

TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): IOWA DOT

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # TPF-5(300)	Transportation Pooled Fund Program - Report Period: Quarter 1 (January 1 – March 31, 2016) Quarter 2 (April 1 – June 30, 2016) Quarter 3 (July 1 – September 30, 2016) <input checked="" type="checkbox"/> Quarter 4 (October 1 – December 31, 2016)	
Project Title: Performance and Load Response of Rigid Pavement Systems		
Project Manager: Brian Worrel	Phone: 239-1471	E-mail: brian.worrel@dot.iowa.gov
Project Investigator: Peter Taylor	Phone: 515-294-9333	E-mail: ptaylor@iastate.edu
Lead Agency Project ID:	Other Project ID (i.e., contract #): Addendum 504	Project Start Date: 5/29/14
Original Project End Date: 5/31/2017	Current Project End Date: 5/31/2019	Number of Extensions: PFS

Project schedule status:

On schedule
 On revised schedule
 Ahead of schedule
 Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Total Percentage of Work Completed
\$1,263,917.00	\$530,347.24	47%

Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
\$47,127.43	\$47,127.43	5%

Project Description:

The modern approach to highway design is embodied in the Mechanistic-Empirical Pavement Design Guide (MEPDG), which incorporates models embedded in dedicated software, such as AASHTOWare Pavement ME Design, to predict pavement performance in greater detail than before. Full implementation of the MEPDG by state departments of transportation requires customizing or calibrating the software to state and local conditions, which in turn requires collecting data on climate, material properties, load response, and pavement performance.

The MEPDG software uses these data inputs to more accurately simulate the load response of pavements and long-term pavement performance. Local calibration of the software involves comparing long-term performance simulation results to actual performance data at local sites if possible or from matching pavements in the LTPP database. New York is one of the states that have previously instrumented test pavement sections to acquire local data to improve calibration of the MEPDG software. The installed sensors are still functioning to an extent that permits collection of additional useful data. This project has these objectives:

- Collecting load response and performance data and environmental monitoring at selected test pavements in New York for four years.
- Installing new instrumented sections as needed for a better understanding of rigid pavement response, including monitoring for the duration of the project.
- Determining the impact of a base on long-term performance of rigid pavement utilizing the data acquired in fulfilling the first two objectives and other nationally available data on the topic.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

NYSDOT priority task list:

- Task 1. Develop relationships between PCC slab thickness and pavement performance
- Task 2. FWD Analysis Procedures

Work for the NYSDOT is progressing on several points.

The MEPDG pavement design catalog tables have been completed. A report has been written and it is currently being edited and finalized.

Information is being gathered to create an example to demonstrate the use of the overlay design software using an excel spreadsheet that implements the AASHTO 93 design method. In the meantime the research team will also explore the feasibility of using the MEPDG program to design overlays in New York.

NYDOT personnel have received the keys for the pull box on Route 9A in New York City. As weather permits, a trip will be scheduled to pull wires and install the data acquisition system.

There was a meeting at Iowa State University on December 6 with Iowa DOT and NYSDOT to explain the progress on the pooled fund study. A brief PowerPoint presentation was made to summarize progress to date.

Anticipated work next quarter:

- Complete draft report on the PCC design catalog with the new design tables for NYSDOT regions.

- A one week trip to the I90 and I490 projects. During those site visits FWD data will be collected in addition to the sensor data and distress surveys. If possible, dynamic truck runs will be conducted on the I90 project.
- Collect core specimens from unbonded overlay on I86 in Olean to examine condition of bondbreaker.
- Visit to RT9A site to complete site work that could not be completed in the last visit.
- Begin analysis of FWD data once they have been provided to the research team

Significant Results:

Circumstances affecting project or budget (Describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope, and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

The release of Version 2.3 of the AASHTOWare Pavement-ME software is imminent. It will be installed when it is provided to the researchers. The results generated with Version 2.1 of the software need to be validated using the newest version as the calibration coefficients have been changed.

**Performance and Load Response of Rigid Pavement Systems
TAC Meeting
Meeting Minutes
December 6, 2016**

Attendees:

Randy Riley, Illinois ACPA

Tom Burnham, MnDOT

Wes Yang NY DOT

Jeff Roesler, University of Illinois

Chris Brakke, Iowa DOT

Dr. Shad Sargand, Ohio Research Institute for Transportation and the Environment

Roger Green, Ohio DOT

Gordon Smith, ICPA

Peter Taylor, CP Tech Center

Tom Cackler, CP Tech Center

Dale Harrington, CP Tech Center

Melisse Leopold, CP Tech Center

- Tom Cackler opened the TAC meeting for the Performance and Load Response of Rigid Pavement Systems TPR-5(300) project.
- Tom stated the project has been going for 2 years.
- Shad Sargand stated that unbounded overlays are a portion of the project.

