Demonstration Project for

Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density

Statement of Work

January 29, 2016

**Background Information**

An approximate investment of $35 billion is needed annually for preserving the existing conditions of United States highways and bridges through 2040 (ASCE 2011). An improvement of 5 to 25 percent in pavements performance could yield a potential annual savings of $1.75 to $8.75 billion. These savings by making more durable roads could then be used to improve the overall condition of the highway system, reduce congestion, or improve safety.

In-place density is one of the most important factors that influence the performance of an asphalt pavement (Asphalt Institute 2007). The desired level of construction density in asphalt layers in the field is achieved by the means of roller compaction. The aggregate in an asphalt layer interlock as the result of the compaction process. An asphalt layer after compaction is a denser layer with lower air voids, with a smooth and uniform surface, and homogenous appearance. The achieved in-place density of an asphalt pavement results from a combination of different activities that include proper design, production, placement, compaction, and quality control of the mixture (Asphalt Institute 2007). The density of an asphalt mixture is normally expressed as a percent of its theoretical maximum specific gravity (Gmm). An asphalt mixture behind a paver typically has a density of 80 to 85 percent of its Gmm. The goal of compaction in the United States is often an in place average density level of 92 to 93 percent of Gmm (7 to 8 percent air voids).

Past studies have shown that a small increase in in-place density can lead to a 10 to 30 percent increase in service life of asphalt pavements. That is the type of increase we can expect according to Epps and Monismith (1971), Finn and Epps (1980) and Puangchi, et al. (1982) as fatigue life (the time from original construction to significant fatigue cracking) of asphalt pavements is increased for every 1 percent decrease in in-place air voids. Due to its significant effect, the cost of providing this increased in-place density can be significantly less than the operation, maintenance, and road user cost realized due to extended service life of the pavements. As stated at the 1977 Association of Asphalt Paving Technologists (AAPT) meeting, “the single most important construction control that will provide for long-term serviceability is compaction.” (Hughes et al. 1989)

There have been significant advancements in technology and techniques to pavement design and construction. These advancements yield the potential to increase asphalt pavement density and increase both durability and cost effectiveness. Many of these advancements are already being employed, however in many instances standards for in-place density have remained unchanged. It is proposed that using already adopted practices in-place density targets can be increased. Thus with enhanced density targets mixture durability and pavement service life can be achieved

**Objective and Scope**

Recognizing the importance of in-place density in building cost effective asphalt pavements, the objective of this demonstration project is to support SHAs in their evaluation regarding the potential to increase to their current density requirements for acceptance.

By March 2016, FHWA in partnership with SHA will identify up to 10 SHAs for participation in this demonstration project. Consideration for project selection will be given to those SHAs that can benefit most from increased compaction requirements as well as a distribution of SHAs in varied geographic and/or climatic regions.

Each SHA will be provided with an “Increased Density Workshop” delivered by the Asphalt Institute. The target audience will be the SHA, contractors, equipment suppliers, and academia. The workshop will include the use of currently recognized best practices as well as “new” materials and technologies. The Asphalt Institute will meet with select SHA staff and contractors before the workshop to discuss this holistic approach of best practices. Topics will vary based upon initial review of the SHA’s practices, but could include mix design, pavement design, and/or construction best practices (equipment and operation) as applicable to selected project. On-site technical advice to participating SHAs during the construction of the project will also be provided.

Project funding of $50,000 will be provided to each SHA for use on this demonstration project. Efforts with additional SHA projects will be considered for calendar year 2017 based on the level of interest. It is also intended that a follow up effort will be conducted with the initial participants from 2016 regarding measurement of actual pavement performance of the increased in-place density pavement sections.

**Applications and Deliverables from SHAs**

To request participation, a SHA working with its FHWA Division Office Pavement & Materials Engineer should prepare an application that identifies the key SHA contact person(s), describes plans for selecting a project, constructing control and test sections, approach to achieving higher compaction, and how the FHWA provided funding would be utilized.

