Experimental Determination of Rail Fracture Properties

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

Project Partners: MxV Rail

Research Project Funding: $110,763 (Federal), $55,382 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2025 to 08/31/2026

Project Description: There are approximately 1,100 train derailments per year in the U.S., and rail fracture is responsible for 7% of these derailments. Fatigue cracking is a widespread rail fracture issue and a significant safety concern accompanied by critical rail maintenance costs. Despite this fact, a reliable model for predicting fatigue fracture in rails has not yet been deployed within the U.S. In this UTCRS project, we have developed an advanced computational algorithm for predicting crack evolution in rails subjected to cyclic fatigue loading. Our fracture model demonstrates the feasibility and scientific rigor over the traditional phenomenological approaches, while several challenges remain for its successful practical implementation. One of the core challenges is to identify fracture properties in the model when rails are subjected to long-term cyclic fatigue loadings. This project aims to determine the fracture properties of railheads subjected to long-term cyclic fatigue loading. Toward that end, we will use our nonlinear cohesive zone (NCZ) fracture model implemented within the finite element computational algorithm and experimental results from the railhead fatigue testing which is currently under development and will be continued in 2025-2026 (as described in our companion UTCRS proposal entitled Experimental Determination of Crack Growth in Rails Subjected to Long-Term Cyclic Fatigue Loading). Successful identification of rail fracture properties (i.e., fundamental material properties) through this project will serve as a core piece for the development of TAMU's rail fracture modeling framework which will significantly impact the current railway safety and asset management program. This project will be carried out with direct interaction and supervision by MxV Rail personnel.

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

Outputs: The Expected outcomes from this project are:

(1) rail fracture properties that are determined through model calibration with rail fatigue testing;
(2) model simulation results compared with experimental rail fatigue testing results;
(3) a final report summarizing all research activities and findings/outcomes;
(4) presentations at major conferences; and
(5) journal publications and/or conference papers.

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 markedly 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.