TECHNOLOGY DIGEST

Timely Technology Transfer

"EVALUATION OF A PROTOTYPE HIGH SPEED TRIBOMETER"

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TD 97-014

Summary

A prototype tribometer concept designed to measure rail friction at speed has been demonstrated and tested by the Association of American Railroads (AAR). Tests were performed under closed loop conditions at the Transportation Technology Center, Pueblo, Colorado, and on a revenue service track location. Data shows that the prototype tribometer evaluated is capable of measuring rail friction at speeds up to 20 mph. The prototype evaluated is the first of three concepts being offered by various vendors for measuring rail friction at track inspection speeds. AAR is sponsoring evaluations of technologies to measure rail friction at speed. These techniques could replace hand-held and hand-operated tribometers to assess lubrication effectiveness of top and gage face of rail.

Rail friction was measured statically with a hand-operated tribometer and compared with data generated by the prototype tribometer at the same locations at various speeds. Within the 5 mph to 15 mph test speeds evaluated, no speed effects were noted. The prototype was not evaluated at speeds of greater than 20 mph as the measurement system support bogie became unstable at 25 mph. The prototype concept, as demonstrated, did not meet all the guidelines suggested by the railroad Technical Advisory Group overseeing this project. Before being introduced as a production system for measuring rail friction, deficiencies should be addressed to ensure a safe, efficient, and user-friendly device is being operated.

Future work in this AAR-sponsored project will include evaluation of the two other concepts and monitoring revenue service use of a high speed tribometer.

Suggested Distribution:

- ❑ Maintenance of Way
- ❑ Maintenance Planning
- ❑ Operating/Mechanical Dept.
- ❑ Equipment/Rolling Stock

Association of American Railroads
Railway Technology Department

April 1997

INTRODUCTION

A viable concept for measuring rail friction at speed has been demonstrated at the Transportation Technology Center (TTC), Pueblo, Colorado. The Association of American Railroads (AAR) is sponsoring evaluations of technologies measuring rail friction at speed that could replace hand-held and hand-operated tribometers. Evaluations will assess lubrication effectiveness of top-of-rail and gage face. The hand-held tribometer, best used for spot measurements, is too slow for production measurement over large territories. Also, the hand-held tribometer requires separate adjustments for top-of-rail and gage face measurements.

Lubrication of the wheel/rail interface has been shown to offer significant benefits in wheel and rail wear, along with reduced train energy consumption. However, improper lubrication in the form of over lubrication or high differentials between the top of rails can lead to poor truck steering and increased lateral loads. To give railroads a tool for managing lubrication over large territories, a method to measure rail friction at high speeds has been proposed.

The AAR has coordinated an effort by the tribometer Technical Advisory Group (TAG) to create a set of operational guidelines for a high speed tribometer (HST). In order to accelerate the introduction of a HST into revenue service, the AAR is testing and evaluating prototype devices and comparing performance to the TAG-generated guidelines.

More than 375 miles of TTC testing and 25 miles of revenue service testing was conducted using a prototype high speed tribometer. Top-of-rail or gage face friction data taken at speeds up to 20 mph showed reasonable correlation with hand-held tribometer data. However, when simultaneous gage face and top-of-rail data was obtained, the accuracy of both suffered.

PERFORMANCE GUIDELINES

The TAG-generated guidelines include basic safety, accuracy, reliability, and operations factors that would be considered by railroad users when selecting HST technology for purchase or contract. These guidelines were sent to prospective vendors in the form of a specifications document. The AAR would evaluate each HST on performance against these guidelines.

A high speed tribometer would be evaluated against the following parameters:

- Safe operation over all track components, including switches, crossings, and guard rails.
- Continuous friction data from top-of-rail and gage face measurements.
- Non-interference with routine track inspection duties.
- Friction data accuracy comparable to a hand-held tribometer.
- Inspection speed of 30 mph.
- Immediate indication of rail friction values.
- Data storage for comparison with previous runs.
- Ease of installation, removal, and operation.
- Successful mate to typical pickup hi-rail equipment.

