A Bold Plan for States and Contractors

With greater knowledge of failure mechanisms and the development of better tests, mixtures that are engineered to deliver the needed performance are now possible.

The PEM program can improve the reliability of concrete mixtures to ensure that long-life pavements are delivered. It is accomplished by assessing concrete by measuring the identified properties controlling concrete mixture performance…*by measuring the things that matter.*

The PEM program is a bold plan designed to improve concrete pavement durability. It can be successful only with the participation of both agencies and contractors.

Join the Pooled Fund

The work called for in this program is both revolutionary and significant. A Transportation Pooled Fund has been established to support the work. The goal is to have the FHWA, states, and industry each contribute one-third of the investment needed for this program.

Consider joining pooled fund Solicitation 1439 to ensure better and longer-lasting concrete pavements.

Contact Us Today

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Performance Engineered Mixtures can be assessed using a variety of methods, including V-Kelly Test

More durable pavements will not only reduce pavement failures but will also save maintenance costs and improve ride, ultimately protecting and enhancing the market share for concrete pavements.

PERFORMANCE ENGINEERED MIXTURES PROGRAM

Ensuring that agencies can specify—and contractors can deliver—durable concrete pavements, *every time*

March 2017

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An Innovative Program for Pavement Reliability

The Performance Engineered Mixtures (PEM) program is designed to provide the tools for agencies to specify, and contractors to deliver, concrete mixtures that reliably and sustainably meet the needs for concrete infrastructure.

The PEM program will result in concrete pavements consistently achieving the performance life of the design. The program is based on the concept of measuring and controlling the concrete mixture around engineering properties that actually relate to performance:

- Identifying critical mixture properties for long-term durability specific to any climatic environment
- Achieving these properties through measuring the performance-related engineering parameters of the mixtures
- Developing a specification for mixtures
- Providing technical guidance and project-level support for preparing and delivering concrete mixtures that meet the specification

The Need to Modernize Concrete Paving Specifications

Current specifications for concrete paving are still largely based on strength, slump, and air content, which provide poor correlation with the mechanisms of pavement failure. The primary tools used to measure specification compliance are the slump cone, which was introduced in 1922, nearly 100 years ago as ASTM C143, and the pressure meter, which became an ASTM standard ASTM C231 in 1949.

Mixtures have become more complex with a growing range of chemical admixtures and supplementary cementitious materials. Traffic is increasing, more aggressive winter maintenance practices are the norm, and demands are growing for systems to be built more quickly, less expensively, and with increased longevity. Many local specifications also are predominantly prescriptive, thus limiting innovation and not necessarily addressing current materials, environments or construction methodologies.

The need exists for a change in the way we specify concrete, especially concrete for paving mixtures. Highway agencies and construction contractors want to build more reliable concrete pavements in any given environment but often have been hindered by specification requirements that are not robust enough to be reliable even when all the requirements are met. A recent review of a limited set of pavements showed that about 8 percent of them experienced premature distresses or failure, despite meeting specifications in place at the time.

More durable pavements will not only reduce such failures, but will also save maintenance costs and improve ride, ultimately improving the user experience.

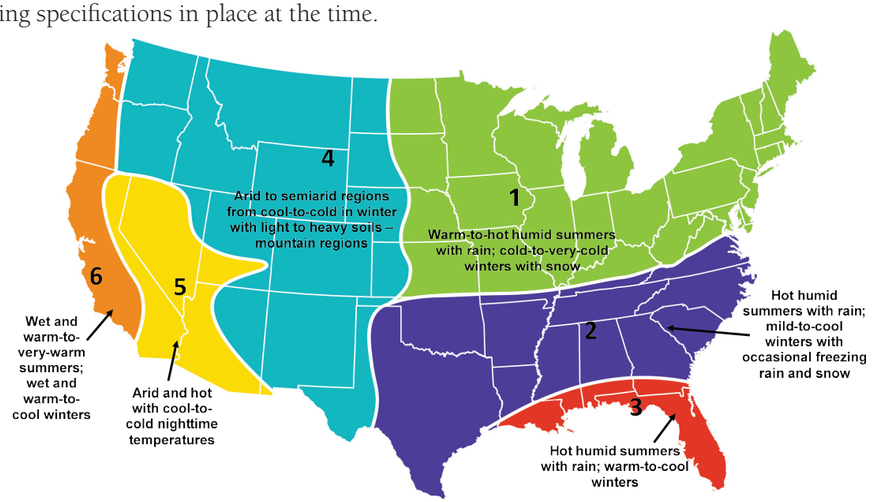
Recent data indicate that ensuring that the concrete mixture in place meets the required needs can almost double its potential life. It underscores the need to provide systems that are less prone to premature failure, while increasing their efficiency and improving their constructability. It is also important to control the burden of testing, both for agencies and contractors.

