Introduction to LTPP Data

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Long-Term Pavement Performance
Serving Your Need for Durable Pavements

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Introduction

The Long-Term Pavement Performance (LTPP) program was established to support a broad range of pavement performance analyses leading to improved engineering tools to design, construct, and manage pavements. Since 1989, LTPP has collected data on the performance of pavement test sections located on in-service roadways across North America. Most of the data and information collected on the approximately 2,500 test sections are stored in the LTPP database called the Information Management System (IMS).

Currently, the LTPP IMS consists of 16 general data modules with 430 tables containing more than 8,000 unique data elements. At present, the online data in the central IMS requires approximately 8.5 gigabytes of storage; offline data increases storage requirements to more than 45 gigabytes. The size of the IMS will continue to grow as new data elements are added and more data are collected and stored.

In the eleventh year of the LTPP program, the IMS continues to evolve. In 1998, the migration of the database to a Windows NT distributed environment was completed. This required programming and other structural changes to the database. Currently, new tables are being added to store computed parameters resulting from various preliminary analyses performed on the data. These computed parameters represent engineering calculations from raw data to enable higher order types of pavement performance analysis to be performed more efficiently. Layer elastic modulus from backcalculation of deflection measurements is an example of a computed parameter.

This document presents a discussion of the uses of and limitations of LTPP data in pavement performance analyses, general data availability, and data update schedule. Specific details on the structure of the IMS and how to obtain data can be found in the *LTPP Data User's Reference Manual* (Ref. 1). *(http://www.ltppdatabase.com/p2a.htm)*

LTPP Data

The information collected by the LTPP program to explain and model pavement performance on a carefully selected set of test sections comes in many forms, the most visible being data stored in the LTPP Information Management System (IMS) - LTPP's database. These data are the easiest to access and most suitable for analysis since they are stored in electronic format. Most of the discussion presented in this document is focused on the IMS data. However, the true LTPP information base extends beyond the IMS data. This includes electronic data stored off-line, data and information stored in paper form, photographs, construction plans and specifications, video tapes, documentation, reports, and analysis results. Where applicable to pavement performance analysis efforts, references are made in this document to the sources of this other information, which can be of potential use.

The central point of contact to obtain LTPP data is the LTPP Customer Support Service Center (Ref. 2). *(ltppinfo@fhwa.dot.gov)*

Only LTPP data that have passed the IMS Quality Control (QC) checks to level E (discussed below) are available without special permission from the FHWA LTPP Program Manager. Off-line electronic data, such as Falling-Weight Deflectometer (FWD) time-histories and 25-mm longitudinal profile measurements; data for agency supplemental sections constructed on Specific Pavement Studies (SPS) project sites; and data currently stored in paper form, such as hand-drawn distress maps and portland cement concrete (PCC) thermal coefficient test results, require special approval to obtain.

In order to check the reasonableness and content of LTPP data in the IMS, a series of quality control checks have been instituted. These checks have been assigned a letter code from A to E as follows:

A Random checks for data transmission corruption problems.

B Data dependency checks to verify the existence of essential section information, such as test section number, location, etc.

C Critical check of required data elements within a table.

D Expanded range checks to verify reasonableness of the values of data fields in a table.

E Intra-modular checks between related tables to ensure consistency with the relational database structure.

It should be noted that level 2 QC checks described in prior LTPP literature have not been implemented.

In the QC process, manual upgrades of some data not passing the checks are performed. For example, if the value of a critical data element is not available, a manual upgrade to level C can be performed. In these situations, comments are entered into the IMS stating the reason such upgrades were performed.

Although quality control checks are applied to the data, data reaching level E do not necessarily imply that all critical data elements are present, or that the data do not contain anomalies or other types of errors. The IMS QC checks can be characterized as very basic, rudimentary checks.

In recognition of this fact, the objectives of the first phase of the data analysis activities, called the preliminary analysis, were to examine groups of related data to: (1) establish precision and bias estimates of computation errors, (2) quantify and segment range and variability attributes, and (3) identify and diagnose extreme or outlier observations and illogical time-series relationships (Refs. 3 and 4). The results of the first set of preliminary analyses were completed in late 1998.

