TECHNOLOGY DIGEST
TD-07-036
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Insulator Performance in High-Load Areas in Revenue Service

Richard Reiff and Tom Stosek

Summary

Transportation Technology Center, Inc. and Union Pacific are monitoring the performance of insulators* on conventional concrete ties at a revenue service site located in severe mountain territory in California.

The life of currently used insulators in this territory varies from curve to curve. With annual traffic of 80 million gross tons, some curves require insulator replacement yearly, while other curves exhibit insulator life exceeding 2 years. For this reason, the evaluation of test insulators was conducted with a simultaneous installation of control (currently used) insulators on the same curve.

Field performance of four new designs (materials and/or shape factors) of insulators for use in concrete tie track is being compared to the standard material currently used in this location. Initial data shows that static load gage restraint between all insulators from highest to lowest was within a 10-percent range, with a scattering of results between the test and control segments. Toe load of newly installed clips on these same insulators indicated a slightly higher range between high and low values (~20%). However, both of the two control sections produced the lowest uplift force.

All currently used insulators have passed existing requirements of the AREMA Chapter 30 screening test. Results of field monitoring will be evaluated to determine the achievable life-cycle improvement of the new insulator designs, and, if feasible, the results will also be used to develop more severe laboratory screening tests for selecting insulators to be used in similar high-load areas.

This digest summarizes installation, monitoring techniques, and limited initial data for the test implemented in April 2007.

Future TDs will report on performance variations and any degradation observed and measured between various insulator designs and comparison with projected life of the control materials.

*Insulators are placed between the rail base and the rail-to-tie fastener to isolate the components electrically. Insulators are needed to allow track circuit based signal systems to function with existing concrete tie designs.

Please contact **Richard Reiff (719) 584-0581** with questions or concerns regarding this *Technology Digest.* E-mail: Richard_Reiff@ttci.aar.com.

INTRODUCTION AND OBJECTIVES

As annual tonnage and axle loads increase, finding available track time to replace components becomes more difficult. Recent experience by several heavy haul railroads has shown that insulator life of the concrete tie system is less than desirable. Early failures, seen as insulator deformation, wide gage, and excessive rail movement are related to premature insulator failures.

In an effort to facilitate development of improved components, the Association of American Railroads' (AAR) Strategic Research Initiatives (SRI) Program has sponsored an evaluation of insulator designs. With the cooperation of Union Pacific (UP), a field demonstration and test of improved insulators have been implemented. The objective is to evaluate improved insulator designs that can be fitted to existing (worn) tie systems which will out perform the current products. Existing insulator designs that pass existing requirements of AREMA screen tests perform adequately in most tracks but often show reduced life when subjected to severe loads in sharp curves and steep grade territories. All such insulators have been screened using AREMA Chapter 30 recommended practices (Committee 30), suggesting more rigorous screening tests may be needed. More stringent screening tests for components will be developed for use in severe track territories as a result of the SRI.

The scope of this project is limited to insulators that can be retrofitted to existing ties in track. New designs or shapes that require different tie designs/changes to tie inserts or different clips/pads will not be evaluated under this SRI.

DESCRIPTION OF TEST SITE

The AAR and the UP are presently evaluating top of rail (TOR) friction control in the Tehachapi Mountains of California, which made it an ideal site for measuring track component performance because other factors, such as lateral curving forces, rail wear, and lubrication, are being carefully monitored. (See TD05-018 for a detailed description of this site.) Key parameters include:

- Severe loading – 2-percent grade, 10-degree curves
- Optimized with wayside-based GF lubrication
- 80+ annual MGT of mixed train traffic

Figure 1 shows the track layout in the 30-mile test area. The primary test curve for this evaluation is located in Zone 2, which only receives gage face (GF) lubrication. One other segment of insulators is installed as a control zone in the TOR+GF area (Zone 1). The control zone was installed to evaluate insulator performance in an area with reduced lateral loading, a benefit of applying TOR friction control. Results of comparing insulator performance between the GF only and GF+TOR areas will be reported in a later TD.