Project selection guidelines should include the type of pavement to be considered. It is suggested that there be a minimum 2-inch overlay that is structurally designed for a minimum of 10 years. The type of overlay could consist of:

* new asphalt overlays over existing asphalt pavements,
* new asphalt overlays over existing concrete pavements,
* new asphalt overlays over existing composite pavements, or
* new construction asphalt projects.

Project characteristics should include a minimum overall project length and tonnage. It is suggested that the minimum be 4,000 feet (or approximately 5,000 tons). The asphalt overlay should be constructed using mix with same aggregate stockpiles, gradations and mix design.

An “Application Form” is attached for use by the SHA and submission to the FHWA Division Office Pavement & Materials Engineer. A description of the SHA’s current density specification should be provided.

Construction should include a control section (the SHA’s normal practice) and test section (increased density based on 1 to 2% above the control section). Increased rolling should be only additional compactive effort on the test section. SHAs are encouraged to identify an additional test section for evaluation that uses enhanced compaction techniques. If a SHA desires, additional enhancements beyond what was done in the control section can include warm mix asphalt, additional rollers, etc. as the SHA finds appropriate. It is suggested that these sections be identified after steady-state field production is achieved. Suggested guidelines for the control and test sections are a minimum of 500-foot long each (approximately 75 tons) with 150 feet on either side for sampling and buffer.

SHAs should conduct their normal testing method and frequency to measure density. This includes the methods for the in-place (or bulk) density and reference density. It is suggested that the in-place densities use cores or be referenced to cores for the control and test sections. It is suggested that the frequency is sufficient to calculate the standard deviation of the relative densities for each section.

A Post-Construction Project Report form (attached) should be completed and submitted to the FHWA no later than the end of calendar year 2016. Data collection during construction of the control and test sections should include, at a minimum:

* General information (route, location, paving dates, project quantities, pavement design, etc.)
* Mix design properties
* Production (plant type, haul time, production rates and temperatures, quantities, etc.)
* Production mix properties
* Construction (weather, mix temperatures, roller types, roller patterns, etc.)
* Field density results (density and reference density testing methods and frequencies, average and standard deviations for each section)
* Summary (brief discussion of differences in density of control and test sections)

The testing should be done by the SHA. A suggested report form has been provided to promote completeness and uniformity.

**Expected Benefits**

It is anticipated that the results from this demonstration effort will provide guidance/incentive to SHAs in reviewing and updating as needed their current field density acceptance criteria for of asphalt pavements. It will also be used by FHWA to provide national guidance for enhancing durability of asphalt pavements through increasing in-place pavement density.

**Contacts**

This demonstration project is being jointly supported the FHWA Office of Asset Management, Pavements, and Construction and the FHWA Resource Center.

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| **Introduction** (route, location, project length, existing pavement type and condition, pavement design life and traffic, lift thickness(es), control section and test section(s) descriptions, project paving dates, asphalt mix quantities) |
| **Mix Design Properties** (nominal maximum aggregate size, mix design method, laboratory compactive effort, aggregate stockpile and binder percentages, binder type, design gradation, design volumetrics, performance test results if applicable) |
| **Production** (plant type, silo capacity, plant fuel, haul time and length, time of production, production rates, production temperatures, quantities) |
| **Production Mix Properties** (sampling location; comparisons to mix design job mix formula for gradation, asphalt content, and volumetrics; moisture content; performance test results if applicable) |
| **Construction** (weather, pavement preparation (tack coat, milling, levelling course, etc.), haul trucks, paver, material transfer device, temperature behind screed, roller types, roller patterns, passes/coverages) |
| **Field Density Results** (density and reference density testing methods and frequencies, average and standard deviations for each section) |
| **Summary** (Brief discussion of differences in density of control and test sections) |
| **Notes:** Any unique features should be included and discussed. This can be done in the appropriate section or at the end. These may include the use of warm-mix asphalt, IR Bar, intelligent compaction, etc. |

It is suggested to include tables and photos as appropriate.