

Research Stage 1 Problem Statement

PROPOSED TITLE: Enhancing Transportation Safety and Sustainability with Mortar-Free Interlocking Hybrid Blocks for Retaining Walls and Road Barriers

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

Retaining walls and barriers are critical components of Oregon's transportation infrastructure, particularly in areas prone to erosion, landslides, and heavy rainfall, as well as protecting traffic from roadside hazards. Traditional construction methods rely on mortar, which increases labor costs, requires skilled labor, and slows down project timelines. Additionally, these methods often lack adaptability for automated construction. There is a pressing need for modular, mortar-free systems that can be deployed quickly and sustainably, especially in remote or high-risk areas.

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

To enable the implementation of this research, the final product must include a comprehensive set of validated design specifications, performance data, and construction guidelines for mortar-free interlocking blocks specifically engineered for transportation infrastructure applications such as retaining walls and barriers. These deliverables should demonstrate the structural integrity, durability, and environmental resilience of the blocks under various loading and climatic conditions typical of Oregon’s transportation corridors. Additionally, the research must evaluate the feasibility of automated construction methods using robotic systems, ensuring compatibility with ODOT’s operational workflows and workforce capabilities.

To support adoption, the research should identify and propose updates to specific ODOT documents, including the ODOT Standard Specifications for Highway Construction, Bridge Design and Drafting Manual, and Construction Manual. These updates would address the inclusion of recycled plastic as a structural material, modular block assembly procedures, and automation-friendly construction practices. The project should also provide evidence-based recommendations for integrating these blocks into ODOT’s asset management and maintenance protocols, aligning with strategic goals such as reducing carbon emissions, improving safety, and enhancing cost-efficiency in public infrastructure delivery.

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.

I doubt if other institutions might be included in this. Someone from Republic Services might be contacted.

Name	Title	Email	Phone

4. Other comments:

This research builds upon prior work supported by the OSU Advantage Innovation Day Award, which focused on developing resource-efficient mortar-free blocks for automated construction. The proposed extension into transportation infrastructure applications, specifically retaining walls and barriers, represents a strategic evolution of technology. The integration of recycled plastic into the block design not only addresses sustainability goals but also aligns with Oregon’s broader environmental objectives, including reducing landfill waste and promoting circular material economies.

Eventually, key tasks proposed for this research include refining block geometry for structural interlocking, developing marine-grade and transportation-grade material formulations, and simulating automated assembly using robotic systems. Testing will encompass compressive strength, shear resistance, and environmental durability under various conditions, including freeze-thaw cycles and exposure to moisture. There is potential for collaboration with some Oregon-based companies that recycle plastic, such as Resco Plastics and Denton Plastics, which will ensure a reliable supply of recycled plastic and provide insights into material processing and quality control.

The project also draws on recent literature, including studies on experimental performance evaluation of an innovative hybrid barrier system filled with waste materials (Yumrutas, 2022), which highlight the limited knowledge about the potential for using natural/waste materials for roadside barrier applications. Experimental results showed that hybrid barriers made from waste materials can serve as an alternative to conventional obstacles. They can be recommended for placement due to their aesthetic design and environmentally friendly features. These insights will inform the design and interlocking mechanisms, ensuring that the blocks meet both structural and environmental performance criteria. The research outcomes will contribute to ODOT’s strategic goals and provide a foundation for future innovations in modular, automated, and sustainable infrastructure systems.

5. State of Oregon Decision Making Lenses

State decision making lenses are a part of the state of Oregon’s policy structure. State policy and federal policy are not always aligned. The state will prioritize research according to state policy, however ODOT may be required to skip prioritized proposals based on constraints placed on the use of federal funds. If state funds are available ODOT will attempt to fund prioritized research that is deemed ineligible for federal funding.

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 a high value research need.