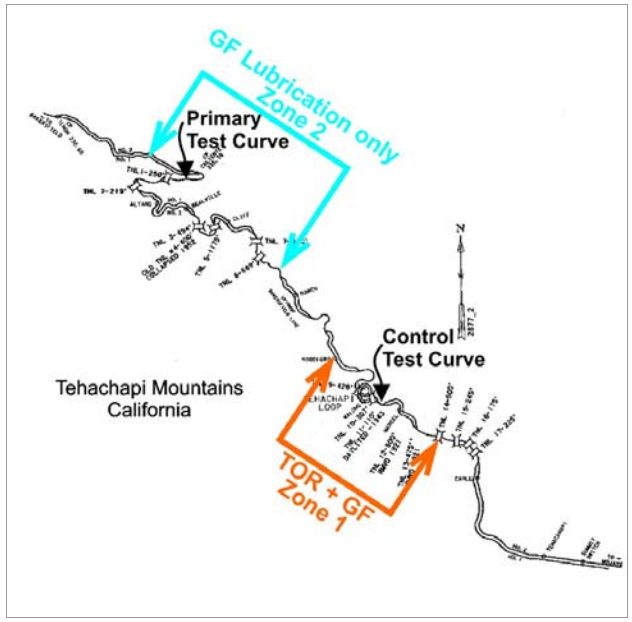

Figure 1. Track Layout in the Test Area
Location of Primary and Control Test Curves

The primary test curve was configured with five segments of insulators, as Figure 2 shows. Insulator segments A, B, C and D are each 50 ties long, whereas segment G is 100 ties long and is used as a control zone. An additional 100-tie segment of control insulators is located in the TOR zone and is tracked as "X."

Insulator variations for this test were selected by UP personnel based on laboratory results of improved materials. All test samples, except for materials used in the control zone, were provided by suppliers.

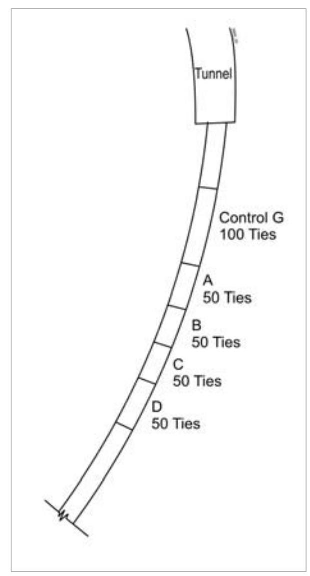

Figure 2. Insulator Layout in Primary Test Curve showing Locations of Insulators A, B, C, D, and G

MEASUREMENTS

Insulator performance is being monitored by visual and measured methods. Measured performance is obtained by monitoring loaded gage restraint at the head and base, and by measuring fastener toe load.

Loaded Gage Widening

By applying a lateral load between the rails and measuring the resulting railhead and base deflections, an overall indication of track strength can be obtained. TTCI's Lightweight Track Loading Fixture (LTLF) facilitates this type of measurement at spot locations. The LTLF is configured to apply a lateral load between the rails. The loading mechanism is placed between the rail (Figure 3a), after which a 500-pound preload is applied. The railhead and base deflection is then set to zero (Figure 3b), after which the lateral load is increased in low-pound increments until 9,000 pounds is obtained (see AAR/TTCI research reports R-746 and R-870). Figure 3 shows the LTLF in use on wood ties; however, the setup is identical for this test on concrete ties.

If insulator performance degrades after tonnage is applied, the resulting railhead and base deflections measured under the full load will increase. The amount of base translation is especially sensitive to insulator wear and deformation.

