Oregon Department of Transportation

Research Stage 1 Problem Statement

Number 26-15 – "High Friction Surface Treatments and Alternative Chip Seals to Reduce Accident Rates and Improve Network Level Roadway Performance"

1. Concisely describe the **transportation issue** (including problems, improvements, or untested solutions) that Oregon needs to research.

According to the 2022 ODOT Pavement Condition Report, the current ODOT pavement program is significantly underfunded. This insufficient funding level, combined with the increasing cost of paving (due to the increasing asphalt and oil prices and high inflation) and increasing traffic levels, has necessitated the development of low-cost but effective alternative solutions for preserving and maintaining Oregon's roadway network. Chip seals are a low-cost pavement preservation solution that enables transportation authorities to pave more lane miles to improve the state's overall pavement quality and user comfort despite budgetary constraints. For this reason, according to the 2022 ODOT pavement condition report, although general paving in Oregon is expected to drop significantly within the next 2-3 years due to budgetary issues, the annual chip seal treated lane miles are expected to stay constant or may even increase. This plan shows the importance of chip seals in Oregon to combat the current high cost of road construction and to avoid any decline in the condition of the ODOT roadway network.

Although chip seals effectively preserve the condition of the Oregon roadway network, their life span is shorter than other alternatives (on average, 4 to 6 years), necessitating more frequent construction and disruptions to mobility. Since chip sealing is a critical cost-effective pavement preservation strategy for ODOT, any improvement in the performance of chip seals can result in significant cost and greenhouse gas (GHG) emission savings. For these reasons, alternative chip seal methods to improve the longevity of roadways need to be tested and implemented. In addition, ways to incorporate recycled asphalt pavements (RAP) into chip seals without sacrificing performance should be investigated to reduce cost and GHG emissions.

High Friction Surface Treatments (HFST) are another strategy for improving roadway conditions while significantly increasing road users' safety by increasing road surface friction. According to field performance studies conducted by Pennsylvania, Kentucky, and South Carolina DOTs (FHWA, 2014), total crash reductions in critical locations (mostly curves and areas with lower visibility) due to the application of HFSTs are 100%, 90%, and 57%, respectively. These significant reductions in accident rates for the three states point out the importance and effectiveness of HFST. However, the high cost of HFST (about $\$23/yd^2$) when compared to chip seals (about $\$4/yd^2$) appears to be the major reason blocking its widespread use in many states. Major components of this high cost are expensive liquid polymer resin and the special bauxite aggregates that are only available in a few states in the U.S. (Arkansas, Alabama, Georgia, and Virginia). Long transportation distances for the bauxite also increase the cost and carbon footprint of HFST. For all these reasons, the potential of using local materials to create a similar surface at a lower cost needs to be investigated. Heavy residue emulsions that are currently being produced in Oregon can be considered to replace expensive polymer resins, while locally available aggregates and recycled asphalt pavements (RAP) can be evaluated to replace bauxite in this proposed research study. The impact of aggregate gradation and nominal maximum aggregate size on pavement surface friction and safety should also be determined.

Pavement surface texture and its friction response to rain events control a significant portion of the safety of road users. Due to the frequent heavy rain events in Oregon, surface friction and skid resistance of the roadways have immense importance. Although HFST applications are used on bridge decks in Oregon for sealing and protecting the underlying concrete with reinforcement, their use on roadway construction is limited due to the high cost. The high cost of HFST is a result of the expensive polymer resin and the special aggregates used for construction. For this reason, developing innovative methods to use locally available aggregates and emulsions for HFST construction without sacrificing performance can significantly benefit ODOT and road users in Oregon. The construction of HFST sections at locations critical to accidents can significantly reduce accident rates (FHWA, 2014).

Since the cost of paving with asphalt concrete and concrete materials is continuously increasing, lower-cost options for pavement preservation, such as chip seals, are starting to become more critical. The major advantage of chip seal strategies, besides the high benefit-to-cost ratio, lies in the effectiveness of the process in sealing the surface cracks and improving the condition of the pavement surface by introducing a protective layer, which also improves ride quality and user comfort in many cases. However, the short lifespan of chip seals generally results in more frequent paving and more disruption to traffic on roadways in Oregon. Since the percentage of chip seals in the overall pavement maintenance and rehabilitation is not expected to decrease within the next 2-3 years, improving the long-term performance of chip seals can solve various budgetary issues, which is expected to result in better roadway network conditions for Oregonians. Using Recycled Asphalt Pavement (RAP) materials in chip seals can also reduce the environmental impact and the overall cost of the process. Other strategies to improve the performance of chip seals [fiber reinforcement (about 12-year expected service life) and sandwich chip seals for fixing failed chip seal sections] should also be investigated to increase the life span of this cost-effective paving method.

