Lessons Learned During Implementation of Mechanistic-Empirical Pavement Design Guide

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Abstract

The purpose of this paper is to present the lessons learned during implementation of the MEPDG (Mechanistic-Empirical Pavement Design Guide) and to provide a detailed framework on how to validate the design guide using level 3 inputs. The performance models in the MEPDG were calibrated using Long Term Pavement Performance (LTPP) data from highway sections all over the United States. Therefore, the design guide with level 3 inputs must be validated for soil, environmental and traffic conditions typically observed in a specific region. In this study, accurate input and performance data from seven LTPP sections in the state of New Jersey was obtained. To ensure accurate data was used in the design guide, the data was collected from multiple sources, such as the as-built plans and NJDOT databases. A case-by-case comparison was conducted between predicted and measured performance data for every section and each distress, such as rutting, fatigue cracking, longitudinal cracking, transverse, cracking and roughness. The analysis determined the conditions where the level 3 inputs may not be appropriate. This step is critical before any state agency starts implementing the design guide. This paper provides the state agency with the tools and the knowledge needed to successfully implement the design guide. The framework will also serve as practical guide to state agencies and research institutions as the pavement community begins to adopt the new design guide.

Total words: 227

Keywords: validation, mechanistic-empirical, design guide, nationally calibrated, implementation

INTRODUCTION

Background

The design of new and rehabilitated pavements in the United States during the past 50 years has relied on sound empirical procedures that have been improved incrementally over time. However, those procedures have limitations because of their empirical nature. To overcome these limitations, further improvements depend on a new generation of design tools that combine the knowledge and experience gained from empirical procedures with the real-time effects of traffic loadings, environmental factors, and pavement materials.

In February 2004, a recommended mechanistic-empirical pavement design guide (MEPDG) (1) was delivered to NCHRP under Project 1-37A. A research version of the MEPDG and software (1) was distributed to interested users in the public and private sector in June of 2004. This research project provided a major advancement for pavement design and moved the pavement community from the existing empirical based procedures to M-E based procedures that combine the advantages of advanced analytical modeling capabilities and the field performance of in service pavements.
Problem Statement

Going to a mechanistic-empirical design process represents a huge paradigm shift for the majority of states, such as New Jersey. It will require tremendous amount of education, training, new testing equipment and requirements, and data collection (2). The state of New Jersey, one of the lead states in this effort, has taken the first critical step towards implementation by developing a catalog of pavement designs using the level 3 inputs of the MEPDG.

The ME Pavement design guide unlike the AASHTO 1993 has three levels of input. The input levels can be mixed and matched but the damage models remain the same, regardless of the input level. A three-tiered hierarchical approach to design inputs is used to provide designers with the flexibility of putting data into the design process depending on the resources warranted by the project under consideration. The level 3 inputs rely heavily on national and regional default values. If the local and regional values for a given state agency are not reasonably close to the default values, it may lead to grossly over designed or under designed pavement sections. This will lead to premature failure or uneconomical pavement design (1,2). Both of these cases can cause significant loss of resources. In addition, the level 3 inputs may not be applicable for all types of pavements and conditions. This makes it essential for state agencies to validate the level 3 inputs of the design guide before implementation. The process of validation becomes even more complicated because state agencies are accustomed to collecting data for AASHTO 1993 which requires only 5 flexible pavement inputs, as compared to more than 35 in the new design guide. The purpose of this paper is to present the lessons learned during implementation and provide a detailed framework on what steps should be taken to validate level 3 inputs a critical step to implement the design guide.

OBJECTIVE

The objectives of the paper are:

a. To present the findings of validation of the design guide using level 3 inputs,
b. To establish the conditions when the level 3 inputs may not be appropriate, and
c. To establish a process and present a framework to validate the design guide using level 3 inputs that can be incorporated by any state agency or research institution.

RESEARCH APPROACH

The following steps were taken to achieve the above stated objectives:

Task 1: Data Collection

To determine all available data needed in the design guide. Extensive data on pavement structure and materials of existing roadways were collected. The roadways were selected to encompass a broad range of traffic, soil, and environmental conditions in the state of New Jersey. In addition, field performance data of those roadways were also collected, such as rutting, cracking and roughness.
Task 2: Evaluating the accuracy of input and performance data

An extensive effort was conducted to obtain input and performance data from multiple sources to ensure accurate data are used in the design guide software. The data collected from different sources was critical in verifying the input and data before conducting an analysis using the design guide.