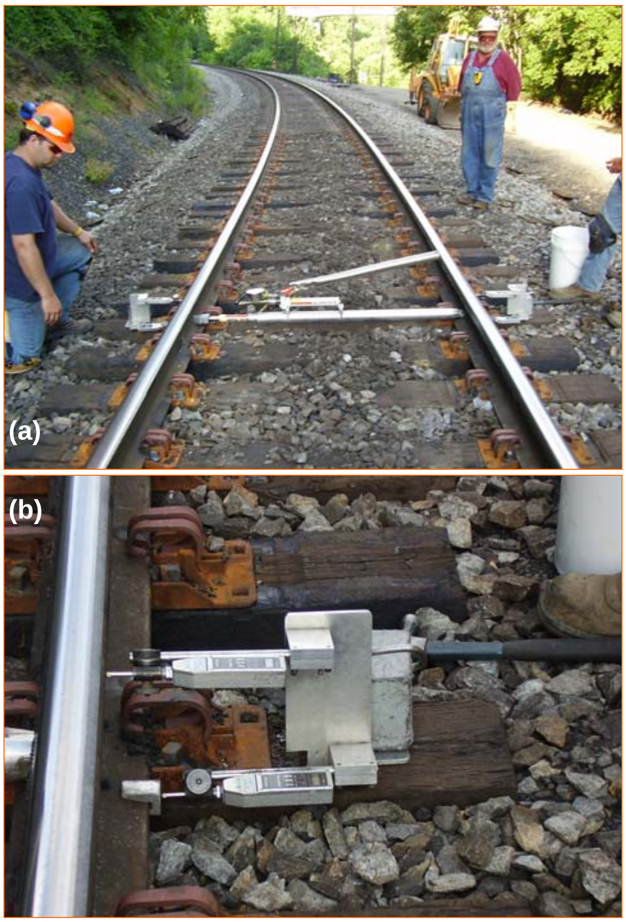

Figure 3 (a): LTLF in Use and (b): Detail of Head and Base Deflection Gages

Fastener Toe Load

During installation, new clips were installed at each location. While the toe load is primarily a measure of clip performance, the effect from insulator wear may also be determined by measuring changes in clip performance. Figure 4 shows the fastener toe load measurement system. The clip is first raised a small amount to allow placement of a 0.006-inch shim between the fastener and insulator. The clip is then allowed to relax, after which the toe load handle is gradually pushed down while a second operator maintains a steady pull on the shim. The force measured on the uplift handle, when the shim is pulled loose, is the hold-down force.

Figure 4. Fastener Toe Load Measurement

Dynamic Performance

Dynamic gage widening was also measured to compare performance between the two control zones (primary site without TOR friction control compared to the TOR zone). This data is supporting the TOR implementation program and will be reported in a separate TD when TOR performance is updated.

INITIAL BASELINE CHARACTERIZATION

Installation

The rail web was marked to designate limits of each insulator zone. All measurements were located by tie number within each zone. Insulators were distributed along the ties and installed by UP track crews. (Figure 5) After removing the existing insulator, the area between rail and cast inserts was cleaned of any debris or dirt, after which test insulators and new clips were installed. Hand tools were used to remove existing clips and insulators. Installation by machine was not feasible due to the short test zones. During installation, a number of insulators broke or cracked when the wider shoulders were forced into the space between the rail base and tie insert.

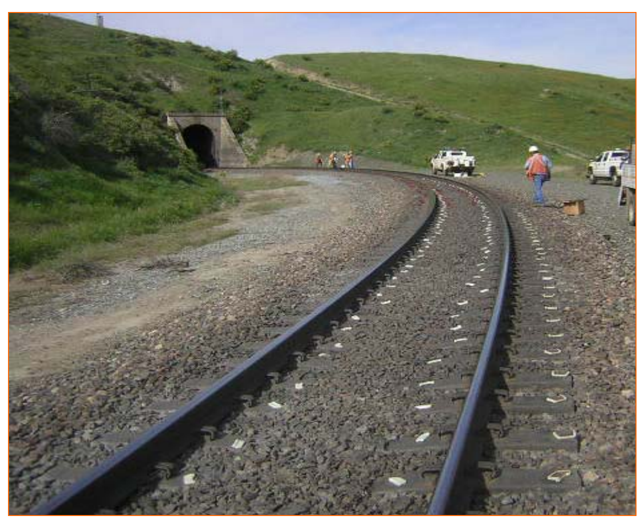

Figure 5. Zone Layout before New Clips and Test Insulators

RESULTS

Lightweight Track Loading Fixture

Figures 6 and 7 summarize LTLF maximum lateral deflection on the base of the high and low rails. Note that insulator C was equipped with both standard (C) and long reach (CLR) clips. G and X are the control segments, with X indicating the control site in the TOR zone.

