Oregon Department of Transportation

Research Stage 1 Problem Statement

Number 26-54 – "Evaluation of Ultra-High Performance Concretes for Longevity and Climate"

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

Ultra-high performance concretes (UHPC) have advanced considerably through research conducted around the world. They are on the verge of becoming widely deployed for new transportation infrastructure designs in the US. The material provides benefits of higher compressive and tensile strength and toughness, allows thinner sections (less weight), and reportedly possess chloride resistance and greater durability. The last two benefits are especially important considering that the expected life of UHPC is anticipated to exceed that of present bridge materials (>75 year). The increased strength and toughness are expected to improve performance during extreme events such as those during an earthquake. The most likely application to ODOT practice is for link slabs. To ensure investments that deploy UHPCs in ODOT projects will achieve long-term durability, provide safe performance, reduce maintenance costs, and thereby reduce summative environmental impacts from carbon costs of grey transportation infrastructure, research is needed. This research needs to determine if Oregon applications of UHPC can endure, even after millions of loading cycles produced from thousands of trucks passing over them for almost a century, while simultaneously being exposed to chlorides from winter deicing operations or ocean salt sprays, and then provide the strength, ductility, and toughness needed to survive when the Cascadia earthquake strikes. This research will evaluate UHPC materials used in bridge systems to ensure that they can achieve the benefits of the expected long-life in our unique Oregon service and hazard conditions.

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

To implement the research findings into practice will require the following products:

1) Standardized testing and evaluation standards. These standards are needed to fairly predict the long-term durability and end-of-life performance of present and emerging UHPC formulations under repeated service-level loading, environmental exposure, and overload.
2) Design specifications, standardized details, and design examples for UHPC use in bridge systems that can achieve the expected seismic performance, even after years of service life and environmental exposure. This would include updates to ODOT BDM.
3) Training and outreach to ODOT engineers and consultants on the new standards and specifications and that can demonstrate their application to practice.

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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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:

While climate is not the focus of this research, the research outcomes have direct impacts on climate. Concrete materials contribute significantly to GHG. Present materials have shorter design lives and thus will require more frequent replacements and maintenance than those purportedly available with UHPCs. The impacts on GHG emissions can be comparatively assessed for different UHPC and conventional materials, operational lives, and hazard resilience estimates (4g and 4h). This study seeks to assess whether the expected long life and corresponding benefits can be achieved in Oregon considering our environmental exposure conditions and seismic hazards (4j).

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:

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:

The proposed research essentially evaluates the safety of transportation structures constructed with UHPC. Safety of the motoring public who make use of it daily, and the safety and security of all Oregonians who will necessarily rely on transportation systems, of which bridges serve as critical links, to perform as intended during the most critical of moments, such as during and after an earthquake (4n). Choosing to bring to service the best available material technology, UHPC, if it can achieve longer life with reduced maintenance needs, will reduce ODOT crew exposures to hazardous working conditions and reduce motorist exposure to construction zones (4o). Selection of one material over another in design is making a strategic investment decision with the expectation that it will safely serve as intended (4q).

5. Other comments:

6. Corresponding Submitter's Contact Information:

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