Task 3: Predicting performance using design guide software

Predict performance of all the sections using the design guide software after reasonably accurate input parameters were obtained.

Task 4: Comparing of the design life predictions and understanding the causes of differences

Compare the predicted performance to measured field performance. A significant effort was conducted to determine the cause of the differences. Some of the issues that were evaluated were a) variability in both input and measured data; b) discrepancies between default level 3 input and actual input data and c) uniqueness in the pavement structure or material properties that could cause the design guide software to predict inaccurate performance.

Task 5: Develop a framework for validation of level 3 inputs as a critical step towards implementing the design guide

In this task, the authors captured what they learned during the entire process of validation in the form of a framework. The framework is a step-by-step process of validating the design guide for level 3 inputs, a critical step towards implementing the design guide.

SIGNIFICANCE OF THIS STUDY TO RESEARCHERS AND PRACTITIONERS

A few state agencies, such as New Jersey have taken some steps towards implementation of design guide. This paper will provide the state agency with the tools and the knowledge to validate the design guide. These include methods to verify input and performance data, verify the level 3 inputs of the design guide for the region, and a process of analysis of data for each section and distress. This paper will also serve as a practical guide to the state agencies and the research institutions as the pavement community begins to adopt the new design guide.

STUDIES CONDUCTED ON MECHANISTIC EMPIRICAL DESIGN GUIDE SOFTWARE

The MEPDG has revolutionized the pavement design process by creating a user-oriented, comprehensive program that utilizes the mechanistic-empirical method. Many studies have been performed on myriad aspects of the current version of the Guide. The studies are summarized in TABLE 1 below along with a brief conclusion.

As listed in TABLE 1, several studies have focused on conducting sensitivity analyses of predictions on various input parameters, such as material properties and traffic and comparison
to laboratory data. These studies provide an invaluable insight into the design guide; it is of greater importance to determine whether the predictions compare reasonably well with field performance. An independent evaluation of the design guide is needed to verify the accuracy of the performance models. This study makes a concerted effort to evaluate the design guide predictions with respect to measured field data. This study highlights the limitations of the MEPDG, and provides an understanding of the risk associated with using the design guide.

**TABLE 1  Studies conducted on MEPDG software**

<table>
<thead>
<tr>
<th>Author</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robinette et al. (3)</td>
<td>The 1972 AASHTO Design Guide was evaluated using the MEPDG. Based on simulations conducted with the MEPDG software on the pavements tested, the AASHTO Design Guide appeared sufficient regarding permanent deformation.</td>
</tr>
<tr>
<td>Tran et al. (4)</td>
<td>The study indicated that state-specific class distribution in the traffic inputs had a significant effect on the prediction of pavement performance.</td>
</tr>
<tr>
<td>Zhang et al. (5)</td>
<td>This study analyzed the growth pattern of truck traffic volume, the impact of error in calculating growth rate on pavement response and developed a procedure to predict the growth rate of truck traffic.</td>
</tr>
<tr>
<td>Walubita et al. (6)</td>
<td>In this study, the laboratory rutting compared well with MEPDG performance predictions.</td>
</tr>
<tr>
<td>Kim et al (7)</td>
<td>This study evaluated the sensitivity of MEPDG input parameters to AC properties, traffic and climatic conditions. One of the studies main findings was that there were multiple ways of reducing distresses, unlike the AASHTO design procedure.</td>
</tr>
<tr>
<td>Zahgloul et al. (8)</td>
<td>The main finding of this study was that the impact of individual traffic of Level 1 could not be simply superimposed on level 3 input to reach the impact of Level 1 traffic.</td>
</tr>
</tbody>
</table>

**DATA**

**Input Parameters and Performance Data**

The level 3 design guide inputs requires the following: 1) general site information; 2) structural data; 3) material properties of each layer, such as gradation, Superpave volumetric properties, asphalt binder grade, soil type of substructure, and 4) Annual Average Daily Truck traffic volume, and growth rate. Default values were used for the remaining input parameters. However, as mentioned earlier, more detailed data could be used when it is available.

