Oregon Department of Transportation

Stage 1 Research Problem Statement

Number: *25-50*

Proposed Title: Improving Roadway Smoothness and Long-Term Performance by Low-Cost Thin Asphalt Overlays and Diamond Grinding

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

Over the last 40 years, the major focus of highway agencies has shifted from constructing new pavements to preserving existing infrastructure. The possibility of decreasing pavement conditions in Oregon over the next decade due to the inadequate pavement program funding levels (ODOT, 2023) created a need for low-cost yet effective alternative ways to preserve roadway network. Since distresses (top-down cracking and rutting) are generally confined to the upper layers for well-constructed thick asphalt pavement structures, the removal of the top one or two layers and replacing them with thin asphalt overlays was determined to be a cost-effective strategy to preserve and improve highway network condition. Although the benefits of thin overlays are evident, the impact of thin overlays on long-term pavement performance needs to be quantified (Watson and Heitzman, 2014). The most cost-effective thin overlay maintenance frequencies, materials (asphalt mixtures and new engineered tack coat types), and thicknesses for different climate regions and traffic levels in Oregon need to be determined by using laboratory testing, field investigations, mechanistic-empirical design methods, life cycle assessment (LCA), and life-cycle cost analysis (LCCA). The life-cycle cost and environmental benefits of thin overlays should be determined to develop more effective long-term pavement preservation and maintenance strategies in Oregon.

Diamond Grinding and Grooving is another strategy that is commonly used to restore the smoothness and driver comfort of the roadway at a significantly lower cost than other alternatives. Diamond grinding is less destructive than milling and can create a smooth concrete surface by removing the irregularities on the surface of the pavement that were caused by different concrete pavement distresses, such as cracking, studded tire damage, faulting, curling, and warping of the slabs. Although diamond grinding is mostly used for concrete pavements, it has also started to prove itself as an effective strategy for improving smoothness on asphalt-surfaced pavements (IGGA, 2015; NYDOT, 2018). However, cost, performance, and environmental impact analysis should be conducted to determine the potential impact of widely implementing this option in Oregon.

2. Document how this **transportation issue** is important to Oregon and will meet the [Oregon Research Advisory Committee Priorities]

House Bill 4139 required forming a technical advisory committee (TAC) to develop different strategies to reduce ODOT's greenhouse gas (GHG) emissions. By following the directives of the House Bill, a committee was formed by ODOT in 2023 to address several needs for reducing the GHG emissions of ODOT. ODOT will report the progress of the TAC annually to the Oregon Transportation Commission and an interim committee of the Legislative Assembly related to transportation. One major factor affecting a vehicle's GHG emissions is surface roughness. Internation Roughness Index (IRI), *a parameter calculated from the data collected by inertial profiler laser systems to quantify the roughness of the pavement surface,* values higher than 90in/mile can create significantly higher vehicle operating costs and emissions (in terms of higher fuel consumption, tire wear, and vehicle maintenance costs). According to the preliminary results of the ODOT-FHWA climate challenge project on smoothness, **the carbon emissions that can be saved in a year by reducing ODOT's roadway network roughness from 90in/mile to 40in/mile is equivalent to about 80% of ODOT's current annual carbon emissions from all activities including road and bridge construction.** This level of reduction in roughness is also expected to save road users $40-50 million annually via reduced fuel consumption, vehicle maintenance costs, and tire replacements. This significant effect of roughness on user costs and emissions points out the importance of pavement smoothness. In addition, roads with higher roughness levels will experience higher truck loads than smoother roads due to higher dynamic truck loads (can be about 30% higher than static load of the truck) experienced on the pavement as a result of the higher truck axle acceleration in the vertical direction (Cebon, 1999). The damage from a loaded truck on a rough pavement surface can be about 2 to 3 times higher than the damage created by the same truck on a smooth pavement surface. Thus, smooth pavements stay smooth and crack-free longer, which can also create significant cost and emission savings in the long term.