Since LTPP field monitoring efforts began with test sections in the General Pavement Studies (GPS) in 1989, more data are available for these sections. Field monitoring of Specific Pavement Studies (SPS) began circa 1991 and, in general, have less data available depending upon the age of the project. The LTPP SPS experiments were implemented starting with SPS-5 (Rehabilitation of Asphalt Concrete Pavements). The other LTPP SPS projects were implemented in the following order: SPS-6 (Rehabilitation of Jointed Portland Cement Concrete Pavements), SPS-1 (Strategic Study of Structural Factors for Flexible Pavements), SPS-2 (Strategic Study of Structural Factors for Rigid Pavements), SPS-7 (Bonded Portland Cement Concrete Overlays), SPS-8 (Study of Environmental Factors in the Absence of Heavy Loads), SPS-9P (Pilot Studies for Superpave Field Validation), and SPS-9A (Validation of Superpave Binder Specifications).

The SPS studies on preventive maintenance on flexible pavements (SPS-3) and rigid pavements (SPS-4) were developed and managed by the Strategic Highway Research Program's Highway Operations group. Although the SPS-3 and 4 studies were not initiated by the LTPP program, field data collection was performed by LTPP contractors and the data are stored in the LTPP IMS.

Under the LTPP Program Improvement activities initiated in 1997, a data resolution effort was begun to identify and resolve the status of all missing and questionable data. Missing data is defined as all data sought and agreed upon as part of the LTPP program, but not in the system. Questionable data is defined as data not releasable due to failure to meet all quality control (QC) checks and/or obtained using non-standard LTPP protocols. Central to this process is the creation of data status reports to provide a summary of the extent, completeness, and character of the data collected for a test section or project. These reports will be used in the data resolution process to coordinate with participating highway agencies and other LTPP team members. They will also be used to provide analysts and others interested in using LTPP data with an indication of what data *may* be available to support various types of analysis. The first round of reports was completed in September 1998. The final reports, which reflect the status of resolution of missing or questionable data, were produced in March 1999.

In assessing the appropriate uses of LTPP data, it is important to distinguish between those data elements that are based on measurements performed on the section and those that are based on construction project information obtained from agency records. The vast majority of the data contained within the LTPP database are derived from some sort of measurement, either performed in the field at the test site, or on samples obtained from the test site. Much of the information contained in the inventory modules (INV tables in the IMS) is based on agency records for the general construction project and not necessarily from test site measurements. For example, the values for CBR, R-value, and K-value contained in the ***INV_SUBGRADE*** table are not based on field measurements or tests performed on samples obtained from the test site location.

Discussions of LTPP data are presented in the following categories:

Pavement Structure
Construction
Material Characterization
Pavement Monitoring
Traffic
Climate

In the discussion of each data category, the general names of the IMS table or series of tables containing the data are noted. In the IMS table names, wild-card characters are used to reference multiple table names. A pound sign (#) represents a single-digit number. An asterisk (*) is used to reference a variable number of characters that begin with the indicated prefix.

Pavement Structure

The data elements in this category include those that describe the general components and physical dimensions of the roadway and pavement structure.

Layer Thickness

Layer thickness measurements for many sites are based on cores, borings, and test pits outside the ends of the monitoring portion of the test section. A shoulder boring was also performed near the center of the test sections to identify rigid subsurface layers. Thickness measurements on GPS test sections were obtained from cores, borings, and/or test pits at the ends of the section. These measurements, as well as a single suggested pavement structure to be used for analysis, are available for all GPS test sections. In addition to thicknesses from cores and borings at the end of the section, thickness variations within the test section are available on some SPS projects. These within-section thickness variations are determined from rod and level elevation measurements performed during construction (five points across the test lane at 15.2-m intervals). There are some gaps in the thickness data on some SPS test sections.

IMS locations: ***TST_L05B***, ***TST_L05A***, ***TST_L05***, and ***SPS#_LAYER_THICKNESS***

Layer Type

Information on the generic type of layer and material, such as granular base or hot-mixed asphalt concrete, are available for all sections, with some exceptions for SPS projects. Not included in this category are material characterizations from laboratory tests, which are covered under another category.

IMS locations: ***TST_L05B***, ***TST_L05A***, ***TST_L05***, ***INV_LAYER***, and ***SPS#_LAYER***

Geometry

The only pavement geometric features captured as data elements in the IMS are lane and shoulder width. Features such as longitudinal grade, transverse cross-slope, super-elevation, and horizontal curvature are not contained in the LTPP database. Some of these features can be determined using the raw field measurements. For example, transverse cross-slope can be computed from the raw transverse profile measurements performed with the dipstick; however, the raw measurement data stored on the field data collection forms would need to be accessed since the data stored in the IMS have been normalized during processing to remove the cross-slope.