To validate the design guide, the research team also collected data on the following performance indicators: a) rutting b) cracking, which includes fatigue cracking, thermal cracking and longitudinal cracking and c) roughness, as measured by International Roughness Index (IRI). The research team obtained the pavement data of New Jersey roads from LTPP and the New Jersey databases, Highway Pavement Management Application (HPMA), and PaveView.
Databases

Long Term Pavement Performance Database

The research team decided to use LTPP sections because the design guide was calibrated using LTPP data and therefore was a logical place to start. They contain the most detailed and readily available data (categories are shown in TABLE 2). Only a small subset of the LTPP sections was used for calibration; therefore, it is necessary to analyze all the LTPP sections.

**TABLE 2 Input Data**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>LTPP</th>
<th>HPMA</th>
<th>Pave View</th>
<th>Hard Copy</th>
<th>State Agency Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Site Info</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Structure (AC)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure (below AC)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X (soil data)</td>
<td></td>
</tr>
<tr>
<td>Material properties</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Traffic / Growth rate and WIM Data</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Construction / Maintenance history</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PaveView and HPMA Database**

The state of New Jersey also has two databases within their Pavement Management System, PaveView and HPMA database (see TABLE 2 for datasets within each source of data). HPMA database is still in its infancy. It was primarily used as only a check to LTPP and PaveView databases. In addition, the research team obtained hardcopy (as-built plans) data available at the state agency. The authors utilized all the above sources of information to compare the necessary input and performance data. The team analyzed the LTPP sections for the following two conditions: 1) default truck distribution, and 2) actual truck distribution (shown in TABLE 3).

**TABLE 3 Data Sections Analyzed**

<table>
<thead>
<tr>
<th>LTPP Section</th>
<th>Route (MP)</th>
<th>Default Truck Distribution</th>
<th>Actual Truck Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1033</td>
<td>202S (4.1)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1034</td>
<td>55S (58.5)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1638</td>
<td>55N (57.5)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6057</td>
<td>95S (1.2)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>0508</td>
<td>195W (10.8)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1003</td>
<td>15N (10)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1031</td>
<td>55N (36.5)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
EVALUATION OF THE ACCURACY OF THE INPUT AND PERFORMANCE DATA

The accuracy of the predicted pavement distresses depends heavily on the accuracy of the input parameters. The first step towards validation is to compare the predicted performance to measured performance. The challenge, therefore, was not only to ensure the accuracy of the input parameters, but also of the field performance data.

Structural, Material and Pavement Performance Data

The structural and materials data was obtained from the following sources: LTPP, HPMA, PaveView, as-built plans, and from hardcopy records at the materials division. The performance data was obtained from LTPP, PaveView and HPMA. Collecting multiple sources, though time consuming, was a worthwhile effort in making sure the data is accurate. When there were inconsistencies, engineering judgment was used to ascertain the best possible value. The inconsistencies provided a good perspective to the authors and the state agency about the need to modify their data collection and storage capabilities in lieu of the increased data requirements in MEPDG.

Traffic Data and Growth Rate

Several studies have shown that in addition to the volume of traffic and the growth rate, the truck distribution has a tremendous influence on predicted pavement performance (4,5). The truck distribution was obtained from the Weigh-in-Motion (WIM) stations closest to the section evaluated and the two databases, PaveView and LTPP. The research team compared the data from the three datasets LTPP, PaveView and the WIM data obtained from the New Jersey Department of Transportation website. The truck growth rates and truck volumes were compared between the abovementioned sources to ensure accurate traffic data was used in the design guide software.

RESULTS AND ANALYSIS

For all the performance indicators discussed above, a detailed comparison was conducted between the measured and predicted performance for each of the sections. A thorough analysis was critical in determining whether level 3 was appropriate, and if so under which conditions. Considering the fact that measured data can have large variability, the research team made every effort to use multiple data within the vicinity of the point of consideration and more than one source because conclusions based on a single value and from one source could be very misleading.

In addition to comparing measured and predicted distresses, several checks for reasonableness were established such as 1) comparing measured distresses with appropriate treatments, for example if the distress reached a failure criterion, was it supported by evidence of some treatment; and 2) correlating various distresses, for example determining if increase in roughness was matched with other distresses. These checks provided an additional tool to verify the accuracy of the measured data. In this section, the results and analysis conducted using the design guide software is presented.
Rutting

Using the design guide software with level 3 inputs, rutting performance was predicted for the LTPP sections. The research team compared the predicted to measured rutting from two sources, LTPP and PaveView. The PaveView data contained rutting values within 100 ft of each other, therefore all the data within a half mile of the point of interest was considered as multiple measurements. These multiple measurements gave us insight into the variability in the measured data.