2. What **final product or information** needs to be produced to enable this research to be implemented?

The following products and information will be developed in this research study: i) the quantified impact of HFST on roadway skid resistance and potential accident rates (by conducting locked wheel skid tester and dynamic friction tester on roads with and without HFST); ii) a more cost-effective and environmentally friendly process for HFST material production and construction to increase its widespread use in critical locations to reduce accident rates; iii) information regarding the effectiveness of fiber-reinforcement in improving the longevity of chip seals in Oregon; iv) information regarding the effectiveness of sandwich chip seals for fixing failed chip seals rather than completely replacing them (as an adaptation to heatwaves and climate change); and v) methods to incorporate RAP materials into chip seal and HFST construction to reduce cost and environmental impact and improve performance.

3. (Optional) Are there any individuals in Oregon who will be instrumental to the success of implementing any solution that is identified by this research? If so, please list them below.

Name	Title	Email	Phone
Timothy Earnest	Assist. Materials Engineer	Timothy.Earnest@odot.oregon.gov	(503) 986-3079
Chris Duman	Pavement Quality & Materials Eng.	Christopher.L.DUMAN@odot.oregon.gov	(503) 986-6574
David Dobson	Statewide Structural Materials Engineer	David.DOBSON@odot.oregon.gov	(503) 986-6628
Dean Chess	Product Evaluation Coordinator	Dean.M.CHESS@odot.oregon.gov	(503) 986-3059

4. Decision making lenses

Please complete the following three sections. Your answers to these questions will be applied on a programmatic basis to support agency decisions. Answering yes to the questions below is not required. Resolving a narrowly focused technical research problem may meet agency needs without answering yes to any of the following questions. The ODOT Research Section will seek a balanced portfolio some projects will answer yes to one of the three categories below (e.g. climate, equity, and/ or safety) and other projects in a different category.

We are looking for an overall program balance and no one project is expected to balance all categories. Generally, a research problem statement is expected to be able to answer yes with clear and verifiable information in only one of the three categories below, some projects may be able to answer yes in two or even three categories. Some projects (i.e. needs focused on specific elements of infrastructure design), may have no yes answers but may still be high value research need.

Climate

Oregon recognizes the climate crisis and makes systemic changes to reduce emissions caused by travel. Every mile driven in Oregon is powered by a clean source of fuel. We seek research that supports construction and maintenance operations are carbon neutral and investments in mobility that support travel by low and no emission modes. While every research project may not result in a reduction in emissions, transportation investments overall support emission reductions to achieve state goals. Oregon envisions a transportation system that is resilient in the face of seismic and climate events and impacts to the degradation of the natural environment are reduced. Our vision includes a transportation infrastructure is built in a way that avoids impacts on key habitat and results in better environmental conditions for wildlife and native vegetation. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

4f. Will addressing the **transportation issue** identified as a need in Question 1 develop, or validate methods for the estimation, measurement, or monitoring of transportation generated greenhouse gasses (GHG)?

☐Yes ☒No ☐Unsure

4g. If climate or GHG is not the focus of this **transportation issue** identified in this problem statement, will the research apply a GHG analysis to transportation infrastructure, planning, operations, maintenance, or materials?

☒Yes ☐No ☐Unsure

4h. Will the addressing the **transportation issue** include development or testing of construction practices, methods, or materials to establish potential reductions in greenhouse gas emissions?

☒Yes ☐No ☐Unsure

4i. Will the solving the **transportation issue** in question 1 study or support the reduction of vehicle miles traveled and single occupancy vehicle travel or support transition to electric vehicles (or other types of zero emission vehicles) or low-carbon alternative fuels?

☐Yes ☒No ☐Unsure

4j. Will the solving the **transportation issue** in question 1 lead to work that will support, measure, monitor, transportation system resilience in response to expected climate events, effects, or natural disasters in general?

☐Yes ☒No ☐Unsure

4k. Will the solving the **transportation issue** in question 1 lead to work that may result in better environmental conditions for wildlife and native vegetation ?

☐Yes ☒No ☐Unsure

4l. If you answered yes to any of the climate questions above or can provide alternative details related to climate, please provide additional information:

The potential of using locally available materials with lower costs for HFST construction, which is currently about six times more expensive than chip seals, is expected to reduce not only the paving costs but also the GHG emissions by reducing hauling distances. Using recycled asphalt pavements (RAP) for chip seal and HFST construction will also reduce the environmental impact and cost of both strategies. This aspect addresses the "Stewardship of Public Resources" and "Sustainability and Climate Action" priorities of the OTP.

