SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

25-86 An Innovative Technology to Prevent Wind-Induced Fatigue Cracks in the Astoria-Megler Bridge.

PROBLEM SUMMARY

The Astoria-Megler Bridge is a 4.1-mile-long river crossing over the Columbia River between Washington and Oregon. It is the longest continuous truss bridge in North America. The nearest alternative river crossing is approximately 50 miles away at Rainier, OR. The bridge was opened in 1966 and has experienced fatigue cracks in many of the long vertical members of the truss. These cracks required expensive remediation. ODOT has made repeated attempts over the decades to stiffen the structural members to prevent additional cracks from forming. A research study conducted previously by OSU captured wind-induced torsional vibrations of the bridge members. This study showed that the bridge members can accumulate large numbers of stress cycles during certain wind events and fatigue cracking would be expected at high stress ranges. In the most recent bridge inspection (2023), many cracks were again observed in truss members. Considering that the continued safe operation of the bridge is essential to Oregon, research is proposed to develop an innovative remediation technology that can eliminate the torsional responses that are causing the cracking by providing both additional damping and altering the wind-flow separation around the truss members.

ODOT OBJECTIVES

The final product would be creation of a new device that would be attached to the truss members. The device would both provide damping and alter the cross-section profile and surface roughness thereby reducing or eliminating wind-induced torsional response of the bridge members. This would reduce the magnitude and amplitude of stresses in the bridge members and prevent wind-induced fatigue cracking of the bridge verticals, providing a long-term and economical solution to the repeated cracking observed in the bridge.

BENEFITS

The proposed outcome of this research would reduce damage to the bridge and thus reduce disruptions and costs associated with repairs and rehabilitation associated with the damage. The reduction in fatigue damage also has the potential to extend the life of this extremely valuable asset.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 24 months.
Estimated Project Budget: $340,900.
ODOT Support:

Steven Lovejoy	Senior Engineer	steven.c.lovejoy@odot.oregon.gov	(503) 931-4764
Ray Bottenberg	Bridge Engineer	Raymond.D.BOTTENBERG@odot.oregon.gov	(503) 551-7934

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/25-86.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2025

PROBLEM NUMBER AND TITLE

25-86: An Innovative Technology to Prevent Wind-Induced Fatigue Cracks in the Astoria-Megler Bridge

RESEARCH PROBLEM STATEMENT

The Astoria-Megler Bridge is a 4.1-mile-long river crossing over the Columbia River between Washington and Oregon. It is the longest continuous truss bridge in North America. The nearest alternative river crossing is approximately 50 miles away at Rainier, OR. The bridge was opened in 1966 and has experienced fatigue cracks in many of the long vertical members of the truss. These cracks required expensive remediation. ODOT has made repeated attempts over the decades to stiffen the structural members to prevent additional cracks from forming. A research study conducted previously by OSU captured wind-induced torsional vibrations of the bridge members. This study showed that the bridge members can accumulate large numbers of stress cycles during certain wind events and fatigue cracking would be expected at high stress ranges. In the most recent bridge inspection (2023), many cracks were again observed in truss members. Considering that the continued safe operation of the bridge is essential to Oregon, research is proposed to develop an innovative remediation technology that can eliminate the torsional responses that are causing the cracking by providing both additional damping and altering the wind-flow separation around the truss members.

RESEARCH OBJECTIVES

The final product would be creation of a new device that would be attached to the truss members. The device would both provide damping and alter the cross-section profile and surface roughness thereby reducing or eliminating wind-induced torsional response of the bridge members. This would reduce the magnitude and amplitude of stresses in the bridge members and prevent wind-induced fatigue cracking of the bridge verticals, providing a long-term and economical solution to the repeated cracking observed in the bridge.

WORK TASKS, COST ESTIMATE AND DURATION

<u>Task 1: TAC Meeting #1</u>

Project kick off meeting. Time Frame: July 2024

<u>Task 2: Draft Literature Review</u>

Time Frame: 4 months following notice to proceed.

<u>Task 3: Develop Laboratory-Scale Tests of Bridge Members</u>

Based on Task 2, laboratory-scale specimens will be designed and fabricated with the necessary details that are important for dynamic response properties including mass, stiffness, and cross-sectional shape. Time Frame: 4 months

<u>Task 4: Laboratory Scale Dynamic Tests with Supplemental Damping</u>

Using the results of Tasks 2 and 3, the test specimens will be experimentally tested in the laboratory to quantify natural frequencies and inherent damping. Supplemental damping will be added to assess its effectiveness. Time Frame: 10 months

<u>Task 5: TAC Meeting #2</u>

Time Frame: 16 months after notice to proceed.

<u>Task 6: Laboratory-Scale Wind Tests with Supplemental Damping and Shape Changes</u>

Using the results of Tasks 2, 3, and 4, specimens will be experimentally tested in a laboratory using artificially generated steady winds to identify critical wind speed(s) and directions that excite torsional modes of response for the bridge members. Specimens will initially have only inherent damping and then be retested using supplemental damping systems. In addition, the cross-sectional shapes will be modified by addition of strakes, fins, and other surface treatments to alter wind-flow separation. Then both surface changes and supplemental damping will be combined. Time Frame: 4 months

Task 7: Field Implementation and Monitoring

Using the results of the prior tasks, the most promising damping and cross-sectional shape modifications will be implemented on two (2) of the most vulnerable bridge members. Instrumentation plans will be developed to capture relevant weather conditions (wind speed and direction) as well as sensors that capture torsional response of the members. Two other similar members will be instrumented without the modifications. Sensor installation and monitoring would be performed by an outside contractor. Time Frame: 9 months

Task 8: Draft Final Report

Time Frame: 6 months concurrent with Task 7

Task 9: TAC Meeting #3

Time Frame: 23 months after notice to proceed.

Task 10: Final Report

Time Frame: Within 1 month after Task 10

Key Deliverables: The deliverables would be Plans and Specifications for acquiring and installing components on the bridge to reduce or eliminate wind induced torsional vibrations to prevent fatigue cracking on retrofitted truss members.

Estimated Project Length: 24 months.
Estimated Project Budget: $340,900.

IMPLEMENTATION

Implementation of this research will require the development of a construction project to install the resulting damping components, the appropriation of the cost of the project and the successful execution of the project. It is also advisable that some sort of monitoring follow the construction project to verify the performance of the damping components and watch for unintended consequences.

POTENTIAL BENEFITS

The proposed outcome of this research would reduce wind-induced fatigue damage to the bridge members and thus reduce disruptions and costs associated with repairs and rehabilitation associated with the damage. The reduction in fatigue damage also has the potential to extend the life of this extremely valuable asset.

PEOPLE

ODOT champion(s):

Steven Lovejoy	Senior Engineer	steven.c.lovejoy@odot.oregon.gov	(503) 931-4764
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Problem Statement Contributors:

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STAFF REVIEW PAGE

Literature Check

TRID&RIP

☒ A review of TRID & RIP databases found no existing research that answers the research question.

This research is specific to the Astoria-Megler Bridge.

Technology & Data assessment

☒ No Identified T&D output

☐ At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

The design and specifications that this project produces are not intended to be transferred to any other ODOT structures or projects.

Cross-agency stakeholders

- There will be maintenance and inspection implications to any changes made to the bridge structure.
- The on-going problem of nesting birds on the bridge means that both the construction and long-term presence of the additions/changes to the bridge could affect birds protected by a variety of environmental laws and regulations.
- Since the Astoria-Megler Bridge is jointly managed by Oregon and Washington, construction and maintenance related to the bridge needs to be coordinated between the two states.