FIGURE 1 of section 6057 showed that the measured rutting was reasonably close to the predicted asphalt concrete layer rutting, and considerably lower than that of the predicted total rutting. The predicted rutting in the subgrade was high, which is counterintuitive because the pavement had been constructed 30 years back and an overlay was done relatively recently. A detailed explanation is provided in the Discussion section. On the other hand, the LTPP section 1034 (FIGURE 2) showed that rutting prediction was closer to the total rutting. The detailed explanation of the differences is outlined in the following section. In the interest of brevity, the rutting predictions of only two sections are shown. In all other LTPP sections, the measured rutting was close to asphalt concrete layer rutting only, similar to the LTPP section 6057 (9).

FIGURE 1 Rutting prediction for All Layers and Measured Rutting for Route I95 S (LTPP section 6057).
FIGURE 2 Rutting prediction for All Layers and Measured Rutting for Route 55S (LTPP section 1034).

Truck Distribution

In the design guide, either default level 3 inputs or site specific distribution of different classes of trucks can be used. For the first four sections, an analysis was conducted using the design guide software for both default and site specific truck distribution. The asphalt concrete rutting from the actual truck distribution matched the measured rutting reasonably well (FIGURE 3). The rutting from default truck distribution was clearly greater than that of the actual truck distribution. After the first four sections, it was clear that the default truck distribution was not appropriate for level 3 analysis in the state of New Jersey. Therefore, the subsequent analysis was conducted using site specific truck distribution only. The explanation for the difference is outlined in the Discussion section.
FIGURE 3 Rutting Prediction for Asphalt Concrete Layer for Default Truck Distribution and Actual Truck Distribution for Route 55N (LTPP Section 1638).

Cracking

In this paper three modes of cracking were investigated:

a. fatigue cracking: bottom-up load related cracking under the wheel path
b. longitudinal cracking: top-down thermal fatigue cracking
c. thermal cracking: top-down crack/ a cold-event transverse cracking

In each of the following sections, the measured distress, primarily from LTPP, was compared with predicted distress and every case was analyzed to understand the cause of differences.

Thermal Cracking

In all sections analyzed, the thermal cracking prediction was within 500 ft/mile of the measured values, a typical section 6057 is shown in FIGURE 4. A detailed explanation of the results is provided later.
Fatigue Cracking and Longitudinal Cracking

The measured and predicted fatigue cracking were within 30 percent of each other, a typical result is shown in FIGURE 5 for LTPP section 6057. The measured longitudinal cracking for all sections were also within 500 ft/mile of predicted longitudinal cracking (9), typical result is shown in FIGURE 6. The discussion regarding the accuracy of the predictions is provided in the following section.
Roughness

The International Roughness Index (IRI) is most commonly used to quantify roughness. The measured data was from two sources, LTPP and PaveView. In many cases, the default starting value IRI of 1 mm/km or 63 in/mile was lower than the IRI after several years in service. Therefore the focus was on comparing the rate of increase in IRI with time rather than the absolute value. The predicted rate of increase in IRI for the most part was slightly greater than that of measured (typical plot is illustrated in FIGURE 7). The explanation of these differences is discussed in the following section.

DISCUSSION

The objectives of the discussion section is to explain the cause of differences in predicted and measured performance and subsequently determine the conditions under which the design guide using level 3 inputs may not be appropriate for the state agency. In the following section each of the major performance parameters will be discussed, such as rutting, cracking, and roughness (IRI).
FIGURE 6  Measured and Predicted Longitudinal Cracking for Route 202S (LTPP section 1033).
Rutting

Subgrade rutting

In LTPP section 6057, an initial jump in rut depth of 0.1 inches or more in the first 24 months of pavement life in sub layers was observed. This is unusual, because the underlying pavement layers and subgrade have not been changed in over 30 years. Moreover, those underlying layers have been extensively compacted due to vehicular traffic; thus, the stiffness of those layers has increased. One would expect the initial rut depth in the subgrade for a new pavement, not one that has been compacted for over 30 years. The authors checked for errors in the material properties of all the unbound layers. After no errors were found in the input parameters and this trend was observed in six out of the seven sections analyzed, the research team investigated the rutting models of the unbound layers.

