UNIVERSITY TRANSPORTATION CENTER FOR RAILWAY SAFETY

Exhibit F - UTCRS

UTC Project Information	
Project Title	Single Bearing Test Rig with Vertical, Lateral, and Impact Load Capabilities
University	The University of Texas Rio Grande Valley (UTRGV)
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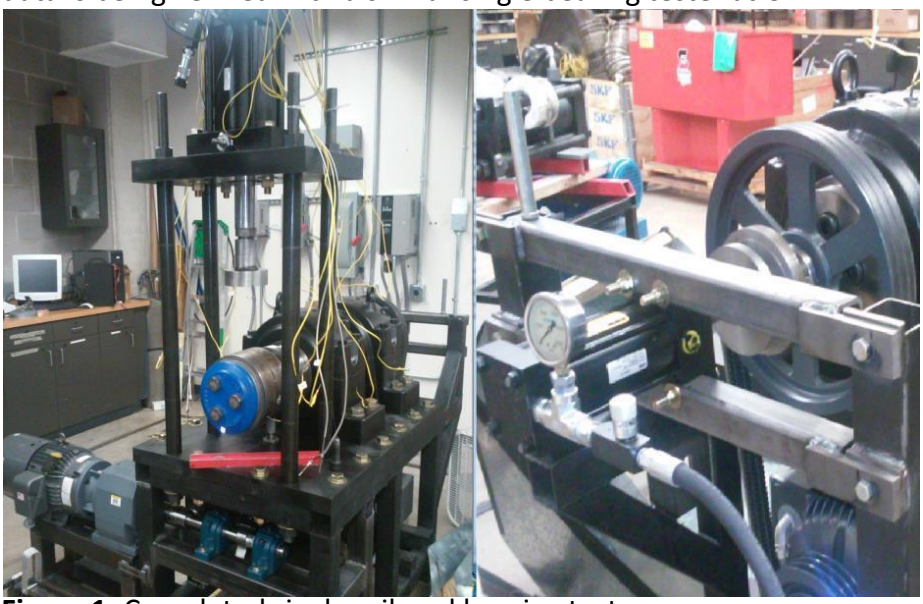
Funding Source(s) and Amounts Provided (by each agency or organization)	Federal Funds (USDOT UTC Program): $57,117 Cost Share Funds (UTPA): $91,399
Total Project Cost	$148,516
Agency ID or Contract Number	DTRT13-G-UTC59
Start and End Dates	November 2013 – December 2014
Brief Description of Research Project	Testing of tapered-roller bearings for railroad cars is an area of active research at The University of Texas-Pan American (UTPA). Current efforts are aimed at bearing health monitoring utilizing emerging temperature and vibration sensor technologies. UTPA currently possesses two four-bearing test rigs that are used to perform laboratory experiments required to support the ongoing development of rolling stock condition monitoring research projects. These two testers only provide static vertical loading that can simulate railcar cargo loads. A thorough literature review revealed that there are no testers with vertical, lateral, and impact loading capabilities in a dynamic single railroad bearing configuration. The need for a single bearing test rig has been motivated by the desire to create a testing environment that more closely simulates the conditions experienced by railroad bearings in field service. To this

	end, a design has been proposed for a single railroad bearing tester that incorporates up to 5000 lbf of lateral loading as well as a variable frequency (0-4 Hz) impact loading in addition to the applied static vertical loading (up to 60,000 lbf). The fabricated tester will be used to compile a library of bearing defects with the purpose of characterizing bearings based on the acquired temperature and vibration signatures under normal and abnormal operating conditions. The data can then be used to identify defective bearings at an early stage so that appropriate preventative measures can be taken to avoid potential catastrophic derailments.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The single railroad bearing test rig with vertical, lateral, and impact load capabilities for use by the University Transportation Center for Railway Safety (UTCRS) projects is instrumented and operational. The single railroad bearing tester allows for 5000 lbf of lateral loading, variable frequency (0-4 Hz) impact loading, and applied static vertical loading (up to 60,000 lbf). The completed system is shown in Figure 1. The right hand side of Figure 1 shows the lateral loading system. A schematic of the proposed design is shown in Figure 2. The impact motor was moved to the opposite side to provide better access to the bearing and shaft during maintenance operations. The test rig is currently being used to monitor railroad bearing health and collected data is being verified with a similar single bearing tester at UTPA.  **Figure 1:** Completed single railroad bearing tester

