Rail Road Car Wheel Contamination Detection

Fall 2015—Spring 2016

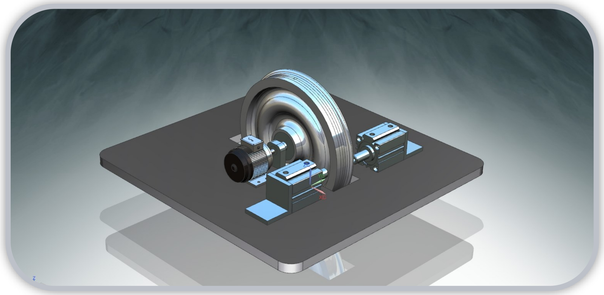
Problem

A hump yard is a type of classification yard used to separate railroad cars onto one of several tracks leading to different destinations. During the sorting process, cars are decoupled and retarders — essentially disk-brakes — are used to slow down cars for when they recouple.

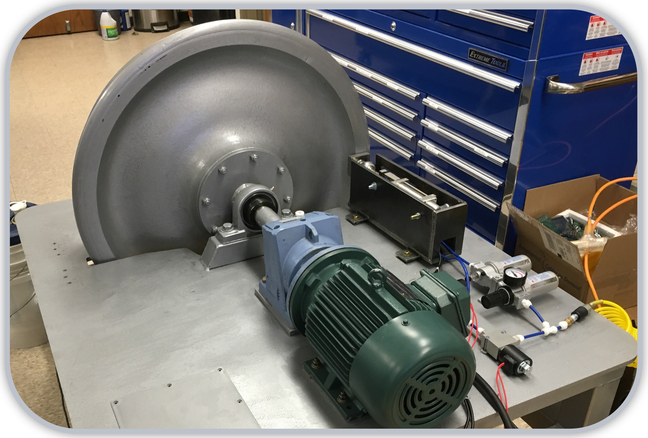
If contaminants are present on the wheels, the retarders won't operate effectively and the cars can blow apart couplers or even derail.

In order to investigate possible detection methods, the effects of different contaminants on the system needs to be quantified.

Contaminant Test Stand

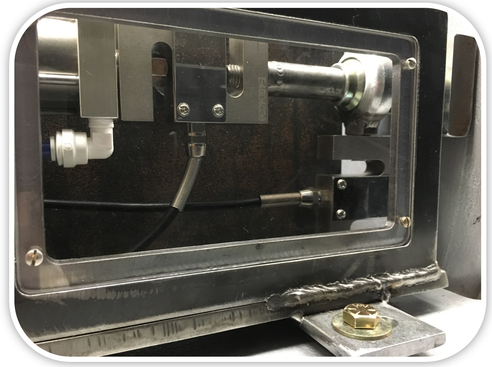


A test stand was designed to simulate the hump yard retarder breaking system in order to get frictional data and gain insight into detection methods. The test stand has a 3 HP motor with a 19.18:1 gear reducer to get the wheel spinning at approximately 10 mph. The variable frequency drive, which runs the motor, and pneumatic braking system are controlled using LabVIEW.



The braking system uses two solenoids, which when energized apply 100 psi of braking force to the wheel. A rotary encoder is also mounted on the wheel giving a speed reference.

Finding the Coefficient of Friction



Two load cells are used in the brake assembly, one inline with the brake shaft to measure the normal force to the wheel and one perpendicular to the brake shaft to measure the frictional force. The coefficient of friction can then be calculated using the two force values.

Investigation

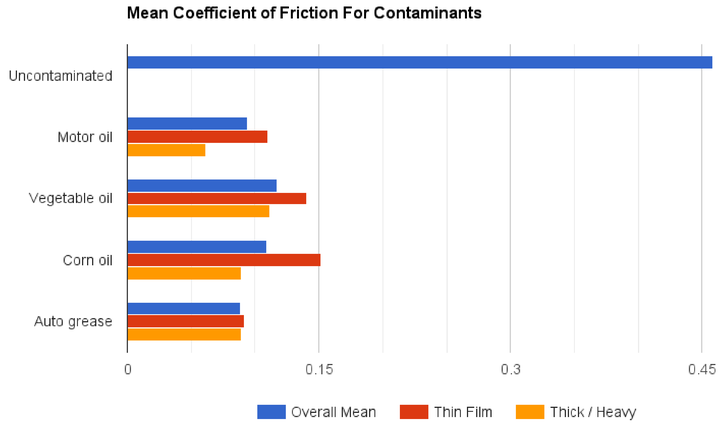
Members of the group visited a Norfolk Southern hump yard in order to speak with yard personnel and get a more hands-on perspective of the problem.

Team Members (Left to Right)

Joel Yauk, Wayne Helminen, Joshua Manela, Dylan Etelamaki

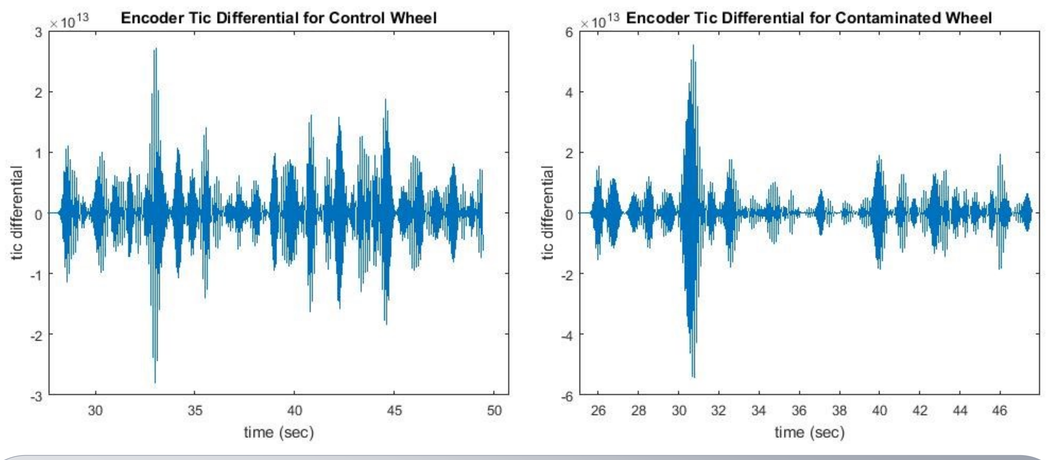
Advisor: Dr. Duane Bucheger

Results



The data shows that even thin films of the tested contaminants result in substantial reductions of the coefficient of friction. This is a major concern at the hump yards because a contaminant that cannot be seen could go unnoticed, while still reducing the coefficient of friction enough to cause problems. Contaminant detection methods will have to be precise enough to detect very thin layers of contaminants. Because of this, visual detection methods would be inadequate.

Preliminary Encoder Detection Method with an SVM



It was noticed that there was more acceleration jerk on a clean wheel than on a contaminated wheel. A Support Vector Machine (SVM), a commonly used Machine Learning classifier, was fed frequency data from the encoder. In preliminary testing, leave-one-out cross validation found 70% accuracy in detection (test accuracy). These results show possible merit in exploring jerk-based detection methods.

Fusing the above data with sound and/or thermal data could increase the accuracy of the classification. This allows sensor-fusion Machine Learning methods to be investigated.

NORFOLK SOUTHERN · NURail Center · Michigan Tech — Create the Future