Since concrete pavements last longer than other pavement types, significant studded tire damage on the concrete pavement surfaces is commonly observed as deformations in the wheel paths. Water can accumulate in these depressions along the wheel paths and create significant safety issues due to reduced skid resistance as a result of hydroplaning (vehicle tire losing its grip on the pavement surface due to the surface friction reduced by the standing water). For this reason, the deformations along the wheel paths need to be fixed by constructing thin asphalt overlays or diamond grinding the pavement surface to remove the wheel path depressions to **improve road user safety**.

Thin asphalt overlays and diamond grinding and grooving are low-cost strategies to reduce pavement surface roughness. Reducing surface roughness will reduce vehicle maintenance, fuel consumption, and tire replacement costs and also save emissions from fuel consumption and tire production. In addition, reduced roughness levels on the roadway can significantly reduce cracking accumulation and other types of load-related distresses on the ODOT roadway network. According to a recent field trial conducted by ODOT, the surface roughnesses of Continuously Reinforced Concrete Pavements (CRCP) were reduced from about 90-100inches/mile to 50-60inches/mile by just diamond grinding the surface. Constructing a thin asphalt surface can also reduce roughness levels down to 30-40in/mile. These levels of reduction in surface roughness point out the effectiveness of those two strategies for **preserving ride quality and reducing cost and emissions** for road users and ODOT.

This proposed research study clearly addresses the *"Economic and community vitality"* and *"Safety"* goals of the Oregon Transportation Plan (OTP) by improving pavement surface and driving conditions via lower-cost strategies, reducing roughness-related vehicle operating costs, and reducing the length of roadway surfaces with low skid resistance in a rain event. Reduction in vehicle emissions due to reduced roughness is expected to result in significantly more energy and emission savings than any other ODOT activity conducted for maintaining and rehabilitating pavement structures. In addition, the use of low-cost strategies for maintaining pavement surface smoothness (via thin asphalt overlays and diamond grinding) is expected to reduce maintenance costs for pavements. These aspects address the *"Stewardship of Public Resources"* and *"Sustainability and Climate Action"* priorities of the OTP.

The proposed research study also addresses the *"Safety"*, *"Climate"*, *"Process, material, or equipment improvements"*, and *"Cost reductions or savings to construction, operations, or asset maintenance"* priorities of the Oregon Research Advisory Committee.

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

In this proposed research study, pavement LCA, LCCA, and mechanistic-empirical design procedures will be used to produce information and guidelines for ODOT to implement in thin overlay design and construction methods. To provide performance data for the LCA and LCCA components of the study, the AASHTOWare software (formerly known as Mechanistic-Empirical Pavement Design Guide-MEPDG) will be used to simulate different pavement design strategies and predict their design lives for different traffic levels and climate regions in Oregon. This research will also provide recommendations for improving the thin overlay mix design criteria. Best materials for thin overlay construction (including asphalt mixture gradation, polymer modification, warm-mix additives, and tack coat emulsion types) will also be identified.

A best practice document for diamond grinding and grooving to improve asphalt and concrete pavement surface conditions will also be developed based on the results of this proposed research study. The document will also include new grinding technologies and methods for achieving smoother pavement surfaces. The environmental and cost benefits of surface improvements will also be quantified via cradle-to-grave pavement LCA and LCCA methods. A detailed document outlining the suggested implementation process and suggestions for field pilot section construction will also be provided.

4. (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.

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5. Other comments:

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

3) HB4139 (2023) Relating to reductions of greenhouse gas emissions in the state's transportation system https://olis.oregonlegislature.gov/liz/2022R1/Downloads/MeasureDocument/HB4139/Enrolled

4) International Grinding and Grooving Association (IGGA). (2015). Diamond Grinding Asphalt Pavement for Improved Performance. https://dot.ca.gov/-/media/dot-media/programs/maintenance/documents/correcting-finish-hma-surfaces-casey-holloway-a11y.pdf

5) New York Department of Transportation (NYDOT). (2018). New Standard Specification Section 505 – Diamond Grinding. www.dot.ny.gov/portal/pls/portal/mexis_app.pa_ei_eb_admin_app.show_pdf?id=12837

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