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Mechanistic-Empirical (M-E) Design Implementation & Monitoring for Flexible Pavements:

2018 PROJECT SUMMARY

Prepared By
Marshall R. Thompson
David L. Lippert

University of Illinois at Urbana-Champaign

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A report of the findings of

ICT PROJECT R27-149-1
Mechanistic-Empirical (M-E) Design Implementation & Monitoring for Flexible Pavements

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16. Abstract

This document is a summary of the tasks performed for Project ICT-R27-149-1.

Mechanistic-empirical (M-E)–based flexible pavement design concepts and procedures were previously developed in Illinois Cooperative Highway Research Program projects IHR-510, IHR-524, ICT- R28, and ICT-R27-060; and have been implemented by the Illinois Department of Transportation (IDOT). IDOT continues to support a variety of M-E flexible pavement analyses as well as design, implementation, and monitoring activities. The objective of Project ICT-R27-149-1 was for University of Illinois staff to continue to provide technical support and cooperate with IDOT in these activities. The cost savings (and probably reduced user delay time) from such designs will benefit IDOT, local roads agencies, and the travelling public.

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Members of the Technical Review panel were the following:

- Charles Wienrank, TRP Chair, Illinois Department of Transportation
- Dennis Bachman, Illinois Division, Federal Highway Administration
- Mike Brand, Illinois Department of Transportation
- Kevin Burke III, Illinois Asphalt Pavement Association
- Dean Mentjes, Illinois Division, Federal Highway Administration
- Dan Mlacnik, Illinois Department of Transportation
- Paul Niedernhofer, Illinois Department of Transportation
- Brian Pfeifer, Illinois Department of Transportation
- Tim Peters, Illinois Department of Transportation
- LaDonna Rowden, Illinois Department of Transportation
- John Senger, Illinois Department of Transportation
- Joseph Vespa, Illinois Department of Transportation
- Tom Winkelman, Illinois Department of Transportation

DISCLAIMER

EXECUTIVE SUMMARY

Mechanistic-Empirical (M-E) - based flexible pavement design concepts and procedures were developed in previous Illinois Cooperative Highway and Transportation Research Program (ICHTRP) projects and Illinois Center for Transportation (ICT) projects and have been implemented and updated by IDOT since the late 1980s. The Illinois Department of Transportation (IDOT) continues to support a variety of M-E flexible pavement analyses as well as design, implementation, and monitoring activities. The objective of ICT-R27-149-1 was for University of Illinois staff to continue to provide technical support and cooperate with IDOT in these activities. ICT R27-149-1 included the following tasks:

Task 1: Provide support and input to IDOT on special topics “as requested or needed.”

Task 2: Provide input regarding the revision/implementation of the Bureau of Local Roads and Streets (BLR&S) Flexible Pavement Design Procedures.

Task 3: Consider Increased Axle/Wheel Load Effects on Flexible Pavement Design and Performance.

Task 4: Evaluate new and developing flexible pavement technology that is applicable to IDOT conditions and practices.

Task 5: Collaborate with IDOT in reviewing and evaluating the Travel Speed Deflectometer (TSD) report and data from the pooled funds study.

The major project activities and accomplishments for the various tasks are summarized in this report. Project inputs concerning the various tasks were provided to IDOT via white papers, TRP meeting presentations, participation in IDOT committee meetings and working groups, e-mail memos, and telephone conversations.

CONTENTS

CHAPTER 1: INTRODUCTION

Mechanistic-Empirical (M-E) - based flexible pavement design concepts and procedures were first developed and implemented in the mid to late 1980s as the result of previous Illinois Cooperative Highway and Transportation Research Program (ICHTRP) Projects (IHR-510 and IHR-524). Since that time, the Illinois Department of Transportation (IDOT) has supported the monitoring, analysis, and implementation of updates to utilize the best available technology for pavement design ICT- R28 and ICT-R27-060 (Thompson & Al-Qadi 2014). IDOT continues to support a variety of M-E flexible pavement analyses as well as design, implementation, and monitoring activities. Many reports and white papers have been prepared in the various projects and provided to IDOT. The objective of ICT-R27-149-1 was for University of Illinois staff to continue to provide technical support and cooperate with IDOT in these activities. ICT R27-149-1 included the following tasks:

