Temperature Effects on Rail Anchor Slip Force

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): Mustapha Rahmaninezhad (PI, UTRGV), Constantine Tarawneh (co-PI, UTRGV), and Arturo Fuentes (co-PI, UTRGV)

Project Partners: Stephen Wilk (Collaborator, MxV Rail), Ryan Medlin and Charity Duran (Collaborators, BNSF)

Research Project Funding: $65,842 (Federal), $62,077 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2024 to 08/31/2025

Project Description: In contemporary railway infrastructure, continuous welded rail (CWR) has gained prominence due to its numerous benefits over jointed track, including enhanced ride quality, prolonged rail and rolling stock lifespan, and reduced maintenance costs. However, the absence of joints presents challenges such as thermal expansion-induced track buckling. The Rail Neutral Temperature (RNT), the temperature at which the rail experiences zero stress, is crucial for managing compressive rail stresses, especially during hot weather conditions. Rail anchors play a pivotal role in maintaining track stability and managing RNT by resisting excessive longitudinal rail movement. Despite their significance, there remains a need to comprehensively understand their behavior under varying temperature conditions.

This study aims to investigate the influence of temperature on the slip force of anchored rails with different steel anchor types. Through a series of full-scale laboratory tests, we will evaluate the slip force under varying temperature regimes, considering different anchor types, tightness levels, and environmental conditions. The test setup to be used for this research will allow for precise control and measurement of temperature variables.

This study represents a significant step towards enhancing our understanding of the interaction between temperature and rail anchor performance, ultimately contributing to the advancement of railway infrastructure resilience and reliability. Additionally, this research will provide insights into how temperature fluctuations affect the effectiveness of rail anchors in preventing longitudinal rail movement. By understanding the temperature-dependent behavior of rail anchors, railway engineers can develop strategies to optimize track stability and mitigate the risk of buckling-induced disruptions.

US DOT Priorities: The proposed work in this project is aligned with four of the six USDOT strategic goals: **(a) Safety:** The project directly investigates a safety concern highlighted by Class I railroads and MxV Rail and BNSF engineers, focusing on the influence of temperature on the slip force of anchored rails with various steel anchor types. **(b) Economic Strength:** Unscheduled stoppages and field repairs cause serious economic losses for rail companies and their customers, and other users of the track. **(c) Equity:** UTRGV is a minority serving institution with an established record of training students from underrepresented groups and placing them in professional positions in the transportation industry. This project will directly employ one graduate and two undergraduate students who will perform experimental testing and data analysis. These students will also undergo professional training at MxV Rail and/or BNSF facilities as part of them receiving relevant workforce development opportunities. **(d) Sustainability:** By understanding the temperature-dependent behavior of rail anchors and their slip forces, optimizing the design and field implementation of these anchors can extend the lifespan of rail track ties. This optimization reduces environmentally significant derailments caused by rail buckling and rail pull-apart failures.

Outputs: The expected products include:

1. Completed modification of the self-reacting loading system on a testing platform.
2. Rail anchors slip force measurements for several different rail anchor types at varying temperatures.
3. Final report documenting all the acquired results.
4. One or more conference or journal publications prepared by the students and PIs. At a minimum, an abstract and a manuscript of a paper will be submitted to the Geo-Congress 2025 and TRB 2025, respectively.

Outcomes/Impacts: The primary impact of the research is characterizing and quantifying the rail anchor slip forces for several simulated rail service and temperature conditions. However, the research will have impacts beyond this specific question. **Industry Impact:** The results could lead to recommendations for industry best practices; for example, a recommendation for proper use of rail anchors under different environmental temperatures that can help optimizations or enhancements to increase slip resistance. **Educational Impact:** The project will be carried out by undergraduate and graduate students working under the supervision of the PIs, who will also conduct a workshop for UTRGV College of Engineering and Computer Science students. As a minority serving institution in a rapidly growing metropolitan area, we anticipate that most of the students will be from underrepresented groups, and that these students will have the chance to work with MxV Rail engineers and spend time during the summer at BNSF or MxV Rail facilities. The students will gain invaluable experience in designing and fabricating the laboratory test setup and in conducting tests according to AAR standards and guidelines. We anticipate that at least three undergraduates and one graduate student will participate in the various aspects of the project.

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