Shad discussed his presentation:

- Shad went over the objectives for the project.
 - Collect load response and performance data and environmental monitoring at selected test pavements in New York for four years.
 - Install new instrumented sections as needed for a better understanding of rigid pavement response, including monitoring for the duration of the project.
 - Determine the impact of a base on long-term performance of rigid pavement utilizing the data acquired in fulfilling the first two objectives and other nationally available data on the topic.
 - Develop a rational overlay design procedure and software for concrete pavements, utilizing FWD test data, and a procedure for determining
 - 1) the mechanical properties of the existing pavement and a suitable model to allow a mechanistic based analysis of the proposed concrete overlay and
 - 2) the effective thickness of the existing flexible, concrete, or composite pavement for use in the United States Army Corps of Engineers (USACE) unbonded concrete overlay design equation.
 - Existing models will be located, analyzed, validated, and if needed, modified, or new models developed.
 -

Shad reviewed the projects in New York State:

- I-86 Olean: unbonded concrete overlay
 - Interstate with heavy traffic. Premature failure; the unbounded may not have caused the stresses. Slag cement and slag aggregate in cold weather caused cracks.

- Three rehab techniques used:
 - UBCO over rubblized JRC
 - UBCO over cracked & sealed JRC
 - UBCO over Untreated JRC
- Slab dimensions: 3.66 m wide x 4.75 m long (12 ft x 15.6 ft)
- The overlays were 9 inches.
- Doweled joints for UBCO.
- Tie bars along longitudinal joints.
- They have all the data of each layer.
- Multiple head breaker used for rubblizing .
- Shad reviewed the Distress Survey:
 - No major distresses were observed during surveys performed since Oct 2008 through June 2016.
 - Distresses observed during survey were primarily spalling of the special joints, with corner breaks and edge breaks.
 - Minor mid panel cracks were observed in all sections.
 - Hairline cracks observed at the location of the tie bars in all sections.
 - Cracks started on the tie bar locations and propagated through the width of the slabs in the driving lane.
 - Cracks are believed to be top-down
 - Untreated section presented the most cracked slabs followed by the rubblized section.
 - Asphalt bond breaker was 3 inches as a way to give the water ability so the pressure does not build up and the pavement performs better.
 - Need a solution to get the water out. More an issue with the thinner layer of bond breaker.
 - May use an interlayer with the asphalt bond breaker so it is not as thick.
 - Shad looked under a full slab and saw the water; center of the slab the asphalt was fully bonded with the concrete. At the joints the concrete overlay was not bonded to the asphalt. Shad did not see reflective cracks.
 - In the future Randy Riley suggested the geotextile at the surface to get rid of the water; geotextile to help with the drainage. Run it in under drains.
 - Mid-Panel cracks were 5% crack & seat, 5% rubblized and 90% untreated. The committee asked how 90% mid panel cracks could happen with the untreated section since we do not see that on normal projects.
 - Hairline Cracks at tie bar locations; on top of the tie bars (epoxy coated). The cracks were scattered through the project. 40% Crack and seat, 50% rubblized and 90% untreated.
 - They have seen issues with big machines with dowel bar inserters; see horizontal crack and on top of the dowel bar they see longitudinal cracks. You see segregation. Unbonded is more effective. Hard to stabilize basket on the concrete.