HST PROTOTYPE

The first prototype tested was provided by Salient Systems, Inc. of Dublin, Ohio. The prototype measurement system is supported by a 4-wheel bogie that is pushed in front of the hi-rail vehicle. Individual measurement wheels are configured to measure left and right top-of-rail and gage face. The measurement concept determines lateral loading of each measurement wheel as it is moved through a sweep pattern.

The sweep pattern creates various amounts of creepage with respect to the rail; maximum friction occurs once creepage is saturated. Control system and data collection software is proprietary.

The data collection system displays a running average friction for each rail (top-of-rail and gage face). This system collects and stores continuous friction, speed, and GPS-referenced location data. The prototype HST is shown in Exhibit 1.

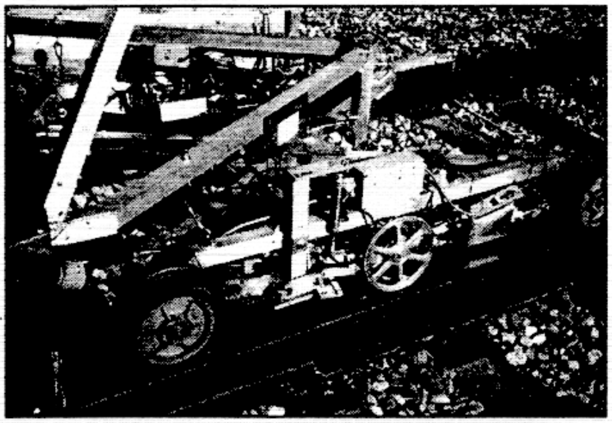

Exhibit 1. Prototype High Speed Tribometer at TTC

DATA/EVALUATION PROCEDURE

After initial shakedown testing by the vendor, the prototype was shipped to TTC where it was attached to a hi-rail vehicle. The prototype HST was operated over various TTC tracks to determine operating safety and stability. In addition, the HST was tested for accuracy, repeatability, and reliability. Operations were conducted through turnouts (facing and trailing moves), curvature up to 12 degrees, dry and lubricated rail, road crossings, high guard rails, tight and wide gage, jointed and welded rail, and a variety of rail wear profiles.

Data consisted of hand-held tribometer readings at selected locations, which were compared with friction indicated by the HST. Additional data includes notes on operations, adjustments, and repairs required by the operator and test staff during the evaluation program. No absolute, independent measurement of field rail friction was available. The existing hand-held tribometer has proven to be very repeatable; thus, it was used as the "baseline" comparison measurement.

RESULTS

During the TTC evaluation, a number of upgrades and changes to the prototype software and hardware were made by Salient Systems personnel. The basic operating system sweeps all four measurement wheels through a prescribed pattern, measuring friction at the maximum angle during each cycle. Top-of-rail and gage face data collected using the standard sweep pattern is shown in Exhibits 2 and 3.

