific test section monitored, or at some existing count location such that the traffic count can be reasonably extrapolated. Although the ADT data may not be completely accurate, its importance requires as accurate an estimate as possible.

One Way Percent Trucks: A two-digit number indicating the mean percent of the total traffic flow that was comprised of trucks (excluding pickup trucks).

One Way Lane Distribution of Trucks: Three-digit spaces are provided for both the left and right lanes for entering the percent of the total trucks using that specific lane, so that trucks using each lane included in the test section being monitored may be accounted for separately. If the distribution is unknown, Table A.16 may be used for a reasonable estimate, or as guidance for an estimate.

Space is also provided for the estimated "Annual" average traffic data for the monitoring year based on the data entered and other information that may improve the estimates. Unless other information (such as seasonal truck traffic increases) indicates otherwise, the annual estimates may be the average of the data entered above (including that from additional sheets, if any).

TRAFFIC DATA - VEHICLE CLASSIFICATION, PERCENT OF TRUCK VOLUME BY TRUCK TYPE (SHEET 25)

Space is provided for entering percent of truck volume by each of nine types of trucks for each of a maximum of four counts during a monitoring year. If data for more than four counts is available, seasonal averages may be taken and entered, as for Sheet 24. It should be noted that the percentage figures entered for a year under the nine truck types must total 100%. The truck types included on this data sheet differ from those on the similar Inventory Data Sheet 25, same title. This is because issuance of a new Truck Weight Study Manual by the FHWA is imminent, and this sheet has been designed for consistency with it.

The month and the year are entered for each count as two-digit numbers as described previously for other sheets. The truck types for which percentages of total truck volume must be calculated are described briefly below:

1. Two-Axle, 6-Tire Single Unit Trucks - This category includes all trucks, camping and recreation vehicles, motor homes, etc., having two axles and dual rear wheels.

2. Three-Axle Single Unit Trucks - All vehicles on a single frame with three axles in any configuration. This category includes concrete mixer trucks, heavy dump trucks, large motor homes, etc., having three axles.

3. Four or More Axle Single Unit Trucks - All trucks on a single frame with four or more axles.

4. Four or Less Axle Single Trailer Trucks - All vehicles consisting of two units, one of which is a

tractor or straight truck power unit, that have four or less axles.

5. Five-Axle Single Trailer Trucks - All vehicles consisting of two units, one of which is a tractor or straight truck power unit, that have five axles.

6. Six or More Axle Single Trailer Trucks - All vehicles consisting of two units, one of which is a tractor or straight truck power unit, that have six or more axles.

7. Five or Less Axle Multi-Trailer Trucks - All vehicles consisting of three or more units, one of which is a tractor or straight truck power unit, that have no more than five axles.

8. Six-Axle Multi-Trailer Trucks - All vehicles consisting of three or more units, one of which is a tractor or straight truck power unit, that have six axles.

9. Seven or More Axle Multi-Trailer Trucks - All vehicles consisting of three or more units, one of which is a tractor or straight truck power unit, that have seven or more axles.

Additional information as to identification of truck types is included in the HPMS Vehicle Classification Case Study Manual and in the new Truck Weight Study Manual issued by the Federal Highway Administration (to be issued in 1984).

TRAFFIC DATA, TYPICAL AXLE LOADS BY VEHICLE CLASS (SHEET 26)

This sheet is filled out once in its entirety for each monitoring year. If more than one load study is made during the monitoring year, the results should be averaged. The year is entered in two digits as previously described and there is a one-digit code for axle type and a three-digit code for entering the axle loads in hundreds of pounds. The truck classifications on this data sheet are consistent with those on the previous data sheet 25.

It should be remembered that all axles are considered to be single axles for truck classification, but the two axles in a "tandem" axle are weighed as a single tandem axle. As an example, consider the "five-axle single trailer trucks". It is possible to have a combination with five single axles, in which case there would be entries in all five of the spaces provided. However, it would be more likely to have a single axle on the front of the drive unit, a tandem axle on the rear of the driver unit, and another tandem axle at the rear of the semi-trailer. In this case, the code 1 would be entered for axle type at the left column and a typical weight for the single axle entered under the load. For the next two sets of entries, the axle type code would be 2 and typical loads entered for each of these tandem axle sets. This would leave two sets of entries blank. This is typical of how entries are to be made in terms of single and tandem axles for other truck types.

It is probable that there will be more than one subtype of truck under a specific truck classification such as "five-axle single trailer trucks". As there is only going to be room in the data bank for one set of entries for each truck classification, the most typical (i.e., the one with the greatest count) will be considered and the typical axle load data entered for it. The assumption is that all of the trucks in this classification are the most typical subtype. This will, of course, introduce some error, but it is believed to be acceptable as unusual truck types do not often occur in great numbers and there will be some compensation.

Traffic data should be processed to the FHWA as for other data for entry into the "W-Tables". W-Tables, specific for the traffic data submitted, will be processed and furnished to the SHA preparing the data sheets. The data for this data sheet may be extracted from those W-Tables.

TRAFFIC DATA, SUMMARY AXLE LOAD DISTRIBUTIONS (SHEET 27)

It can be seen that the data to be entered on this data sheet is that appearing as "Total All Trucks and Combinations, Probable No." in Part 5 of the W-4 tables. This data may be entered as number of axles under each single or tandem axle load group in the six-digit spaces provided. The year is entered as two digits as previously described, and this data sheet is to be repeated for each monitoring year.

Although most test sections were specifically selected to be in the vicinity of a weigh station or weigh-in-motion system, this may not always be the case. In this case, judgement must be applied to best represent the traffic data for the test section. If count and weigh data is developed for a test section, it can be forwarded to the FHWA for processing into special "W-Tables" for the LTM test sections as described above for Sheet 26.

DATA USES: A,B,C,D

SHEET 1	STATE CODE	__ __ 1-2
MONITORING DATA	PROJECT ID	__ __ __ __ 3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __/__ __
	YEAR	__ __

ROUGHNESS, SKID, AND PSI MEASUREMENTS

	LEFT LANE	RIGHT LANE
LANE NUMBER	__ 12	__ 12
PAVEMENT SERVICEABILITY INDEX (TO NEAREST TENTH)	__.__ 21-22	__.__ 21-22
MEASUREMENT DATE FOR PSI (MONTH/DAY/YEAR)	__ __/__ __/__ __ 23-28	__ __/__ __/__ __ 23-28
SKID NUMBER (SN)(WET)	__ __. 29-30	__ __. 29-30
MEASUREMENT DATE FOR SN (MONTH/DAY/YEAR)	__ __/__ __/__ __ 31-36	__ __/__ __/__ __ 31-36
ROUGHNESS INDEX (R.I.)	__ __ __. 37-39	__ __ __. 37-39
MEASUREMENT DATE FOR R.I. (MONTH/DAY/YEAR)	__ __/__ __/__ __ 40-45	__ __/__ __/__ __ 40-45
SPEED AT WHICH R.I. OBTAINED (MPH)	__ __. 46-47	__ __. 46-47
SPEED AT WHICH SN OBTAINED (MPH)		__ __. 48-49
EQUIPMENT USED TO MEASURE SN		__. 50

TRAILER (LOCKED WHEEL WITH ASTM 3274 STANDARD TIRE)..1
Mu METER..2
OTHER (SPECIFY)___________________________________3 51-63

EQUIPMENT USED TO MEASURE R.I.	__. 64

BPR ROUGHOMETER (IN/MILE)............................1
MAY'S RIDE METER (IN/MILE)...........................2
PCA ROUGHOMETER (IN^2/MILE)........................3
PROFILOGRAPH (IN/MILE)...............................4
GM PROFILOMETER......................................5
OTHER (SPECIFY)______________________________________6 65-77

NOTE: DATA FOR EACH LANE ARE ENTERED ON ONE LINE FOR ENTRY INTO THE DATA BANK. EQUIPMENT CODES AND DESCRIPTIONS OF EQUIPMENT FOR WHICH CODES WERE NOT FURNISHED (COLUMNS 47-77) ARE COMMON BETWEEN LANES AND ARE TO BE ENTERED ONLY FOR THE RIGHT LANE

DATA USES: A,B,C,D

SHEET 2 MONITORING DATA LTM PROGRAM		
	STATE CODE	__ __ 1-2
	PROJECT ID	__ __ __ __ 3-6
	DATE (MONTH/DAY)	__ __/__ __ 14-17
	YEAR	__ __ 18-19

DISTRESS SURVEY FOR PAVEMENTS WITH A FLEXIBLE SURFACE

LANE NUMBER __ 12 SUBSECTION NUMBER __ 13

DISTRESS TYPE	SEVERITY LEVEL		
	LOW	MODERATE	HIGH
ALLIGATOR/FATIGUE CRACKING (Square Feet)	__ __ __ __. 20-23	__ __ __ __. 24-27	__ __ __ __. 28-31
RAVELING (Square Feet)	__ __ __ __. 32-35	__ __ __ __. 36-39	__ __ __ __. 40-43
BLEEDING (Square Feet)			__ __ __ __. 44-47
BLOCK CRACKING (Square Feet)	__ __ __ __. 48-51	__ __ __ __. 52-55	__ __ __ __. 56-59
LONGITUDINAL CRACKING (Linear Feet)	__ __ __ __. 60-63	__ __ __ __. 64-67	__ __ __ __. 68-71
TRANSVERSE CRACKING (Linear Feet)	__ __ __ __. 20-23	__ __ __ __. 24-27	__ __ __ __. 28-31
POTHOLES/POTHOLE PATCHING (Number)	__ __ __. 32-34	__ __ __. 35-37	__ __ __. 38-40
REFLECTION CRACKING (Linear Feet)	__ __ __. 41-43	__ __ __. 44-46	__ __ __. 47-49

LANE/SHOULDER DROPOFF OR HEAVE-MEAN SEVERITY FOUND (Enter 1 for low, 2 for moderate, 3 for high mean severity) __. 50

LANE/SHOULDER SEPARATION-MEAN SEVERITY FOUND (Enter 1 for low, 2 for moderate, 3 for high mean severity) __. 51

NOTES: 1. EXTENT OF DISTRESS (IN SQ. FT., LIN. FT., OR NUMBER AS INDICATED) IS TO BE ENTERED FOR EACH SEVERITY LEVEL, EXCEPT ONLY ONE ENTRY IS MADE FOR 'BLEEDING', 'LANE/SHOULDER DROPOFF OR HEAVE', AND FOR 'LANE/SHOULDER SEPARATION'.

2. THE DATA ON THIS SHEET (REPRESENTING ONE SUBSECTION) ARE ENTERED ON TWO LINES FOR ENTRY INTO THE DATA BANK. COLUMNS 1-19 ON LINE 1 MUST BE REPEATED ON LINE 2.