> **Task 1:** Provide support and input to IDOT on special topics "as requested or needed."
>
> **Task 2:** Provide input regarding the revision/implementation of the Bureau of Local Roads and Streets (BLR&S) Flexible Pavement Design Procedures.
>
> **Task 3:** Consider Increased Axle/Wheel Load Effects on Flexible Pavement Design and Performance.
>
> **Task 4:** Evaluate new and developing flexible pavement technology that is applicable to IDOT conditions and practices.
>
> **Task 5:** Collaborate with IDOT in reviewing and evaluating the Travel Speed Deflectometer (TSD) report and data from the pooled funds study.

The major project accomplishments for the various tasks are summarized in this report. Project inputs concerning the various tasks were provided to IDOT via white papers, TRP meeting presentations, participation in IDOT committee meetings and working groups, e-mail memos, and telephone conversations.

CHAPTER 2: TASK 1 ACTIVITIES

The goal of Task 1 was to provide support and input to IDOT on special topics as requested or needed.

Throughout the four-year duration of the project, prompt responses have been provided to IDOT on many issues. Some of the most common topics and inquires that were addressed are listed below:

- Analyzed and reviewed Falling Weight Deflectometer (FWD) data for many projects throughout the state (state & local roads projects).
- Determined permissible contact pressure for Material Transfer Devices.
- Reviewed cement-stabilized base reclamation projects (mixture design and thickness design).
- Reviewed and commented on BLR&S Special Provision for Pulverization - LR 400-8 (IDOT 2017).
- Provided inputs on various Portland Cement Concrete Pavement (PCCP) rubblization projects (state & local levels).
- Monitored the design-construction-performance of the Monticello Road rubblization project.
- Reviewed and commented on the “staged” HMA Overlay of rubblized PCCP on I-39 (North of Bloomington, IL).
- Participated in a review of the “construction problems” on IL 130 CIR with asphalt project.
- Provided input to Champaign County concerning Full-Depth-Reclamation (FDR) with cement project in Compromise Township – Champaign County.

CHAPTER 3: TASK 2 ACTIVITIES

The goal of Task 2 was the revision and implementation of the BLR&S flexible pavement design procedures.

One activity consisted of conducting technical evaluations related to the various thickness design issues. Another activity called for reviewing and providing feedback on the DRAFT versions related to the revision and implementation of Chapter 44 (Pavement Design) of the BLR&S Manual (IDOT 2012a). The revisions were specific to the period of FY15–FY18. Comprehensive inputs related to flexible pavements were provided. As a result, two major changes were implemented:

1) The design charts were modified and implemented based upon the revised HMA fatigue algorithm:

$$N = 8.2^{E-8} * \left[\left(\frac{1}{HMA\ Strain} \right)^{3.5} \right]$$

Where:

$N =$ Load repetitions to failure

HMA Strain is in engineering strain

2) The upper limit for CFP (Conventional Flexible Pavement) was increased to a TF of 0.5 (500,000 ESALS).

The project PI provided comments to the BLR&S Manual Update Committee for the Chapter 44 - Pavement Design update. A revised version of Chapter 44 of the LR&S Manual has been developed to replace the existing chapter (IDOT 2012). The update is pending as of the date of this publication.

CHAPTER 4: TASK 3 ACTIVITIES

The goal of Task 3 was to consider the increased axle and wheel load effects on flexible pavement design and performance.

The report on truck size and weight limit (USDOT 2015) was reviewed. Of particular interest was the impact of the proposed axle loading options on the structural response and performance of typical Illinois flexible pavement sections. The single trailer options were 80 & 88 kip dual-tandem axles and 91 & 97 kip tridem axles. ILLI-PAVE structural analyses were conducted for those axle loading conditions and for a standard 20-kip single axle. Two typical conventional flexible pavements: 1) 5.5-inch HMA surface + 8-inch granular base; and 2) 3-inch HMA surface + 8-inch granular base were analyzed. Eight, 10, & 12-inch Full-Depth HMA pavements were also analyzed. In all cases, the 20-kip single axle load was critical based on ILDOT HMA fatigue criteria. As expected, the increase in either dual-tandem or tridem axle loading resulted in a decreased HMA fatigue life.