The authors found that the inaccurate rutting prediction is due to the error in the rutting model of the unbound layers. According to the design guide manual (10), the rut depth in the subgrade layer decreases as the subgrade resilient modulus decreases, this is counter intuitive. Modified models have been developed, but have not been incorporated.
The rutting predictions in the substructure were reasonably close to observed rutting (FIGURE 2) for pavement structures with new construction (defined as having no overlays). This was expected because significant compaction was observed in the thick sandy-silt base.

**Impact of truck distribution**

The predicted rutting with default truck distribution assumption was greater than that of predicted rutting with the actual truck distribution. The New Jersey Weigh-in-motion (NJ WIM) system which records traffic levels as well as the number of different classes of vehicles, showed that average distribution of Class 12 and class 13 was less than one percent. The default distribution, which is based on a nationwide default values, have a relatively high percentage (18%) of Class 12 and Class 13 trucks. This value is much higher than those observed in the state of New Jersey. The discrepancy in the volume of the heavy trucks explains the trend that the predicted rutting with default truck distribution was significantly greater than the measured rutting and the predicted rutting values with actual truck distribution were reasonably close to field rutting values.

**Cracking**

Cracking results were fairly accurate considering that there is significant error in performance prediction using level 3 inputs ([11](#)). The average error, as mentioned in the design guide manual, in transverse cracking prediction is 86.5% and standard error in longitudinal cracking prediction is 1245 ft/mi. For fatigue cracking the standard error was 12% ([11](#)).

In the LTPP section 1033 ([9](#)) a minor surface treatment (patching) was performed after the failure reached the criterion of 50% and immediately after that the measured value dropped. Therefore, this was a clear indication that the remedial actions were consistent with the measured performance. Correlating various distress increased confidence in the measured performance and hence also on the process of validation. Overall, considering that most of the predictions were done solely based on the binder grade, level 3 inputs have done reasonably well for cracking predictions.

**Roughness (IRI)**

Roughness is a very important performance indicator that the design guide can predict. The greatest deficiency of the IRI calculation is that the starting IRI (1mm/km or 63 in/mile) is inconsistent with measured. During the analysis, the researchers focused mainly on comparing the predicted rate of increase in IRI with the measured rate of increase in IRI values. The predicted rate of IRI increase for the most part was greater than the measured. A thorough investigation on the IRI prediction model was done to understand the cause of difference.

The IRI prediction model consists of various distresses depending on the type of pavement. For example, in hot mix asphalt overlays on flexible pavements, IRI depends on age, cracking (fatigue, transverse, and longitudinal), block cracking, patching and potholes ([12](#)). The two possible reasons for the difference in predicted and measured IRI are:

a. Age is weighted relatively high in the IRI prediction model ([12](#)) and
b. Patching and potholes are not predicted in the design guide but they are part of the model.
If there was patching done on the sections, the treatment would not be captured by the model and hence cause the age to significantly influence the IRI model. This would explain the higher predicted rate of increase in IRI as compared to the measured values.

In some cases, measured IRI were consistent with measured rutting for Route 15N and Route 202S (9). However, as mentioned earlier, the IRI prediction model for overlays on flexible pavements does not include rutting as one of the parameters. These trends clearly highlighted the possible limitations of the IRI prediction models.

LESSONS LEARNED

As the title of the paper mentions, the authors would like to share what they learned in this process. They are outlined in the following sections:

a. Communication between divisions within the state agency
b. Collect data from independent source whenever possible, and
c. Conduct case-by-case comparison of performance for all sections and distresses.

Communication between divisions within the state agency

The state agencies are not geared towards collecting the extensive data that is needed in the new design guide. The system has been set-up for the AASHTO 1993 guide. Therefore, all the data may not be readily available in one place. The research institution and agencies will have to coordinate the data collection activities between materials, pavements, traffic, and pavement management divisions. This may require a very supportive contact person within the state agency and to have a face-to-face confidence building measures with all stakeholders within the state agency.