IMS locations: ***INV_GENERAL*** and ***SPS_GENERAL***

Drainage

Drainage information contained in the IMS includes the presence and type of subsurface drainage features, such as permeable layers, transverse drains, and longitudinal drains. There are currently no measures of the effectiveness or performance of drainage features. (The best source of information on the effect of in-pavement drainage systems will be from comparison of the drained-undrained sections on SPS 1 and 2 projects.) Some GPS projects contain edge drains, but these were not included as a primary experimental factor.

IMS locations: ***INV_GENERAL*** and ***SPS_GENERAL***

PCC Reinforcement

Details of the transverse and longitudinal steel reinforcement in PCC layers are available for all but a small subset of test sections. This information comes from agency records since most of these test sections are in the GPS experiment and those in the SPS are rehabilitation projects. It is expected that most of the missing PCC reinforcement data will be obtained and processed into the IMS by June 1999.

IMS locations: ***INV_PCC_STEEL*** and ***SPS2_PCC_STEEL***

PCC Joint

Information on PCC joint details is available for all GPS test sections and most SPS projects. The general information available on average joint spacing is not necessarily specific to the test section; details on joint locations within a test section can be obtained from fault measurements and hand-drawn distress survey maps prepared for each test section.

IMS locations: ***INV_PCC_JOINT***, ***MON_DIS_JPCC_FAULT***, ***RHB_PCCO_JOINT_DATA***, ***SPS2_PCC_JOINT_DATA***, ***SPS7_PCCO_JOINT_DATA***, and ***SPS8_PCC_JOINT_DATA***

Construction

Information on construction methods, techniques, and other related details is available for the majority of the test sections; however, the availability of detailed information varies greatly depending upon the type of test section and LTPP experimental designation.

The available construction information for the test sections in GPS experiments 1, 2, 3, 4, 5, 6A, 7A, and 9 is very general in nature since it was obtained from agency records after construction was completed. In some cases, this information was collected more than 10 years after the pavement was constructed and opened to traffic. In most cases, this information represents general features of the construction project, and is not specific to the test section location of the project. In many cases, the entries in the database represent the highway agency's construction specifications existing at the time the project was constructed.

The most detailed construction information is available for test sections whose construction was monitored by LTPP. This includes all of the test sections in the SPS experiments. The construction data forms for the SPS experiments are published in separate documents, one for each experiment, contained in references 5, 6, 7, 8, 9, 10, and 11. The exception are SPS-9 test sections for which the data tables in the IMS have not yet been created to store the collected construction information.

Construction data for maintenance activities on LTPP test sections and test sections rehabilitated during the LTPP monitoring period are collected by the participating highway agency and reported on LTPP data forms. The current absence of this data in the IMS for many of these test sections is one of the data resolution emphasis areas.

IMS locations: ***INV_*** *, ***MNT_*** *, ***RHB_*** *, and ***SPS#_*** *

Material Characterization

The material sampling and test plans for GPS test sections are published in the *SHRP-LTPP Guide for Field Materials Sampling, Handling, and Testing* (Ref. 12). Details of the material tests performed on these samples can be found in the *SHRP-LTPP Interim Guide for Laboratory Materials Handling and Testing* (Ref. 13). The material sampling and test plans for the SPS experiments are published in separate documents, one for each experiment, contained in references 14, 15, 16, 17, 18, 19 and 20.

As with most other data elements, most of the data for GPS test sections are available. All materials testing on GPS test sections is the responsibility of LTPP contract laboratories. Most of the testing of GPS materials was performed by laboratories under contract with the Strategic Highway Research Program (SHRP). In two LTPP regions, resilient modulus testing of unbound materials was not completed under the SHRP contracts and was transferred to FHWA contract laboratories.

Currently, there is much lower availability of materials test data for SPS test sections. The responsibility for SPS material tests is split between the participating highway agencies and LTPP test laboratories. The LTPP contract laboratories are tasked with the more complex resilient modulus and associated tests, while agencies are responsible for all other tests.