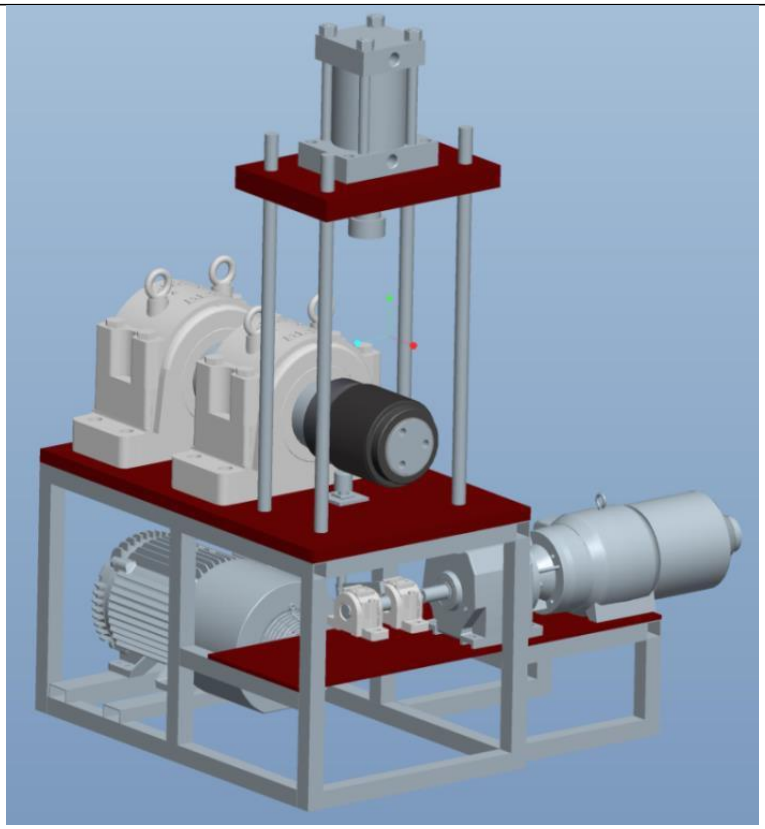


Figure 2: Single railroad bearing tester design

The initial vertical impact system did not produce the required impact forces and was completely redesigned. The new design has been tested and provides the required impact forces. The redesigned vertical impact loading system is shown in Figure 3. A variable frequency drive on the 10 hp impact motor allows for variation in the frequency of impacts. The profile of the cam is used to control the impact force which can be adjusted to a maximum of 5000 lbf. Varying the material of the removable impact head can be used to control the profile of the impact. An accelerometer mounted on the impact head will be used to dynamically measure and record impact data.

A high quality lubricant was used for the pillow block bearings as a substitute for the active cooling system that allows for high speed testing on the single bearing tester. As part of the continuation project that has approved for funding by the UTCRS, two active cooling systems are currently under development including an enhanced forced air system and a water cooled jacket that uses a small chiller. Moreover, the current fixture being used for the compliant element of the suspension is a modified bearing adapter. Additional fixtures are still under development.

