Oregon Department of Transportation

Research Stage 1 Problem Statement

Number 26-46 – "Performance Requirements for Durability: Transport Properties that Aid the Agency in Assessing Long-Term Permeability"

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

Historically, the concrete industry has relied on strength as a surrogate for durability; however, direct durability performance is needed for mixtures with lower global warming potential (GWP). The work will:

1) outline the classes of concrete/exposures that the state needs to specify/accommodate;
2) recommend equipment procurement for the state to perform the test;
3) train state personnel and consultants in testing;
4) outline how performance criteria can be established and perform measures typical in Oregon;
5) outline a quality assurance (QA) approach for low-carbon specifications;
6) help contractors establish a quality control procedure;
7) develop and implement training materials;
8) demonstrate the value of using electrical methods for low-carbon materials.

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

This project will provide ODOT with several deliverables. Specifically, the project will provide a state-of-the-art specification language for a variety of concrete exposures in Oregon. A program will be outlined that provides training materials and trained personnel. The work will also outline a series of benchmarks (by the way of electrical properties such as resistivity or F-Factor) for current ODOT concrete mixtures (of which they are familiar). The work will also outline how concrete mixtures can be improved to reduce the GWP (GHG emissions). A QC/QA program will be outlined that includes instruction on typical levers that can be used control the mixture parameters that impact electrical properties.

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.

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Austin Johnson	Concrete Quality Coordinator	Austin.L.JOHNSON@odot.oregon.gov	503-510-1384
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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

The project asses GHG/GWP associated with testing more durable concrete materials and seeks methods to keep this low and reduce it further

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

The project asses GHG/GWP associated with testing more durable concrete materials and seeks methods to keep this low and reduce it further

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

The project asses GHG/GWP associated with testing more durable concrete materials and seeks methods to keep this low and reduce it further

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

The project asses GHG/GWP associated with testing more durable concrete materials and seeks methods to keep this low and reduce it further

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:

See responses above

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:

While the project is not focused on equity the process can be used by all and provides a level platform for evaluating material solutions.

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

Establishing practices for quantifying and specifying long-term durability reduces the number of construction cycles removing construction workers from dangerous situations. This also reduces traffic at construction sites which have been known to result in a substantial increase in accidents and fatalities.

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:

These results are provided in the sections above.

5. Other comments:

Title: Performance Requirements for Durability: Transport Properties that Aid the Agency in Assessing Long-Term Permeability

Category: LCTM Quality Assurance (QA) and LCTM specifications

The adoption of lower-carbon concrete is resulting in a shift from cements that are predominately clinker-based to systems with high clinker replacements or novel non-clinker-based cement systems. Historically, the concrete industry has relied on strength as a surrogate for durability; however, direct durability performance is needed for mixtures with lower global warming potential (GWP). Historically, permeability has been assessed by prescriptively setting the water to cement ratio or using the RCPT testing (ASTM C1202) and many specifications are written around this. Recently, resistivity testing (AASHTO T358, T402, AASTHO C1876) has been added as a part of AASHTO R101 to reduce the time of testing and to improve accuracy. Resistivity works well for conventional concrete; as the clinker fraction is reduced or eliminated, changes in the pore solution (i.e., the fluid in the pores) impact how these tests should be interpreted. The formation factor (F-Factor) allows the resistivity to be applied to a wide range of concrete binders by accounting for the resistivity of the pore solution (i.e., the fluid in the concrete). New procedures have been developing for measuring pore solution including a cold-water leaching method from OSU and an embedded sensor from the PIs that has been expanded on by FHWA. The F-Factor enables agencies to specify and ensure adequate permeability performance is provided by low GWP materials so that long-term performance can still be achieved. The goal of this work will be to relate the GWP from EPDs to resistivity classes. This work will develop the processes to 1) outline the classes of concrete/exposures that the state needs to specify/accommodate; 2) purchase equipment for performing the test; 3) train state personnel and consultants in testing; 4) outline how performance criteria can be established (i.e., relates F-Factor to known performance) and perform measures typical of those in the state; 5) outline a quality assurance (QA) approach for low-carbon specifications; 6) help contractors establish a quality control procedure; 7) develop and implement training materials; and 8) demonstrate the value of using F-Factor for low-carbon materials. In the end, the state will have state-of-the-art specification language, trained personnel, EPDs for the mixtures used, and benchmarks for F-Factor with their existing concrete (of which they are familiar) as well as a QC/QA program that points to the levers that control the mixture parameters that impact F-Factor.

6. Corresponding Submitter's Contact Information:

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