IMS locations: ***TST_*** *

Laboratory-Measured Modulus of Elasticity

For most materials, the laboratory-determined modulus of elasticity is measured using resilient modulus test procedures, the exception being for PCC in which a static modulus of elasticity test is used. The greatest amount of resilient modulus data currently available is for unbound materials, with the amount varying by LTPP region. Testing is nearly complete on all fine-grained materials. Resilient modulus testing on coarse-grained unbound materials being tested by LTPP contract laboratories is expected to be completed by September 1999.

Laboratory modulus of elasticity data for PCC layers are available for nearly all GPS test sections and some SPS test sections.

Laboratory resilient modulus data for asphalt concrete layers exist for most GPS test sections in the North Atlantic, North Central, and Southern regions. However, due to concerns over the reliability of these results, their QC record status is set to A, which requires special permission to obtain. Due to irreconcilable problems with test equipment, there are no available resilient modulus data for GPS test sections in the Western region. Presently, it is planned to obtain and test samples from only the asphalt concrete (AC)-surfaced Seasonal Monitoring Program (SMP) test sections in the Western region; there are no plans for obtaining these missing values on other GPS test sections in the Western region. Laboratory resilient modulus tests on asphalt concrete samples from SPS test sections and GPS overlay projects started in the fall of 1998 using a new procedure that provides both resilient modulus and creep compliance from the indirect tensile test. The first upload of this data into the IMS is expected in the fall of 1999.

IMS locations: ***TST_AC07_****, ***TST_PC04***, and ***TST_UG07_SS07_****

Backcalculated Elastic Modulus

Results of the preliminary analysis project to produce backcalculated moduli for distribution through the LTPP IMS are scheduled to be available by September 1999. There are currently no plans to make available through the IMS backcalculation results from other LTPP-sponsored analyses (Refs. 21, 22, and 23).

IMS locations: ***MON_DEFL_FLX_BAKCAL_****, and ***MON_DEFL_RGD_BAKCAL_****

AC Creep Compliance

These measurements were designated only for SPS projects, they were not designated for GPS test sections. Measurements were performed on samples from 23 GPS test sections as part of the SHRP work on development and validation of performance prediction models and are available in a published report (Ref. 24). The approach to measuring these values during the resilient modulus testing has been accepted. The first upload of this data into the IMS is expected in the fall of 1999.

IMS locations: ***TST_AC07_****

PCC Strength

There is good availability of PCC strength data, compressive and splitting tensile, for most PCC layers on GPS test sections. These are mostly long-term strength values obtained at various ages depending on the project’s construction date. A complete suite of time-sequence strength gain data, nominally at 28, 90, and 365 days, should be available for most SPS-2 projects. This data suite includes compressive and indirect tensile strength from cores and formed cylinders, and modulus of rupture from formed beams.

IMS locations: ***TST_PC01***, ***TST_PC02***, and ***TST_PC09***

AC Strength

Indirect tensile strength tests are a standard part of the resilient modulus test and are available for all sites in which resilient modulus data are available. These tests are also performed as part of the moisture susceptibility test performed on SPS test sections.

IMS locations: ***TST_AC05*** and ***TST_AC07_A_SUM***

Unbound Base and Subgrade Strength

For fine-grained subgrade material with adequate strength to survive sampling, unconfined compressive strength data are available. Strength information is also available for unbound base and subgrade materials as part of the resilient modulus testing protocol for these materials. These data are limited to tests at only one density, moisture content, and confining pressure. These values are available for all sites in which resilient modulus data are available.

IMS locations: ***TST_SS10*** and ***TST_UG07_SS07_****

Bound Base Strength

Unconfined compressive strength tests were performed on bound base materials provided they were strong enough to survive coring.

IMS location: ***TST_TB02***

Superpave Asphalt and Mixture Tests

Currently Superpave asphalt and mix design tests are only designated for SPS-9 projects. Results of these tests performed on the SPS-9 projects are currently stored in paper form. Entry of these data into the IMS is not planned until after December 1999. Results of tests performed on the 22 GPS tests sections used in the Superpave validation effort are available in the previously referenced document.

PCC Thermal Coefficient

PCC samples for the thermal coefficient tests were obtained from PCC layers on SPS projects. These very specialized tests are being performed at the FHWA Turner-Fairbank Highway Research Center laboratory. These tests are currently in progress and results from tests on 116 cores have been obtained. Due to the slow test production rate, testing of all samples is not expected to be completed until 2002. These data are currently available only in paper form; entry into the IMS is not expected until after December 1999.