A Better Specification Through Engineering for Local Requirements

Stakeholders from coast to coast and border to border will benefit from the PEM program. It gives an agency the freedom to customize a specification to its own climatic zone, whether it is cold, humid, or arid. Another advantage of the PEM program is that not every parameter is critical in every location. For example, cold weather-related properties need not be regulated in warm locations, and shrinkage is less critical in moist environments.

Work under the PEM program is planned in three steps:

1. Develop a guide specification (complete)
2. Implement technologies currently available (starting)
3. Refine existing and develop new test methods (starting)



Performance Engineered Mixtures can be customized for different United States Weather Regions

Guide Specification

AASHTO will publish a provisional guide specification, PP84, in April 2017. The specification is structured around the recommendations of an expert task group concerning the critical parameters that control concrete mixture performance. The parameters are fluid transport properties, strength, cold weather resistance, shrinkage, aggregate stability, and workability (see adjacent chart).

The AASHTO document is a provisional specification, allowing it to evolve to best suit the needs of agencies and contractors:

- As tests are improved or replaced, changes can be incorporated
- Precision and bias statements can be developed
- The efficacy of the current pass/fail limits can be reviewed

Implementation at All Levels

Implementing the PEM program is dependent on significant education and assistance for all levels of staff across the community, from the design office through the construction site. Work will include construction of shadow projects and demonstration projects that can be monitored over time.

The program will develop and offer a suite of training materials for both agency and contractor staff, providing guidance on several important PEM concepts:

- What parameters are required for the project's climatic region
- What tools to use to monitor compliance
- How to run the new test methods
- Information on quality-related activities
- How to develop mixtures that will meet requirements while improving ruggedness and reducing financial and environmental impacts

The materials will be presented through webinars, National Concrete Consortium meetings, at specially convened workshops in participating states, and at American Concrete Pavement Association Chapter/State meetings.

Identified Properties Controlling Concrete Mixture Performance

- **Fluid transport properties** —The ability to resist passage of aggressive fluids
- **Strength** —The ability to carry static and fatigue loads
- **Cold weather** —The ability to resist freezing and thawing and the effects of deicing salts
- **Shrinkage** —As it affects random cracking as well as warping
- **Aggregate stability** —Including alkali aggregate reaction and D-cracking
- **Workability** —As it affects the constructability of the system, and the observation that the efforts to overcome poor workability can impact durability

Shadow Testing and Ongoing Assistance

The National Concrete Pavement Technology Center (CP Tech Center) team and the FHWA mobile concrete trailer will be available to visit states to assist DOTs with shadow testing of the specification on projects, helping field personnel gain firsthand experience with the PEM methods and associated quality plan requirements. The team also can assist contractors to review their mixtures to ensure specification compliance while remaining efficient and cost effective.

Shadow sites will be monitored over time to develop models that can correlate field test data with long-term performance of the system. In addition, researchers will mine data from the Long-Term Pavement Performance Plan records to obtain longer term information.

Also, work will continue to develop better tests to relate fresh concrete properties to performance. Research will be conducted by a partnership including the FHWA, CP Tech Center, Oklahoma State University, and Oregon State University. Additional consultants and researchers can be utilized as needed for specific training and field and investigation tasks.

Recent data indicate that improving the quality of the concrete pavement in place can almost double its potential life.