Oregon Department of Transportation

Research Stage 1 Problem Statement

Number 26-52 – "Practical Blended Cementitious Mixtures to Reduce CO2"

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

The concrete industry is pushing toward lower carbon footprint systems. However, research is needed to elucidate the local materials in Oregon (and surrounding areas) that can be used to produce low carbon concrete while still achieving the desired mechanical and durability properties necessary for implementation. A recent approach that is gaining significant traction in the U.S. are LC3 systems (limestone calcined clay cement). These cementitious blends have been shown to reduce CO_{2eq} emissions without compromising design strength and durability. Several challenges and also opportunities exist for full-scale implementation in Oregon.

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

CO_{2eq} emissions from cement production account for approximately 8% of the world's CO2eq contribution. In mid-2022 most U.S. cement suppliers made a significant change by increasing the substitution of finely ground limestone from less than 5% to 10-15%. In combination with replacements by supplementary cementitious materials (SCMs), CO_{2eq} emissions can be lowered by as much as 50% or more. Utilizing, locally available SCMs, particularly natural pozzolans, can be used in place of the calcined clay portion of a typical LC3 system where kaolinitic/reactive clays are not available. Finally, while later-age strength is retained, or even exceeded compared to 100% OPC systems, the early-age strength (e.g., prior to 7 days) can be reduced when compared with systems with high cement replacements. Such blended cements must be carefully designed to maximize the synergistic benefits while obtaining desired mechanical and durability properties. Several different acceleration techniques to overcome the early-age strength impacts are possible, and merit investigation in this proposed project so that carbon reduction goals, constructability, and performance can be met. This research will identify local materials that can be potentially used to produce low carbon concrete, will assess the fresh and hardened characteristics of these systems, and will propose needed changes to ODOT specifications for these new materials.

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
Zechariah Heck	Sustainability Program Manager	Zechariah.HECK@odot.oregon.gov	503-779-4815
David Dobson	Structural Materials Engineer	David.DOBSON@odot.oregon.gov	970-900-7118
Austin Johnson	Concrete Quality Coordinator	Austin.L.JOHNSON@odot.oregon.gov	503-510-1384

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 blended cementitious mixtures developed through this research project will reduce the CO_{2eq} footprint of normal and high strength concrete mixtures by 30-50%. This will be quantified using an open source greenhouse gas emission calculation tool recently utilized by the research team on a CalTrans project.

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:

Reducing the CO_{2eq} footprint of our most used building material, concrete, will result in improved health and livability for Oregon. Further the increased use of regional resources will be an economic benefit for the state and keep more state dollars within the state rather than importing materials from other states and/or countries. The dollar value of this could be quantified using an appropriate life cycle costing, or up front costing tool/database in conjunction with appropriate ODOT staff and personnel.

5. Other comments:

6. Corresponding Submitter's Contact Information:

Name:	Jason H. Ideker
Title:	Professor
Affiliation:	Oregon State University
Telephone:	541-737-9571
Email:	jason.ideker@oregonstate.edu

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