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:** **X** Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 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	$3,636.81	18%

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.):

Task 1 – Literature Review

No work was done on this task. 100% completed.

Task 2 – Connection Testing & Verifying Design/Fabrication Details

Task 2A – Welded Dual Grade Connections

Multiple challenges at VTRC caused progress to slow on the welded connections. The chiller system at VTRC was inoperable for approximately 2+ months. This chiller system cools the waterjet, so while the chiller was inoperable, the waterjet could not be used to cut samples from the PQR plates received from High Steel. The VDOT health division also wanted to take water/solid samples from the VTRC waterjet to ensure operator safety. It took 3 weeks to schedule the VDOT health division to come to VTRC, and VDOT health division would not allow VTRC to run the waterjet until their sampling was complete with passing results. On 3/31, VDOT health division told VTRC that all of their sampling had passed OSHA limits and VTRC could continue using the water jet. 10% 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

Corrosion testing and analysis has been the focus of this project for the last quarter. Accelerated corrosion chamber testing, similar to what will be done in the TPF project, was started on 3/31 and is expected to run for 80 days.

Electrochemistry testing is being completed on uncoupled metals (base metals and weld metal) and coupled metals. Results show galvanic corrosion occurring on both sides of the weld and pitting corrosion occurring on the 50CR side of the weld. The magnitude of the galvanic corrosion on the carbon steel side of the weld is an order of magnitude worse than on the 50CR side of the weld. This was confirmed through open circuit potential, potentiodynamic, and zero resistance ammeter testing. General corrosion is present on the carbon steel side of the weld, with much more severe corrosion in the carbon steel at the weld interface. Pitting corrosion is present on the 50CR side of the weld, with much more severe pits at the weld interface. 50CR next to the interface also experiences selective corrosion and intergranular cracking.

Analysis has also begun on the saltwater droplet testing samples. These were in a less aggressive environment than the two previously mentioned tests. Pitting corrosion is present on both sides of the weld, with pitting depths being deeper at the weld interface than those away from the interface.

Anticipated work next quarter:

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

Fillet welds and groove weld samples will be cut using the water jet. Samples will then be distributed to the agency conducting testing on them (VTRC, Missouri, or Utah State). Testing will commence.

Task 2B – Bolted Dual Grade Connections

The research team will begin 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

Accelerated corrosion chamber testing will be complete and test data will be analyzed. Analysis on the electrochemistry and saltwater droplet testing will continue.

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 is a viable alternative to 50CR. It has similar properties and much shorter lead times. Dissimilar metal welds made with ATI 412 should be made with a cored 309L filler. This type of filler is more resistant to cracking than the traditional solid wire 309L

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 Steel and Metals 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.