Climate

Oregon recognizes the climate crisis and makes systemic changes to reduce emissions caused by travel. To that end, we seek research that reduces carbon emissions from construction activities and materials, and from maintenance equipment and operations. Oregon envisions a transportation system that is resilient, this means a system that is durable in the face of seismic events and extreme weather to avoid negative impacts, withstand them or bounce back quickly to resume system function. We seek research that improves the ability of the transportation system to adapt or cope with more frequent and extreme weather events. This may include innovations in data and data sharing, construction materials and project design, communication, emergency planning and response, and more. Similarly, we seek research that avoids negative impacts on key habitats and ecosystems that can buffer or reduce damage to infrastructure and improve 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](#).

5a. 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 gases (GHG)?

☐ Yes

☐ No

☒ Unsure

5b. 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

5c. Will 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

5d. Will 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

5e. Will the solving the **transportation issue** in question 1 lead to work that will support, measure, or monitor, transportation system resilience in response to expected climate events, effects, or natural disasters in general?

☒ Yes☐ No☒ Unsure

5f. Will 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

5g. If you answered yes to any of the climate questions above or can provide alternative details related to climate, please provide additional information:

The project focuses on developing construction materials that reduce reliance on traditional mortar, thereby lowering carbon emissions. Using recycled plastic helps reduce waste and promote environmental preservation. The blocks are designed to be durable and resilient, supporting the longevity of infrastructure in the face of climate events. The research supports Oregon's climate goals by promoting sustainable construction practices.

Equity

Equity can have many dimensions and impacts relating to communities and transportation. It is important that problem statement proposals clearly explain the equity dimensions or impacts being examined. Oregon commits to social equity in the OTP, specifically 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.* We seek research that studies elements of this goal or applies analysis to specific transportation topics to ensure the resulting research recommendation is consistent with agency equity goals. For definitions and details please review the equity vision, goals, and objectives of the [ODOT Strategic Action Plan](#) and [Oregon Transportation Plan](#).

5h. Is the **transportation issue** identified as a need in Question 1 specifically focused on transportation equity?

☐ Yes☒ No☐ Unsure

5i. 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

5j. 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

5k. 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

5l. If you answered yes to any of the equity questions above or can provide alternative details related to equity, please provide additional information:

While equity is not the primary focus, the project supports equitable outcomes by enabling cost-effective and scalable construction methods. This can improve access to safe infrastructure in underserved communities. The use of recycled materials also promotes environmental justice.

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](#).

5m. Will solving the **transportation issue** in question 1 support improving **safety culture** for either transportation workers or the traveling public?

☒ Yes

☐ No

☐ Unsure

5n. Will the solving the **transportation issue** support improving safety through **healthy and livable communities**?

☒ Yes

☐ No

☐ Unsure

5o. Will solving the **transportation issue** support improving safety through using **best available technologies**?

☒ Yes

☐ No

☐ Unsure

5p. Will solving the **transportation issue** support improving safety through **communication and collaboration**?

☒ Yes

☐ No

☐ Unsure

5q. Will solving the **transportation issue** support improving safety through **investing strategically**?

☒ Yes

☐ No

☐ Unsure

5r. If you answered yes to any of the safety questions above or can provide alternative details related to safety, please provide additional information:

The research directly addresses critical transportation safety concerns by designing and deploying mortar-free interlocking blocks for retaining walls and road barriers. These structures play a vital role in protecting road users from hazards such as slope failures, roadside erosion, and vehicle collisions. By improving the structural integrity and reliability of these components, the proposed blocks can reduce the likelihood of infrastructure failure, which is essential for maintaining safe travel conditions across Oregon's transportation network.

Additionally, the modular and automation-ready nature of the blocks enhances safety during construction and maintenance operations. Traditional methods for building barriers and retaining walls often require extensive manual labor in high-risk environments, such as steep embankments or active roadways. The proposed system minimizes on-site labor and accelerates installation timelines, thereby reducing worker exposure to traffic and construction-related hazards. This approach aligns with ODOT's safety goals by promoting safer construction practices and delivering infrastructure that better protects both the traveling public and transportation personnel.

6. Corresponding Submitter's Contact Information:

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7. ODOT Sponsor Contact Information (Required if Submitter is not an ODOT employee)

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This form is not a grant application or contract document. Please do not include proprietary information on this form. Once this form is received ODOT may revise and publish the problem statement. If selected, ODOT will assign investigator(s) of the department's choosing to conduct research.