The report on truck size and weight limits (USDOT 2016) was also reviewed. The summary indicated:

> “In many ways, this study produced more questions than it sought to answer. Another study effort, with more time and more money, would not at this point yield more reliable results. To make a genuine, measurable improvement in the knowledge needed for these study areas, a more robust study effort should start with the design of a research program that can establish data sources and models to advance the state of practice. Not all of this is within the purview or capacity of DOT. Even recent gains in long term reauthorization of transportation programs does not sufficiently advance the state of research and data to enable us to say when or even whether we will be in a position to collect and analyze better data and apply it to improved policy determinations and regulatory strategies.”

> “Changes made by congress regarding the size and weight of vehicles allowed on the Nation’s Interstate System are matters of policy. The work performed and the findings produced in this study can inform the debate on these manners, but do not provide definitive evidence or direction to support any specific new change of direction in the areas of truck size and weight limitations. This work has helped to identify the areas in which we are reminded that we need to know more, and that new technologies for data collection and sharing can offer us improved mechanisms for growing that knowledge.”

CHAPTER 5: TASK 4 ACTIVITIES

The goal of Task 4 was to monitor and evaluate new and developing flexible pavement technology that is applicable to IDOT conditions and practices.

Several issues were considered and various activities were pursued in Task 4. The ones that were of primary concern are discussed below.

5.1 FULL-DEPTH RECLAMATION WITH CEMENT

In previous ICT projects, University of Illinois (UIUC) project staff members worked with IDOT's BLR&S in the development of the Full-Depth-Reclamation with Asphalt Products (FDRwAP) specifications, policies, and procedures. It became apparent that BLR&S also needed to develop specifications, policies, and procedures for Full-Depth Reclamation with Cement (FDRC). In this project, the project staff provided extensive support to advance that effort. As a result, significant activities were undertaken and inputs provided (as summarized below).

On November 9, 2017 the project PI participated in the FDRC working group meeting chaired by IDOT's Bureau of Materials Jim Krstulovich. The goal of the meeting was to develop a special provision for utilizing cement-slurry in FDRC stabilization construction. Cement-slurry will likely be an option for spreading cement in an FDRC specification.

An important first effort was the evaluation of five Jasper Co. FDRC projects. Jasper County has constructed eleven FDRC projects in recent years and they have performed very well. The construction dates for the sections ranged from 2003 to 2014. The FDRC thickness was 8 inches and the cement content was 8 to 9% with an A-2 surface treatment. The mixtures met the strength requirement (500 psi @ 7-day curing) of IDOT specifications Section 352, Soil-Cement Base Course (IDOT 2016). All of the sections were in very good shape with no indications of fatigue cracking. IDOT's Bureau of Materials and Physical Research (BMPR) conducted FWD testing (9-kip load) on the projects. There were no visible cracks noted for three of the projects and the load transfer efficiencies for other the two projects were 78% and 80%, which is considered very good. The back-calculated compressive 2014 strengths ranged from 800 psi to 1265 psi. The maximum 9-kip deflections ranged from 7.5 mils to 16.9 mils and the Coefficients of Variation (COV) ranged from 28% to 50%. The largest COVs were for the older sections.

A series of comprehensive analyses were conducted for the FWD data collected by IDOT's BM&PR for the Jasper Co. projects. The FWD data and project performance were considered relative to various thickness design procedures. The Meyerhof Ultimate Load and the UIUC/IDOT High Strength Stabilized Base (HSSB) Mechanistic-Empirical (M-E) design approaches appear promising. The selection of the Soil-Cement Fatigue algorithm is very important for M-E design. An Austroads summary of their comprehensive data fatigue information (Alderson and Jameson 2014) suggested that lab-based fatigue testing for a specific project is the best approach, but also acknowledged that lab testing is not always practical. This is especially relevant for small projects with limited funding.

