TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): North Carolina DOT

INSTRUCTIONS:
Lead Agency contacts should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(493)*	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) XQuarter 3 (July 1 – September 30) ☐Quarter 4 (October 1 – December 31)
TPF Study Number and Title: TPF-5(493) – Investigation of Dual Grade/Hybrid Steel Plate Girders Utilizing Stainless Steels	

Lead Agency Contact: Jason Provines	**Lead Agency Phone Number:** (434) 293-1917	**Lead Agency E-Mail:** Jason.provines@vdot.virginia.gov
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:** 2/13/24
Original Project Start Date: 2/13/24	**Original Project End Date:** 11/13/26	**If Extension has been requested, updated project End Date:** N/A

Project schedule status:

X On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Funds Expended This Quarter	Percentage of Work Completed to Date
$400,000	$16,603	11%

Project Description:

Corrosion is a major concern for steel bridges, and if not properly designed for or mitigated, can lead to costly maintenance or service failures. One such option for making steel bridges more corrosion resistant is by using a dual grade girder, in which ASTM A709 Grade 50CR (50CR) plate is welded or bolted to conventional steel bridge girder components. In this case, the 50CR could be placed in a more corrosive environment, such as under a deck joint, and the conventional steel bridge material would be placed in other areas to allow for cost savings. However, there are still several unknowns related to welded and bolted dual grade connections.

This project will address those unknowns through experimental testing and analysis. Dual grade welds will be fabricated with different welding parameters, and PQR tests will be conducted to evaluate the welds for their structural performance. NDE research will be conducted to determine the suitability of eddy current to be used for weld inspection and to refine UT techniques to account for the high attenuation of austenitic weld metals and the different ultrasonic velocity and high anisotropic ratio of 50CR. Corrosion research will be conducted to assess the galvanic, stress, pitting, and crevice corrosion performance of dual grade connections. Results from that corrosion research will then be used to determine appropriate bolt types to be used in bolted dual grade connections. Additionally, torqued tension testing of stainless steel bolts will be conducted to determine tabulated values for installation pretension and installation criteria (such as rotation requirements for turn-of-nut installation).

After the experimental testing and analysis are complete, a final report will be developed. It will include recommendations for additions or revisions to be made in the AASHTO LRFD Bridge Design Specifications, AASHTO Bridge Construction Specifications, and AASHTO/AWS D1.5 that will allow welded and bolted dual grade connections to be designed, fabricated, and constructed successfully.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Overall

During this quarter, one of the co-PIs on this project, Dr. Matt Hebdon, changed jobs. He previously worked at the University of Texas-Austin (UT-A) but is now employed by Utah State University (USU). UT-A has since terminated their contract with VTRC as part of this project. VTRC is currently engaged in contract negotiations with USU to bring them on as a subcontract so that Dr. Hebdon can maintain his co-PI role on this project. VTRC previously notified NCDOT via email about this upcoming subcontract change and will continue to provide updates as this new subcontract is put in place.

Task 1 – Literature Review

The literature review was completed during a previous quarter. 100% completed.

Task 2 – Connection Testing & Verifying Design/Fabrication Details

Task 2A – Welded Dual Grade Connections

The research team has developed a specification to use for fabricating the dissimilar metal weld specimens for this project. This specification has been reviewed and approved by High Steel. High Steel has indicated that specimen fabrication will begin soon, depending on their welder availability. 5% completed.

Task 2B – Bolted Dual Grade Connections

No work was done on this task in this report period. 0% completed.

Task 3 – Final Report & Guidelines

No work was done on this task in this report period. 0% completed.

Virginia Transportation Research Council (VTRC)/University of Virginia (UVA) Dissimilar Metal Welding Research Project

VTRC cut all of the samples out of the dissimilar metal welded plates from High Steel. These samples included those using ATI 412 as the base metal for the stainless steel side of the welds. Some of the side bend tests have been conducted, with some having failing results. Analysis is still underway to determine the cause and potential solution for these test failures.

VTRC's atmospheric and salt water droplet corrosion testing has been running for approximately 4 months. At 3 months, some samples were removed from testing to be analyzed using optical and scanning electron microscopy. Corrosion pits are present near the weld fusion zone and in the base metals of the samples, as expected. Pit depth measurements are being conducted to determine if the galvanic corrosion at the weld fusion zone is more severe than in the base metal. Electrochemistry corrosion testing is also underway on the dissimilar metal welds.

Fillet weld break samples have been completed, with 3/12 samples having failing results. These failures were due to porosity and lack of fusion, both in the weld root. The fillet weld samples were welded using the same weld parameter settings that resulted in acceptable PQR test results. Analysis is still ongoing to determine the cause of these failures.

Anticipated work next quarter:

Overall

VTRC hopes to have a contract in place with USU for Dr. Hebdon to continue serving as a co-PI on this project.

Task 1 – Literature Review

This task has been completed. No additional work planned.

Task 2 – Connection Testing & Verifying Design/Fabrication Details

Task 2A – Welded Dual Grade Connections

High Steel is expected to begin welding specimens this quarter. The timeline for VTRC to receive specimens from High Steel will depend on welder availability at High Steel.

Task 2B – Bolted Dual Grade Connections

The research team will continue planning the dissimilar metal bolted connection corrosion tests. This will include assembling a list of items to be procured, including specimens, consumables, and testing equipment. This will focus on the bolted corrosion tests first since these tests will be conducted prior to the testing required to develop pretension values and installation criteria for stainless steel bolts.

Task 3 – Final Report & Guidelines

No work is planned on this task in the next report period.

VTRC/UVA Dissimilar Metal Welding Research Project

Analysis on the failed side bend and fillet weld tests is expected to be completed. Atmospheric, salt water droplet, and electrochemistry corrosion testing will also continue and some preliminary results are expected.

PQR tests are expected to be completed on the dissimilar weld samples using the 412 base metal. Once PQR tests are completed, corrosion testing of these samples will begin.

Significant Results:

Due to the early stages of this project, no significant results have been found yet.

VTRC/UVA Dissimilar Metal Welding Research Project

- According to welder observations, it is much easier to make good, quality welds using FCAW compared to SMAW.
- FCAW and SMAW welds made using a 309L consumable can pass PQR tests using typical welding parameters.

- Solidification and cold cracking can be alleviated in the SAW welds by using a single vee with backgouged joint at a low heat input.
- ATI 412 may be a potential alternative to 50CR. It has similar properties and much shorter lead times. PQR test results may confirm this when completed.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None.

Potential Implementation:

The primary research product will be the final report as developed in Task 3. Recommended changes to the AASHTO LRFD BDS/BCS and AWS D1.5 will be included in appendices within the report and will be based on the combined results from this research and the VTRC/UVA research dual grade welding research. Recommended changes will be written in a similar format to the specifications for which they are intended (i.e., recommendations for AASHTO specifications will follow a two-column specification/commentary format, and recommendations for D1.5 will follow a two-chapter specification/commentary format.). Using a similar format to existing specifications will allow these revisions to be more easily balloted and adopted.

The research team will present at conferences, meetings, and the AASHTO/NSBA Collaboration as well as develop journal publications to disseminate research findings to the steel bridge community. The research team will also present recommendations to the AASHTO COBS Technical Committee T-14 Structural Steel Design committee for review/adoption into the AASHTO LRFD BDS/BCS and to the Joint AASHTO/AWS Bridge Welding Subcommittee for review/adoption into AWS D1.5.