

Development of a Computational Model for Predicting Fracture in Rails Subjected to Long-Term Cyclic Fatigue Loading

Deliverables and Reporting Requirements for UTC Grants Awarded in 2023 (June 2023)

Exhibit D

Research Project Requirement Template

Recipient/Grant (Contract) Number: University of Texas Rio Grande Valley (UTRGV), Texas A&M University (TAMU)/Grant No. 69A3552348340

Center Name: University Transportation Center for Railway Safety (UTCRS)

Research Priority: Promoting Safety

Principal Investigator(s): Dr. David Allen (PI, TAMU), Dr. Yong-Rak Kim (Co-PI, TAMU)

Project Partners: MxV Rail

Research Project Funding: \$175,927.31 (Federal), \$88,058.15 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2023 to 08/31/2024

Project Description: It is well-known that one of the most significant causes of train derailments within the U.S. is rail fracture. Despite this fact, a reliable model for predicting fatigue fracture in rails has not yet been deployed within the U.S. We have recently been developing a two-way coupled multiscale computational algorithm for predicting crack evolution in ductile solids subjected to long-term cyclic loading. In this UTCRS project, we will adapt this model to the prediction of crack growth in rails. Concomitantly, with funding provided by TTCI (Now MxV), we have for nearly a decade performed long-term laboratory cyclic crack growth experiments on rails. We possess the ability to both predict crack growth due to cyclic fatigue in rails and utilize our experimental results to validate our predictive methodology. It is therefore our intention to: (1) modify our multi-scale computational model to predict crack growth due to cyclic fatigue in rails; (2) validate our model against our own previously obtained experimental results; and (3) develop a procedure based on our model for railway engineers to utilize to determine when rails should be inspected and potentially removed from service for cause, thereby enhancing rail safety.

US DOT Priorities: This project aligns with the following USDOT strategic goals, as established in the USDOT Strategic Plan for FY2022-FY2026: **(a) Safety:** The project directly addresses a major safety concern, rail fractures. **(b) Economic Strength:** The model produced will improve the accuracy and cost effectiveness of rail inspections and reduce the economic impacts of unplanned stoppages and derailments.

Outputs: Our research will result in the following at the end of a multi-year effort:

- a. The modification of our computational multi-scale model for rail fracture.
- b. The validation of our rail fracture model versus our previously obtained rail fracture experimental data.
- c. The dissemination of our computational model for predicting rail fracture to the U.S. railway community.
- d. An improved rail fracture model that is more user friendly.

Outcomes/Impacts: The primary long-term impact of this project is improved rail safety and efficiency by providing railway engineers with accurate, user-friendly models enabling quantifiable decision making about track replacement.

Final Research Report: Upon completion of the project, a URL link to the final report will be provided.