DATA USES: A,B,C,D

SHEET 3
MONITORING DATA
LTM PROGRAM

STATE CODE __ __ 1-2
PROJECT ID __ __ __ __ 3-6
DATE (MONTH/DAY) __ __/__ __ 14-17
YEAR __ __ 18-19

RUTTING SURVEY FOR PAVEMENTS WITH A FLEXIBLE SURFACE

LANE NUMBER................ __ 12 LANE NUMBER............... __ 12

RUTTING (SQUARE FEET)

SUB-SECTION	LEFT LANE			RIGHT LANE		
	LOW	MODERATE	HIGH	LOW	MODERATE	HIGH
0.0	__ __ __ __ 21-24	__ __ __ 25-27	__ __ __ 28-30	__ __ __ __ 21-24	__ __ __ 25-27	__ __ __ 28-30
0.1	__ __ __ __ 31-34	__ __ __ 35-37	__ __ __ 38-40	__ __ __ __ 31-34	__ __ __ 35-37	__ __ __ 38-40
0.2	__ __ __ __ 41-44	__ __ __ 45-47	__ __ __ 48-50	__ __ __ __ 41-44	__ __ __ 45-47	__ __ __ 48-50
0.3	__ __ __ __ 51-54	__ __ __ 55-57	__ __ __ 58-60	__ __ __ __ 51-54	__ __ __ 55-57	__ __ __ 58-60
0.4	__ __ __ __ 61-64	__ __ __ 65-67	__ __ __ 68-70	__ __ __ __ 61-64	__ __ __ 65-67	__ __ __ 68-70
0.5	__ __ __ __ 21-24	__ __ __ 25-27	__ __ __ 28-30	__ __ __ __ 21-24	__ __ __ 25-27	__ __ __ 28-30
0.6	__ __ __ __ 31-34	__ __ __ 35-37	__ __ __ 38-40	__ __ __ __ 31-34	__ __ __ 35-37	__ __ __ 38-40
0.7	__ __ __ __ 41-44	__ __ __ 45-47	__ __ __ 48-50	__ __ __ __ 41-44	__ __ __ 45-47	__ __ __ 48-50
0.8	__ __ __ __ 51-54	__ __ __ 55-57	__ __ __ 58-60	__ __ __ __ 51-54	__ __ __ 55-57	__ __ __ 58-60
0.9	__ __ __ __ 61-64	__ __ __ 65-67	__ __ __ 68-70	__ __ __ __ 61-64	__ __ __ 65-67	__ __ __ 68-70

NOTE: THE DATA FOR EACH LANE ARE ENTERED ON TWO LINES FOR ENTRY INTO THE DATA BANK. COLUMNS 1-19 MUST BE REPEATED ON EACH LINE.

DATA USES: A,B,C,D

SHEET 4	STATE CODE	__ __ 1-2
MONITORING DATA	PROJECT ID	__ __ __ __ 3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __/__ __ 14-17
	YEAR	__ __ 18-19

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED RIGID SURFACES

LANE NUMBER __. 12 SUBSECTION NUMBER __. 13

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
BLOWUPS (Number)	__ __. 21-22	__ __. 23-24	__ __. 25-26
TRANSVERSE JOINT SPALLING (No. of Joints)	__ __. 27-28	__ __. 29-30	__ __. 31-32
LONGITUDINAL JOINT SPALLING (No. of Joints)	__ __. 33-34	__ __. 35-36	__ __. 37-38
JOINT LOAD TRANSFER SYSTEM ASSOCIATED DETERIORATION (No. of Joints)	__ __. 39-40	__ __. 41-42	__ __. 43-44
PUMPING AND WATER BLEEDING, HIGHEST SEVERITY FOUND (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			__. 45
LONGITUDINAL 'D' CRACKING (Linear Feet)	__ __ __ __. 46-49	__ __ __ __. 50-53	__ __ __ __. 54-57
TRANSVERSE 'D' CRACKING (Linear Feet)	__ __ __ __. 58-61	__ __ __ __. 62-65	__ __ __ __. 66-69
LONGITUDINAL CRACKING (Linear Feet)	__ __ __ __. 21-24	__ __ __ __. 25-28	__ __ __ __. 29-32
TRANSVERSE CRACKING (Linear Feet)	__ __ __ __. 33-36	__ __ __ __. 37-40	__ __ __ __. 41-44
LANE/SHOULDER DROPOFF OR HEAVE, MEAN SEVERITY FOUND (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			__. 45
LANE/SHOULDER SEPARATION, MEAN SEVERITY FOUND (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			__. 46
CORNER BREAKS (NUMBER, ALL SEVERITIES)			__ __ __. 47-49
REACTIVE AGGREGATE (% OF AREA)			__ __. 50-51

NOTES: (1) EXTENT OF DISTRESS (LIN. FT. OR NUMBER AS INDICATED) IS ENTERED FOR EACH SEVERITY LEVEL, EXCEPT WHERE SPACE IS PROVIDED FOR ONLY ONE ENTRY (PUMPING AND WATER BLEEDING, CORNER BREAKS, ETC.).

(2) THE DATA ON THIS SHEET (REPRESENTING ONE SUBSECTION) ARE ENTERED ON TWO LINES FOR ENTRY INTO THE DATA BANK. COLUMNS 1-19 ON LINE 1 MUST BE REPEATED ON LINE 2.

DATA USES: A,B,C,D

SHEET 5	STATE CODE	__ __ 1-2
MONITORING DATA	PROJECT ID	__ __ __ __ 3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __/__ __ 14-17
	YEAR	__ __ 18-19

TRANSVERSE JOINT FAULTING SURVEY FOR RIGID PAVEMENTS (JRCP/JCP ONLY)

SUB-SECTION	LANE NUMBER __ 12 LEFT LANE	LANE NUMBER __ 12 RIGHT LANE
0.0	__.__ __ 21-23	__.__ __ 21-23
0.1	__.__ __ 25-27	__.__ __ 25-27
0.2	__.__ __ 29-31	__.__ __ 29-31
0.3	__.__ __ 33-35	__.__ __ 33-35
0.4	__.__ __ 37-39	__.__ __ 37-39
0.5	__.__ __ 41-43	__.__ __ 41-43
0.6	__.__ __ 45-47	__.__ __ 45-47
0.7	__.__ __ 49-51	__.__ __ 49-51
0.8	__.__ __ 53-55	__.__ __ 53-55
0.9	__.__ __ 57-59	__.__ __ 57-59

NOTES:
1. JOINT FAULTING IS ENTERED AS THE MEAN VALUE IN INCHES.
2. THE DATA FOR EACH LANE ARE ENTERED ON ONE LINE FOR ENTRY INTO THE DATA BANK. COLUMNS 1-10, 14-19 MUST BE REPEATED ON LINE FOR RIGHT LANE.

DATA USES: A,B,C,D

SHEET 6

MONITORING DATA

LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	14-17
YEAR	__ __	18-19

DISTRESS SURVEY FOR PAVEMENTS WITH CONTINUOUSLY REINFORCED RIGID SURFACES

LANE NUMBER __ 12 SUBSECTION NUMBER __ 13

	LOW	MODERATE	HIGH
TRANSVERSE CRACK SPALLING (LINEAR FEET)	21-24	25-28	29-32
LONGITUDINAL CRACK SPALLING (LINEAR FEET)	33-36	37-40	41-44
TRANSVERSE D CRACKING (LINEAR FEET)	45-48	49-52	53-56
LONGITUDINAL D CRACKING (LINEAR FEET)	57-60	61-64	65-68
PUMPING (HIGHEST SEVERITY) (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			70
SCALING, MAP CRACKING, CRAZING (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			72
LONGITUDINAL CRACKING (LINEAR FEET)	21-24	25-28	29-32
LONGITUDINAL JOINT SPALLING (LINEAR FEET)	33-36	37-40	41-44
LONGITUDINAL JOINT FAULTING (NUMBER OF AREAS)			46-48
PUNCHOUTS (NUMBER)	49-50	51-52	53-54
CONSTRUCTION JOINT DETERIORATION (NUMBER)	55-56	57-58	59-60
REACTIVE AGGREGATE (% OF AREA)			61-62
LANE/SHOULDER DROPOFF (MEAN SEVERITY) (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			64
LANE/SHOULDER SEPARATION (MEAN SEVERITY) (Enter 1 for Low, 2 for Moderate, 3 for High Severity)			66

NOTES: (1) EXTENT OF DISTRESS (LIN. FT. OR NUMBER AS INDICATED) IS ENTERED FOR EACH SEVERITY LEVEL, EXCEPT WHERE SPACE IS PROVIDED FOR ONLY ONE ENTRY (PUMPING, CORNER BREAKS, ETC.).

(2) THE DATA ON THIS SHEET (REPRESENTING ONE SUBSECTION) ARE ENTERED ON TWO LINES FOR ENTRY INTO THE DATA BANK. COLUMNS 1-19 ON LINE 1 MUST BE REPEATED ON LINE 2.

DATA USES: A,B,C,D

SHEET 7
MONITORING DATA
LTM PROGRAM

STATE CODE __ __ 1-2
PROJECT ID __ __ __ __ 3-6
DATE (MONTH/DAY) __ __/__ __
YEAR __ __

DATA ON DEFLECTION DEVICE, TEMPERATURES, AND DATES OF MEASUREMENT

TYPE OF DEFLECTION DEVICE __ 12

BENKLEMAN BEAM....1
DEFLECTION BEAM...2
DYNAFLECT.........3
FALLING WEIGHT DEFLECTOMETER..4
ROAD RATER....................5
OTHER (SPECIFY BELOW)
______________________________6 13-27

LOAD, POUNDS __ __ __ __ __ 29-33

FREQUENCY, HERTZ __ __ 35-36

LOCATION OF SENSORS (FT. FROM CENTER OF LOAD, TO NEAREST TENTH)

SENSOR 1 __.__ 38-39

SENSOR 2 __.__ 41-42

SENSOR 3 __.__ 44-45

SENSOR 4 __.__ 47-48

SENSOR 5 __.__ 50-51

LEFT LANE:

DATE OF MEASUREMENT (MONTH/DAY/YEAR) __ __/__ __/__ __ 52-57

AIR TEMPERATURE (°F) __ __ __ 58-60

PAVEMENT TEMPERATURE (°F) __ __ __ 62-64

RIGHT LANE:

DATE OF MEASUREMENT (MONTH/DAY/YEAR) __ __/__ __/__ __ 65-70

AIR TEMPERATURE (°F) __ __ __ 72-74

PAVEMENT TEMPERATURE (°F) __ __ __ 76-78

NOTE: SAME DEVICE, LOAD, AND LOAD FREQUENCY SHOULD BE USED FOR ALL MEASUREMENTS FOR A SPECIFIC TEST SECTION

DATA USES: A,B,C,D

SHEET 8
MONITORING DATA
LTM PROGRAM

STATE CODE __ __ 1-2
PROJECT ID __ __ __ __ 3-6
DATE (MONTH/DAY) __ __/__ __
YEAR __ __

DEFLECTION MEASUREMENTS

LANE NUMBER...__ 11

DECIMAL CODE..__ 12
(ZERO IF ALL DEFLECTIONS RECORDED IN HUNDREDTHS OF A MIL., 1 IF SENSOR 1 TO BE IN TENTHS, 2 IF SENSORS 1 AND 2 IN TENTHS, ETC.)