Fatigue data information, such as those noted, continue to be collected from various publications and sources as part of this study effort and incorporated into the Project Fatigue Summary.

Construction site visits were conducted for additional FDRC projects to better characterize the structural response and performance of FDRC pavements. In recent years, several FDRC projects have been constructed utilizing a 300 psi strength requirement (not included in any IDOT specification). Some of the 300 psi projects were also monitored.

The pertinent information regarding the monitored FDRC projects is summarized below.

- Coles County FDRC - CH-28 NE of Mattoon – east of I-57

    - The project (constructed in the summer of 2015) is a 10-inch 8% cement-modified base section with an A-2 surface treatment. In some locations, the treated section extends a few inches into the subgrade. This project is of interest since the 7-day lab-cured compressive strengths were not adequate enough to attain IDOT's stabilized base criterion of 500 psi, but it did meet the Portland Cement Association's (PCA's) recommended 300 psi criterion. Follow-up FWD testing was requested from IDOT's BM&PR. The section was periodically monitored by Thompson.

    - In the summer of 2016, the project's principle investigator (PI) conducted a project site visit. It was noted that no rutting (due to the project having an A-2 surface treatment) and limited transverse shrinkage cracking was noted.

    - The project (constructed in 2015 with an asphalt surface treatment) was surfaced with a thin HMA lift in 2016. Many of the previously developed shrinkage cracks had already reflected through the HMA surface.

- The FWD data for CH 28 Coles County and Compromise Township in Champaign County has been reviewed and analyzed. The FWD data for Coles Co. indicates that the cement-treated base shows structural responses (max deflection / AUPP) characteristic of a High Strength Stabilized Base with an estimated compressive strength of 600 psi. This section has developed characteristics of transverse shrinkage cracking. The FWD data for the Compromise Township project indicates that a low-level of stabilization (typical modulus of ~ 100 ksi) has been achieved, but the pavement responses are superior to a conventional flexible pavement.

- The PI conducted a site visit of the UIUC St. Mary's Road FDRC project. The project (constructed in 2012) is a 12-inch soil-cement base course with a 4-inch HMA surface. The field-mixed material did not achieve the 500 psi strength requirement of the IDOT Section 352 specification. The roadway width is only 20 feet and has a center-line stripe. There was significant edge cracking and some limited transverse cracking has also developed. Several areas where edge cracking has occurred have been repaired with full-depth Portland cement concrete (PCC). It is suggested that the center-line striping has contributed to the edge cracking.

- The PI conducted a site visit of the Champaign County - Compromise Township (one mile long / TR 2800 [TR2000E – TR 2100E]) FDRC project. The section (constructed in late summer of 2015) is a 12-inch cement-stabilized base with an A-2 surface treatment. The cement content was ~ 6% by weight. The project is in excellent condition with no signs of distress. The FWD data (9-kip load) for Compromise Township-Champaign County were reviewed/analyzed. The section has developed characteristic transverse shrinkage cracking. The FWD data for the Compromise project indicate a “low-level” of stabilization (typical modulus of ~ 100 ksi) has been achieved, but the pavement responses are superior to that of a conventional flexible pavement.

- The pavement design for the Algonquin, IL FDRC experimental feature project was reviewed. The pavement has very limited traffic because it serves a cul-de-sac area. The pavement design is 4.25 inches of HMA surface/binder and a 10-inch FDRC (5.5% cement) base.

- Two FDRC projects were identified as being of particular interest.

    - The first project of interest was Grundy County – Livingston Road. The existing pavement was 4-inches of HMA + 15 inches of crushed stone base. The mixture design criteria (7-day curing) were 500 psi and 350 psi vacuum saturation strength. The mixture design was 6% cement. The FDRC pavement section was a 12-inch FDR layer + an A-2 surface treatment. (NOTE: The FDR layer was profile-milled prior to surface treatment placement). The FDR layer was micro-cracked two days after construction. FWD testing was conducted immediately prior to and immediately following the micro-cracking process, and then again following 7-days of curing. The data indicated that damage was inflicted by the micro-cracking and that subsequent healing (gain in strength and modulus) was achieved with the additional curing. Studies have indicated that micro-cracking reduces the development of subsequent transverse shrinkage cracking.

