AAPTP Airport Asphalt Pavement Technology Program

NAPA NATIONAL ASPHALT PAVEMENT ASSOCIATION

Request for Proposals (RFP)

Re: Evaluating Stone Matrix Asphalt (SMA) for U.S. Airfield Pavements

I. BACKGROUND

Stone Matrix Asphalt (SMA), developed in Germany in the 1960s, was introduced to the U.S. in the 1990s through a FHWA–AASHTO–NAPA European study tour. SMA has since been widely adopted by state agencies for high-traffic roads and interstate overlays due to its superior resistance to rutting and cracking, resulting in greater durability and lower long-term maintenance costs. While initial costs are higher, SMA is cost-effective over the pavement lifecycle. Additional benefits include reduced noise and enhanced surface friction.

In 2009, the AAPTP 04-4 report reviewed the suitability of SMA for airfield pavements, concluding that SMA was a promising alternative to traditional asphalt due to its ability to resist rutting, cracking, and moisture, and handle heavy aircraft loads. SMA is now included in the DoD Unified Facilities Guide Specifications (UFGS), section 32 12 15 16, including documented applications at U.S. Air Force bases in Germany and Italy.

Internationally, SMA is a proven runway surface at major airports in Europe, Australia, and China. In addition to its resistance to rutting, fatigue, and moisture, its adoption is driven by high skid resistance that eliminates the need for surface grooving. This performance results from SMA's coarse macrotexture, which breaks surface water films and maximizes exposure of high-friction, polish-resistant mineral surfaces.

Despite SMA's success on heavily trafficked highways and its use on international airports, its adoption in U.S. airfield pavements remains very limited. There is a clear need to further evaluate SMA under U.S. airfield conditions and develop guidance to facilitate its broader implementation as a high-performance airfield pavement surfacing.

II. OBJECTIVE

The objective of this project is to evaluate the suitability and benefits of Stone Matrix Asphalt for U.S. airfield pavements and to develop technical guidelines for its use. This includes assessing SMA's structural and functional performance relative to current FAA-standard mixes and providing recommendations on mix design, production, construction, and maintenance to support safe, cost-effective use on runways, taxiways, and aprons.

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III. PROJECT SCOPE

This project includes a literature review and planning effort (Phase I), followed by laboratory evaluation, and engineering and life-cycle cost analysis (Phase II). A future Phase III field trial is anticipated and will be funded through a separate project, informed by the outcomes of Phases I and II.

<u>Phase I of this project shall include at least the following</u>:

- **Literature Review & Planning.**
  - Conduct a comprehensive literature review to document SMA performance outcomes, failure modes, maintenance practices, and relevant specifications. The review will highlight SMA's key advantages—such as enhanced resistance to rutting, cracking, and skidding—as well as potential challenges, including material availability, constructability, binder draindown, and surface flushing. It will also address SMA-specific considerations for surface preparation, longitudinal joint construction (including density requirements), and typical smoothness performance. It will also compare SMA mix design procedures in AASHTO M325-R46 with UFGS SMA provisions and FAA-standard P-401 specifications and evaluate the potential for integration into a Balanced Mix Design (BMD) framework for airfield pavements.
  - In parallel, interview airfield operators with experience using SMA and collect data on operational aspects such as friction performance, rubber removal frequency, maintenance, and life-cycle cost analysis (LCCA). In particular, gather insights on how SMA's ability to meet friction requirements without grooving impacts runway availability, construction sequencing, surface durability, and overall project costs.

Phase I will conclude with an interim report summarizing key findings and presenting a detailed experimental plan for Phase II, establishing the foundation for evaluating SMA's performance and cost-effectiveness in U.S. airfield applications.

<u>Phase II of this project shall include at least the following</u>:

- **Laboratory Evaluation & Analysis.** Conduct controlled laboratory testing to quantify the performance of SMA compared to conventional airfield asphalt. The research team will design representative SMA mixtures and a control P-401 mix. Evaluation will include:
  - *Durability and FOD Resistance*: Assess raveling resistance due to its direct link to Foreign Object Debris (FOD) risk, often a primary trigger for runway resurfacing. Use test methods such as the Cantabro test and selected European procedures (see Appendix). Investigate lab-to-field performance correlations using data from airports that have trialed raveling tests.

