Lateral Load Effect on Railway Tapered Roller Bearing Performance

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): Arturo Fuentes (PI, UTRGV) and Constantine Tarawneh (Co-PI, UTRGV)

Project Partners: N/A

Research Project Funding: $70,226 (Federal), $35,342 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2024 to 05/31/2025

Project Description: Lateral forces are a critical factor in railroad tapered roller bearing performance. To improve the reliability and safety of railway systems, vibration and thermal signatures can be powerful diagnostic and prognostic tools for monitoring railway bearing health. While temperature variations can signal spall deterioration, they often become evident only after extensive damage. Therefore, understanding the effects of lateral loading on railroad tapered-roller bearings, including vibration and temperature behavior, under varying train speeds and loads is crucial. Unfortunately, there is limited publicly available research in this area.

Motivated by this area of opportunity, researchers at the University Transportation Center for Railway Safety (UTCRS) developed a dynamic bearing test rig to investigate the effects of lateral loading on bearing performance. The proposed study focuses on Association of American Railroads (AAR) class F and K bearings, widely used in freight rail service. A hydraulic cylinder setup will apply lateral loads up to 44.5 kN (10 kips), mimicking forces experienced during hunting, track irregularities, and curves. Healthy, reconditioned, and spalled bearings will be used for the experiments.

The proposed study will offer a unique contribution by exploring how lateral loads affect bearing vibration (in addition to temperature), providing insights into factors influencing bearing performance in the rail industry. The aim is to improve the long-term reliability and safety of rail systems by understanding how to mitigate performance-compromising issues. It is expected that, based on the findings of this study, the team will optimize onboard vibration, temperature, and load measurement sensors for more accurate and reliable monitoring of bearing condition.

US DOT Priorities: The proposed work in this project is aligned with five of the six USDOT strategic goals: **(a) Safety:** This project directly improves railroad safety by enabling the early detection of impending failures in railroad bearings. Furthermore, quantifying the effect of lateral loads on bearings can improve the ability of the onboard sensor technologies in identifying abnormal track and railcar operating conditions, thus providing a holistic approach to preventing accidents. **(b) Economic Strength:** This project aims to provide the railroad industry with reduced costs and improved efficiency. Unscheduled stoppages and field repairs significantly impact rail companies and the entire transportation system. By enabling early prediction of potential issues, this project empowers companies to schedule repairs during planned maintenance windows, minimizing disruptions and associated economic losses for rail companies, their customers, and other track users. **(c) Equity:** As a Hispanic Serving Institution (HSI), UTRGV is committed to fostering diversity within the transportation industry. This project directly contributes to this goal by employing one graduate and one undergraduate student and indirectly supporting the employment of others. By providing valuable research experience, this project equips these students with the skills and knowledge to become future leaders in the field. **(d) Sustainability:** This project contributes to environmental sustainability in two different ways. First, by enabling proactive maintenance, it extends the lifespan of rolling stock. This reduces the need for frequent replacements, resulting in a lower overall

carbon footprint associated with bearing manufacturing. Second, by preventing bearing failures and potential derailments, the project directly minimizes the risk of environmentally damaging spills and accidents. **(e) Transformation:** The project will generate extensive experimental data that will serve as a rich resource for future advancements of onboard sensor technologies.

Outputs: The expected products include:

1. An improved experimental setup for testing railroad bearings with lateral loads.
2. Final report including any DoT or UTCRS required information on the experimental results of railroad bearings at different velocities and vertical/lateral loads.
3. One or more conference or journal publications by a graduate student working toward the completion of a master's thesis. At a minimum, we will submit to the Spring 2025 Joint Rail Conference (JRC).

Outcomes/Impacts: The research itself, as well as the training of engineering students, will have impacts beyond the immediate information of the lateral load effect on the railroad bearing performance to avert accidents and enable proactive maintenance. **Industry Impact:** As stated earlier, this study will offer a unique contribution by exploring how lateral loads affect bearing vibration (in addition to temperature), providing insights into factors influencing bearing performance in the rail industry. The aim is to improve the long-term reliability and safety of rail systems by understanding how to mitigate performance-compromising issues. It is expected that, based on the study's findings, the team will refine vibration and load onboard measurement sensors for even more precise onboard data collection considering the effects of lateral loads. **Educational Impact:** As a minority serving institution in rapidly growing metropolitan area, we anticipate that most of the students will be from underrepresented groups and that a good fraction of them will contribute to industrial development in the region. The project budget itself supports one graduate and one undergraduate student who will gain experience in developing railroad specific experiments, as well as bearing test equipment. The enhanced experimental setup will also enable several other students to be trained in the use of the system and its data for independent research projects.

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