    - The second project of interest was Grundy County, Nettle Creek Township – LaSalle Road. The existing pavement is rather non-uniform. The surface is ~ 1-inch of oil & chip with either a ~ 6-inch cemented base course (north bound) or 13-24 inches of cemented base + granular (south bound). JOLENA (a blend of 50% cement + 50% Type C fly ash) was used as a stabilizer. The mix design criteria were a 7-day compressive strength of 300 psi and a vacuum saturation strength of 250 psi. The mix design was 10% JOLENA. The FDR pavement section is 10-inches of FDRC and an A-2 surface treatment. The section was profile-milled prior to the construction of the A-2 surface.

5.2 SURFACE COURSES FOR CIR/FDR CONSTRUCTION

Per IDOT’s Bureau of Local Roads & Streets Manual -Chapter 46, (IDOT 2012c) Cold-In-Place Recycling (CIR) with asphalt products (emulsion or foam) is limited to a thickness of 2–6 inches. Full-Depth Recycling (FDR) with asphalt products is limited to a maximum 10-inch depth.

Per Section 46-6 - Flexible Pavement In-Place Recycling, a structural pavement design is not required for CIR/FDR projects if the Structural Number (SN) of the CIR/FDR pavement section is larger than the required SN and a Hot-Mix-Asphalt (HMA) overlay is not required. However, a surface treatment, whether micro-surfacing or cape seal, is required. If the SN of the CIR/FDR pavement section is less than the required SN, both a structural pavement design and an HMA overlay are required.

Section 46-4, which covers the Local Agency Structural Overlay (LASO) policy, provides the HMA overlay minimum thickness and material requirements [Section 46-02(j)] based on the required SN of the pavement section. The requirements range from 2 inches for SN < 2.5 to 4 inches for SN > 3.5.

The Basic Asphalt Recycling Manual (BARM) recommends a wearing surface for low traffic volumes, and a minimum HMAO of 1 to 1.5 inches for higher traffic volumes (ARRA/FHWA, 2001). The 2nd BARM edition (ARRA/FHWA, 2015) offers similar advice, but does not recommend HMAO thicknesses. The Wirtgen Cold Recycling Technology Manual's 1st Edition (Wirtgen GmbH, 2012) indicates that surface treatments are sufficient for traffic levels < 3 Million Equivalent Single Axle Loads (MESALs).

In Illinois, surface treatments such as micro-surfacing and cape seals (an A-1 Surface treatment topped with a micro-surfacing) have provided satisfactory performance in many CIR/FDR projects. However, there are some projects where these thin/non-structural surface courses have not performed well.

The Tennessee Black Top (Class III Road) in McDonough County (6-inch CIR with an A-2 surface treatment) constructed in 2014 is an example of this. Some significant rutting (the average rut depths range from 0.25–0.34 inches based on limited measurements) has developed and some limited patching has been required. Signs that say "PAVEMENT HOLDS WATER" are posted on the project.

A recent project (August 2017) in Fulton County is a Class III road (20-year TF of ~ 0.28/ 280,000 ESALs). The CIR thickness is 4 inches and the surface course is a cape seal. This project merits follow-up monitoring. No problems have been reported for previous cape seal projects.

It would be prudent/desirable to develop some guidelines for selecting an appropriate surface course (surface treatment, micro-surface, cape seal, or HMA overlay) for CIR and FDR projects. Traffic factor, road class, and SN are potential parameters to consider.

Local agencies have successfully (in most projects) utilized the various surface course types. It is proposed that BLR&S conduct a survey to collect data that can be used to establish the guidelines. Significant performance parameters would include rutting, roughness, raveling/weathering, and other various surface distresses.

