SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

25-45 – Increasing Asphalt Recycling in Oregon through Improvements in Cold and Hot Mix Asphalt Production Processes

Recycleability of Cold mix asphalt as well as hot mix asphalt is limited by plant-level processes. Performance testing methods specifically for cold mix asphalt currently do not exist in Oregon. Since the material properties of cold mixtures are significantly different from other road construction materials, unique test and rapid quality assurance methods, specifications, and new strategies need to be developed and implemented to achieve high-performance EAC mixtures with high RAP contents. Similarly, heating processes for hot asphalt mixtures is the most limiting factor of the amount of reclaimed asphalt that can be used. For this reason, alternative heating processes and new technologies for heating and processing reclaimed asphalt should be evaluated.

ODOT OBJECTIVES

The major objective of this proposed research study is to reduce the cost and environmental impact of pavements in Oregon by increasing the RAP content of cold (also known as EAC) and hot-mix asphalt paving materials without sacrificing long-term performance

BENEFITS

Due to the economic and environmental benefits of increased asphalt recycling, this proposed research study directly addresses the *"Economic and Community Vitality"*, *"Stewardship of Public Resources"*, and *"Sustainability and Climate Action"* goals of the Oregon Transportation Plan (OTP). It also directly addresses the *"Climate", "Process, material, or equipment improvements", and "Cost reductions or savings to construction, operations, or asset maintenance"* research focus areas of ODOT.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 36 months.
Estimated Project Budget: $385,000
ODOT Support:

Jeff Shambaugh – State Pavement Engineer
Chris Duman – State Pavement Quality & Materials Engineer

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/25-45.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2025

PROBLEM NUMBER AND TITLE

25-45 - INCREASING ASPHALT RECYCLING IN OREGON THROUGH IMPROVEMENTS IN COLD AND HOT MIX ASPHALT PRODUCTION PROCESSES

RESEARCH PROBLEM STATEMENT

Increasing asphalt recycling has the potential to significantly reduce the overall cost of paving and material production emissions. Although increasing the recycled asphalt pavement (RAP) content in asphalt mixtures is beneficial in many aspects, the primary concern when using high RAP mixes lies in the altered long-term durability properties of asphalt mixtures. Aged and oxidized binder in RAP is less ductile than a virgin binder and gives rise to failure under repeated high axle loads and thermal effects. For this reason, in Oregon, the use of RAP in asphalt mixes is currently limited to about 30% by weight of the mix for medium to high-traffic locations (Level 3 asphalt mixtures) and 20% for locations with heavy truck traffic (Level 4 asphalt mixtures).

In an ongoing ODOT research project (SPR862), different types of additives and virgin asphalt binder combinations were mixed with different aggregate size distributions to achieve high RAP (around 40%) asphalt mixtures that perform equal or better than the current lower RAP alternatives. According to the results of the research study, by using the most suitable mixture combinations, it may even be possible to increase the RAP content to 50%. It was also determined that **significant cost and greenhouse gas (GHG) savings** could be created by implementing high RAP asphalt mixtures at 40% and eventually at the 50% level.

Although the production of high RAP asphalt mixtures with high durability is possible according to the laboratory results, increasing RAP content at the production stage has several other challenges related to the operational capabilities of the asphalt plants and the inadequacy of the current standard plant procedures for high RAP asphalt mixture production. For instance, in a laboratory study, it is always possible to bring different constituents of the asphalt mixtures to ideal temperatures by using multiple calibrated ovens. However, heating systems at asphalt plants are not always structured to directly control the temperature of different components in the mixture due to the larger size of the plant production.