- Using 1 ½ inch dowel bar. Randy suggested 1 inch dowel bar to help with the segregation.
 - Suggested to look at the condition of joints; look at load transfer and deflection
 - Jeff Roesler stated using no dowels may help.
 - Randy Riley stated with thin you get slab creep (bonded concrete on asphalt sections). Faulting down below. Would rather see geotextile. Shad said the problem is in the subbase layers. Need to see what is under the concrete.
 - Shad stated we need to calculate environmental issues and calculate the stresses and apply the load. There is not a problem with the strength of the concrete; we need to look at the environmental factor.
 - Shad stated they will study the finite element with the field work and draw a conclusion for the report.
 - Randy Riley stated, Industry is using structural synthetic fibers.
 - Shad stated if you rubblize without asphalt interlayer you will have water problems.
 - 90% of the untreated had mid panel cracking. The cracks are fine but not breaking down. The sections are about 8 years old. It may perform well but if you went a shorter joint spacing you might not have the cracking.
 - Shad stated because of the stiffness of the untreated are resulting in the mid panel cracking. With a thick interlayer you still see hardness. Need to look at what was the condition beneath the 9 inch overlay.
 - It was mentioned that not compacting the interlayer may be an issue or construction problem.
 - It appears the more deflection the less cracking. The joints are doweled and the mid is not doweled. Shad stated New York DOT gave the numbers for the report to him. It has permeable base. Shad stated once the report is complete it will explain what it happening.
- Tom Cackler explained outcome of the meeting:
 - Go over the work done
 - Key findings
 - Get feedback from the TAC
 - Overlay design – what’s the approach, plan and gaps. Get the TAC input on this work.
- Shad reviewed the I-90 Syracuse project (base selection)
 - Full Depth Reconstruction of I-90 West of Syracuse
 - Section 2 uses the standard NY State Design permeable base
 - Section 1 modified to use a Dense graded aggregate base
 - Placed in 2009. Strain gages monitored since then
 - Data collection in 2010, 2012 and 2015 (lane closure limitations)
 - FWD test results were done in 2015.
 - FDR of I-90 west of Syracuse
 - Drainage – both with edge drains
 - Moisture not much difference between the two
 - Not much problem with the drainage
 - No major distress were recorded with either section
 - Could save a lot of money using the crushed stone
 - Compacted subgrades; no interlayers

- Rt 9A Manhattan – heavy load effects
 - Test section in proximity to Freedom Tower location
 - Section instrumented to monitor effects of heavy load
 - Initial data collection in 2008
 - Traffic restrictions have not allowed subsequent data monitoring
 - Subgrade manufacture aggregate, light weight
 - Traffic restrictions have not allowed subsequent data monitoring
 - New data collection installed in 2016
 - Field trip in May 2016 to reroute wires into new cabinet
 - Wire rerouting to be completed later this year due to contractor restrictions

- I-490 Rochester –dowel bar and tie bar configurations
 - I-490 is approximately 10 miles south-east of Rochester NY (Victor NY)
 - East bound lanes placed in 1999 to study the effects of varying dowel bar configurations
 - West bound test sections were placed in 2000 to monitor the standard NY PCC design
 - Concrete was finished with a carpet. (PCC was not grooved)
 - FWD data and forensic investigation conducted regularly since 1999.
 - Last data collection trip in 2015
 - All section are performing well
 - No major distresses
 - Some corner breaks were seen in the west bound lanes.
 - Minor cracks and polishing seen on the east bound lanes

- MEPDG Design Catalog – Final version is almost done. Both AASHTO with Mechanistic
 - Using AASHTO developing a catalogue using MEPDG Design
 - Separated New York into four zones environmentally
 - Ran the software to develop the catalog
 - Should have data in 3 to 4 months
 - Shad will share the research reports with the TAC

- Jeff Roesler found unreliable predictions with the climate on the MEPDG.
- Shad stated the new version is much better.
- Shad stated that 90% of the cracking is mainly top down cracking.
- Shad stated top down or bottom up there are different ways to solve the cracking problem.
- Shad stresses due to traffic is not very large; we need to look at the environment.
- Randy Riley stated how can you add to the work that has already been done to help. Climate is always a factor.
- Wes Yang stated they are happy with the program.
- Chris is going the AASHTO meeting next week and they want him to give an update on this program. Chris asked Shad for any information he would like to give to the group. Shad will send something to Chris this week.

Overlay Design Procedures

- Tom Cackler stated the existing Guide to the Design of Concrete Overlay Methodologies was published in 2012. Dale stated it is out of date.
- Tom stated we need to identify the needs and approach.