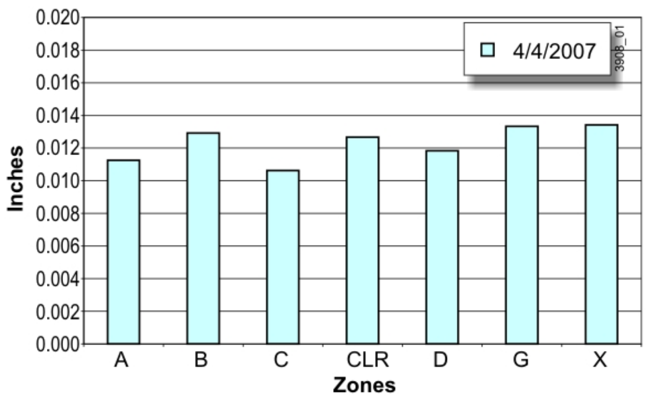

Figure 6. High Rail Base Deflections at 9 kips

Figure 7. Low Rail Base Deflections at 9 kips

Data suggests some scatter in the initial measurements; however, the range is similar for both high and low rail (0.010 to 0.14 inch at 9 kips). Data from head deflections is about 3 times greater and shows similar trends between products.

Toe Load

Figures 8 and 9 show results of toe load measurements for the gage side of high and low rails.

Toe load results show that both control zones exhibit slightly lower toe loads than generated by test insulators A-D. Overall, the toe load generated by clips installed on the high rail is about 100 to 300 pounds less than the equivalent clips installed on the low rail.

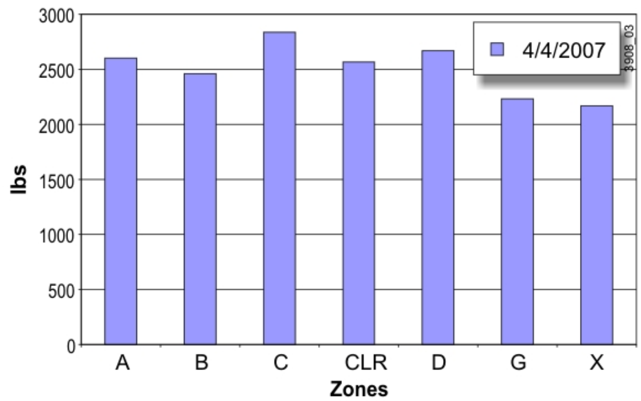

Figure 8. High rail — Fastener Toe Load Results

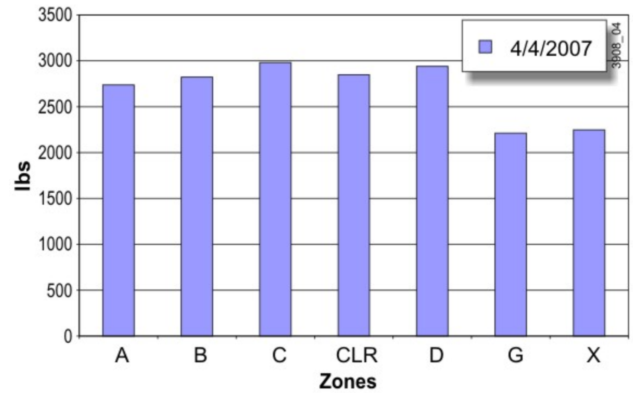

Figure 9. Low Rail — Fastener Toe Load Results

SUMMARY AND NEXT STEPS

Concrete ties in this area are over 5 years old and some wear of the cast shoulders has occurred. These ties required insulators with wider shoulders to ensure proper gage. Most insulators were installed April 2, 2007, while Zone D was not installed until May 8, as the initial shipment did not have wider shoulders. Tonnage is being applied at a monthly rate of approximately 7 MGT. The next set of inspections and measurements will be conducted this summer. Only limited initial data is shown in this TD. Data from all locations and additional plots showing load versus deflection and standard deviation will be shown in the next update. This will also include degradation trends, comparing "as installed" LTLF and toe load values for each segment with performance data collected after approximately 20 MGT of traffic.

ACKNOWLEDGMENTS

This demonstration was conducted with the cooperation and participation of several individuals and sponsors, including Ed Kohake and Rusty Belmore of the UP. John Wagner of Leading Edge and Bob Coates of Pandrol USA LP provided the insulators.