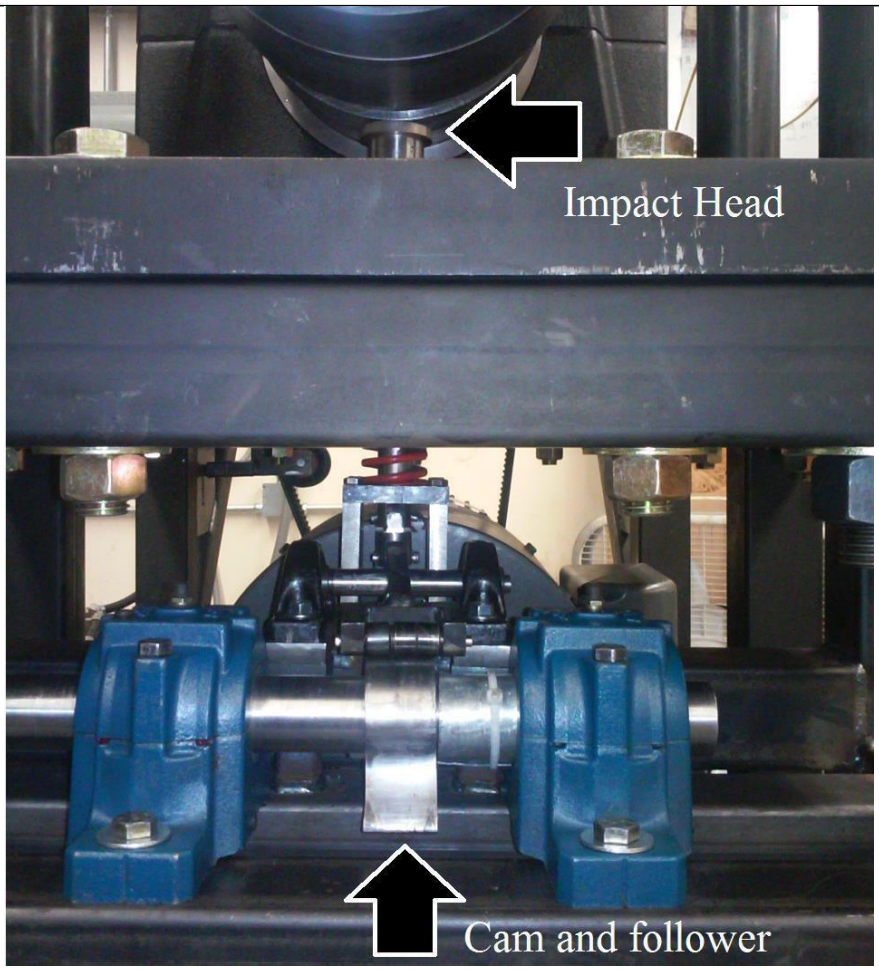


Figure 3: Vertical impact loading system

The hydraulic cylinder used to control the vertical loading provides both static and dynamic loading of up to 60,000 lbf. The pressure in the main hydraulic cylinder is controlled through the use of a smaller secondary hydraulic cylinder that is used as a low volume pump that only displaces the volume of the piston rod. The secondary cylinder is driven by a threaded rod and computer controlled stepper motor. The control system is shown in Figure 4. The system allows for low frequency dynamic control of vertical load, ramping loads, and accurately controlled static loads for long testing periods that prohibit manual control.

	 **Figure 4:** Hydraulic pressure control system for vertical loading
Impacts/Benefits of Implementation (actual, not anticipated)	Recent track data shows that sensors developed and tested on the single bearing tester correlate well with field data, which validates the design concept and proves that the single bearing test rig closely mimics field operation. The later implies that testing performed on this test rig in the laboratory setting will provide data that is applicable for field service. A railroad bearing manufacturer recently contacted UTPA regarding running tests using the center's single bearing tester. The contact was made through information posted on the UTCRS web site demonstrating the need for and interest in a single bearing tester. A newly submitted UTCRS project has been approved for funding which will use the single bearing tester to better optimize wayside hot box detection systems. Work on this project involved four undergraduate students who gained invaluable expertise in design, optimization, and fabrication of this test rig. The project also created opportunities for two senior design projects which helped students academically as well as gaining valuable hands-on experience.
Web Links • Report • Project Website	http://www.utrgv.edu/railwaysafety/research/mechanical/2014/single-bearing-test-rig/index.htm