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 CO2/year, while ODOT's total annual emissions from all operations were calculated to be 182,592 MT CO2/year (Proudfoot and Toneys 2022). This important result shows that low-cost paving materials and strategies, such as chip seals and HFST, 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

Equity can have many dimensions and impacts relating to communities, and transportation. It is important that problem statement proposals clearly explain in what capacities are equity dimensions or impacts being examined within problem statements. It is a goal of the OTP to "Improve access to safe and affordable transportation for all, recognizing the unmet mobility needs of people who have been systemically excluded and underserved. Create an equitable and transparent engagement and communications decision-making structure that builds public trust". Proposed research may have the intent of studying elements of this goal or apply analysis to specific transportation topics to ensure the resulting research recommendations is consistent with our equity goals. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

4a Is the **transportation issue** identified as a need in Question 1 specifically focused on transportation equity?

☐Yes ☒No ☐Unsure

4b If the **transportation issue** is not focused on transportation equity, will the primary topic be assessed for equity benefits or impacts within the research project?

☒Yes ☐No ☐Unsure

4c Is the implementation of potential findings from this research likely to directly involve participation from an identified group that would benefit from an equitable process or outcome?

☐Yes ☒No ☐Unsure

4d Is the intended final product or information expected to support ODOT's equity efforts (Including but not limited to supporting one of the equity related objectives of the ODOT's Strategic Action Plan or Oregon Transportation Plan) ?

☒Yes ☐No ☐Unsure

4e If you answered yes to any of the equity questions above or can provide alternative details related to equity, please provide additional information:

Although this research proposal does not directly address transportation equity, developing strategies and methods to improve traffic safety in areas with heavy rain and freeze events is critical. This research study has the potential to provide a safer driving experience for Oregonians living in areas with higher skid-resistance issues and provide a more equitable safety level for all road users.

Safety

Research outcomes may include interventions and countermeasures to prevent or reduce the frequency of crashes or other causes of transportation-related injury or death; or may include measures to reduce severity of injury (including prevention of death) after a crash or other injurious event. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan, Oregon Transportation Safety Action Plan and Oregon Transportation Plan.

4m. Will solving the **transportation issue** in question 1 support improving **safety culture** for either transportation workers or the traveling public?

☒Yes ☐No ☐Unsure

4n. Will the solving the **transportation issue** support improving safety through **healthy and livable communities**?

☒Yes ☐No ☐Unsure

4o. Will solving the **transportation issue** support improving safety through using **best available technologies**?

☒Yes ☐No ☐Unsure

4p. Will solving the **transportation issue** support improving safety through **communication and collaboration**?

☒Yes ☐No ☐Unsure

4q. Will the solving the **transportation issue** support improving safety through **investing strategically**?

☒Yes ☐No ☐Unsure

4r. If you answered yes to any of the safety questions above or can provide alternative details related to safety, please provide additional information:

This proposed research study clearly addresses the "Economic and community vitality" and "Safety" goals of the Oregon Transportation Plan (OTP). High Friction Surface Treatments (HFST) are a reliable strategy for improving roadway conditions while significantly increasing road users' safety by increasing road surface friction. According to field performance studies conducted by Pennsylvania, Kentucky, and South Carolina DOTs (FHWA, 2014), total crash reductions in critical locations (mostly curves and areas with lower visibility) due to the application of HFSTs are 100%, 90%, and 57%, respectively. These significant reductions in accident rates for the three states point out the importance and effectiveness of HFST.

5. Other comments:

REFERENCES:

1) FHWA (2014) Frequently Asked Questions about High Friction Surface Treatments (HFST). www.fhwa.dot.gov/innovation/everydaycounts/edc-2/pdfs/fhwa-cai-14-019_faqs_hfst_mar2014_508.pdf

2) Coplantz (2023) 2022 ODOT Pavement Condition Report. www.oregon.gov/odot/Construction/Documents/Pavement/2022_condition_report_maps.pdf

3) Proudfoot, J., and A. Toneys. 2022. *Oregon Department of Transportation Operational Greenhouse Gas Reductions: Best Practices & Recommendations*.

6. Corresponding Submitter's Contact Information:

Name:	Erdem Coleri
Title:	Associate Professor
Affiliation:	Oregon State University
Telephone:	(541) 737-0944
Email:	erdem.coleri@oregonstate.edu

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