Advanced Model for Predicting Buckling in Rails

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))

Project Partners: MxV Rail

Research Project Funding: $91,402 (Federal), $45,701 (Non-Federal Cost Share)

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

Project Description: It is well-known that track buckling is one of the most commonplace causes of train derailments. Accordingly, with partial funding provided by our previous USDOT UTC and the Technology Transportation Center, Inc. (TTCI, now MxV Rail), we are continuing to develop a track buckling model for deployment by MxV Rail as a tool for predicting track buckling. A significant advancement over currently deployed track buckling models, our technology includes an open-source nonlinear finite element algorithm that is user-friendly. Briefly, our track buckling model accounts for the effects of the following on track buckling: rail neutral temperature (RNT), temperature change, lateral and longitudinal track walk; both lateral and longitudinal crosstie-aggregate interfacial friction; track modulus; nonlinear track liftoff; and broken spikes.

In the most recent contractual year, we have extended the model to include the following: nonlinear lateral friction, longitudinal friction, longitudinal track walk, and longitudinally varying track properties. Most importantly, we have extended the model to include displacement control, hence, giving us the ability to predict the rail configuration in the post-buckled state, thereby rendering our model to be the first rail specific algorithm with this capability.

During the previous year, we met with MxV personnel at least once per month, and we have both ported the model over to them for their personal use and supplied them with expert advice on how to run the algorithm themselves. A TAMU doctoral student spent two months at MxV Rail facilities the previous summer guiding their personnel on the use of our buckling model.

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

Outputs: The research will result in the following during the upcoming contractual year:

1. Further predictions of the effects of longitudinal and lateral nonlinear friction on track buckling;
2. Continued predictions of the range of buckling loads caused by variations in experimentally determined values of track modulus and ballast-crosstie coefficients of friction; and
3. Under the guidance of MxV Rail engineers, the development of a more simplified user-friendly version of the buckling algorithm, thereby rendering it readily accessible to track engineers.

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.