SUB-SEC-TION	TEST LOCA-TION	MEASUREMENTS FROM DEFLECTION SENSORS (MILS) 1	2	3	4	5
0.0	A	__ __ __ 14-16	__ __ __ 17-19	__ __ __ 20-22	__ __ __ 23-25	__ __ __ 26-28
	B	__ __ __ 29-31	__ __ __ 32-34	__ __ __ 35-37	__ __ __ 38-40	__ __ __ 41-43
	C	__ __ __ 44-46	__ __ __ 47-49	__ __ __ 50-52	__ __ __ 53-55	__ __ __ 56-58
	D	__ __ __ 59-61	__ __ __ 62-64	__ __ __ 65-67	__ __ __ 68-70	__ __ __ 71-73
0.1	A	__ __ __ 14-16	__ __ __ 17-19	__ __ __ 20-22	__ __ __ 23-25	__ __ __ 26-28
	B	__ __ __ 29-31	__ __ __ 32-34	__ __ __ 35-37	__ __ __ 38-40	__ __ __ 41-43
	C	__ __ __ 44-46	__ __ __ 47-49	__ __ __ 50-52	__ __ __ 53-55	__ __ __ 56-58
	D	__ __ __ 59-61	__ __ __ 62-64	__ __ __ 65-67	__ __ __ 68-70	__ __ __ 71-73
0.2	A	__ __ __ 14-16	__ __ __ 17-19	__ __ __ 20-22	__ __ __ 23-25	__ __ __ 26-28
	B	__ __ __ 29-31	__ __ __ 32-34	__ __ __ 35-37	__ __ __ 38-40	__ __ __ 41-43
	C	__ __ __ 44-46	__ __ __ 47-49	__ __ __ 50-52	__ __ __ 53-55	__ __ __ 56-58
	D	__ __ __ 59-61	__ __ __ 62-64	__ __ __ 65-67	__ __ __ 68-70	__ __ __ 71-73
0.3	A	__ __ __ 14-16	__ __ __ 17-19	__ __ __ 20-22	__ __ __ 23-25	__ __ __ 26-28
	B	__ __ __ 29-31	__ __ __ 32-34	__ __ __ 35-37	__ __ __ 38-40	__ __ __ 41-43
	C	__ __ __ 44-46	__ __ __ 47-49	__ __ __ 50-52	__ __ __ 53-55	__ __ __ 56-58
	D	__ __ __ 59-61	__ __ __ 62-64	__ __ __ 65-67	__ __ __ 68-70	__ __ __ 71-73

NOTES:
1. DATA FOR EACH SUBSECTION ARE ENTERED ON ONE LINE FOR ENTRY INTO DATA BANK. COLUMNS 1-10 MUST BE REPEATED ON EACH LINE.
2. ENTER DECIMAL POINTS ON DATA SHEET (BUT NOT IN DATABANK)
3. CONTINUE ON NEXT SHEET.

0.4	A	___ ___ ___ 14-16	___ ___ ___ 17-19	___ ___ ___ 20-22	___ ___ ___ 23-25	___ ___ ___ 26-28
	B	___ ___ ___ 29-31	___ ___ ___ 32-34	___ ___ ___ 35-37	___ ___ ___ 38-40	___ ___ ___ 41-43
	C	___ ___ ___ 44-46	___ ___ ___ 47-49	___ ___ ___ 50-52	___ ___ ___ 53-55	___ ___ ___ 56-58
	D	___ ___ ___ 59-61	___ ___ ___ 62-64	___ ___ ___ 65-67	___ ___ ___ 68-70	___ ___ ___ 71-73
0.5	A	___ ___ ___ 14-16	___ ___ ___ 17-19	___ ___ ___ 20-22	___ ___ ___ 23-25	___ ___ ___ 26-28
	B	___ ___ ___ 29-31	___ ___ ___ 32-34	___ ___ ___ 35-37	___ ___ ___ 38-40	___ ___ ___ 41-43
	C	___ ___ ___ 44-46	___ ___ ___ 47-49	___ ___ ___ 50-52	___ ___ ___ 53-55	___ ___ ___ 56-58
	D	___ ___ ___ 59-61	___ ___ ___ 62-64	___ ___ ___ 65-67	___ ___ ___ 68-70	___ ___ ___ 71-73
0.6	A	___ ___ ___ 14-16	___ ___ ___ 17-19	___ ___ ___ 20-22	___ ___ ___ 23-25	___ ___ ___ 26-28
	B	___ ___ ___ 29-31	___ ___ ___ 32-34	___ ___ ___ 35-37	___ ___ ___ 38-40	___ ___ ___ 41-43
	C	___ ___ ___ 44-46	___ ___ ___ 47-49	___ ___ ___ 50-52	___ ___ ___ 53-55	___ ___ ___ 56-58
	D	___ ___ ___ 59-61	___ ___ ___ 62-64	___ ___ ___ 65-67	___ ___ ___ 68-70	___ ___ ___ 71-73
0.7	A	___ ___ ___ 14-16	___ ___ ___ 17-19	___ ___ ___ 20-22	___ ___ ___ 23-25	___ ___ ___ 26-28
	B	___ ___ ___ 29-31	___ ___ ___ 32-34	___ ___ ___ 35-37	___ ___ ___ 38-40	___ ___ ___ 41-43
	C	___ ___ ___ 44-46	___ ___ ___ 47-49	___ ___ ___ 50-52	___ ___ ___ 53-55	___ ___ ___ 56-58
	D	___ ___ ___ 59-61	___ ___ ___ 62-64	___ ___ ___ 65-67	___ ___ ___ 68-70	___ ___ ___ 71-73
0.8	A	___ ___ ___ 14-16	___ ___ ___ 17-19	___ ___ ___ 20-22	___ ___ ___ 23-25	___ ___ ___ 26-28
	B	___ ___ ___ 29-31	___ ___ ___ 32-34	___ ___ ___ 35-37	___ ___ ___ 38-40	___ ___ ___ 41-43
	C	___ ___ ___ 44-46	___ ___ ___ 47-49	___ ___ ___ 50-52	___ ___ ___ 53-55	___ ___ ___ 56-58
	D	___ ___ ___ 59-61	___ ___ ___ 62-64	___ ___ ___ 65-67	___ ___ ___ 68-70	___ ___ ___ 71-73
0.9	A	___ ___ ___ 14-16	___ ___ ___ 17-19	___ ___ ___ 20-22	___ ___ ___ 23-25	___ ___ ___ 26-28
	B	___ ___ ___ 29-31	___ ___ ___ 32-34	___ ___ ___ 35-37	___ ___ ___ 38-40	___ ___ ___ 41-43
	C	___ ___ ___ 44-46	___ ___ ___ 47-49	___ ___ ___ 50-52	___ ___ ___ 53-55	___ ___ ___ 56-58
	D	___ ___ ___ 59-61	___ ___ ___ 62-64	___ ___ ___ 65-67	___ ___ ___ 68-70	___ ___ ___ 71-73

DATA USES: A,B,C,D

SHEET 9
MONITORING DATA
LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

MAINTENANCE DATA

MONTH/YEAR	MAINTENANCE CASE NO. (CASE)	WORK TYPE CODE (Table A.12)	LOCATION ON PAVEMENT CODE (Table A.13)	MAINTENANCE MATERIAL CODE (Table A.14)	WORK QUANTITY	THICKNESS (INCHES)
__ __/__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __/__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __/__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __/__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __/__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
__ __/__ __	__ __ __	__ __	__ __	__ __	__ __ __ __ __.	__ __.__
12-15	17-19	21-22	24-25	27-28	30-34	36-38

NOTE: EACH LINE OF DATA ABOVE IS ENTERED IN THE DATA BANK AS ONE LINE IN THE POSITIONS INDICATED BELOW THE DATA TABLE. A MAXIMUM OF SIX CASES MAY BE ENTERED FOR A MONITORING YEAR.

DATA USES: A,B,C,D

SHEET 10	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

MAJOR PAVEMENT IMPROVEMENT DURING MONITORING YEAR

LANE NUMBER(S) ___ 13 ___ 14

TYPE OF MAJOR IMPROVEMENT ___ 15

OVERLAY.............................1
SLAB JACKING........................2
JOINT REPAIR........................3
IMPROVED SHOULDER...................4
RECYCLED............................5
UNDERDRAINS.........................6
REMOVED AND RECONSTRUCTED...........7
SLAB SUBSEAL (GROUT) OR
UNDERSEAL (ASPHALT)...............8
OTHER (SPECIFY BELOW)
___________________________________9 17-36

COST FOR MAJOR IMPROVEMENT (THOUSANDS OF DOLLARS PER LANE MILE) __ __ __ __. 37-40

OVERLAY DATA (LEAVE BLANK IF NOT OVERLAID)	THICKNESS, INCHES	__ __.__	42-44
	MATERIAL TYPE CLASSIFICATION	__ __	46-47

REPLACEMENT DATA
(LEAVE BLANK IF NO LAYER REPLACED OR RECYCLED)

LAYER 1	THICKNESS, INCHES	__ __.__	49-51
	MATERIAL TYPE CLASSIFICATION	__ __	53-54
LAYER 2	THICKNESS, INCHES	__ __.__	56-58
	MATERIAL TYPE CLASSIFICATION	__ __	60-61
LAYER 3	THICKNESS, INCHES	__ __.__	63-65
	MATERIAL TYPE CLASSIFICATION	__ __	67-68

NOTES:

(1) IF LEFT LANE IMPROVED, ENTER ITS NUMBER IN NUMBER SPACE DESIGNATED AS '13'. IF RIGHT LANE IMPROVED, ENTER ITS NUMBER IN SPACE DESIGNATED AS '14'.

(2) MATERIAL TYPE CLASSIFICATIONS ARE FROM TABLES A.4 AND A.5.

