SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

26-36 The Potential Of Using Crack-Attenuating Asphalt Mixtures In Oregon To Combat Long-Term Durability Issues

PROBLEM SUMMARY

Reflection pavement cracking occurs in Oregon when load-related surface level shear stress or underlaying cracks in asphalt or concrete propagate to surface. A successful approach to mitigate this problem is to construct a highly flexible thin asphalt layer underneath fresh asphalt pavement that can absorb displacement and impede cracking from propagating through and reaching the surface. While this approach has been successful in nearby states, there is no experience applying it in Oregon and this research project seeks to determine the optimum parameters (aggregate size, layer thickness, binder content, etc) for its successful application in Oregon roads.

ODOT OBJECTIVES

- Develop and Optimize Crack Attenuating Mix Designs
- Evaluate Performance and Cost-Effectiveness
- Establish Construction Guidelines and Specifications

BENEFITS

The primary potential benefit of this research project is to extend asphalt pavement service life and a reduced costs associated with maintenance. Additionally, enhanced ride quality and reduced impact on vehicle operating costs by reducing pavement roughness are likely to result from this research. Other tangible benefits resulting from this work would include sustainability benefits by reducing the frequency of maintenance due to greater pavement longevity. Finally, a reduction in the frequency of road maintenance activities is directly related to an increase in the safety of road maintenance workers.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 24 months.
Estimated Project Budget: $295,000
ODOT Support:
Timothy Earnest – Assistant Pavement Materials Engineer - Timothy.Earnest@odot.oregon.gov (503)979-7205
Chris Duman – State Pavement Q&M Engineer – Christopher.L.DUMAN@odot.oregon.gov (503)559-4994
Jeff Shambaugh – State Pavement Engineer – Jeff.SHAMBAUGH@odot.oregon.gov (503)986-3115

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/26-36.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2026

PROBLEM NUMBER AND TITLE

26-36 The Potential Of Using Crack-Attenuating Asphalt Mixtures In Oregon To Combat Long-Term Durability Issues

RESEARCH PROBLEM STATEMENT

Fatigue cracking is a major issue of Oregon's asphalt pavements, leading to costly maintenance. It occurs either from surface-level shear stresses caused by heavy truck tires (top-down fatigue cracking) or from excessive tensile stresses at the bottom due to pavement bending (bottom-up fatigue cracking). Additionally, reflection cracking, where underlying cracks in asphalt or concrete layers propagate to the surface, further accelerates pavement deterioration and increases long-term maintenance costs.

Many of Oregon's concrete pavements are aging, with surface cracks and roughness affecting ride quality and vehicle fuel efficiency. A common solution is constructing thin asphalt layers to reduce roadway roughness levels that can increase fuel consumption by 2% to 4% (Estaji et al. 2021). However, existing cracks can reflect through, causing premature failures. The same issue occurs with the widely used Oregon "mill & fill" method, where milling may not fully remove cracks or may introduce microcracks that reflect through the new surface (Weaver et al. 2023). Developing effective strategies to mitigate reflection cracking is essential for improving pavement durability in Oregon.

The concept of *"crack attenuating asphalt mixes"* was originally developed by the Texas Department of Transportation (TxDOT) (FHWA, 2022). The major purpose was to install the crack attenuating layer, a 0.5inch to 1inch thick layer with fine-gradation (small size aggregates) and high asphalt binder content, to mitigate reflection cracking. This thin asphalt layer is constructed on top of the old asphalt layer after milling, and the new asphalt layer is constructed on top of it. By having the thin and highly flexible crack attenuating layer in between the old and the new pavement layers, the occurrence of reflection cracking is mitigated. Crack-attenuating asphalt mixtures are designed for high crack resistance using finer gradation and increased binder content. Their performance can be further enhanced with polymer modification, recycled crumb rubber, and fiber reinforcement, which require further research.

