



**Summary of TPF Deliverables for Performance
Engineered Mixtures (Solicitation 1439)**

In order to provide support to study participants with implementation of performance engineered paving mixtures, a PEM website will be developed. This website will house on-going project information on the testing, methods, videos, results, Q&A summary and quarterly reports being generated by Tasks 1, 2, & 3. In addition, an annual summary report will be furnished as well as a final report at the end of the project.

It is anticipated that the project resources and level of effort will be allocated as follows:

- Task 1: 40%
- Task 2: 20%
- Task 3: 40%

The research institutions, comprised of the CP Tech Center at Iowa State University (Dr. Peter Taylor), Oklahoma State University (Dr. Tyler Ley), and Oregon State University (Dr. Jason Weiss), along with Nichols Consulting Engineers (Dr. Tom VanDam) and other team members, will collaborate on each of the tasks to ensure efficient accomplishment of the work. The detailed work plan and budget showing the budget and level of effort for all team members will be approved by the TAC before work is started.

Tasks 1, 2, and 3 will be performed concurrently to minimize the time needed to accomplish the planned deliverables. An emphasis will be placed on the accelerated tests in Task 3 so they can be accomplished early in the study in order to provide baseline information for Task 2, Performance Monitoring.

Task 1: Implementation of Technical Support Deliverables:

This task will provide support to study participants with implementing performance engineered paving mixtures within their states. Implementation assistance will include:

- Project Level Support (shadow testing and pilot projects)
 - FHWA Mobile Concrete Trailer (MCT) – FHWA will support four or five projects per year with testing and training of state and contractor personnel on the projects. All states participating in the PFS will have the opportunity for the MCT support.
 - CP Tech Center – CP Tech will coordinate field support with the FHWA MCT and provide project assistance with running field tests and also be available to work with DOTs on assistance with mixture qualification tests.
- Assistance with running test procedures and incorporating them into state specifications
 - A train-the-trainer webinar will be offered in the spring of 2017. This will be complimented with an optional two-hour session at each of the spring and fall 2017 NCC meetings to discuss specific trainer questions.
 - On demand videos of each test method will be available on the PEM website.

- On-call assistance – The research team will be available to answer questions that may arise on specific test methods as well as on how to incorporate PEM requirements into a specific state’s specification.
 - Technical material to supplement the AASHTO provisional PEM Specification and Commentary will be supplied. This will include tech briefs giving an overview of the benefits of PEM Specifications and what this will mean for agencies, contractors, and suppliers. These can be used to assist DOTs as they work with local stakeholders to evaluate and adopt PEM Specifications.
 - Standard test procedures will be proposed for the new testing methods as DOTs work with the research team to validate the test procedures and incorporate them in appropriate mixture qualification and construction specifications.
 - SAM
 - Determination of F Factor using electrical methods and mixture constituent properties
 - Vibrating Kelly Ball (VKelly)
 - Dual Ring
 - Oxychloride methods
 - Box Test
- Specification support
 - Assistance with developing state level pilot project specifications
 - AASHTO provisional specification and commentary
 - State-based workshops and presentations for each participating state
One physical workshop per state during the first year a state joins the study and an annual one- to two-hour web-based update presentation thereafter. A DOT may elect to have the workshop presented electronically in lieu of in person if they prefer.
 - Web-based training
A one-hour webinar will be developed each year to address specific topics of priority to the TAC. All training material will be archived on the website.
 - Quarterly web-based TAC meetings with one physical (1 - 1½ day) meeting per year. Travel support will be provided through the project for two DOT participants from each state. The TAC may elect to coordinate the physical TAC meeting with one of the semiannual meetings of the National Concrete Consortium (NCC) by having the TAC meeting directly following the NCC meeting.

Task 2: Performance Monitoring and Specification Refinement Deliverables:

With any new specification it is critical to monitor the requirements and ensure they are written to consistently produce good performing pavements. Specification values and testing limits should be adjusted to represent the best balance between cost and performance. This task will provide field performance data for use in making decisions on specification limits in the areas of transport, salt damage, and freeze-thaw damage. An organized process of data collection from the DOT, correlation

with exposure conditions and local materials, pavement monitoring and evaluation will be established in this task. It is proposed that the projects built under PEM specification requirements will be monitored in Phase 1 and the future proposed Phase 2 of the study. Deliverables will include:

- Protocol for the data collection for all tasks and projects. The performance monitoring information will be determined after considering what pavement performance data each state is currently collecting along with the information desired by the research team to validate specification limits.
- Database for all DOTs to enter PEM project testing data as well as extract data for local specifications.
- Annual assessment of pavement performance conducted by each participating state using the TAC approved protocol for data collection for each project built using PEM requirements.
- Use of the existing Long-Term Pavement Performance (LTPP) information (database and project materials) to identify relationships between project material and field performance. Materials stored in the Materials Reference Library (MRL) will be obtained and analyzed and also used to compare to field properties and performance. This data set can then be used to calibrate durability performance models based on analysis of LTPP data for specific pavement sections.
- Development of a typical materials data base to identify:
 - Propensity of typical binders to form calcium oxychloride. For binders not yet tested the Low Temperature Differential Scanning Calorimetry (LTDSC) test will be performed. The states will evaluate a newly developed test from Oregon State that can be used in lieu of the LTDSC test.
 - A chemical evaluation of each binder will be performed by Oregon State to compare with the mill certificates for use on the prediction of the pore solution composition which is an important factor in determining the formation factor.
 - New methods for fly ash and slag classification that have improved correlation with performance in concrete. This is a characterization procedure developed at Oklahoma State that shows good promise. The results have been completed for 35 different sources and this study will allow it to be extended to more projects and provide important guidance to DOTs.
- Annual report to the AASHTO SOM on PEM
 - Refine test limits if necessary to improve the relationship to field performance.
 - Overview to PEM implementation experience with the member states.

Task 3: Measuring and Relating Early Age Concrete Properties to Performance Deliverables:

This task will build upon the foundational work done to date in measurement technologies to design and control concrete pavement mixtures to obtain key engineering properties. Work will also include investigating how to correlate long term performance with test data. Items include:

- Accelerated tests to determine transport properties. At the end of the five years an AASHTO test method(s) will be developed to provide accurate methods for measuring formation factor, time to critical saturation, and other transport properties if deemed essential.

- Thermodynamic model to link fluid transport to performance. This work will build on work started at Oregon State to link joint damage to the chemistry of the cementitious materials. Work is also underway to determine how this would relate to transport and chloride binding.
- Moisture movement model that focuses on the environment at joints from application of salts/drying/wetting as well as capillary action from the subgrade. This will extend work being performed at Oregon State.
- Rapid method to determine water content and/or water to cement ratio (or a measurement that can be related to these values). Work has begun at Oklahoma State and Oregon State on a simple test method that can be used to determine these values rapidly and this test will be further developed and compared with state observations in an attempt to better quantify the as-built variability of concrete.
- Rapid test method for in place concrete to assess the impact of construction practices (curing and compaction) on long term pavement performance by examining in place concrete samples and imaging the ingress of a controlled fluid with X-rays.
- VKelly formal test method and calibration with broad range of paving equipment.

The final report of the pooled fund project will include guidelines on how to correlate test data with potential service life, test methods, and data bases of field and laboratory results.