DATA USES: A,B,C,D

SHEET 11	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

RIGID PAVEMENT OVERLAY OR REPLACED SURFACE LAYER JOINT DATA

LANE NUMBER(S) __ 13 __ 14

LAYER NUMBER (ENTER 1) __ 15

AVERAGE CONTRACTION JOINT SPACING IN FEET __ __ __.__ 16-19

(RANDOM JOINT SPACING, IF ANY: ______________________)

BUILT-IN EXPANSION JOINT SPACING IN FEET __ __ __ __. 20-23

SKEWNESS OF JOINT IN FT/LANE __.__ 24-25

TRANSVERSE CONTRACTION JOINT LOAD TRANSFER SYSTEM __ 27

- Dowels................................1
- No mechanical load transfer device....2
- Other (Specify) ______________________3

DOWEL DIAMETER IN INCHES __.__ __ 30-32

DOWEL SPACING IN INCHES __ __. 34-35

DOWEL LENGTH IN INCHES __ __. 37-38

DOWEL COATING __ 40

- Paint and/or Grease..................1
- Plastic..............................2
- Monel................................3
- Stainless Steel......................4
- Epoxy................................5
- Other (Specify) ______________________6

METHOD USED TO INSTALL DOWELS __ 41

- Preplaced on baskets.................1
- Mechanically installed...............2
- Other (Specify) ______________________3

NOTES: (1) THIS SHEET AND SHEET 12 ARE TO BE FILLED OUT FOR A RIGID OVERLAY WITH JOINTS. DATA FROM BOTH SHEETS ARE ENTERED ON SAME LINE IN DATA BANK.

(2) IF LEFT LANE IMPROVED, ENTER ASSIGNED LANE NUMBER IN LEFT LANE NUMBER SPACE PROVIDED. IF RIGHT LANE IMPROVED, ENTER ASSIGNED LANE NUMBER IN RIGHT SPACE PROVIDED.

DATA USES: A,B,C,D

SHEET 12

MONITORING DATA

LTM PROGRAM

STATE CODE __ __

PROJECT ID __ __ __ __

DATE (MONTH/DAY) __ __ / __ __

YEAR __ __

RIGID PAVEMENT OVERLAY OR REPLACED SURFACE LAYER JOINT DATA CONTINUED

METHOD USED TO FORM TRANSVERSE JOINTS __ 43

- Sawed............................1
- Plastic Insert...................2
- Metal Insert (i.e., Uni-Tube)...3
- Other (Specify) ________________ 4

TRANSVERSE JOINT SEALANT TYPE (AS BUILT) __ 45

- Preformed (open web)............1
- Asphalt..........................2
- Rubberized Asphalt (old type)...3
- Rubberized Asphalt (new type)...4
- Silicone.........................5
- Other (i.e., closed neoprene or specify) ________________ 6

TRANSVERSE JOINT SEALANT RESERVOIR (AS BUILT)

(A) WIDTH, (IN.) __.__ __ 47-49

(B) DEPTH, (IN.) __.__ 51-52

TYPE OF LONGITUDINAL JOINT (BETWEEN LANES) __ 54

- Butt..................1
- Keyed.................2
- Sawed Weakened Plane.3
- Insert Weakened Plane..4
- Other ________________ 5 (Specify)

TIE BAR DIAMETER IN INCHES __.__ __ 56-58

TIE BAR LENGTH IN INCHES __ __. 60-61

TIE BAR SPACING IN INCHES __ __. 63-64

TYPE OF SHOULDER-TRAFFIC LANE JOINT __ 66

- Butt..................1
- Keyed.................2
- Sawed Weakened Plane.3
- Insert Weakened Plane..4
- Tied Concrete Curb.....5
- Other ________________ 6 (Specify)

SHOULDER-TRAFFIC LANE JOINT TIE BAR (FOR CONCRETE SHOULDER)

DIAMETER IN INCHES __.__ __ 68-70

LENGTH IN INCHES __ __. 72-73

SPACING IN INCHES __ __. 75-76

NOTE: DATA ON THIS SHEET IS ENTERED FOR DATA BANK ON SAME LINE AS DATA FROM SHEET 11

DATA USES: A,B,C,D

SHEET 13	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

RIGID PAVEMENT OVERLAY OR REPLACED SURFACE LAYER
REINFORCING STEEL DATA

LANE NUMBER(S) __ 13 __ 14

LAYER NUMBER (ENTER 1) __ 15

TYPE OF REINFORCING __ 16

Deformed Bars.........................1
Welded Wire Fabric....................2
Other (specify)________________________3

TRANSVERSE BAR DIAMETER IN INCHES __.__ __ 17-19

TRANSVERSE BAR SPACING IN INCHES __ __.__ 20-22

LONGITUDINAL BAR DIAMETER IN INCHES __.__ __ 23-25

LONGITUDINAL BAR SPACING IN INCHES __ __.__ 26-28

YIELD STRENGTH OF REINFORCING (KSI) __ __.__ 29-31

DEPTH TO REINFORCEMENT FROM SLAB SURFACE, INCHES __.__ 32-33

METHOD USED TO PLACE REBAR __ 34

Preset on Chairs......................1
Mechanically..........................2
Between Layers of Concrete............3
Other (Specify)________________________4

LENGTH OF STEEL LAP AT CONSTRUCTION JOINT, INCHES __ __. 35-36
(CRCP ONLY)

NOTE: DATA ON SHEET 14 IS ENTERED INTO DATA BANK ON THE SAME LINE AS THE DATA ON THIS SHEET

DATA USES: A,B,C,D

SHEET 14	STATE CODE	__ __
MONITORING DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

RIGID PAVEMENT OVERLAY OR REPLACED SURFACE LAYER CONCRETE DATA

MIX DESIGN (lb./yd^3)	(A) Coarse Aggregate	__ __ __ __.	37-40
	(B) Fine Aggregate	__ __ __ __.	41-44
	(C) Cement	__ __ __ __.	45-48
	(D) Water	__ __ __ __.	49-52
STRENGTH (28-day Modulus of Rupture) (psi)(based on 3rd point loading)	(A) Mean	__ __ __.	53-55
	(B) Range	__ __ __.	57-59
SLUMP (inches)	(A) Mean	__.__	60-61
	(B) Range	__.__	62-63
TYPE CEMENT USED (See Cement Type Codes, Table A.9)		__ __	64-65
ALKALI CONTENT OF CEMENT, %		__ __.__	66-68
ENTRAINED AIR, %	(A) Mean	__.__	70-71
	(B) Range	__.__	72-73
ADDITIVE OTHER THAN AIR-ENTRAINER (See Cement Additive Codes, Table A.10)		__ __	74-75
MAXIMUM SIZE OF COARSE AGGREGATE, INCHES		__.__	76-77
TYPE OF COARSE AGGREGATE		__	78

Crushed Stone...............1
Gravel or Crushed Gravel....2
Crushed Slag................3
Blend Crushed Stone/Gravel..4
Blend Crushed Stone/Slag....5
Blend Gravel/Slag...........6
Other (specify)______________7

NOTE: DATA ON THIS SHEET IS ENTERED FOR DATA BANK ON THE SAME LINE AS DATA FROM SHEET 3

DATA USES: A,B,C,D

SHEET 15	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

RIGID PAVEMENT OVERLAY OR REPLACED SURFACE LAYER CONCRETE DATA CONTINUED

LANE NUMBER(S) __ 13 __ 14

LAYER NUMBER (ENTER 1) __ 15

SOURCES OF COARSE AGGREGATE

Source Code Number Obtained From a State List of Sources and Producers of Aggregates for Highway Construction

- (A) Source I __ __ __ __ __ __ 16-21
- (B) Source II __ __ __ __ __ __ 22-27
- (C) Source III __ __ __ __ __ __ 28-33

TYPE OF FINE AGGREGATE __ 34

- Natural or Crushed Sand..........................1
- Manufactured Sand (From Crushed Gravel or Stone)..2
- Other (Specify)________________________________3

SOURCES OF FINE AGGREGATE

Source Code Number Obtained From a State List of Sources and Producers of Aggregates for Highway Construction

- (A) Source I __ __ __ __ __ __ 35-40
- (B) Source II __ __ __ __ __ __ 41-46
- (C) Source III __ __ __ __ __ __ 47-52

TYPE OF AGGREGATE DURABILITY TEST USED __ __ 54-55
(See Durability Test Type Codes, Table A.11)

RESULT OF DURABILITY TEST __ __.__ 57-59

TYPE OF PAVER USED __ 61

Slip-Form..........1 Side-Form..........2

METHOD USED TO CURE CONCRETE __ 62

Membrane Curing Compound....1	Burlap-Polyethylene Blanket..5
Burlap Curing Blankets......2	Cotton Mat Curing............6
Waterproof Paper Blankets...3	Hay..........................7
White Polyethylene Sheeting.4	Other________________________8 (Specify)

NOTE: DATA ON SHEET 16 IS ENTERED INTO DATA BANK ON THE SAME LINE AS THE DATA ON THIS SHEET

DATA USES: A,B,C,D

SHEET 16	STATE CODE	__ __
MONITORING DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

RIGID PAVEMENT OVERLAY OR REPLACED SURFACE LAYER CONCRETE DATA CONTINUED

METHOD USED TO FINISH CONCRETE __ 63

Tine.............1   Grooved Float.........4
Broom............2   Astro Turf............5
Burlap Drag......3   Other ______________ 6
(Specify)

GEOLOGIC CLASSIFICATION OF COARSE CRUSHED STONE CONCRETE AGGREGATE (See Geologic Classification Codes, Table A.8) __ __ 64-65

ELASTIC MODULUS (KSI) __ __ __ __ __. 66-70

TEST METHOD FOR ELASTIC MODULUS __ 71

Indirect Tensile Test on Cores..................1
Compression Test on Cores (ASTM C469)...........2
Compression Test on Cylinders During Initial Construction (ASTM C469).............3
Calculated Using ACI Relation Between Elastic Modulus and Compressive Strength......4
Other (Specify) ______________________________ 5

COMPRESSIVE STRENGTH OF IN-PLACE CONCRETE IN PSI __ __ __ __ 72-75

INDIRECT TENSILE STRENGTH OF IN-PLACE CONCRETE IN PSI __ __ __ 76-78

NOTE: DATA ON THIS SHEET IS ENTERED FOR DATA BANK ON THE SAME LINE AS DATA FROM SHEET 9.