Although the crack attenuating layers are effective in reducing reflection cracking, they are more expensive than conventional asphalt mixtures. However, the long-term performance improvement that crack attenuating mixes can create reduces their life-cycle (long-term) cost by 20% to 30% (FHWA, 2022). In addition, crack-attenuating mixes can replace other interlayers that are used to avoid reflection cracking. Since those interlayers are generally more expensive than any asphalt mix, crack attenuating layers can be considered to be cost-effective strategies when implemented with the correct mix designs and construction processes.

Although crack attenuating mixes have been proven to reduce long-term paving costs and improve the longevity of pavements, their effectiveness with Oregon aggregates, binder types, and additives needs to be tested to incorporate that strategy into ODOT's processes and specifications. An asphalt mixture design process for the crack attenuating layers also needs to be developed with Oregon materials. A field study must also be performed to test the practicality of the construction of this layer. Adhesion between pavement layers should be evaluated to prevent potential delamination issues that can be detrimental to long-term pavement performance. For all those reasons, a laboratory and field-level research study should be conducted to find the best materials, design methods, and construction processes that can provide the highest level of performance with this promising technology. The long-term cost-effectiveness must also be evaluated by conducting a life-cycle cost analysis (LCCA) using the collected performance data.

RESEARCH OBJECTIVES

The major objectives of this research study are to:

- **Develop and Optimize Crack Attenuating Mix Designs**: Design and test asphalt mixtures with various material combinations to enhance crack resistance and durability, including HiMA and traditional CAM surface and base mixtures.
- **Evaluate Performance and Cost-Effectiveness**: Assess crack attenuating layers through laboratory testing, field implementation, and life-cycle cost analysis (LCCA) compared to traditional interlayers and current conventional paving strategies.
- **Establish Construction Guidelines and Specifications**: Develop best practices for mix design, placement, and construction to ensure successful implementation in Oregon.
- **Monitor Long-Term Performance and Structural Compatibility**: Conduct field trials, assess bonding strength, and track pavement performance using Automated Pavement Condition Surveys (APCS).
- **Support ODOT's Material Selection and Standardization**: Identify high-performing materials for inclusion in ODOT's materials specifications to guide future pavement strategies.

WORK TASKS, COST ESTIMATE AND DURATION

1. **Literature Review**: Review existing studies and state DOT practices to establish a knowledge base for crack attenuating layers.
2. **Laboratory Mix Design and Performance Testing**: Develop and test asphalt mixtures with various material combinations to optimize crack resistance and durability.
3. **Field Implementation and Long-Term Monitoring**: Construct pilot test sections and assess real-world performance using Automated Pavement Condition Surveys (APCS).
4. **Cost-Effectiveness and Structural Compatibility Analysis**: Compare crack attenuating layers with conventional interlayers through life-cycle cost analysis (LCCA) and adhesion testing.
5. **Development of Guidelines and Specifications**: Establish mix design, construction, and implementation recommendations for ODOT.
6. **Final Report and Technology Transfer**: Document research findings, recommend materials for ODOT's Qualified Products List (QPL), and provide training for implementation.

Key Deliverables: i) Optimized crack attenuating mix designs, ii) Field test sections and monitoring data, iii) Results of cost-effectiveness analysis, iv) Design and construction guidelines, v) Final report and recommendations including the findings, material recommendations and specifications, and implementation plan.

Estimated Project Length: 24 months.
Estimated Project Budget: $295,000

IMPLEMENTATION

The major products from this proposed research project would be:

- Laboratory asphalt mix testing and designs with various additives, fibers, RAP contents, binder types, contents, and aggregates with different properties.
- New mix design, construction methods, and specifications to successfully implement crack attenuating mixes in Oregon.
- Cost and performance comparisons between the crack attenuating layers and other more expensive interlayer options.
- Long-term cost-effectiveness of crack attenuating layers.

- **Demonstrations:** Field implementation of mixture designs (pilot section constructions) that are most promising based on the laboratory results.
- Long-term performance monitoring of the constructed field pilot sections by Automated Pavement Condition Surveys (APCS) to validate the long-term performance effectiveness of the selected strategies.
- Based on the research findings, recommend a list of materials to be included in ODOT's material specifications.
- A comprehensive research report with a literature review, all research components and results, and major conclusions.