In Oregon, RAP material is generally indirectly heated by mixing it with the superheated aggregates. Thus, increasing the RAP content to higher levels may require even higher aggregate temperatures (since the virgin aggregate volume will be reduced), which may significantly increase plant emissions. Not heating the aggregates to the required temperature will result in lower RAP temperatures that will significantly reduce the blending of the RAP and virgin binders and the performance of the mixture. For this reason, alternative heating processes and new technologies for heating and processing RAP should be evaluated in a research study. This example was just related to the heating issues expected during the production of asphalt mixtures with high RAP contents. There are also other potential issues that need to be addressed at the production level for successful implementation *(protecting RAP and aggregates from moisture, addressing the RAP stockpile variability effect, mixing additives at different stages, etc.)*. Increasing RAP content without addressing the potential production challenges will result in a mixture with reduced durability. For all these technical reasons, a production-level research study should be conducted in collaboration with the asphalt industry to complement the findings of ODOT research project SPR862 and achieve a seamless implementation of high RAP asphalt mixtures with high long-term performance in Oregon.

Emulsified Asphalt Concrete (EAC), *also commonly referred to as Cold-Mix Asphalt (CMA)*, with high RAP contents **(about 60-80% of the mix can be RAP)** stands out as another cost-effective paving strategy for pavement construction in Oregon. In addition, since EAC production does not require excessive heating of

aggregates and the binder at an asphalt plant, production of EAC is significantly less carbon intensive than its Hot-Mix Asphalt (HMA) and Warm-Mix Asphalt (WMA) counterparts.

EAC has been used in Oregon for road construction, especially in colder regions. However, although comprehensive design and performance testing methods are currently being implemented and used by ODOT for HMA and chip seals, performance testing methods specifically for EAC currently do not exist in Oregon. Since the material properties of EAC mixtures are significantly different from other road construction materials, unique test and rapid quality assurance methods, specifications, and new strategies should be developed and implemented to achieve high-performance EAC mixtures with high RAP contents.

RESEARCH OBJECTIVES

The major objective of this proposed research study is to reduce the cost and environmental impact of pavements in Oregon by increasing the RAP content of cold (also known as EAC) and hot-mix asphalt paving materials without sacrificing long-term performance.

WORK TASKS, COST ESTIMATE AND DURATION

1) **Literature review:** A comprehensive literature review will be conducted to summarize plant production processes for HMA and EAC. Successful high RAP examples from the U.S. and worldwide will be collected and evaluated based on their similarities and differences to Oregon cases.
2) **Industry survey:** An industry survey will be conducted to determine current plant production processes for EAC and HMA materials in Oregon. Opinions of the industry on methods to increase RAP content without any long-term performance issues will also be collected and summarized.
3) **Plant and laboratory level trials for process and technology development:**
   a. HMA: The tasks and the potential objectives of this phase of the study are to:
   - Determine the most effective processes followed by the industry domestically and abroad to process and heat RAP particles at the asphalt production plants.
   - Determine the effectiveness of the aggregate superheating process commonly used in Oregon.
   - Identify reasonable alternatives to address the uneven RAP heating problem of Oregon's industry.
   - Identify additional plant constraints that limit the amount of RAP that can be used in HMA pavements.

   b. EAC: The tasks and the potential objectives of this phase of the study are to:
   - Determine the suitability of rejuvenators and other additives for high RAP EAC applications.
   - Assess the viability of using existing EAC pavements as RAP through laboratory performance testing.
   - Develop laboratory and field quality assurance (QA) tests to determine the susceptibility of high RAP EAC to fatigue cracking, deformation, raveling, thermal cracking, and several other factors.
   - Develop QA tests for high RAP EAC to measure moisture content, evaporation rate, curing time, and other tests to determine when to start compacting and when to open the road to traffic.
4) **Life-cycle cost analysis (LCCA)and life-cycle assessment (LCA):** The performance of mixes quantified in Task 3 and the cost of all mixes will be used to determine the LCCA (life-cycle cost) and LCA (environmental impact) benefits of increasing RAP content for EAC and HMA materials.
5) **Construction of field pilot sections:** Based on the findings from the four previous tasks, field pilot sections will be constructed using the most promising EAC and HMA material strategies with high RAP contents. The performance of the sections will be monitored and compared to the parts of the roadway constructed with lower RAP contents to determine the effectiveness of high RAP mixes at the field level.