- Shad:
 - Look what is cause of early distresses in the unbonded overlay and identify the factors that are giving a problem.
 - Think it is the unbonded overlay causing problem.
 - Loss of support and disintegration of the bond breaker.
 - Need to look in the field to see what is going on to see what is the cause.
 - May be able to change the metrics to solve some of the problems.
 - May need to build a test section; approach it in the field.
 - Had the specimen tested in New York with a mobile lab instead of bringing it to Ohio.
 - Don't want to invent something that has already been done. Would like to combine the data that has already been done.
 - Randy Riley stated we need to identify the problem first and then look at the research.
 - Immediate response if the state needs help share the information.
 - Don't know all the answers but this is what we do know. We are looking at why some things fail and look at that in the design procedure.
 - Why it failed and how to fix it.
 - Dale said they need to find out what caused the high percent of mid panel cracks of untreated UBCO. Not that it did not occur, but what caused it. It could not be hardness when it is setting on 3" of HMA interlayer.
 - Tom Cackler asked what inventory of projects are they looking at for the performance for unbonded overlays, particularly untreated UBCO; do you have a data set.
 - They have all the data for Ohio and are collecting the data for New York.
 - Randy Riley felt they need more information from other states around the country.
 - Randy Riley stated if you don't have density you will have stripping.
 - Dale stated there is not a characteristic on the asphalt interlayer. Looking for cushion, uniformity, drainage and the mix. You should get the cushion adequate with geotextile. Replace the dowel bar inserter with fibers. Any interest of changing the interlayer moving to a geotextile interlayer and moving towards fibers to speed up the process and have long term benefits. The mid panel cracks do not make sense for the untreated UBCO when we don't see it anywhere else.
 - Shad stated the interlayer is a problem and we need to solve the problem. Because you lose the material under the concrete. Big percent of the problem.
 - Dale stated the interlayer may affect the joint spacing.
 - Shad stated he wants to confirm that the drainage is a main problem. Need to figure out how to get rid of the water.
 - Dale stated maybe the solution is to get rid of the type of interlayer that gets so affected by water. If you can get rid of some of the variables; need a better interlayer.
 - Randy stated we need to have a reference point to know if we are doing better or worse. Need to tie the density of the asphalt into the metrics
 - Shad stated in Ohio the Interstate or heavy traffic roadways the subgrade has to be stabilized. They are using AASHTO specs.
 - Tom Cackler stated the Center has been to Ohio and NY training on overlays. There are gaps in the knowledge and there are opportunities available.
 - Roger Green stated there are about 20-30 projects in Ohio. Ohio uses 1 inch bituminous. The pavements are 7 up to 10 inches.

- In NY they don't have too many projects for unbonded overlay. They are trying to learn from this project and learn from Ohio for a procedure for unbonded overlays.
 - Tom Cackler asked where the opportunities are to advance the design procedures. There are a lot of projects nationally on overlay design.
 - Dale felt there may be too many variables nationally.
 - Randy felt there is good information but the only way to test it is you start building end to end sections. It takes test sections.
 - Dale stated we need a system to hold the test result information. We need to collect the information.
- Tom Cackler asked the committee where they felt the gaps are and where are the needs.
 - Shad stated we need to look at the pool fund study that Minnesota is involved in and the NY study and share the information.
 - Tom Burnham stated there are 8 states involved in the pool fund study. They are finishing the structural models. Looking at the sections in the participating states. Characterization of the interlayer. There may be a desire for thicker asphalt interlayer.
 - Tom Burnham stated there is a TAC meeting on December 20, 2016 and we should have more information.
 - They are struggling with the particular model.
 - Should be done late spring next year – 2017
 - Wes stated they don't have plans to build any unbonded overlays in New York. They use asphalt overlay over concrete. 5 inches asphalt over the concrete typically.
 - NY wants to get to the concrete overlays and this is why they requested the research.
 - Tom Cackler asked what the needs are from the design side for NY:
 - Would like a tool to consider for the rehab.
 - Would like to develop a better concrete overlay system.
 - What are the deficiencies with the AASHTO that NY won't use:
 - They have not used the new MEPDG AASHTO. They want an MEPDG catalog for overlays.
 - In the interim if they can develop a tool to consider.
 - Dale stated we will see what the pool fund research shows and share with NY to use.
 - Shad stated in a few months the study may come up with a good model and validate it and then see if NY will use this approach. NY stated they are open to this.
 - Chris Brakke stated NY is looking at a local calibration from the national models.
 - Roger Green stated Ohio wants a model to see what is out there.
 - Chris Brakke stated originally they were looking at the interlayer question. Now looking at more calibration of what comes out of the Minnesota pool fund design procedure for unbonded. NY is looking at dense graded and drainage asphalt. Designed for standard concrete underneath.
 - Tom Cackler asked about having a controlled variable design and asked if NY is in a position to build test sections. Wes did not think they would have time with

their current project to build test sections, only have 2 years left. They want to finish the data analysis. Any new project would not be ready for the current pool fund study.