5.3 FHWA - REMAINING STRUCTURAL PERIOD (RSP) AND REMAINING FUNCTIONAL PERIOD (RFP)

Baladi et al. 2016 proposed several key concepts.

RSP was defined as: "the shortest time period years in years from the time of data collection to the time when a structural distress reaches its corresponding threshold value."

For flexible pavements, it is recommended that two or more RSP values should be calculated when considering transverse, longitudinal, alligator, edge, and block cracking. However, only one RSP value is needed for calculating rut depth.

RFP was defined as: "the shortest time period years in years from the time of data collection to the time when a functional condition (e.g. IRI, rut depth or other) reaches its corresponding threshold value."

A recent (May- 2017) FHWA publication brought about a complete rule-making set of metric thresholds for pavement performance. For flexible pavements, the metrics are IRI, cracking, and rutting (FHWA 2017).The metrics differ for "Good," "Fair" and "Poor" pavements as shown in the table below. Good condition suggests that no major investment is needed and Poor condition suggests that major reconstruction investment is needed.

Rating	**Good**	**Fair**	**Poor**
IRI (inches/mile)	<95	95-170	>170
Cracking (%)	<5	5-20	>20
Rutting (inches)	< 0.2	0.2-0.4	>0.4

The FHWA performance metrics went into effect in January of 2018. The ability to predict future flexible pavement performance is an important component of the program. IRI and rutting predictions are typically considered based on algorithms developed from historical data. The current technology for predicting RSP (remaining life of HMA pavement layers) is not very robust. The "errors of estimate" associated with RSP are typically quite large. FHWA continues to pursue R&D activities in this area. The project PI constantly reviews/evaluates this very important technology.

Recent FHWA and other publications concerning "HMA Remaining Life" and the concept of Remaining Functional Period (RFP) and Remaining Structural Period (RSP) continue to be reviewed. The FHWA draft report "Characterizing Existing Asphalt Concrete Layer Damage for Mechanistic Pavement Rehabilitation Design" was reviewed and comments were provided to FHWA by the project PI. The concept of utilizing the ratio of FWD calculated HMA modulus for the outside wheel path to the "undamaged modulus" (as determined from lab data or back-calculated from the FWD data for the "mid-lane" location) did not successfully characterize HMA fatigue damage. The final report has yet to be published by FHWA.

5.4 MACOMB BY-PASS (US 67)-MOBA PAVE-IR / GPR STUDY

For paving on HMA layer thicknesses < 10 inches, current IDOT Material Transfer Device (MTD) specs limit MTD surface contact pressure to =/< 25 psi. (NOTE: ICT Project R27-149-1 has contributed to the development of MTD track pressure criteria). The tracked Terex/Cedar Rapids MTD meets the 25 psi criterion and remixing capability. The VOGELE MT 300-2 MTD series meets the 25 psi criterion. However, its remixing capability to reduce/eliminate mixture segregation is an issue of interest to IDOT.

IDOT has a MOBA PAVE-IR and cooperates with the Illinois Asphalt Pavement Association (IAPA) in utilizing the device. HMA mat temperature differentials, which can be detected by the MOBA PAVE-IR, are indicative of HMA segregation. HMA density has traditionally been considered as an indicator of HMA segregation.

The paving process for the United Contractor's Midwest (UCM) Macomb By-Pass (US 67) Full-Depth HMA project was initiated in 2016. IDOT installed the MOBA PAVE-IR on a UCM paver. The VOGELE MT 300-2 MTD and the Terex/Cedar Rapids MTD were utilized. Thus, the comparative HMA mat temperature data were available.

Ground Penetrating Radar (GPR) equipment was available at Illinois Center for Transportation (ICT). Dr. Al-Qadi and his ICT colleagues have developed and validated procedures for estimating HMA density and HMA layer thickness from the GPR data.

The project staff proposed to conduct GPR testing on selected HMA lifts on the Macomb By-Pass. The GPR data was to be used to supplement and enhance IDOT's MOBA PAVE-IR data and contribute to the evaluation of the VOGELE MTD. (NOTE: Jim Trepanier and Tom Zehr from IDOT's BM&PR had previously expressed their interest in the GPR testing procedure).