- *Balanced Mix Design (BMD) framework*: Align with findings of AAPTP BMD research. Evaluate rutting resistance using test options including the Asphalt Pavement Analyzer (APA), Hamburg Wheel Tracking Test (HWTT), IDEAL-RT, and HT-IDT. Assess cracking resistance at intermediate temperature using IFIT or IDEAL-CT. For cold climates, include low-temperature cracking evaluations using Low-Temperature SCB. Moisture susceptibility should be evaluated using HWTT and the Tensile Strength Ratio (TSR).
    - *Surface characteristics*: Measure macrotexture and friction using standardized methods (e.g., ASTM E2157 with the Circular Track Meter (CTM) for macrotexture, ASTM E1911 with the Dynamic Friction Tester for friction). Use lab-compacted SMA and P-401 slabs or specimens to compare macrotexture and friction properties. Phase III should include field testing under wet conditions using Continuous Friction Measurement Equipment (CFME, ASTM E274) to compare SMA with grooved P-401 surfaces. The review should also evaluate the durability of SMA's macrotexture—monitored in the field using CTM or vehicle-mounted laser-based systems—its ability to break surface water films, and whether periodic cleaning or vacuuming is needed to maintain performance. This study aims to evaluate SMA's ability to deliver comparable or superior friction performance without grooving.
- **Pavement Design and Structural Contribution:** Evaluate the structural contribution of SMA overlays relative to P-401, comparing modulus values and estimating pavement life extension using tools such as PCASE or FAARFIELD. Align results with long-life pavement design strategies.
- **Life-cycle cost analysis (LCCA):** Conduct a life-cycle cost analysis comparing SMA and conventional airfield surface mixes. Use AirCOST as the primary tool to assess long-term economic performance, accounting for material costs, grooving avoidance, maintenance intervals, and projected service life, based on aircraft traffic characteristics (frequency and weight) and climatic conditions.
- **Draft Guidance for SMA Implementation in Airfields**: Phase II will conclude with a draft guidance document outlining recommendations for SMA mix design, material selection, quality control, and considerations for production and construction. It will integrate structural and LCCA findings to assess how SMA's higher upfront cost can be offset by reduced maintenance, grooving elimination, and extended performance. The document will also include a proposed plan and methodology for Phase III field trials.

<u>Future Phase III – Field Trial & Implementation (To be funded under a separate project):</u>

Phase III will validate SMA performance through a full-scale field trial at a U.S. airfield or designated test facility (e.g., taxiway, apron section, or the National Asphalt Pavement Materials Research Center). An SMA pavement section will be constructed and monitored under actual aircraft traffic or simulated loading conditions.

Key performance indicators will include rutting under aircraft loads, progression of raveling and cracking, macrotexture (ASTM E1845), and surface friction (measured using FAA-approved methods such as ASTM E1911 with a Dynamic Friction Tester or ASTM E1551 with a Mu-Meter). Where feasible, results will be benchmarked against a conventional P-401 section.

Phase III will conclude with a final report and implementation plan, including recommended updates to FAA advisory circulars and UFGS specifications to support SMA as a qualified airfield pavement option.

IV. PROJECT REQUIREMENTS

The project must be completed within the proposed timeframe and within the proposed budget. The final report must be 508 compliant. NAPA will be responsible for the final design of the research report.

AVAILABLE FUNDS (Phases I and II)**:** $500,000

CONTRACT PERIOD (Phases I and II)**:** 24 months

V. PROPOSAL SUBMISSION

Submissions should include qualifications of the individual(s) involved in the project, proposed methods for achieving objectives, timeline, and summary of budget for the project. Proposals should use a minimum 11pt font, standard margins, a maximum of 15 pages, and Adobe PDF file format. Resumes, budgets, and timelines will be in addition to the allotted pages and will not count against the 15-page limit.

Proposals should be sent via email to Richard Willis, Vice President, Engineering, Research, & Technology, by August 28, 2025. Please include the “Re: Evaluating Stone Matrix Asphalt (SMA) for U.S. Airfield Pavements” in the subject line of your email.

Appendix – European Test Methods for Surface Raveling Resistance

To supplement the Cantabro test for evaluating raveling resistance and Foreign Object Debris (FOD) risk, the research team shall conduct a literature review of standardized European raveling resistance test methods outlined in prCEN/TS 12697-50:2022. These procedures simulate surface degradation mechanisms relevant to airfield pavements and have been validated through lab-to-field performance correlations. Those methods are summarized below:

A. Aachener Raveling Tester (ARTe)

Test Principle: Simulates surface scuffing by applying shear and normal loads via rotating wheels over a laterally moving slab.

- Specimen Type: Large asphalt slabs (typically 500 × 500 mm) compacted in the lab.
- Test Metrics: Material loss per covered area (g/mm^2) or increase in macrotexture volume (ΔV).
- Environment: Conducted at 20 ± 2 °C in a temperature-controlled room.
- Relevance: Mimics surface damage from turning aircraft tires on airfield pavements.

B. Darmstadt Scuffing Device (DSD)

Test Principle: Applies cyclic shear loads via an oscillating platform under a loaded tire at elevated temperature.

- Specimen Type: Medium-sized slabs (260 × 260 mm) pre-heated to 40 ± 1 °C.
- Test Metrics: Visual damage assessment and mass loss tracking.
- Features: Includes vacuum cleaning to isolate grain loss from frictional damage.

C. Rotating Surface Abrasion Test (RSAT)

Test Principle: Uses a rotating arm and loaded solid rubber wheel to simulate rolling-induced scuffing and abrasion.

- Specimen Type: Asphalt slabs or a set of 3 cores (150 mm diameter) mounted on an octagonal base.
- Test Metrics: Real-time aggregate loss tracking using a vacuum system and weight sensors.
- Duration: 24-hour test to replicate long-term field wear.

D. Triboroute Device (TRD)

Test Principle: Applies tangential force via a logarithmic-shaped rubber load applicator simulating truck/aircraft tire contact.

- Specimen Type: Parallelepiped slabs or cores up to 300 mm diameter.
- Test Metrics: Measures mass loss, surface damage, and horizontal forces during test.
- Unique Feature: Capable of sinusoidal or monotonic displacement loading.