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

Recipient/Grant (Contract) Number: University of Texas Rio Grande Valley (UTRGV)/Grant No. 69A3552348340

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

Research Priority: Promoting Safety

Principal Investigator(s): Dr. David H. Allen (PI, Texas A&M University (TAMU)) and Dr. Yong-Rak Kim (Co-PI, TAMU)

Project Partners: MxV Rail

Research Project Funding: $199,426 (Federal), $100,313 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2024 to 05/31/2025

Project Description: It is well known that one of the most significant causes of train derailments within the U.S. is due to 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 an advanced computational algorithm for predicting crack evolution in ductile solids subjected to long-term cyclic loading. In this part of the UTCRS we will continue to adapt this model to the prediction of crack growth in rails. Concomitantly, with funding provided by MxV Rail, we have recently completed a decade-long series of experiments designed to provide data usable for the purpose of developing just such a model. We therefore possess the ability to both predict crack growth due to cyclic fatigue in rails, as well as to utilize our previously obtained experimental results to validate our predictive methodology. We have therefore begun the following rather challenging task of: 1) modifying computational model for predicting crack growth for application to cyclic fatigue in rails; 2) developing an experimental protocol for obtaining the material properties required to deploy our computational fracture model (described in our companion project entitled *Experimental Determination of Crack Growth in Rails Subjected to Long-Term Cyclic Fatigue Loading*); 3) demonstrate the effectiveness of our model for predicting the effects of long-term cyclic loading on rail fracture; and 4) 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 increasing rail safety. This project will be carried out with direct interaction and supervision by MxV Rail.

US DOT Priorities: This research aligns with the following U.S. DoT goals: safety, economic strength and global competitiveness, climate and sustainability, and transformation.

Outputs: The expected products include:

1. The continued modification of our computational multi-scale model for rail fracture.
2. The inclusion of newly obtained experimental fracture properties within our model (see our companion proposal).
3. The validation of our rail fracture model versus our previously obtained rail fracture experimental data.
4. The dissemination of our computational model for predicting rail fracture to MxV Rail.

Outcomes/Impacts: The broader impact of this research is that it will significantly impact railway safety via the development of more scientifically based track failure models that will significantly mitigate the probability of future environmentally and socially impactful train derailment incidents.

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