Material Classification

These data are available for all GPS test sections and most SPS projects. Resolution of missing material classification data from SPS projects is part of the current data resolution activity to be completed by October 1999.

IMS locations: ***TST_SS04_UG08***, ***TST_TB01***, ***TST_L05A***, and ***TST_L05B***

Other Material Data

Other materials data, as specified in the materials testing plans for each type of experiment, are available. Better coverage is currently available for GPS test sections.

IMS locations: ***TST_****

Pavement Monitoring

Most pavement monitoring measurements are performed by LTPP contractors, using standard equipment and procedures, to maintain a high degree of uniformity. The routine measurements include deflection, longitudinal profile, and distress. The measurements are performed at set intervals; however, they are not always scheduled to occur at the same time. For example, longitudinal profile measurements are not performed on the same day that distress surveys are performed. Although these time mismatches can complicate analysis of the relationships between roughness-based performance measures and distresses, it is possible to obtain matched sets of data that occur within a reasonably close time period for these types of investigations. In general, there is excellent availability of routine pavement monitoring data on all LTPP test sections. Specialized measurements of sub-surface moisture and temperature and pavement load response are collected on a subset of test sections. Collection of friction data is the responsibility of the participating highway agency and the data do contain some gaps.

Falling-Weight Deflectometer

Measurements performed using the Falling-Weight Deflectometer (FWD) are available for all LTPP test sections. Test frequencies vary between bimonthly measurements during the spring thaw on Seasonal Monitoring Program (SMP) sites in frost areas, to 5-year intervals on other sites. Deflection measurements are also performed before and after overlay placement. The deflection data set includes peak values; 60-ms-long time-histories; and temperature measurements of the air, pavement surface, and at three depths in the surface layer. Details of the LTPP deflection testing procedures are contained in references 25 and 26. During test section material sampling, bore holes were made into the shoulder to a depth of 6.1 m to detect the presence of rigid layers that might influence backcalculation results.

As noted under material properties, interpretation of the deflection measurements is currently progressing with backcalculation of the layer moduli. LTPP-sponsored analysis work has been performed to compute subgrade modulus of reaction (K-values) from deflection measurements on PCC pavements (Ref. 27). These values are not available through the LTPP IMS. To date, no work has been performed on computation of load and deflection transfer efficiencies of transverse joints, but the raw data exists to compute these quantities.

IMS locations: ***MON_DEFL_****

Longitudinal Profile

Longitudinal profile measurements are available for all LTPP test sections. The overwhelming majority of these measurements are performed using an inertial reference-plane-instrumented vehicle operating at highway speeds. On some remote sections, manual measurements were performed using a digital incremental profiling device. Details of the LTPP profile measurement procedures are available in reference 28. The profile data from these measurements have been filtered and normalized to remove the long wavelength content. Measurement frequencies vary from 5 times per year on SMP sites to 2-year intervals; many sections have a 1.5-year interval frequency. Each data set collected using the instrumented vehicle consists of five consecutive measurements collected on the same day.

Pavement ride parameters, computed from the profile measurements, are available in the IMS. These parameters include International Roughness Index (IRI), simulated slope variance (SV), root mean square vertical acceleration (RMSVA) at varying base lengths, and standardized Maysmeter Index (MO).

LTPP has also sponsored pavement roughness model building analyses. These efforts are documented in references 29 and 30.

IMS locations: ***MON_PROFILE_****

Distress

Distress data are available for all LTPP test sections. Collection frequencies vary from measurements three times per year for SMP test sections to 2-year intervals. There are two distinct methods used to obtain ratings of distress occurrences on LTPP test sections. The initial primary method was based upon interpretation of images captured on 35-mm black-and-white, continuous-strip photographs. This is supplemented, and recently supplanted, by manually performed surveys conducted by a field rater. LTPP distress definitions and measurement details are documented in reference 31. The differences between the two data sources and the differences between distress raters and interpreters have created some apparent anomalies in the time sequence relationships for some sites. Work has begun to develop an analysis set of distress data that combines information from different sources into a logical, coherent time sequence. This work is scheduled to be completed by December 1999.