POTENTIAL BENEFITS

1. **Extended Pavement Life and Reduced Maintenance Costs:** Crack-attenuating asphalt mixes will reduce reflection and fatigue cracking, leading to longer-lasting pavements and lower repair costs.
2. **Improved Cost-Effectiveness:** Life-cycle cost analysis (LCCA) will provide long-term savings compared to traditional interlayer treatments and current conventional paving strategies.
3. **Optimized Materials and Construction Practices:** The study will develop high-performance asphalt mix designs suited for Oregon's materials and climate while refining construction methods for successful implementation.
4. **Enhanced Ride Quality and Reduced Vehicle Operating Costs:** Smoother pavements due to improved longevity reduce surface roughness, improving driver comfort and vehicle fuel efficiency (about 2% to 4% reduction) and the associated emissions.
5. **Sustainability and Environmental Benefits:** The potential use of recycled materials (RAP, rubber, fibers) will contribute to ODOT's sustainability goals while reducing reliance on virgin materials. Reduced frequency of paving due to improved pavement longevity is also expected to reduce material production and construction emissions.
6. **Increased Safety for Workers and Road Users:** Improved pavement durability reduces the frequency of maintenance and rehabilitation, minimizing work zones and enhancing safety for both construction crews and the traveling public.
7. **Standardized Specifications and Data-Driven Decision-Making:** The research will help establish new mix design specifications, support the development of ODOT's material specifications, and provide performance data for future pavement strategies.

PEOPLE

ODOT champion(s):
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Problem Statement Contributors:
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REFERENCES

- Estaji, M.; Coleri, E.; Harvey, J.T.; Butt, A.A. (2021). Predicting Excess Vehicle Fuel Use Due to Pavement Structural Response Using Field Test Results and Finite Element Modelling. Int. J. Pav. Eng., 22, 973–983.
- FHWA. (2022). Targeted Overlay Pavement Solutions (TOPS). U.S.DOT. FHWA, FHWA-HIF-22-030.
- Weaver, J., Coleri, E., & Chitnis, V. (2023). Centerline Rumble Strip Effects on Pavement Performance (Final Report FHWA-OR-RD-23-09; p. 170). Oregon Department of Transportation.

https://www.oregon.gov/odot/Programs/ResearchDocuments/SPR838CLRSODOTFINAL.pdf

STAFF REVIEW PAGE

LITERATURE CHECK

TRID&RIP

☒ A review of TRID & RIP databases found no existing research that answers the research question

ODOT DECISION LENSES

Climate:

This proposed research study is expected to improve the longevity of pavements and result in less frequent construction and maintenance activities. This benefit will reduce greenhouse gas (GHG) emissions by reducing long-term material production, construction, and construction-related traffic delay emissions.

According to an ODOT/FHWA research study (FHWA Climate Challenge) recently completed by the OSU-Asphalt Materials and Pavements (AMaP) research group, the cost of fuel and tire wear that can be saved by reducing current pavement roughness levels by 20% is around $73 million/year for the road users. The associated annual emissions savings are around 193,000 MT CO_2/year, while ODOT's total annual emissions from all operations were calculated to be 182,592 MT CO_2/year. This important result shows that strategies to improve the long-term durability of pavement structures are needed in this low paving budget environment to keep the roadway roughness and rolling resistance low to reduce GHG emissions and road user costs.

Equity:

None

Safety:

This proposed research study is expected to reduce reflection cracking, a major distress mode in Oregon, and improve the longevity of pavements. Improved performance will reduce the frequency of paving and improve worker and road user safety.

TECHNOLOGY & DATA ASSESSMENT

☒ No Identified T&D output

☐ At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

CROSS-AGENCY IMPACTS

- List ODOT partners or impacted units: **Pavement Services**
- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns: **None**