- Dale asked if NY wants to use the information from the study and apply the procedure to NY local conditions in the future. Wes stated they don't have projects to build test sections.
- Tom Burnham stated there are projects with excessive faulting and they did not want to put the fabric interlayer instead of an asphalt interlayer.
- Tom Cackler asked about building test section on the 3 interlay options from the methodology and look at the performance between them.
- Shad stated they will analysis existing sections and look at the performance differences from what they have.
- Randy Riley stated you need to build test sections to prove the analysis.
- Tom Cackler asked Tom Burnham his thoughts about validation of the results from the study.
- Tom Burnham stated the pavement engineer has been following the study and it would be up to him. He felt it would be implemented immediately by the pavement engineer. They have been doing unbonded overlays for a long time in Minnesota.
- Chris Brakke asked Tom Burnham where they looked for the data to develop the study. He stated if they looked at other states they could share that information with NY so they don't have to repeat the process.
- The data for the geotextile is well developed. Need a place where the information is gathered.
- Gordon Smith felt we have a lot of variables and we need to keep it simple for the counties and cities, etc. And keep it practical for the user.
- Tom Cackler stated the work with the Minnesota study would be focused on validating the model looking at sections that have been built and specifically calibrate it for NY.
- Shad stated some design information cannot be put in the equation but you still may need to deal with it. Need to share the information with the TAC.
- Tom asked Roger to modify the deliverables for the scope and asked the TAC to review the modifications.

The deliverables were modified as follows:

- Review literature and compile annotated bibliography on unbonded concrete overlays
- Technique for characterizing existing layers of rigid pavement.
- Validate model from TPF-5(269) and other identified models for New York State to evaluate how these may be beneficial or can be used to enhance existing unbonded concrete overlay design procedures.
- Construction recommendations for unbonded concrete overlay of rigid pavements based on characterization of existing pavement layers.

The deliverables of this study include:

- Validation of models(s) for designing unbonded concrete overlays
- Procedures for collecting falling weight deflectometer data to be used with software in designing overlays.
- Design recommendations for unbonded concrete overlay of rigid pavements based on characterization of existing pavement layers.

- Project case studies

Dale felt the overlay guide is up to date. He stated the overlay guide TAC will recommend to FHWA and the Center the guide needs to be modified once there are 3 or 4 major revisions. They want the guide to keep up. The overlay guide does not address many design elements. There may be some information after this study that will warrant revisions of the Overlay Guide.

Tom stated we will have quarterly TAC meetings. We will have a physical meeting Fall 2017. Tom will work with Shad and suggest some dates for the TAC meetings and send them to the TAC along with a physical meeting Fall 2017.

Tom Burnham will invite Shad Sargand and Wes Yang to the December 20, 2016 TAC meeting. If they cannot attend they will be sent the meeting minutes. Tom Burnham will send the invitation to Tom Cackler and he will send it to the TAC.

Summary Comments & Questions from the TAC relative to the I-86 test sections. (The distresses reviewed with the TAC raised questions as these test sections do not appear to be performing as would be expected considering other national experience. These comments should be addressed with the TAC in more detail at subsequent TAC meetings.)

- Hairline cracks over tie bars: (These are likely not related to the base support but construction or environmental related issues.)
 - From the slides the cracks appear to have developed at the longitudinal construction joints. Were the sections built under traffic?
 - Need to understand the timing of the adjacent slab placements and weather conditions.
 - Tie bar size and spacing?
- Mid-panel cracking:
 - Mid-panel cracking has not typically been a problem on concrete overlays. This points to some construction or design concern.
 - Are the sawn transverse joints cracked?
 - It was mentioned that slag cement and slag aggregate was used and the pavement was placed in cold weather. Was there a difference in climatic conditions at the time of placement of the 3 sections?
 - It was stated that 1.5" dowel bars were used. This seems large for the 9" pavement thickness. How is the dowel bar alignment? Were all placed with the DBI or baskets set?
- HMA interlayer:
 - National practice would be to use thinner interlayers, typically ~1.5". Why was the thicker interlayer selected?
 - What were the compaction requirements? Inadequate compaction of the interlayer can lead to performance problems.
- UBCOL Support Comment:

Typically unbonded concrete overlays over concrete have been built with good performance results using an HMA or geotextile fabric interlayer with minimal or no repairs to the underlying concrete pavement. Performance of other overlays build in other states with similar traffic criteria should be considered. This could save significant cost and improve long term performance by maintaining a higher support value from the existing p

