SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

24-12 Post Installed Resin Bonded Anchor for Side Mounted Bridge Rail

PROBLEM SUMMARY

The AASHTO Manual for Assessing Safety Hardware (MASH) is the new state of the practice for the crash testing of safety hardware devices for use on the National Highway System (NHS). The implementation of MASH will necessitate the examination and evaluation of bridge rails currently being used by State DOTs. Ohio and Illinois DOTs paid for research and testing of a MASH TL-4 Steel Side-Mounted Beam and Post Bridge Rail with cast-in-place anchors. However, we cannot use this rail to upgrade existing side mounted bridge railing with post installed resin bonded anchors as this type of connection has not been crash-tested. The current design equations in the AASHTO LRFD Bridge Design Specifications (LRFD) and American Concrete Institute (ACI) design manuals are overly conservative and do not support the use of post installed connections. In order to verify and use the equations in the Ohio/Illinois report, we will need actual testing of post installed bridge rail connections to confirm the modified equations for designing post installed resin bonded connections.

ODOT OBJECTIVES

ODOT has a large number of substandard side mounted bridge rails in the bridge inventory that need to be upgraded. The research and testing outcome will produce design procedures for future bridge rail replacements. The research and testing results will provide tested connections and design methodologies for ODOT to use on upcoming side mounted rail replacements for all of the non-standard (not meeting MASH) side mounted bridge rails throughout the state. Under current practice, projects require a Design Exception to cover the lack of specific design procedures for each side mounted bridge rail retrofit/replacement.

BENEFITS

ODOT is undertaking bridge-railing upgrades to comply with updated MASH requirements. This is fully consistent with ODOT's mission to provide a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economy thrive. The application of resin anchors for completing railing upgrades offers the potential to reduce construction cost, increase construction speed, and produce the level of safety needed for the upgrades. Unfortunately, design guidance is lacking, and this uncertainty means designers are not able to improve designs and reduce construction costs using resin anchors for bridge railing upgrades. This research will reduce the risk to the Agency and save the staff costs for a large number of bridge rail Design Exceptions.

SCHEDULE, BUDGET, AND AGENCY SUPPORT

Estimated Project Length: 24 months
Estimated Project Budget: $400,000
ODOT Support: Alex Lim, Steel Bridge Standards Engineer, alex.k.lim@odot.oregon.gov

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/24-12.pdf

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2024

PROBLEM NUMBER AND TITLE
24-12 Post installed resin bonded anchor for the side mounted bridge rail

RESEARCH PROBLEM STATEMENT
The AASHTO Manual for Assessing Safety Hardware (MASH) is the new state of the practice for the crash testing of safety hardware devices for use on the National Highway System (NHS). The implementation of MASH will necessitate the examination and evaluation of bridge rails currently being used by State DOTs. Ohio and Illinois DOTs paid for research and testing of a MASH TL-4 Steel Side-Mounted Beam and Post Bridge Rail with cast-in-place anchors (Pena, et al., 2020). However, we cannot use this rail to upgrade existing side mounted bridge railing with post installed resin bonded anchors as this type of connection has not been crash-tested. The current design equations in the AASHTO LRFD Bridge Design Specifications (LRFD) and American Concrete Institute (ACI) design manuals are overly conservative and do not support the use of post installed connections. Dickey, et al., 2012 attempted to refine the design equations. In order to verify and use the equations in this report, we will need actual testing of post installed bridge rail connections to confirm the modified equations for designing post installed resin bonded connections.

RESEARCH OBJECTIVES
ODOT has a large number of substandard side mounted bridge rails in the bridge inventory that need to be upgraded. The objective of research and testing is to produce design procedures for future bridge rail replacements. This will eliminate the need for a large number of Design Exceptions, provide for safer side mounted bridge rails for numerous bridges across Oregon, increase safety for traveling public by preventing a heavy truck penetrating through or rolling over a bridge railing or a passenger vehicle collision causing vaulting of a substandard bridge railing.