DATA USES: A,B,C,D

SHEET 17	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

ASPHALT CONCRETE OVERLAY OR REPLACED SURFACE LAYER AGGREGATE PROPERTIES

LANE NUMBER(S) __ 13 __ 14

LAYER NUMBER (ENTER 1) __ 15

PERCENT PASSING NO. 200 SIEVE __ __ . __ 16-18

TYPE OF COARSE AGGREGATE __ 19

- Crushed Stone....................1
- Gravel or Crushed Gravel.........2
- Crushed Slag.....................3
- Blend Crushed Stone/Gravel.......4
- Blend Crushed Stone/Slag.........5
- Blend Gravel/Slag................6
- Other (Specify)__________________7

SOURCE OF COURSE AGGREGATE (Source code number obtained from a State list of sources and producers of aggregates for highway construction)

- (A) Source I __ __ __ __ __ __ 20-25
- (B) Source II __ __ __ __ __ __ 26-31
- (C) Source III __ __ __ __ __ __ 32-37

TYPE OF FINE AGGREGATE __ 39

- Natural or Crushed Sand..........1
- Manufactured Sand................2
- Other (Specify)__________________3

SOURCE OF FINE AGGREGATE (Source code number obtained from a State list of sources and producers of aggregates for highway construction)

- (A) Source I __ __ __ __ __ __ 41-46
- (B) Source II __ __ __ __ __ __ 47-52
- (C) Source III __ __ __ __ __ __ 53-58

DATA USES: A,B,C,D

SHEET 18	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

ASPHALT CONCRETE OVERLAY OR REPLACED SURFACE LAYER
ASPHALT PROPERTIES

LAYER NUMBER (ENTER 1)	__	13
ASPHALT GRADE AC -	__ __	14-15
SOURCE (CODE NUMBER ASSIGNED BY STATE DOT)	__ __	17-18
ASPHALT CONTENT (PERCENT OF WEIGHT)	__ __.__	20-22
VISCOSITY OF ASPHALT AT 140°F (ASTM D2171)	__ __ __ __ __ __.	24-29
VISCOSITY OF ASPHALT AT 275°F	__ __ __ __ __ __.	31-36
DUCTILITY MEASURED BY ASTM D113 TEST METHOD	__ __ __ __.	38-41
TEST TEMPERATURE FOR DUCTILITY MEASUREMENT(°F)	__ __ __.	43-45
PENETRATION AT 77°F (ASTM D5)	__ __ __.	47-49
SOFTENING POINT (ASTM D36)	__ __ __ __.	51-54

NOTE: DATA FROM THIS SHEET AND SHEET 19 ARE ENTERED ON SAME LINE FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 19	STATE CODE	__ __
MONITORING DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

ASPHALT CONCRETE LAYERS
OVERLAY OR REPLACED SURFACE LAYER
IN-PLACE MIXTURE PROPERTIES

DENSITY (PCF)	__ __ __.	55-57
MARSHALL STABILITY (LBS)	__ __ __ __.__	59-63
HVEEM STABILITY	__ __ __.	65-67
PERCENT AIR VOIDS	__ __.__	69-71
MARSHALL FLOW (0.01 IN.)	__ __ __ __.	73-76

NOTE: DATA ON THIS SHEET ARE TO BE ENTERED ON THE SAME LINE AS THAT ON SHEET 18 FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 20	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

ASPHALT CONCRETE OVERLAY OR REPLACED SURFACE LAYER DYNAMIC MODULI

LANE NUMBER(S) ___ 13 ___ 14

LAYER NUMBER (ENTER 1) ___ 15

DYNAMIC MODULI FOR SELECTED TEMPERATURES:

TEMPERATURE (°F)		DYNAMIC MODULUS (KSI)	
__ __ __.	16-18	__ __ __ __.	19-22
__ __ __.	23-25	__ __ __ __.	26-29
__ __ __.	30-32	__ __ __ __.	33-36

TEST LOAD DURATION IN HUNDREDTHS OF A SECOND __ __ __. 37-39

FREQUENCY OF LOAD REPETITIONS (HERTZ) __ __.__ 40-42

TEST METHOD ___ 43

Indirect Tensile Test (ASTM D4123).........1
Unconfined Compression Test (ASTM D3497)..2
Confined Compression Test..................3
Witczak Regression Equations...............4

CONFINING PRESSURE, PSI (IF CONFINING PRESSURE APPLIED) __ __. 45-46

NOTE: DATA FROM THIS SHEET AND SHEET 21 ARE ENTERED ON SAME LINE FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 21	STATE CODE	__ __
MONITORING DATA	PROJECT ID	__ __ __ __
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __
	YEAR	__ __

ASPHALT CONCRETE OVERLAY OR REPLACED SURFACE LAYER TENSILE STRENGTH

TENSILE STRENGTH FOR SELECTED TEMPERATURES:

TEMPERATURE (°F)		TENSILE STRENGTH, PSI)	
__ __ __.	48-50	__ __ __.	52-54
__ __ __.	56-58	__ __ __.	60-62
__ __ __.	64-66	__ __ __.	68-70

TENSILE STRAIN RATE (INCHES PER MINUTE) __ __.__ 72-74

TEST METHOD __ 77

Indirect Tensile Test 1

Other (Specify)____________________________2

NOTE: DATA ON THIS SHEET ARE TO BE ENTERED ON THE SAME LINE AS THAT ON SHEET 20 FOR ENTRY INTO THE DATA BANK

DATA USES: A,B,C,D

SHEET 22	STATE CODE	__ __	1-2
MONITORING DATA	PROJECT ID	__ __ __ __	3-6
LTM PROGRAM	DATE (MONTH/DAY)	__ __ / __ __	
	YEAR	__ __	11-12

UNBOUND OR STABILIZED BASE OR SUBBASE MATERIAL DESCRIPTION

LANE NUMBER(S) __ 13	__	14
LAYER NUMBER (FROM SHEET 10)	__	15
AASHTO SOIL CLASSIFICATION (SEE CODE, TABLE A.7)	__ __	16-17
OPTIMUM LAB DRY DENSITY, PCF	__ __ __.	18-20
OPTIMUM LAB MOISTURE CONTENT (%)	__ __.__	21-23
TEST USED TO MEASURE OPTIMUM DRY DENSITY	__	25
STANDARD PROCTOR (T-99)..........................1		
MODIFIED PROCTOR (T-180).........................2		
OTHER (SPECIFY)______________________________3		27-40
COMPACTIVE ENERGY FOR 'OTHER' METHOD (FT.-LBS./CU.IN.)	__ __.__	42-44
IN SITU DRY DENSITY, (PERCENT OF OPTIMUM) (AVERAGE OF DATA AVAILABLE)	__ __ __.	46-48
IN SITU MOISTURE CONTENT (PERCENT OF OPTIMUM)	__ __ __.	50-52
IN SITU DRY DENSITY (PCF)	__ __ __.	54-56
PERCENT BINDER (PASSING NO. 40 SIEVE)	__ __.	58-59
PERCENT PASSING NO. 200 SIEVE	__ __.	61-62
PERCENT STABILIZING AGENT (FOR STABILIZED LAYERS)	__ __.	64-65

NOTE: THIS SHEET IS TO BE FILLED OUT FOR EACH BOUND OR UNBOUND BASE OR SUBBASE LAYER IDENTIFIED ON SHEET 10.

DATA USES: A,B,C,D

SHEET 23
MONITORING DATA
LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	11-12

ENVIRONMENTAL DATA

	AVG. MONTHLY TEMP., °C	AVG. MAX. DAILY TEMP., °C	AVG. MIN. DAILY TEMP., °C	MONTHLY PRECIP., CMS. OF WATER
JANUARY	__ __ __. 13-15	__ __ __. 16-18	__ __ __. 19-21	__ __.__ 22-24
FEBRUARY	__ __ __. 25-27	__ __ __. 28-30	__ __ __. 31-33	__ __.__ 34-36
MARCH	__ __ __. 38-40	__ __ __. 41-43	__ __ __. 44-46	__ __.__ 47-49
APRIL	__ __ __. 51-53	__ __ __. 54-56	__ __ __. 57-59	__ __.__ 60-62
MAY	__ __ __. 64-66	__ __ __. 67-69	__ __ __. 70-72	__ __.__ 73-75
JUNE	__ __ __. 12-14	__ __ __. 15-17	__ __ __. 18-20	__ __.__ 21-23
JULY	__ __ __. 25-27	__ __ __. 28-30	__ __ __. 31-33	__ __.__ 34-36
AUGUST	__ __ __. 38-40	__ __ __. 41-43	__ __ __. 44-46	__ __.__ 47-49
SEPTEMBER	__ __ __. 51-53	__ __ __. 54-56	__ __ __. 57-59	__ __.__ 60-62
OCTOBER	__ __ __. 64-66	__ __ __. 67-69	__ __ __. 70-72	__ __.__ 73-75
NOVEMBER	__ __ __. 12-14	__ __ __. 15-17	__ __ __. 18-20	__ __.__ 21-23
DECEMBER	__ __ __. 25-27	__ __ __. 28-30	__ __ __. 31-33	__ __.__ 34-36

FREEZE-THAW CYCLES DURING YEAR	__ __ __.	38-40
DEICING SALT ($CaCl_2$) APPLICATION DURING YEAR (TON/LANE MILE)	__ __.	42-43
HIGHEST MONTHLY MEAN SOLAR RADIATION (LANGLEYS/DAY)	__ __ __ __.	61-64
LOWEST MONTHLY MEAN SOLAR RADIATION (LANGLEYS/DAY)	__ __ __ __.	66-69

NOTES: 1. DATA ON THIS SHEET IS ENTERED ON THREE LINES IN THE DATA BANK.
2. FILL OUT AFTER END OF YEAR AND SUBMIT FOR ENTRY INTO DATA BANK ENTERING '12/31' AS DATE, AND YEAR FOR WHICH DATA IS COLLECTED.

DATA USES: A,B,C,D

SHEET 24
MONITORING DATA
LTM PROGRAM

STATE CODE	__ __ 1-2
PROJECT ID	__ __ __ __ 3-6
DATE (MONTH/DAY)	__ __/__ __
YEAR	__ __ 11-12

TRAFFIC DATA

MONTH	ONE-WAY ADT	*ONE-WAY % TRUCKS	ONE-WAY LANE DISTRIBUTION OF TRUCKS (%) LEFT LANE	RIGHT LANE
__ __ 14-15	__ __ __ __ __ 17-21	__ __ 23-24	__ __ 26-27	__ __ __ 28-30
__ __ 32-33	__ __ __ __ __ 35-39	__ __ 41-42	__ __ 44-45	__ __ __ 46-48
__ __ 14-15	__ __ __ __ __ 17-21	__ __ 23-24	__ __ 26-27	__ __ __ 28-30
__ __ 32-33	__ __ __ __ __ 35-39	__ __ 41-42	__ __ 44-45	__ __ __ 46-48
ANNUAL	__ __ __ __ __ 50-54	__ __ 56-57	__ __ 59-60	__ __ __ 61-63

*EXCLUDING PICKUPS AND PANELS.

NOTES:
1. DISTRIBUTION ACROSS LANES MUST SUM TO 100 FOR 2-LANE HIGHWAYS IN ONE DIRECTION. RIGHT LANE DISTRIBUTION FACTOR MUST EQUAL 100 FOR HIGHWAYS OF ONE LANE IN ONE DIRECTION.
2. DATA ON THIS SHEET ARE ENTERED ON TWO LINES FOR ENTRY INTO THE DATA BANK. COLUMNS 1-12 MUST BE REPEATED ON LINE 2.
3. FILL OUT AND SUBMIT AT END OF EACH CALENDAR YEAR.

