

Research Stage 1 Problem Statement

PROPOSED TITLE: [Assessment of concrete bridges without plans enabled by imaging and image fusion](#)

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

The load posting of a bridge can have devastating social and economic consequences for the affected communities, as well as result in additional greenhouse gas emissions, due to extra lane miles traveled from driving out of direction by avoiding the posted bridge. Often, a posting is not the result of inadequate capacity or a deficiency but due to a lack of available as-built plans and affiliated information such as design specifications and materials testing results. Imaging and image fusion using ground penetrating radar and ultrasonic array data offers a practical solution that has not been evaluated and adopted sufficiently in bridge assessment. The resulting final images are digital cross-sectional views of the interior of a concrete member, allowing bridge engineers to accurately examine, visualize, and ascertain pertinent geometric and material properties when as-built information is not available, ultimately enabling accurate assessments and supporting analytical load ratings, with the ultimate goal to avoid unnecessary bridge load postings. While the focus of this work will be on slabs, girders, and crossbeams of reinforced and prestressed concrete bridges, the methods will also be fully applicable to bridge substructure members.

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

The final product is a detailed practical guide and procedures to enable NDT professionals to perform imaging and image fusion based on GPR and ultrasonic array measurements of concrete bridge members, allowing bridge engineers to perform condition assessments and enable analytical load ratings based on the resulting images. The guide will present the applications and limitations of imaging and image fusion, describe step-by-step procedures and codes to perform them, discuss necessary calibration and validation procedures, as well as discuss expected uncertainties and errors associated with the results. To produce this information, imaging and image fusion will be evaluated on laboratory specimens as well as some selected in-service concrete bridge members, in collaboration with ODOT.

A training workshop and educational materials will be developed and made available in an open access format. The workshop will consist of theory and hands-on application in a real-world setting. The plan is to continue to offer the workshop in the following years, which ensures that the research has a lasting impact.

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
Travis Kinney	Bridge Preservation Service Leader, Sr. Associate	Travis.Kinney@deainc.com	541-914-7219

4. Other comments:

The PI has extensive experience with the non-destructive testing (NDT) methods pertaining to this work. In a recent example, he demonstrated the use of imaging and image fusion to allow an analytical load rating to be applied to a prestressed concrete bridge without plans. Thanks to the use of this approach, the bridge did not have to be load posted. On the other hand, using ODOT’s simplified *Bridges Without Plans* procedure would have resulted in a load posting for several vehicles. Reference to open access article: <https://www.mdpi.com/2813-477X/2/3/22>.

Note that this is a problem that goes beyond Oregon’s borders. As an example, the PI has had an exchange with the Idaho Department of Transportation (ITD), which faces similar challenges with cost for scanning and load testing local agency bridges without plans. The proposed approach offers a practical, effective, yet inexpensive solution to tackle this problem.

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:

Load posted bridges require trucks to drive out of direction, creating increased lane miles. Reducing the number of load posted bridges thus results in reduced overall greenhouse emissions. Avoiding having to drive out of direction also saves cost for the trucking industry (fuel and truck maintenance), as well as road maintenance cost for ODOT.

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:

If bridge plans are unknown, then the bridge is posted based on the *Bridges Without Plans* procedure. A load posted bridge can result in a significant economic impact to those around the structure. Smaller local communities may be more likely to have not maintained good construction records and therefore may be disproportionately impacted by bridges without plans.

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

Analytical bridge load ratings enabled by imaging and image fusion will improve the safety of the traveling public by providing a greater understanding of the bridges' load capacity to facilitate timely bridge load postings.

6. Corresponding Submitter's Contact Information:

Name:	Thomas Schumacher
Title:	Professor & Associate Chair of Graduate Programs
Affiliation:	Portland State University
Telephone:	503-725-4199
Email:	thomas.schumacher@pdx.edu

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

Name:	Jon Rooper
Title:	Senior Load Rating Engineer
Crew Number:	
Telephone:	503-302-6188
Email:	jonathan.w.rooper@odot.oregon.gov

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.