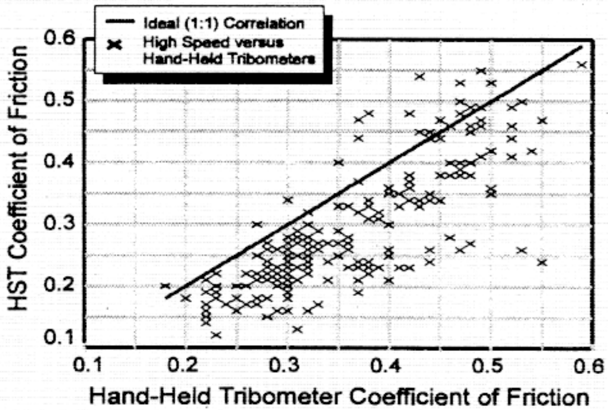

Exhibit 2. Top-of-Rail Friction with Standard Sweep Pattern

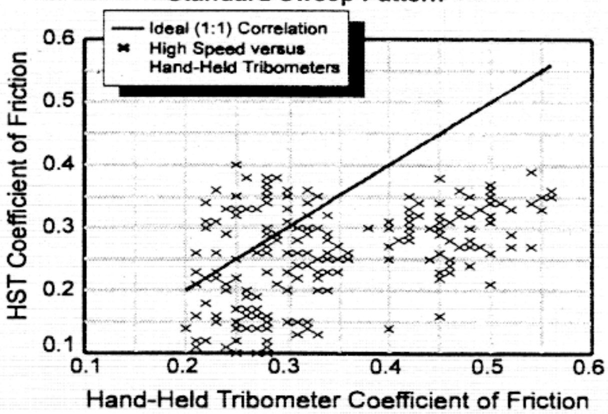

Exhibit 3. Gage Face Friction with Standard Sweep Pattern

The data suggests a trend of reasonable correlation between HST top-of-rail friction and hand-held tribometer readings; however, the HST readings are still highly variable. The gage face correlation is not as good. Salient Systems staff provided an increased sweep pattern for limited testing. Top-of-rail and gage face data with this modification is shown in Exhibits 4 and 5, respectively.

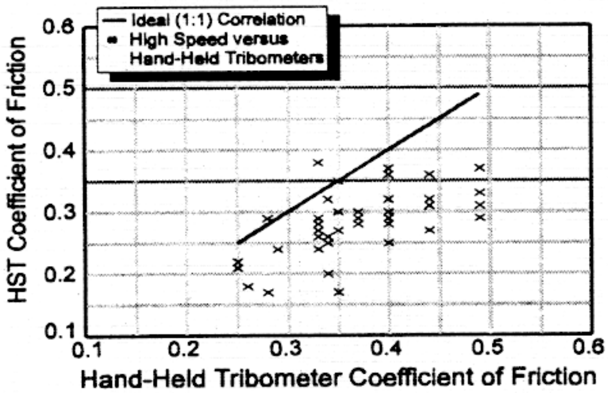

Exhibit 4. Top-of-Rail Friction with Increased Sweep

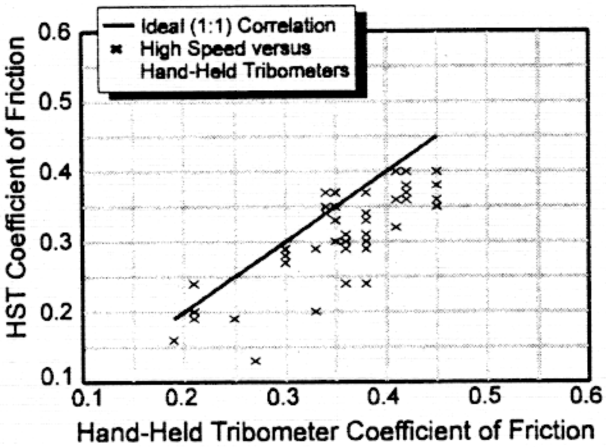

Exhibit 5. Gage Face Friction with Increased Sweep

Increasing the sweep appears to have improved the accuracy of gage face data but has significantly reduced accuracy of top-of-rail data. One potential solution would be to apply two separate sweep functions— one for top-of-rail friction and one for gage face friction. However, this was not evaluated.

RECOMMENDATIONS

Test results and observations indicate a number of the TAG guidelines were not met. The following issues should be addressed in a production HST:

- Accuracy of top and gage face data must improve.
- Measurement wheels tended to collect and retain excess lubricant; thus, the data was invalidated.
- Clearances did not allow unrestricted operation through some special track work.
- Support bogie became unstable at test speeds over 20 mph.
- Data display difficult to read.

A method of measuring rail friction at speed has been demonstrated. If the above issues are adequately addressed in a production model, the ability to measure lubrication effectiveness over long territories is now available.

Because the HST was a prototype, and according to the vendor a reconfigured design is under consideration for a production version, statistical analysis of the data was not performed. A more rigorous evaluation of data repeatability and scatter will be conducted when a revised production design is available and has been tested.

Note: Contact Rich Reiff at (719) 584-0581 with questions or comments regarding this document. E-mail: richard_reiff@aar.com

A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, MAY BE AVAILABLE AT A LATER DATE THROUGH THE AAR, PUBLICATION ORDER PROCESSING, 50 F STREET, NW, 5TH FLOOR, COG, WASHINGTON, D.C.,20001