DATA USES: A,B,C,D

SHEET 25

MONITORING DATA

LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

TRAFFIC DATA

VEHICLE CLASSIFICATION

(PERCENT OF TRUCK VOLUME BY TRUCK TYPE)

MONTH/YEAR	2-AXLE 6-TIRE S.U. TRUCKS	3-AXLE S.U. TRUCKS	4^+-AXLE S.U. TRUCKS	4^--AXLE SINGLE TRAILER TRUCKS	5-AXLE SINGLE TRAILER TRUCKS	6^+-AXLE SINGLE TRAILER TRUCKS	5^--AXLE MULTI-TRAILER TRUCKS	6-AXLE MULTI-TRAILER TRUCKS	7^+-AXLE MULTI-TRAILER TRUCKS
__ __/__ __ 11-14	__ __. 15-16	__ __. 18-19	__ __. 21-22	__ __. 24-25	__ __. 27-28	__ __.__ 30-32	__ __.__ 34-36	__ __.__ 38-40	__ __.__ 42-44
__ __/__ __ 45-48	__ __. 49-50	__ __. 52-53	__ __. 55-56	__ __. 58-59	__ __. 61-62	__ __.__ 64-66	__ __.__ 68-70	__ __.__ 72-74	__ __.__ 76-78
__ __/__ __ 11-14	__ __. 15-16	__ __. 18-19	__ __. 21-22	__ __. 24-25	__ __. 27-28	__ __.__ 30-32	__ __.__ 34-36	__ __.__ 38-40	__ __.__ 42-44
__ __/__ __ 45-48	__ __. 49-50	__ __. 52-53	__ __. 55-56	__ __. 58-59	__ __. 61-62	__ __.__ 64-66	__ __.__ 68-70	__ __.__ 72-74	__ __.__ 76-78

NOTE: 1. THE PERCENTAGES ENTERED ON EACH LINE MUST TOTAL 100 PERCENT.

2. THE DATA ON THIS SHEET ARE ENTERED ON TWO LINES FOR ENTRY INTO THE DATA BANK. COLUMNS 1-10 MUST BE REPEATED ON LINE 2.

3. FILL OUT AND SUBMIT AT THE END OF EACH CALENDAR YEAR.

DATA USES: A,B,C,D

SHEET 26

MONITORING DATA

LTM PROGRAM

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

TRAFFIC DATA
TYPICAL AXLE LOADS BY VEHICLE CLASS

YEAR.. __ __. 12-13

TRUCK CLASSIFICATION	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]	AXLE[1] TYPE	LOAD[2]
2-AXLE, 6-TIRED S.U. TRUCKS	__. 15	__ __ __. 16-18	__. 19	__ __ __. 20-22										
3-AXLE S.U. TRUCKS	__. 23	__ __ __. 24-26	__. 27	__ __ __. 28-30	__. 31	__ __ __. 32-34								
4^+-AXLE S.U. TRUCKS	__. 35	__ __ __. 36-38	__. 39	__ __ __. 40-42	__. 43	__ __ __. 44-46	__. 47	__ __ __. 48-50						
4^--AXLE S.T. TRUCKS	__. 51	__ __ __. 52-54	__. 55	__ __ __. 56-58	__. 59	__ __ __. 60-62	__. 63	__ __ __. 64-66						
5-AXLE S.T. TRUCKS	__. 15	__ __ __. 16-18	__. 19	__ __ __. 20-22	__. 23	__ __ __. 24-26	__. 27	__ __ __. 28-30	__. 31	__ __ __. 32-34				
6^+-AXLE S.T. TRUCKS	__. 35	__ __ __. 36-38	__. 39	__ __ __. 40-42	__. 43	__ __ __. 44-46	__. 47	__ __ __. 48-50	__. 51	__ __ __. 52-54	__. 55	__ __ __. 56-58		
5^--AXLE M.T. TRUCKS	__. 59	__ __ __. 60-62	__. 63	__ __ __. 64-66	__. 67	__ __ __. 68-70	__. 71	__ __ __. 72-74	__. 75	__ __ __. 76-78				
6-AXLE M.T. TRUCKS	__. 15	__ __ __. 16-18	__. 19	__ __ __. 20-22	__. 23	__ __ __. 24-26	__. 27	__ __ __. 28-30	__. 31	__ __ __. 32-34	__. 35	__ __ __. 36-38		
7^+-AXLE M.T. TRUCKS	__. 39	__ __ __. 40-42	__. 43	__ __ __. 44-46	__. 47	__ __ __. 48-50	__. 51	__ __ __. 52-54	__. 55	__ __ __. 56-58	__. 59	__ __ __. 60-62	__. 63	__ __ __. 64-66

[1] AXLE TYPE CODE: SINGLE AXLE..1 TANDEM AXLE..2 TRIPLE (TRIDEM) AXLE..3 [2] ALL LOADS IN HUNDREDS OF POUNDS.

NOTES: (1) DATA ON THIS SHEET IS ENTERED ON THREE LINES IN DATA BANK IN THE COLUMNS INDICATED BY SMALL NUMBERS UNDER DATA ENTRY SPACES. THE 'HEADER DATA' IN COLUMNS 1-13 ON LINE 1 MUST BE REPEATED ON LINES 2 AND 3.
(2) FILL OUT AND SUBMIT AT THE END OF EACH CALENDAR YEAR.

SHEET 27

MONITORING DATA

LTM PROGRAM

DATA USES: A,B,C,D

STATE CODE	__ __	1-2
PROJECT ID	__ __ __ __	3-6
DATE (MONTH/DAY)	__ __ / __ __	
YEAR	__ __	

TRAFFIC DATA
SUMMARY AXLE LOAD DISTRIBUTIONS

YEAR. . . . . __ __ . 12-13

SINGLE AXLE LOAD (SA)	NUMBER OF AXLES	TANDEM AXLE LOAD (TA)	NUMBER OF AXLES
UNDER 3,000	__ __ __ __ __ __ . 15-20	Under 6,000	__ __ __ __ __ __ . 33-38
3,000 - 6,999	__ __ __ __ __ __ . 21-26	6,000 - 11,999	__ __ __ __ __ __ . 39-44
7,000 - 7,999	__ __ __ __ __ __ . 27-32	12,000 - 17,999	__ __ __ __ __ __ . 45-50
8,000 - 11,999	__ __ __ __ __ __ . 33-38	18,000 - 23,999	__ __ __ __ __ __ . 51-56
12,000 - 15,999	__ __ __ __ __ __ . 39-44	24,000 - 29,999	__ __ __ __ __ __ . 57-62
16,000 - 17,999	__ __ __ __ __ __ . 45-50	30,000 - 31,999	__ __ __ __ __ __ . 63-68
18,000 - 18,499	__ __ __ __ __ __ . 51-56	32,000 - 32,499	__ __ __ __ __ __ . 69-74
18,500 - 19,999	__ __ __ __ __ __ . 57-62	32,500 - 33,999	__ __ __ __ __ __ . 15-20
20,000 - 21,999	__ __ __ __ __ __ . 63-68	34,000 - 35,999	__ __ __ __ __ __ . 21-26
22,000 - 23,999	__ __ __ __ __ __ . 69-74	36,000 - 37,999	__ __ __ __ __ __ . 27-32
24,000 - 25,999	__ __ __ __ __ __ . 15-20	38,000 - 39,999	__ __ __ __ __ __ . 33-38
26,000 - 29,999	__ __ __ __ __ __ . 21-26	40,000 - 41,999	__ __ __ __ __ __ . 39-44
30,000 or Over	__ __ __ __ __ __ . 27-32	42,000 - 43,999	__ __ __ __ __ __ . 45-50
TOTAL SINGLE AXLES	__ __ __ __ __ __ .	44,000 - 45,999	__ __ __ __ __ __ . 51-56
		46,000 - 49,999	__ __ __ __ __ __ . 57-62
		50,000 OR OVER	__ __ __ __ __ __ . 63-68
		TOTAL TANDEM AXLES	__ __ __ __ __ __ .

NOTE: THE DATA FROM THE W-4 TABLE IS ENTERED IN THE DATA BANK AS THREE LINES. IDENTIFICATION DATA AND YEAR MUST BE REPEATED ON EACH LINE. FILL OUT AND SUBMIT AT END OF EACH CALENDAR YEAR.

CHAPTER 4

NETWORK AND PROJECT LEVEL PAVEMENT MANAGEMENT AND DESIGN (TYPES B AND C DATA USE)

It appears that the great majority of data required for either network or project level pavement management or for design of overlays or other major improvements have been included in the inventory and monitoring data for the LTM Program (Chapters 2 and 3). However, it is quite probable that specific pavement management systems may require other data not included in the LTM data sheets described in Chapters 2 and 3. In this case, additional data sheets and instructions should be developed to provide the additional data required. The inclusion of such data in the material LTM data bank would require coordination with the FHWA and revisions to the data bank schema.

CHAPTER 5

RESEARCH AND OTHER SPECIAL STUDIES (TYPE D DATA USE)

It appears that the great majority of data required for most types of research or special studies related to pavements, pavement performance, or pavement costs have been included in the inventory and monitoring data for the LTM Program (Chapters 2 and 3). The primary exception to this appears to be data from more sophisticated test procedures for characterizing material properties that are used for research purposes, other special studies, and by most private sector consultants conducting pavement evaluation and mechanistic design. The primary purpose of this chapter is not to provide instructions and data sheets for collecting this data, but instead to discuss a few of these material characterizations that are commonly used and to provide references for test procedures.

Certain research or special studies will undoubtedly require data not anticipated in the previous chapters. For these cases, additional data sheets and instructions should be developed to provide the additional data required.

The material characterizations to be discussed in this chapter are: 1) resilient moduli for subgrade, subbase, and base materials; 2) resilient moduli (often called dynamic moduli) for asphalt concrete materials; 3) permanent deformation potential under repetitive loads for subgrade, subbase, base, and asphalt concrete layers; and 4) fatigue life potential for asphalt concrete materials. Each of these is described briefly below.

RESILIENT MODULI FOR SUBGRADE, SUBBASE, AND BASE MATERIALS

Resilient modulus testing has become quite common in the last decade, but there is not presently an ASTM standard for conducting this test. An ASTM standard is available in draft form and is undergoing subcommittee review by ASTM D18.10 at this time. However, a reasonably good set of procedures for this test appear in Reference 13.

