Rapid Detection of Track Changes from Onboard Data Acquisition Records

Exhibit D

Research Project Requirement Template

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

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

Research Priority: Promoting Safety

Principal Investigator(s): Dr. Dimitris Rizos (PI, UofSC), Dr. Yu Qian (Co-PI, UofSC)

Project Partners: N/A

Research Project Funding: $72,974 (Federal), $37,573 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2023 to 08/31/2024

Project Description: The objective of this research project is to develop a simple yet efficient track stiffness assessment system that can quickly estimate both the lateral and the vertical track stiffness and detect stiffness changes in space and time. The proposed system uses track geometry data and vehicle response data collected from instrumentation already onboard railroad inspection cars or locomotives (e.g. DOTX220, DOTX216). The acquired measurements are processed through the innovative Rapid Vehicle-Track Interaction (R-VTI) calculator developed by the PI to calculate the track stiffness while the vehicle is moving at its normal operation speed along the track. It is noted that the proposed system simply makes better use of existing data already being collected and does not require any additional instrumentation on the track. The proposed approach facilitates continuous track stiffness assessment along the network in space and time. In addition, it provides the real track stiffness values as vehicles move on top of the loaded track. The success of the proposed research will significantly improve railroad safety by effectively assessing the track stiffness and detecting stiffness changes from existing data being collected from the field without extra instrumentation burden to the railroads or the administration.

The proposed intelligent monitoring procedures apply to: (1) real-time monitoring and detection, (2) on-demand real-time monitoring of high-risk areas, and (3) accident investigation to identify possible contributing track conditions. These applications are facilitated by the fact that: (1) the vibration measurements are continuously acquired by onboard instrumentation, (2) R-VTI computes characteristic track responses (an indirect measure of track stiffness) that depend only on the track condition, and (3) the characteristic responses can be correlated to past responses for change detection.

US DOT Priorities: This project revolutionizes the current practice in vehicle-track interaction by solving the inverse problem to calculate the track dynamic stiffness and to detect changes over space and time, thus, addressing track infrastructure inspection for safer operations. It aligns directly with multiple USDOT strategic goals: **(a) Safety:** This project directly impacts safety of operations since it automates the quantification of the track stiffness and detects stiffness changes in real-time or near real-time for continuous track monitoring simultaneously with standard track geometry inspections, enabling performance-based maintenance that accounts for vulnerability, risk, and consequence. **(b) Economic Strength:** Service disruptions due to compromised track cause serious economic impact and loss of confidence in service reliability. Preventing track caused derailments minimizes the financial and societal impact, especially when hazmat is involved. **(c)**

Sustainability: The detection of factors that lead to track settlement and failures along the right of way enables predictive action for hazard mitigation, extending the life of track and structures. The proposed technology makes better use of the existing recourses and provides more useful information without the need for additional sensors and instrumentation on track, enabling performance-based maintenance. As a result, targeted maintenance operations that account for risk, vulnerability, and consequence lead to maximizing track life and minimizing the environmental impact. **(d) Transformation:** This project revolutionizes the current practice in vehicle-track interaction by solving the inverse problem to calculate the track dynamic stiffness and to detect changes over space and time. The proposed system can be integrated with existing automated track geometry inspection technologies without additional resources and becomes the backbone for developing performance-based maintenance practices.

Outputs: Specific outcomes stemming from this project's mission are centered around the need to improve the safety of track infrastructure and performance of track risk management, and will be captured in the following deliverables:

a. Report with technical details and documentation of the DSR of railcar and track parameters.
b. Journal or conference paper on the “Inverse Problem” algorithm and the extended R-VTI method.
c. Journal paper on track stiffness change detection method.
d. IP disclosure of the technology.

Outcomes/Impacts: This project aims to:

a. Revolutionize the current practice in vehicle-track interaction by solving the inverse problem to calculate the track dynamic stiffness and to detect changes over space and time.
b. Quantify the track stiffness directly based on the existing track geometry data, vehicle configurations, and vehicle dynamic responses data. The proposed technology makes better use of the existing recourses and provides more useful information without the need for additional sensors and instrumentation on track.
c. Automatically quantify the track stiffness and detect stiffness changes in real-time or near real-time for continuous track monitoring simultaneously with standard track geometry inspections.
d. Integrate with existing automated track geometry inspection technologies without additional resources.

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