# Use of PMS Data for Performance Monitoring with Superpave as an Example

## 10. Other Examples of Using PMS Data in Performance Monitoring

In Sections 7.6, 8 and 9 examples were provided illustrating how the linking of PMS and materials and construction data could be used to evaluate specific facets of Superpave technology. It is important to note that Superpave is only one example, although an important one, of what can be done with engineering analysis of PMS and related data. It was chosen as the primary example because the increasing use of this new technology for mix design and evaluation requires that performance information be obtained to test the performance of Superpave technology and whether modifications are necessary to enhance its usefulness.
The purpose of this section is to illustrate some other examples and to briefly point out the kinds of changes or additions that would be needed to PMS data collection procedures for a particular subset of pavement sections. For asphalt concrete (AC) pavements brief examples are given here for the performance and evaluation of pavement structures and overlays designed according to the forthcoming *AASHTO 2002 Guide*, and for the performance evaluation of porous friction courses, surface treatments, and asphalt treated permeable base (ATPB). For Portland cement concrete (PCC) pavements examples are given on the effect of aggregate type, the effect of maintenance procedures such as joint sealing and the effect of load transfer devices.
It must be emphasized that the basic PMS database with good location and referencing identification is critical to all of these evaluations. However, in each case a supplementary data set is required which depends upon the details of the materials, construction, or design techniques being evaluated. Each concept requires that some detailed materials or construction data be recorded for individual test sections and in some cases it is important that a small amount of additional performance information be recorded for these same sections. No modifications are needed to the basic data structure of the PMS database. However, additional sub-files keyed to the appropriate location identification should be set up with required query functions so that routine data may be extracted from the PMS database and assembled with the individual data subsets for analysis. Likewise, the data subsets can be imported into a PMS database for overall analysis as appropriate.

### 10.1. AASHTO Pavement Design Guide 2002

The proposed mechanistic-empirical 2002 *Pavement Design Guide* presents a unique opportunity for the use of PMS data. New mechanistic concepts will be employed that have not been tested. Work should be done in 2001 to set up plans for a database with nationwide potential to initialize data for sections designed according to the 2002 Guide. State DOTs can be encouraged to set up the required data set and start collecting data using standard data collection protocols. In this way a broad, dependable performance database could be built.
Linking of PMS and materials and construction databases will be essential to the successful application/implementation of the AASHTO 2002 Guide for pavement design and rehabilitation. Clear records should be made of design parameters, calculation, and predicted layer thickness and material properties. These should be followed with accurate records of asphalt thickness and properties.
To evaluate the performance models on which the 2002 Guide is based will also require a detailed materials database. Some of the elements of this database are:

- Material characteristics of the various components including subgrade, determined either in the laboratory and in-situ (e.g. by back calculation from FWD measurements) or both;
- QC/QA construction data for the various layers to assess both variability and reliability of design estimates and to assess as-built properties; and
- Other as-designed records.

To verify the models in the 2002 Guide, it will be important to ensure that good traffic/load data are recorded annually. Weigh-in-motion data will be desirable but as a minimum, good load spectrum and ESAL estimates must be recorded on an annual and seasonal basis. Annual performance measures should include distress, roughness and deflection data. The type and location of maintenance activities must also be recorded.

Comparisons of estimated and measured performance both as a function of traffic and environment will permit calibration and necessary modifications to be made to the performance models, thereby improving confidence of the transportation community in the use of the 2002 Guide.

## 10.2. Asphalt Pavement Examples

### 10.2.1. Porous Friction Courses

Porous friction courses of open - graded asphalt mix have been used for the last several years as a surfacing on both asphalt and concrete payments to carryout one or more of the following functions:

- Reduce the potential of hydroplaning, and consequently minimize loss of skid resistance at higher speeds;
- Reduce tire splash and spray, thus improving visibility to the road users; and,
- Reduce vehicle noise.

These purposes are fulfilled through increased pavement macro-texture and improved contact between tires and the pavement surface under conditions of heavy traffic and rainy weather. The function of the material depends upon the open pores created remaining open so that surface water will quickly drain, permitting the tires to continually contact the aggregate. The performance of such mixes is influenced by the composition of both the aggregate and the asphalt, the aggregate gradation, and by construction practices such as compaction, thickness, etc. There is no doubt that a properly placed porous course fulfills its goals. However, there is evidence that in a short time many porous friction courses fill up with debris and lose their effectiveness under road traffic.

Typically PMS performance indicators in the database include surface distress, ride quality and skid resistance. Additional indicators would need to be incorporated to study porous friction courses to measure noise levels and surface water permeability for the affected section. These additional data factors could be appended to a subsidiary data set keyed to pavement location since they will not routinely be collected on all PMS sections.

The materials database should include the following factors as a minimum:

1. Mix design, aggregate gradation, shape, and durability characteristics, both as-designed and as-constructed;
2. Asphalt/binder type and amount, both as-designed and as-constructed;
3. Density and void information as-constructed;
4. Layer thickness as-designed and as-constructed; and preferably,
5. Permeability measurements, both laboratory determined, and as-constructed.

As little as three or four years of these data combined with PMS data could be used to evaluate performance and could lead to a determination of the benefits and actual life of such porous friction courses. It could also lead to improvements in material selection and mix design procedures as well as construction practices, which would insure the desired functional performance of this type of free draining surface course.