The object of this test is to obtain an elastic modulus for use in mechanistic analysis procedures such as elastic layer theory. As moduli of elasticity from static tests vary widely from those obtained during repetitive-load tests, it is necessary for the analysis of pavements with repetitive loads to use a modulus of elasticity measured after a suitable number of repetitive loadings. This test is run on cylindrical samples, either undisturbed samples from the field or samples suitably compacted in the laboratory. The "triaxial test" is conducted on a cylindrical sample in a triaxial cell, with short-term loads applied repetitively and the resulting vertical strains measured by linear variable differential transformers (LVDT's) and recorded by an oscillographic recorder with rapid response. The trace from the recorder is calibrated to the responses of the LVDT's so that the total strains in the sample (between the clamps holding the LVDT's) may be determined under specific loads to suitable accuracy. Given the applied vertical stress, the lateral pressure in the triaxial cell, and the measured strains; a deviator stress (difference between the vertical and lateral stresses on the sample) and the unit resilient axial strain may be used to calculate the resilient modulus, which is just the ratio of the deviator stress and the unit resilient strain. This test is usually conducted for a range of deviator stresses and lateral pressures in the triaxial cell to provide data that can be applied over a range of stress conditions.

RESILIENT MODULI FOR ASPHALT CONCRETE MATERIALS

Resilient modulus testing for new asphalt concrete mixes is usually conducted on samples four inches in diameter and eight inches in length compacted in the laboratory. This procedure is very similar to that described above for soils, except that the strains are sometimes measured with strain gauges instead of LVDT's and the moduli are so temperature dependent that the tests must be a series of three or more conducted at different carefully controlled temperatures to appropriately characterize the stiffness of the asphalt concrete materials over the various seasons of the year. Fortunately, these resilient moduli are not heavily stress dependent, so the stress state is not especially critical. However, it has been found (Ref. 8) that it is rather important at the higher temperatures (say above 65°F) to have some confinement, so it is believed that the unconfined testing procedure developed by the Asphalt Institute and implemented as ASTM D3497-79 should be revised to require a triaxial test. Confining pressures in the order of five to ten psi are probably adequate for this purpose. Reference 8 offers some useful information in this regard.

Where the resilient modulus for existing mixtures in the field is desired, this is generally run on cores having a diameter of approximately four inches. The test described above for cylindrical samples may only be conducted when the asphalt concrete is in the order of eight inches or more in thickness. However, this usually results in testing of different layers having different characteristics as if they were one layer. The preferred test in this case is the repetitive-loading indirect tension test (ASTM D4123-82). This test can be successfully run with cores having a thickness of around 2-1/2 inches or greater, and has been found to give essentially the same results as the tests on cylindrical samples below around 65°F. Above 65°F, it approximates the results from a cylindrical sample tested with confining pressure, giving generally more realistic values for the asphalt concrete at higher temperatures.

PERMANENT DEFORMATION POTENTIAL UNDER REPETITIVE LOADS FOR SUBGRADE, SUBBASE, BASE, AND ASPHALT CONCRETE LAYERS

The testing for permanent deformation potential under repetitive loads is conducted in essentially the same manner as the resilient modulus testing described above. The primary difference is that the tests are continued for many thousands of cycles (should be at least 100,000 cycles of loading) and the accumulated permanent deformations (total strain) over some gauge length between LVDT clamps is measured as well. The output from this testing is generally permanent strain versus number of cycles, as well as the resilient moduli. These test results may then be used to develop appropriate characterizations for use in mechanistic models. The most common characterization for permanent deformation potential is the two-parameter characterization used in the VESYS flexible pavement model. These two parameters are called ALPHA and GNU, and their values are dependent upon stress state for all materials, and upon temperature for asphalt concrete materials.

There are no established procedures for permanent deformation testing, but satisfactory techniques are described by Barksdale in Reference 14.

FATIGUE LIFE POTENTIAL FOR ASPHALT CONCRETE MATERIALS

The characterization of fatigue life potential for asphalt concrete materials is a very sophisticated combination of applying laboratory fatigue test results with some transformation to approximately reflect field conditions. The state of the art is believed to be reflected in References 15 and 16.

There is no established ASTM or other standard for conducting these laboratory tests. In fact, they have been conducted in a variety of ways. The usual test specimen is a small beam compacted in the laboratory or sawed from an existing pavement. These were originally tested with midpoint repetitive loading while simply supported at the ends. More recently, a somewhat better characterization of field conditions has been obtained by testing these beams on a bed of relatively stiff rubber to simulate the support of the base and subgrade. This latter procedure appears to be the best available at this time and is described in Reference 14.

It must be remembered that the results of these tests are both stress and temperature dependent, so it is necessary to run a series of tests that include a factorial in terms of several levels of stress and several levels of temperature. The measured values are generally the initial strain after some suitable number of cycles (say 50 to 100), the calculated stress, and the number of repeated loads until the specimen failed in fatigue. The result used in the mechanistic design procedures is usually a relationship between number of repetitive loads to failure and strain level at the bottom of the specimen, with the parameters of this relationship being temperature dependent.

It should be remembered that there is no dependable relationship between a beam test in the laboratory and the actual fatigue performance in the field. A beam test in the laboratory, especially if the beam is simply supported, usually results in a failure of the beam fairly soon after a crack is initiated at the bottom of the beam. That is, the rate of crack propagation from the bottom of the beam to the top is fairly rapid. This is often not the case for real pavements (or even asphalt concrete slabs in a wheel tracking test such as reported by Shell in Ref. 17). In fact, the number of loads to propagate the crack to the surface may be a multiple of the number of loads to initiate cracking at the bottom of the slab. Consequently, the laboratory test results must be transformed by some "shift factor" or other relationship to be representative of field conditions, and this is extremely difficult to do. That is the reason that methods such as those described in References 15 and 16 have been applied in lieu of attempting the massive materials test program and research required to successfully transform laboratory results into the field environment for even one asphalt concrete mixture and pavement structure.

APPENDIX A. STANDARD CODES

APPENDIX A
STANDARD CODES

This appendix provides standard codes to simplify entry of data during collection and the subsequent storage and processing of this data. These codes are tabulated as follows:

Table A.1	Standard codes for States, District of Columbia, Puerto Rico, and American Protectorates
Table A.2	Functional Class Codes
Table A.3	Pavement Type Codes
Table A.4	Pavement Surface Material Type Codes
Table A.5	Base and Subbase Material Type Codes
Table A.6	Subgrade Soil Descriptions
Table A.7	Soil Type Codes, AASHTO Soil Classification
Table A.8	Geologic Classification Codes
Table A.9	Cement Type Codes
Table A.10	Cement Additives Codes
Table A.11	Aggregate Durability Test Type Codes
Table A.12	Maintenance and Rehabilitation Work Type Codes
Table A.13	Location on Pavement Code
Table A.14	Maintenance Materials Type Codes
Table A.15	Material Type Codes for Thin Seals and Interlayers

Table A.1 Table of Standard Codes for States, District of Columbia, Puerto Rico, and American Protectorates

State	Code	State	Code
Alabama	01	Nevada	32
Alaska	02	New Hampshire	33
Arizona	04	New Jersey	34
Arkansas	05	New Mexico	35
California	06	New York	36
Colorado	08	North Carolina	37
Connecticut	09	North Dakota	38
Delaware	10	Ohio	39
District of Columbia	11	Oklahoma	40
Florida	12	Oregon	41
Georgia	13	Pennsylvania	42
Hawaii	15	Rhode Island	44
Idaho	16	South Carolina	45
Illinois	17	South Dakota	46
Indiana	18	Tennessee	47
Iowa	19	Texas	48
Kansas	20	Utah	49
Kentucky	21	Vermont	50
Louisiana	22	Virginia	51
Maine	23	Washington	53
Maryland	24	West Virginia	54
Massachusetts	25	Wisconsin	55
Michigan	26	Wyoming	56
Minnesota	27	American Samoa	60
Mississippi	28	Guam	66
Missouri	29	Puerto Rico	72
Montana	30	Virgin Islands	78
Nebraska	31		

Note: These codes are consistent with the Federal Information Processing Standards (FIPS) and HPMS

Table A.2 Functional Class Codes

Functional Class	Code
Rural:	
Principal Arterial - Interstate	01
Principal Arterial - Other	02
Minor Arterial	06
Major Collector	07
Minor Collector	08
Local Collector	09
Urban:	
Principal Arterial - Interstate	11
Principal Arterial - Other Freeways or Expressways	12
Other Principal Arterial	14
Minor Arterial	16
Collector	17
Local	19

Note: These codes are consistent with the HPMS system.

Table A.3 Pavement Type Codes

Type of Pavement	Code
Flexible Pavements:	
Original Construction	01
With Flexible Overlay	02
With JCP Overlay	03
With JRCP Overlay	04
With CRCP Overly	05
Rigid Pavements:	
JPCP - Original Construction	11
JRCP - Original Construction	12
CRCP - Original Construction	13
JPCP With Flexible Overlay	14
JRCP With Flexible Overlay	15
CRCP With Flexible Overlay	16
JPCP With JPCP Overlay	17
JPCP With JRCP Overlay	18
JRCP With JPCP Overlay	19
JRCP With JRCP Overlay	20
CRCP With JPCP Overlay	21
CRCP With JRCP Overlay	22
Composite Pavements (Overlay Included in Initial Construction:	
CRCP With Flexible Overlay	31
CRCP Over Flexible Subbase	32
JPCP Over Flexible Subbase	33
JRCP Over Flexible Subbase	34
CRCP Over Lean Concrete	35
JPCP Over Lean Concrete	36
JRCP Over Lean Concrete	37

Definition:

JPCP - Jointed Plain Concrete Pavement

JRCP - Jointed Reinforced Concrete Pavement

CRCP - Continuously Reinforced Concrete Pavement

Flexible Pavement - Asphalt Concrete Pavement

Table A.4 Pavement Surface Material Type Codes

Material Type	Code
Asphalt Concrete	1
Cold Mix Bituminous Material	2
Sand Asphalt	3
Portland Cement Concrete (JPCP)	4
Portland Cement Concrete (JRCP)	5
Portland Cement Concrete (CRCP)	6
Portland Cement Concrete (Prestressed)	7
Portland Cement Concrete (Fibrous)	8
Double Bituminous Surface Treatment	9
Recycled Asphalt Concrete	10
Recycled Portland Cement Concrete	
JPCP	11
JRCP	12
CRCP	13

Table A.5 Base and Subbase Material Type Codes

	Code
No Base (pavement placed directly on subgrade)	21
Gravel (uncrushed)	22
Crushed Stone or Gravel or Slag	23
Sand	24
Soil Aggregate (predominantly soil)	25
Bituminous Treated Soil-Aggregate	26
Bituminous Aggregate Mixture (plant mix)	27
Asphalt Concrete Hot Mix	28
Open Graded Asphalt Treated	29
Thin Asphalt Concrete Layer Over Granular Material	30
Soil Cement	31
Cement-Aggregate Mixture (gravel and crushed stone)	32
Cement-Aggregate Mixture over Granular Material	33
Lean Concrete Mixture	34
Recycled Concrete Mixture	35
Lime-Treated Clay Soil	36
Cement-Treated Clay Soil	37
Pozzolanic-Aggregate Mixture	38
Recycled Asphalt Concrete	39