Key Deliverables: **i)** Asphalt mix design recommendations and strategies to reach higher RAP contents for EAC and HMA materials without sacrificing long-term performance; **ii)** A detailed plant production process recommended to improve the performance of high RAP asphalt mixtures; **iii)** Laboratory and field test methods for evaluating EAC mixture performance; **iv)** Rapid field quality assurance and product acceptance tests for EAC; and **v)** The most effective rejuvenator brands and mixing processes.

Estimated Project Length: 36 months. ***Estimated Project Budget:*** $385,000

IMPLEMENTATION

The following products and knowledge will be created and implemented in this proposed research study: **i)** The most suitable processes and technologies for producing high-performance HMA and EAC materials with high RAP contents; **ii)** Guidelines regarding the use of rejuvenators, new emulsion types, and other additives to improve EAC and HMA performance and increase the RAP content; **iii)** Identify and address plant-related constraints that limit the amount of RAP that can be incorporated in HMA production; **iv)** The most suitable laboratory and field quality assurance test methods for evaluating the fatigue cracking, deformation, raveling, and thermal cracking performance of EAC mixtures; **v)** Rapid field quality assurance and product acceptance tests for the measurement of in-situ EAC moisture content, evaporation rate, curing time (to determine when to start compacting and open to traffic), density, penetration resistance, and shear resistance; and **vi)** Information regarding the suitability of using existing EAC pavements as RAP.

POTENTIAL BENEFITS

According to the 2022 ODOT Pavement Condition Report (Coplantz, 2023), the current ODOT pavement program is significantly underfunded ($280M is needed while the expected funding for 21-24 STIP is less than $115M and 24-27 STIP is around $110M), which is expected to result in a major decline in pavement conditions in Oregon within the next five years. It was also mentioned in the same report that *"The pavement funding levels for the 27-30 STIP may be as low as $65 million per year or even lower. This funding level is lower than it has been in decades".* The reductions in funding in previous years have already started to show their effects as a decline in pavement network conditions for all five regions in Oregon (see Figure 9 in the 2022 ODOT Pavement Condition Report). For this reason, **reducing the cost of paving through increased asphalt material recycling is critical to combating current budget problems.**

By following the directives of House Bill 4139, a technical advisory committee (TAC) was formed in 2023 to develop strategies to reduce ODOT's greenhouse gas (GHG) emissions. 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. According to a recently published ODOT research report (Proudfoot et al., 2021), about 50% of ODOT's annual emissions are from the production of paving materials. According to an ongoing ODOT research project (FHWA Climate Challenge), a 15% reduction in asphalt production emissions is possible by increasing paving materials' recycled asphalt (RAP) content from 20% to 40%. This significant reduction, combined with renewable fuel use for asphalt concrete production, has the potential to result in **a 16% reduction in the overall annual GHG emissions of ODOT.**

Due to the **economic and environmental benefits of increased asphalt recycling**, this proposed research study directly addresses the *"Economic and Community Vitality"*, *"Stewardship of Public Resources"*, and *"Sustainability and Climate Action"* goals of the Oregon Transportation Plan (OTP). It also directly addresses the *"Climate", "Process, material, or equipment improvements", and "Cost reductions or savings to construction, operations, or asset maintenance"* research focus areas of ODOT.

PEOPLE

ODOT champion(s):

Timothy Earnest, Assist. Materials Eng., Timothy.Earnest@odot.oregon.gov, (503) 986-3079
Chris Duman, Pavement Quality & Materials Eng., Christopher.L.DUMAN@odot.oregon.gov, (503) 986-6574
Jeff Shambaugh, State Pavement Eng., Jeff.SHAMBAUGH@odot.oregon.gov , (503) 986-5764

Problem Statement Contributors:

Erdem Coleri, Associate Professor, erdem.coleri@oregonstate.edu, (541) 737-0944
Cristhian Galvez, ODOT Research Coordinator, cristhian.galvez@odot.oregon.gov, (503) 986-3538

STAFF REVIEW PAGE

Literature Check

TRID&RIP

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

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 stakeholders

- 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