Collect data from independent source

The research team made a concerted effort to independently verify every piece of information. This effort paid dividends because it gave the agency and the researcher a better understanding on how the data is collected, stored and interpreted. For example, the roughness values from the state agency database were different from that of LTPP. After several meetings with the agency, the difference was found to be due to different manufacturers of the profiler equipment. If there was a discrepancy in the input and the performance data, the research team used the best engineering judgment to select an appropriate value for validation.

Conduct case-by-case comparison of performance for all sections and distresses

The authors recommend that comparison of predicted and measured performance should be considered for all sections and distresses. Every effort should be made to determine the cause of difference by reviewing the assumptions, understanding the variability of the performance prediction models, and the variability in measured data and the input parameters. An assessment of each case will provide a thorough validation of the design guide.
FRAMEWORK

The authors learned a lot during the process of validation using design guide software which is in its beta version and where the stakeholders sill no got the full grasp of what is needed to successfully implement the design guide. The key is to move ahead with caution and to learn from others mistakes to avoid costly errors in the future. A framework, in a form of a step-by-step process (FIGURE 8) is established that captures the lessons learned. It will guide the state agencies and researchers when they are trying to implement the design guide.

SUMMARY

The summary of findings based on the analysis conducted is:
1. Multiple sources of information will help independently verify input parameters and performance data.
2. In the state of New Jersey, the predicted subgrade rutting was much higher than expected for overlays. Asphalt concrete rutting was used as total rutting for overlays.
3. The rutting predictions using default truck distribution is greater than the measured rutting for the state of New Jersey. The rutting predictions with actual truck distribution compared well with the measured rutting performance.
4. In the state of New Jersey, the fatigue, thermal and longitudinal cracking predictions compared well with the measured cracking performance.
5. The predicted rate of increase in IRI is greater than the measured rate of increase in IRI for the state of New Jersey.
6. The limitations of the performance models, such as rutting in unbound layers and IRI were investigated when the predicted values did not compare well with measured values.
7. A framework was established for the state agencies and the research institutions to follow as they take steps toward implementing the design guide.

CONCLUSIONS AND RECOMMENDATIONS

Based on the above summary, the following conclusions were made:
1. Default truck distribution was not appropriate for the state of New Jersey and it should be investigated for the respective state agencies.
2. The independent verification of the all the data was critical in ensuring accurate validation.
3. Understanding the outliers and the distress prediction models was critical in understanding the limitations of level 3 analyses using the design guide software.
4. Communication between the divisions of the state agency is essential for a successful implementation of the design guide.

The recommendation based on the findings and conclusions is that the state agency must proceed with the design guide with caution. The framework (FIGURE 8) outlined in this study, provides a step-by-step process of validation. This framework should be used by the state agency and the partnering research institution to validate and implement the design guide. This process also outlines methods on how to use all the tools available at the agencies disposal to minimize the risks associated with implementing the design guide.
Review the input parameters needed for level 3 design guide software.

Determine the performance indicators needed, such as rutting, cracking and roughness. Include the ones that are most predominant in the state.

Start with the LTPP sections within the state. Obtain all the necessary data from LTPP online database as well as from stand-alone version.

Collect similar data for the same sections from other sources, such as the agency pavement management system, hardcopy of as-built plans and the website.

Verify field performance data from independent sources—use all sources for validation.

Compare datasets, hash-out inconsistencies, document the cause of differences and select the appropriate value for the analysis in the design guide.

Verify traffic distribution and growth rate for each section with data from independent sources.

After confidence is established in all the input parameters and field performance data, conduct analysis using design guide software.

Avoid making generalizations until you have sufficient dataset to make that case.

Compare every predicted distress with measured field performance for all sections. Analyze all datasets and determine the cause of differences, if any.

Do not dismiss any outliers. They may provide critical information about the limitations of level 3 design guide.

For every distress mode determine the conditions, such as pavement structure, traffic or environment where the predictions do NOT compare reasonably well with the measured. For example, default truck distribution versus actual truck distribution and source of rutting (total versus asphalt concrete rutting).

Provide the state agency with the tools and the knowledge base needed for the successful implementation of the design guide.

FIGURE 8 Framework for implementing Level 3 Design Guide.

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responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the New Jersey Department of Transportation or the Federal Highway Administration.

REFERENCES


Appendix II: Calibration of Fatigue Cracking Models for Flexible Pavements

Appendix OO: Background and Preliminary Smoothness Prediction Models for Flexible Pavements