### 10.2.2. Surface Treatments and Seal Coats

This category includes spray applications of asphalt covered by a single layer of aggregate to improve surface characteristics of the pavement structure. This type of construction encompasses fog seals (asphalt alone or a softening or recycling agent), chip seals, and slurry seals. Currently in the United States, application is limited to relatively lower volume roads and to maintenance of existing pavements under low and medium traffic volumes. In other countries such as New Zealand [Seal 87], Australia [AAPA 98], and South Africa [Emery 94] many miles of single and double surface treated roads are used to carry primary rural traffic.

Surface distress such as cracking and patching in a PMS database are obliterated when the surface is covered up with a layer of asphalt and stone chips or slurry seal. This creates a discontinuity in the PMS performance data. However, roughness data remain continuous and can be used for performance evaluation. For this type of pavement it is also necessary to add aggregate loss and bleeding as additional distress factors since they are important modes of failure.

The subsidiary materials and construction database for chip seals as an example, should include:

1. Details of existing surface before application (smoothness, degree of cracking, cracking and patching, presence of bleeding, or raveling, etc.);
2. Type of treatment, single or double application, etc;
3. Asphalt/binder data - emulsion or cutback, grade, modification if incorporated in binder;
4. Aggregate data - gradation, shape, polishing tendencies, adhesion characteristics;
5. Application rates for binder (gallons/$yd^2$) and aggregate (lbs/$yd^2$);
6. Construction control data, curing time prior to traffic;
7. Environmental data (temperature, possible rain fall or humidity during construction procedures); and,
8. Laboratory test data (e.g., wheel tracking or abrasion test results).

These data should be placed in a database (subset) for surface treatments to be studied, then keyed to the PMS database by location identifier. Performance evaluation would use both the PMS and the auxiliary database and should lead to improved chip seal performance predictions. In turn this will improve materials requirements and construction practices as well as add to the understanding of traffic conditions and surface conditions under which these procedures perform acceptably.

### 10.2.3. Asphalt Treated Permeable Bases (ATPB)

These mixes generally consist of a uniformly-graded relatively large size aggregate and a paving grade asphalt. They are usually placed in the pavement section directly beneath the HMA surfacing to intercept water entering from the pavement surface. An alternative application is to place this permeable material near the subgrade surface to intercept water, which might enter the pavement from subsurface sources. Some evidence suggests that ATPB may not be as effective as originally envisioned when it was adopted by many state DOTs to reduce the effect of surface water infiltration on pavement performance. The reduced effectiveness may result from lack of maintenance of the necessary side drains required for proper functioning of the drainage layer and/or infiltration of fines from the untreated base and subbase layers caused by heavy traffic and lack of a suitable filter layer.

Pavement performance data linked with materials data have the potential to define the efficacy of the use of the ATPB. In addition to the usual type of performance information obtained for the PMS database, data records relative to the performance of side drains are extremely important and must be recorded.

For the materials database, mix design and construction QC/QA data are important. In addition, special design features such as the use of filter fabrics or soil filters should be recorded as well as the location of the ATPB.

## 10.3. Example Uses of PMS Data for PCC Pavements

PMS data can also be used for performance evaluation of PCC pavements and various design and construction characteristics [Dossey 94, McCullough 95]. In most state DOTs PCC pavements make up a small but very important portion of the pavement network. For purposes of evaluation, a separate PCC PMS data set may be desirable and is often maintained because design factors, distress types, and maintenance methods are different from A/C pavements.

### 10.3.1. Continuously Reinforced Concrete Pavements

The first example relates to the performance of continuously reinforced concrete pavements (CRCP). Many states have banned the use of CRCP but the poor performance blamed for this situation may be due more to bad construction than to the pavement type itself. A nationwide study of PMS data might clarify this situation.

For this study, it would be necessary to pull PMS data records of pavement sections by pavement type and to identify CRCP sections and examine their performance life. Construction records would then need to be obtained for all performing sections for analysis and comparison. TXDOT, as one example, already has set up a performance analysis database, which is maintained for concrete pavements. Other state DOTs could do the same.

### 10.3.2. Effect of Aggregate Type

Based on work done in Texas [Dossey 94, McCullough 95] it is now widely believed that aggregate type and its coefficient of expansion can have a major effect on concrete pavement distress and performance. In Texas, pavement built with siliceous gravel aggregates show earlier failure than those with limestone aggregates.

In this study it would be necessary to examine the PMS database and define aggregate in some way perhaps by coring for direct observations. A direct comparison could then be made of pavement serviceability and distress history as a function of aggregate type and other variables [Hankins 91].

### 10.3.3. Other Concrete Pavement Studies

Many other concrete pavement studies could also be made using the PMS database. The effect of joint and crack sealing could be examined by studying recorded maintenance history versus PMS distress history. The effect of load transfer could be examined by comparing roughness history for pavements with and without dowels or CTB bases.

Retrofitting of existing un-dowelled, plain, jointed concrete pavements with dowels (dowel-bar retrofit) is now underway in a number of states. The effectiveness of this technique on pavement performance can be accomplished in those states, e.g. Washington, with well established PMS databases.

These are just a few examples of the many possibilities to use this methodology. Apart from monitoring various materials for structural and functional treatments one might also consider the following categories:

- Different construction techniques for laying, compacting, recycling, etc.
- Different types of contracts with incentives, warranties, etc.
- Maintenance techniques, including preventive maintenance.