The research and testing results will provide tested connections and design methodologies for ODOT to use on upcoming side mounted rail replacements for all of the non-standard (not meeting MASH) side mounted bridge rails throughout the state. No further design is required. Under current practice, projects require a Design Exception to cover the lack of specific design procedures for each side mounted bridge rail retrofit/replacement. This research will reduce the risk to the Agency and save the staff costs for a large number of bridge rail Design Exceptions.

WORK TASKS, COST ESTIMATE AND DURATION
Multiple component (bogie impacting a single post) testing to verify the epoxy bond strength of post installed resin bonded anchors for side mounted bridge rail, and confirm the use of the combined cone and bond equations for post installed anchors as discussed in Chapter 3 of this Dickey et al., 2012. Also, a published report that includes testing procedures used, statistical data obtained, design equations or validation of the previously reported equations and summarized conclusions for implementation.
Rough estimate for the cost is about $30,000 for each bogie impacting a single post, multiple tests are needed. The scope includes the following:

- Construction of a small section of bridge deck edge
- Acquisition / fabrication / installation of a single post attached with epoxy anchors into concrete for each test
- Performing as many surrogate vehicle (bogie) impact tests as needed to statistically establish design equations for anchor capacities

- Demolition and removal of test article
- Documentation and reporting of test findings

Key Deliverables: Testing and analysis of the performance of resin anchors for ODOT guardrails in ODOT bridge decks. This testing and analysis will provide the information needed to establish a design for MASH compliant guardrail retro fits. A published report with a refined design approach and equations for post installed resin bonded anchor connections for side mounted bridge rail replacement projects.

Estimated Project Length: 24 months
Estimated Project Budget: $400,000

IMPLEMENTATION

New design and construction recommendations will be produced based on experimental and analytical results. Research findings will be synthesized into a report appendix that demonstrates specification language that can incorporated into existing ODOT practices (BDM) and AASHTO-LRFD specifications, Section 5 (as has been demonstrated in past research products). These products will enable AASHTO-LRFD compatible design of resin anchors for bridge railing upgrades.

POTENTIAL BENEFITS

ODOT is undertaking bridge-railing upgrades to comply with updated MASH requirements. This is fully consistent with ODOT's mission to provide a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economy thrive. The application of resin anchors for completing railing upgrades offers the potential to reduce construction cost, increase construction speed, and produce the level of safety needed for the upgrades. Unfortunately, design guidance is lacking and this uncertainty means designers are not able to improve designs and reduce construction costs using resin anchors for bridge railing upgrades.

PEOPLE

ODOT champion(s):

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Problem Statement Contributors:

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REFERENCES

Dickey, B. J., Faller, R. K., Rosenbaugh, S. K., Bielenberg, R. W., Lechtenberg, K. A., & Sicking, D. L. (2012). *Development of a Design Proceedure for Concrete Traffic Barrier Attachments to Bridge Decks Utilizing Epoxy Concrete Anchors.* Lincoln, NE: Midwest Roadside Safety Facility. Retrieved from https://mwrsf.unl.edu/researchhub/files/Report14/TRP-03-264-12.pdf

Pena, O., Faller, R. K., Rasmussen, J. D., Steelman, J. S., Rosenbaugh, S. K., Bielenberg, R. W., . . . Duren, J. T. (2020). *Development of A MASH Test Level 4 Steel, Side-Mounted, Beam-and-Post, Bridge Rail.* Lincoln, NE: Midwest Roadside Safety Facility. Retrieved from https://mwrsf.unl.edu/researchhub/files/Report391/TRP-03-410-20.pdf

STAFF REVIEW PAGE

Literature Check

TRID&RIP

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

The proposed research represents an application of resin anchors unique to ODOT. It will be building upon existing research by others, such as the studies mentioned in the problem statement.

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.

Cross-agency stakeholders

- List stakeholders or impacted units

Bridge Engineering Section

- Identify any issues of concern raised by an ODOT stakeholder. Note expected mitigation

The exact balance of boogie testing, analysis, and full testing will need to be worked out as part of the project development process.