The distress information on LTPP test sections should not be interpreted as representing the general status of pavements in the United States. The LTPP test sections are not a proportional sample of the general pavement types across the United States; they are a highly biased set of pavement structures, purposefully selected to restrict the inference space to a more manageable level. Additionally, the terminal values of distress or condition on LTPP test sections should not be interpreted as the terminal condition leading to a rehabilitation treatment. In many instances, the cause for rehabilitation of a test section has nothing to do with the conditions on the test section; some other portion of the project may be the cause. Furthermore, on some sections, we have requested that the section be allowed to deteriorate to a level lower than that normally allowed. New data forms documenting the reason for rehabilitation were implemented in May 1998 for all new rehabilitation projects.

IMS locations: ***MON_DIS_**** and ***MON_DROP_SEP***

Friction

Friction data are supplied by participating highway agencies. This data set consists of SN values. Complementary explanatory data on items such as surface texture are not available. Although LTPP has developed guidelines for collection and reporting of this data (Ref. 32), significant variability between agencies is suspected. Results of a preliminary data analysis study were obtained in 1998 (Ref. 33).

IMS location: ***MON_FRICTION***

Seasonal Effects

The LTPP Seasonal Monitoring Program (SMP) was developed to address seasonal changes in pavement behavior due to variations in temperature and moisture. These measurements are primarily limited to asphalt concrete-surfaced, jointed plain PCC and jointed reinforced PCC pavements with unbound granular base layers. Monthly measurements conducted on the 60 test sections in the program include multiple deflection measurement passes during the test day on the same set of test points, time-domain reflectometery (TDR) measurements for subsurface moisture-depth gradient, electrical resistivity depth gradient for frost zones (freeze areas only), and water-table depth. Continuous measurement of precipitation, air temperature, and subsurface pavement temperature profiles are recorded by on-site data loggers. These measurements are supplemented with elevation surveys and longitudinal profile measurements conducted four to five times per year. Distress measurements are performed three times per year. On the jointed PCC pavements, joint opening and faulting measurements are also performed on each test day. (Warp and curl surface profile measurements are not performed on the jointed PCC pavements.) Instrumentation, installation, and data collection details for SMP test sections are documented in reference 26. It should be noted that the objective of the SMP is to provide data needed to attain a fundamental understanding of the magnitude and impact of temporal variations in pavement response and material properties due to the effects of temperature, moisture and frost/thaw variations, and their interactions. Thus, issues, such as traffic data collection method and intensity, were not included in site selection considerations.

For field operation efficiencies, the SMP test sections are divided into two groups within an LTPP region. The monthly cyclical measurements are alternated between each group of test sections over a continuous annual cycle. Production testing on the first set of SMP test sections began in September 1993. The initial test cycle lasted for 2 years, with two test sections added between the first and second year. Measurements on the second group of test sections began in late summer/early fall of 1995. Measurements on the first group of sections were repeated in 1996-1997. The current cycle of measurements on the second group of test sections began in the fall of 1997.

The majority of the raw data from SMP test sections are currently available in the IMS. The exception is a subset of TDR measurements whose traces were recorded on paper strip charts. The interpretation and storage of the dielectric constant from these paper traces were competed in November 1998.

Several preliminary analyses were initiated in 1997 whose objectives are to interpret the SMP measurements to estimate moisture content and frost zones. These studies were completed in 1998. The results of the moisture estimates were uploaded into the IMS in late 1998. The frost zone interpretation is expected to be loaded into the IMS during the spring of 1999.

IMS locations: ***SMP_****

Load Response

Pavement responses from moving truck loads have been collected at two SPS project sites. In North Carolina, four PCC pavement test sections on the SPS-2 project were instrumented with linear variable displacement transducers (LVDT), strain gauges, pressure cells, and SMP instrumentation (Ref. 34). To date, eight measurement rounds have been conducted seasonally (four times per year). This data, available in the IMS, consists of instrumentation response traces from the passing load truck, with known axle loads, operated at two speeds.

The other active load response site is located in Ohio. Measurements on four SPS-1 asphalt concrete and four SPS-2 PCC pavement test sections are being taken under the sponsorship of Ohio DOT. To date, two to three rounds of measurements have been performed. While similar, the equipment and data processing techniques vary from those used on the North Carolina site. Currently, work is underway to coordinate the receipt and storage of these Ohio data in the IMS.

Loading of the data from the rigid PCC test sections is expected to be completed by summer 1999, while the measurements taken on the flexible test sections are expected to be completed in December 1999.