Extensive GPR data were obtained with Advanced Transportation Research and Engineering Laboratory (ATREL) GPR equipment for the VOGELE and the IDOT approved Cedar Rapids-BOMAG MTDs. GPR estimated density data were forwarded to IDOT (Brian Hill). Based on the Macomb database, IDOT subsequently approved the use of the VOGELE MTD (MT 3000-2i).

5.5 ADDITIONAL ACTIVITIES

- The 2017 FWD data for the Monticello Road rubblization project were reviewed and analyzed. The estimated HMA strain (from the AUPP term) for the 87°F HMA at the time of FWD testing was 89 micro-strain. The Design Time HMA pavement temperature for the project is 72°F (less than the FWD test temperature). The HMA strain for 72°F would be considerably less than the 89 micro-strain resulting in a longer anticipated HMA fatigue life.

- In a previous project (Thompson et al. 2009); the PI participated in the IDOT BLR&S CIRWAP (Cold In-Place Recycling with Asphalt Products) working group that developed the relevant mix design and construction specifications and procedures. The specifications and procedures were published by IDOT BLR&S on April 1, 2012 (IDOT 2012b). Thompson continues to review and evaluate CIRWAP research & development activities as well as to observe CIRWAP project construction and performance.

- Many project sites were visited that are of particular significance relative to flexible pavement design and performance. The pertinent information from these site visits was presented at TRP meetings.

- The project research team participated in IDOT's Pavement Management Workshop (9-9-16).

- The project PI participated in the following Webinars:

    - TRB – "Use of Traffic-Speed Deflection devices in Network-Level Pavement Management Applications (6-8-17)

    - TRB - "Flexible pavement Rehabilitation, Looking Back, Looking Forward" (7-2017)

    - American Concrete Pavement Association/International Society Concrete Pavements – "Concrete Pavements designed and Constructed Over In-Situ Full-Depth Reclamation (FDR) with Cement" (3-2017).

    - TRB - Truck Size and Weight Limits Research Plan Committee" (1-2018)

CHAPTER 6: TASK 5 ACTIVITIES

The goal of Task 5 was to review and evaluate the Travel Speed Deflectometer (TSD).

The project PI cooperated with IDOT in the FHWA Pooled Funds Travel Speed Deflectometer (TSD) study. TSD testing was conducted in 2014 and 2015. The Greenwood TSD was employed in the testing program. The TSD outputs of interest in this project were the surface deflections and various offsets. Report data for the flexible pavement projects (mostly full-depth HMA pavements and rubblized PCCP + HMAO) were reviewed and the feedback was submitted to IDOT.

Typical results were presented at the 3-27-2015 TRP meeting. Maximum deflection data appeared to be reasonable, but the AUPP values were not compatible to those obtained from FWD data. It was noted that some of the de-noised data resulted in negative deflections.

The Illinois TSD “Draft Final Report” was reviewed and comments submitted to the TRP Chair.

The TSD Pooled Funds Study “Draft Final Report” was reviewed and the feedback was submitted to the TRP Chair.

The consensus concerning TSD testing is that it is useful for system level activities, but at this time is not well suited for project level analysis activities.

The Greenwood analysis procedure is started at the “max deflection” and works “outward” toward larger offsets. This sometimes results in “negative deflections” at the 36-inch offset. In contrast, the Australian Road Research Board (ARRB) procedure is started at a remote offset (assumes a 0 deflection) and proceeds toward the max deflection (0 offset). The ARRB Group is now offering data analysis services for computing surface deflections. Thus, negative deflections are not achieved. The ARRB Group indicates:

“Using ARRB models, the Hawkeye software uses the TSD data to produce deflection basins comparable to FWD outputs.”

Other TSD equipment /procedures are currently being developed. Dynatest has a new TSD device (RAPTOR) that will be available in 2018. Dynatest has also developed software for utilizing RAPTOR data to calculate surface deflections (preliminary results are encouraging).

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