Table A.6 Subgrade Soil Descriptions

Soil Description	Code
Clay (Liquid Limit >50)	51
Sandy Clay	52
Silty Clay	53
Silt	54
Sandy Silt	55
Clayey Silt	56
Sand	57
Poorly Graded Sand	58
Silty Sand	59
Clayey Sand	60
Gravel	61
Poorly Graded Gravel	62
Clayey Gravel	63
Shale	64
Rock	65

Table A.7 Soil Type Codes, AASHTO Soil Classification

	Code
A-1-a	01
A-1-b	02
A-3	03
A-2-4	04
A-2-5	05
A-2-6	06
A-2-7	07
A-4	08
A-5	09
A-6	10
A-7-5	11
A-7-6	12

Table A.8 Geologic Classification Codes

Igneous:	
Granite	01
Syenite	02
Diorite	03
Gabbro	04
Peridotite	05
Felsite	06
Basalt	07
Diabase	08
Sedimentary:	
Limestone	09
Dolomite	10
Shale	11
Sandstone	12
Chert	13
Conglomerate	14
Breccia	15
Metamorphic:	
Gneiss	16
Schist	17
Amphibolite	18
Slate	19
Quartzite	20
Marble	21
Serpentine	22

Table A.9 Cement Type Codes

	Code
Type I	01
Type II	02
Type III	03
Type IV	04
Type V	05
Type IS	06
Type ISA	07
Type IA	08
Type IIA	09
Type IIIA	10
Type IP	11
Type IPA	12
Type N	13
Type NA	14
Other	15

Table A.10 Cement Additives Codes

	Code
Retarding Admixture	01
Water-reducing Admixture	02
Accelerating Admixture	03
Fly Ash	04
Coloring Admixtures	05
Dampproofing Agents	06
Water-reducing and Retarding Admixture	07
Water-reducing and Accelerating Admixture	08
Other	09

Table A.11 Aggregate Durability Test Type Codes

	AASHTO	ASTM	Code
Abrasion of Stone and Slag by Use of the Deval Machine	T3	--	01
Abrasion of Gravel by Use of Deval Machine	T4	--	02
Specific Gravity and Absorption of Fine Aggregate	T84	C128	03
Specific Gravity and Absorption of Coarse Aggregate	T85	C127	04
Resistance to Abrasion of Small Size Coarse Aggregate by Use of Los Angeles Machine	T96	C131	05
Soundness of Aggregate by Freezing and Thawing	T103	--	06
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	T104	C88	07
Resistance to Abrasion of Large Size by Use of Los Angeles Machine	--	C535	08
Potential Volume Change of Cement-Aggregate Combinations	--	C342	09
Scratch Hardness of Coarse Aggregate Particles	T189	C851	10

Table A.11 Aggregate Durability Test Type Codes (Cont.)

	AASHTO	ASTM	Code
Evaluation of Frost Resistance of Coarse Aggregates in Air-Entrained Concrete by Critical Dilution Procedures		C682	11
Concrete Aggregates	M80	C33	12
Potential Alkali Reactivity of Cement Aggregate Combinations	--	C227	13
Potential Reactivity of Aggregates	--	C289	14
Test for Clay Lumps and Friable Particles in Aggregates	--	C142	15
Recommended Practice for Petro-grafic Examination of Aggregates for Concrete	--	C295	16
Test for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates	--	C586.......	17
Other..			18

Table A.12 Maintenance and Rehabilitation Work Type Codes

	Code
Crack Sealing (linear ft.)	01
Transverse Joint Sealing (linear ft.)	02
Lane-Shoulder Longitudinal Joint Sealing (linear ft.)	03
Full Depth Transverse Joint Repair Patch (sq.ft.)	04
Full Depth Slab Patching Other Than Joint (sq.ft.)	05
Slab Replacement (sq.ft.)	06
Longitudinal Subdrainage (linear ft.)	07
Shoulder Replacement (sq. yards)	08
Overlay (sq.ft.)	09
Grinding Surface (sq.ft.)	10
Grooving Surface (sq.ft.)	11
Pothole Repair (sq.ft.)	12
Pressure Grout to Fill Voids (no. of holes)	14
Slab Jacking Depressions (no. of depressions)	15
Asphalt Undersealing (no. of holes)	16
Spreading of Sand or Aggregate (sq. yards)	17
Reconstruction (Removal and Replacement)(sq. yards)	18
Mechanical Premix Patch (using motor grader and roller)(sq.yards)	19
Manual - Premix Spot Patch (sq. yards) (hand spreading and compacting with roller)	20
Machine - Premix Patch (placing premix with paver roller)(sq. yards)	21
Full Depth Patch (removing damaged material, repairing supporting material, and repairing)(no. of holes)	22
Patch Pot Holes - Hand Spread Compacted with Truck (no. of holes)	23
Skin Patching (hand tools/hot pot to apply liquid asphalt and aggregate)(sq. yards)	24
Strip Patching (using spreader and distributor to apply hot liquid asphalt and aggregate)(sq. yards)	25
Surface Treatment, Single Layer	26
Surface Treatment, Double Layer	27
Surface Treatment, Three or More Layers	28
Aggregate Seal Coat	29

Table A.12 Maintenance and Rehabilitation Work Type Codes (Continued)

Sand Seal Coat	30
Slurry Seal Coat	31
Fog Seal Coat	32
Prime Coat	33
Tack Coat	34
Dust Layering	35
Longitudinal Drains	36
Transverse Drains	37
Drainage Blankets	38
Well System	39
Drainage Blankets with Longitudinal Drains	40
Other	41

Table A.13 Location on Pavement Code

	Code
Traffic Lanes	01
Shoulder	02
Curb and Gutter	03
Side Ditch	04
Culvert	05
Other	06

Table A.14 Maintenance Materials Type Codes

	Code
Preformed Joint Fillers	01
Hot-Poured Joint and Crack Sealer	02
Cold-Poured Joint and Crack Sealer	03
Open Graded Asphalt Concrete	04
Hot Mix Asphalt Concrete Laid Hot	05
Hot Mix Asphalt Concrete Laid Cold	06
Sand Asphalt	07
Portland Cement Concrete (overlay or replacement)	
Jointed Plain (JPCP)	08
Jointed Reinforced (JRCP)	09
Continuously Reinforced (CRCP)	10
Portland Cement Concrete (Patches)	11
Hot Liquid Asphalt and Aggregate (Seal Coat)	12
Hot Liquid Asphalt and Mineral Aggregate	13
Hot Liquid Asphalt and Sand	14
Emulsified Asphalt and Aggregate (Seal Coat)	15
Emulsified Asphalt and Mineral Aggregate	16
Emulsified Asphalt and Sand	17
Hot Liquid Asphalt	18
Emulsified Asphalt	19
Sand Cement (Using Portland Cement)	20
Lime Treated or Stabilized Materials	21
Cement Treated or Stabilized Materials	22
Cement Grout	23
Aggregate (Gravel, Crushed Stone or Slag)	24
Sand	25
Mineral Dust	26
Mineral Filler	27
Other	28

Table A.15 Material Type Codes for Thin Seals and Interlayers

	Code
Chip Seal Coat	71
Slurry Seal Coat	72
Fog Seal Coat	73
Porous Friction Course	74
Woven Fabric	75
Nonwoven Fabric	76
Stress Absorbing Membrane Interlayer	77

Table A.16. Distribution Of Trucks By Lane In Percent Of Total Trucks For Multiple Lane Controlled Access Highways (Computed From Models Developed Using 129 Traffic Counts In Six States, 1982-1983, see Ref. 20)

One-Way ADT	2 Lanes (One-Direction)		3+ Lanes (One-Direction)		
	Inner	Outer	Inner*	Center	Outer
2,000	6**	94	6	12	82
4,000	12	88	6	18	76
6,000	15	85	7	21	72
8,000	18	82	7	23	70
10,000	19	81	7	25	68
15,000	23	77	7	28	65
20,000	25	75	7	30	63
25,000	27	73	7	32	61
30,000	28	72	8	33	59
35,000	30	70	8	34	58
40,000	31	69	8	35	57
50,000	33	67	8	37	55
60,000	34	66	8	39	53
70,000	--	--	8	40	52
80,000	--	--	8	41	51
100,000	--	--	9	42	49

* Combined inner one or more lanes.

** Percent of all trucks in one direction

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APPENDIX E
HARDWARE SPECIFICATIONS

QUANTITY	DESCRIPTION
3	TS-100 Magnetic Tape System for the micro-computer system described below. Connecting cable must be at least eight (8) feet in length.
7	Okidata 82A column printer (205-95-5363)
7	300/1200 BPS Stand-alone Modem with Pulse Dialer (205-04-5475)
7	16-bit Microcomputer System with color monitors meeting the following minimum specifications:

A) One (1) floppy drive providing a minimum of 360 KB of storage per drive.

B) One (1) 20-megabyte hard disk storage device integrally mounted.

C) One (1) 8088 (16-bit) CPU with 256 KB RAM. Operating System being:
   1) DOS 2.1 or better with system utilities

D) One (1) Color monitor with color/graphics capability with the following:
   1) 80 char. by 24 line display
   2) Eight (8) colors available at a time
   3) 12" diagonal screen
   4) 600h. *200v. pixel graphics resolution.

E) One (1) Parallel port for printer and user applications

F) Two (2) Serial RS-232C ports with independent operation up to 9600 bps for printer and user applications.

G) Detachable keyboard with numeric keypad, cursor control keys, and ten (10) programmable function keys. Upper and lower case characters required. All alph-numeric keys must repeat automatically or with use of a "repeat" key.

H) All available operator and maintenance manuals.

This system will be used as a desk-top system and must be physically integrated as follows (minimum):

QUANTITY	DESCRIPTION
	A) CPU, the floppy drive, and hard disk drive must be contained within the same physical case. The two (2) serial ports and the parallel port must be mounted in the rear of the physical case.
	B) The monitor must be either mounted onto or be able to be set on the physical case in (A). If not permanently mounted, the monitor must plug into the rear of the physical case in (A) still leaving the serial (2) and parallel (1) ports free for user applications. Any external cabling of the monitor must allow the monitor to be positioned off the physical case.
	C) The keyboard must plug into the physical case (not into the serial (2) or parallel (1) ports) by a 6 foot coiled cord and act as a separate module.

Manuals

1) One set of operator/maintenance manuals will be provided with each single integrated system that is purchased.