Experimental Determination of Crack Growth in Rails Subjected to Long-Term Cyclic Fatigue Loading

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 Mr. Garrett Dorsett (Co-PI, TAMU)

Project Partners: MxV Rail

Research Project Funding: $55,243 (Federal), $27,622 (Non-Federal Cost Share)

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

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 a multiscale computational algorithm for predicting crack evolution in ductile solids subjected to long-term cyclic loading. With funding provided by MxV, we have also recently completed cyclic crack growth experiments on seven bi-axially loaded rails with internal cracks that had previously been in service. Within our companion UTC proposals, we are developing the ability to: a) characterize fracture parameters for deploying our advanced fracture mechanics model; b) utilize these parameters to predict crack growth due to cyclic fatigue in rails; and c) utilize our experimental results obtained over the previous decade of testing to validate our computational predictive methodology. In this UTCRS project, we will continue to perform intricate experiments on rails with internal cracks as a means of: 1) obtaining material properties, as described in our companion proposal Determination of Rail Fracture Properties, and 2) validating our advanced computational model under development in our companion proposal entitled Computational Model for Predicting Fracture in Rails Subjected to Long-Term Cyclic Fatigue Loading. Should this model development prove to be useful, it is our ultimate intention to utilize this new advanced technology as a tool for determining when rails with critical internal flaws should immediately be removed from service, or alternatively, how long rails in which subcritical flaws have been detected can be safely retained in service.

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

Outputs: This research will result in the following during the succeeding contractual year:

1. Refinement of our new advanced protocol for laboratory testing of previously in-service rails with defects;
2. The identification of proper material properties necessary to deploy our advanced computational model for predicting fracture in rails subjected to cyclic loading;
3. The continued improvement of our ability to accurately predict how long pre-damaged in-service rails can remain in service as functions of experimentally observed crack size, location, and orientation within rail heads; and
4. The dissemination of our computational model for predicting rail fracture to the U.S. railway community both via our research relationship with MxV Rail and our publications in technical journals.

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.