IMS locations: ***DLR_****

Traffic

Traffic data within the LTPP program are stored in the IMS and the Traffic Data Base (TDB). The TDB was primarily designed to store and process the raw traffic measurements collected by participating agencies and to compute annual summary statistics for the traffic stream passing over the test lane. These computed traffic summary statistics are stored in the IMS for easy access.

Because LTPP traffic data are primarily limited to the test lane, its use to develop prediction procedures based upon total facility traffic data is limited on many sites. There are some sites at which data for traffic in all lanes and directions have been submitted to LTPP. The data from non-LTPP lanes are stored in raw form in the TDB since they are not used in the traffic computations for the test lane. These data have not been processed or subjected to quality control checks.

Within LTPP, there are two broad classes of traffic information: traffic estimates and monitored traffic.

Traffic Estimates

Traffic estimates are provided by the participating highway agencies for years when no on-site traffic monitoring measurements were taken. In LTPP, these data are referred to as historical and updated traffic data. The source of this information varies from agency to agency and site to site. This information typically consists of annual traffic statistics in the test lane, such as 18k ESAL, number of trucks, and vehicle volumes. The estimated traffic data typically does not contain axle-load spectrum distributions and is not stored in the IMS. The quality, precision, and reliability of these traffic estimates are unknown.

IMS location: ***TRAF_EST_ANL_TOT_LTPP_LN***

Monitored Traffic

Although on-site collection of traffic data using continuously operated weigh-in-motion (WIM) devices is the preferred measurement method, highway agencies have employed a wide range of traffic measurement devices and sampling methods. Most traffic measurements are based upon automatic vehicle classifiers and/or WIM.

The raw data submitted by the participating highway agency are stored in the TDB. Raw data include individual vehicle records, which contain information such as the date and time the vehicle crossed the scale, vehicle class, number of axles, axle spacing, and weight of each type of axle group. Raw automatic-vehicle-classifier (AVC) data typically consist of the number of daily vehicles in each vehicle class. If traffic load data have been supplied, daily and annual axle-load distributions are computed using linear, time-based, expansion factors. Seasonal factors are not used in this process.

Monitored traffic data for LTPP test sections are released by calendar year. The release date occurs around June of each year to allow time for receipt and processing of the previous year's data. Monitored traffic is available for LTPP sites from 1990 to 1997. (The 1998 data are currently being processed.)

IMS locations: ***TRAF_MONITOR_****

Climate

Climate data for the LTPP program are derived from two sources: public climate databases and on-site weather stations.

Data from the public climate databases, the National Climatic Data Center (NCDC), and the Canadian Climatic Center (CCC) are used to create a statistical “virtual” weather station for all test sites (even those with on-site weather stations). This virtual weather station consists of distance-weighted average climate statistics from up to five nearby weather stations. In addition to the statistical virtual weather station, the weather station data used in the computations are also stored in the IMS.

The virtual weather data primarily consists of monthly parameters starting from the construction year to the last update. Currently, there are a possible 22 different climatic observation parameters and associated descriptive statistics, including minimum temperature, maximum temperature, mean temperature, precipitation, snowfall, minimum relative humidity, maximum relative humidity, average wind speed, peak gust speed, percent sunshine, and percent sky cover. Also included are derived quantities calculated from the measured data, such as air freezing index, air freeze-thaw cycles, total precipitation, total snowfall, etc. Also available are a limited set of annual statistics, which includes annual air freezing index, number of air freeze-thaw cycles, and coverage data for each of the monthly parameters.

The hourly and daily climatic parameters are stored off-line.

The virtual weather data was last updated in 1998.

Climatic measurements from on-site instrumentation are taken from on all SMP test sections and SPS-1, 2, and 8 projects. The SMP climate measurements consist of air temperature and precipitation from a non-heated rain gauge. The climate measurements on the SPS projects are taken using an Automated Weather Station (AWS) that measures air temperature, precipitation (heated gauges in frost areas), solar radiation, humidity, and wind speed and direction. Data from these measurements stored in the IMS include hourly, daily, and monthly statistics.

IMS locations: ***AWS_**** and ***CLM_****

IMS Update Schedule

The LTPP IMS schedule for data uploads is updated on a periodic basis. The most current schedule can be obtained from the LTPP Customer Service representative.

References

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