TECHNOLOGY DIGEST

Timely Technology Transfer

"CWR LONGITUDINAL RESTRAINT TESTS: WINTER RAIL BREAK AND SUMMER RAIL DE-STRESS SIMULATIONS,"

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Summary

Preliminary results from a study conducted jointly by the Association of American Railroads, Transportation Technology Center, Pueblo, Colorado, and the Volpe National Transportation Systems Center indicate that the "effective longitudinal resistance" of timber tie track with rail anchors is lower when the rail is in tension than when it is in compression.

As a result, restoration of desired rail neutral (stress free) temperature after a cold weather rail break requires adjustment of a longer rail length than under comparable compressive forces during hot weather.

Field tests were performed to quantify the longitudinal force and displacement response of continuously welded rail (CWR) to a simulated rail break, or pull-apart, with high tensile forces in the rail. Additional tests were conducted to determine rail response to adjustments made with the rail in compression. A disturbance zone of about 890 feet, where the existing force level changed by more than 20,000 pounds, was measured during a winter rail break (WRB) test. The tensile force level before the test was 115,000 pounds. Similar compressive forces (111,000 pounds) during a Summer Rail Destress test produced a disturbance zone of 480 feet. A WRB test with an initial tensile force of 186,000 pounds produced a disturbance zone in excess of 1,300 feet.

These test results have furthered the understanding of CWR behavior and will lead to improved CWR maintenance practices.

Suggested Distribution:
Operating/Engineering Dept.
- ❑ Maintenance of Way
- ❑ Maintenance Planning
- ❑ Track Maintenance

Association of American Railroads
Research and Test Department

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INTRODUCTION AND CONCLUSIONS

The general use of continuously welded rail (CWR) has necessitated development of strict maintenance procedures to prevent development of excessive longitudinal rail forces. These procedures may specify unfastening and restressing a minimum length of rail when installing repair plugs in cold weather or when relieving "tight rail" conditions in hot weather.

CWR longitudinal restraint tests were performed to measure the length of track affected by a rail break in the winter or a rail cut in the summer to prevent track buckling. The data gives an indication of the disturbance zone where the rail requires restressing to recover the original or desired neutral temperature. The tests were conducted as a combined effort by the Volpe National Transportation Systems Center (VNTSC), and the Association of American Railroads (AAR).

Testing was performed in a 1,200-foot-long test zone with tangent alignment, timber ties, cut spikes, every second tie box anchored, slag ballast, and 136-pound welded rail. Instrumentation was installed at regular intervals throughout the zone to measure longitudinal rail force, longitudinal rail displacement, and rail temperature (Exhibit 1).

To simulate a broken rail in cold weather, the neutral temperature in the zone was set at approximately 80° F. The rail was then cut near the center of the test zone with the rail temperature at 7° F, or 73° below neutral. The tensile force at the time of cutting was 186,000 pounds. This test was designated Winter Rail Break Test 1 (WRB1).

Longitudinal movement of the anchored rail within the test zone immediately after cutting the rail in WRB1 is shown in Exhibit 2. The rail gap at the cut was 3.5 inches.

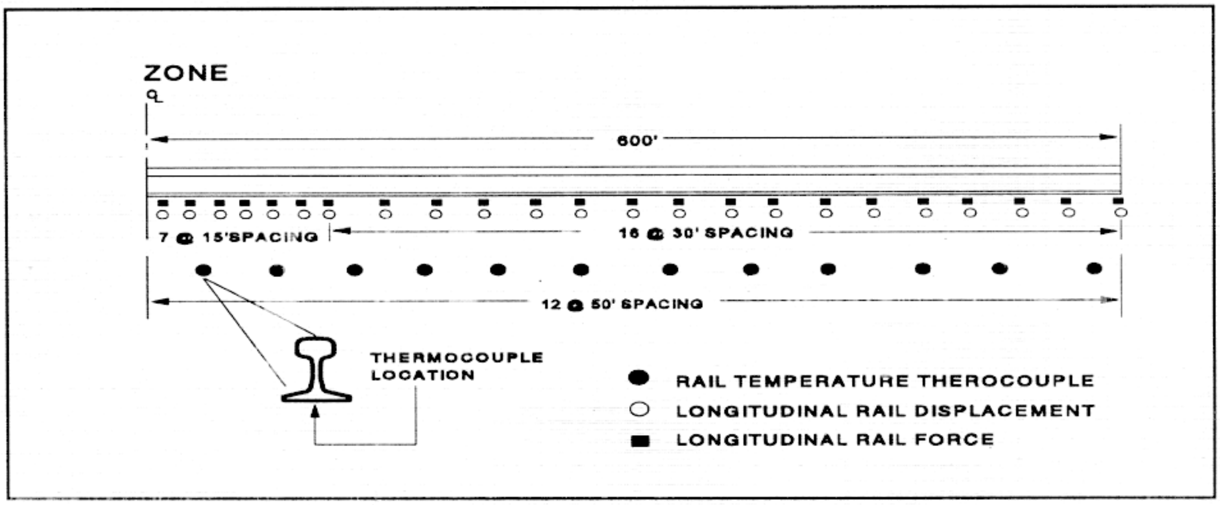

Exhibit 1. Test Zone Instrumentation

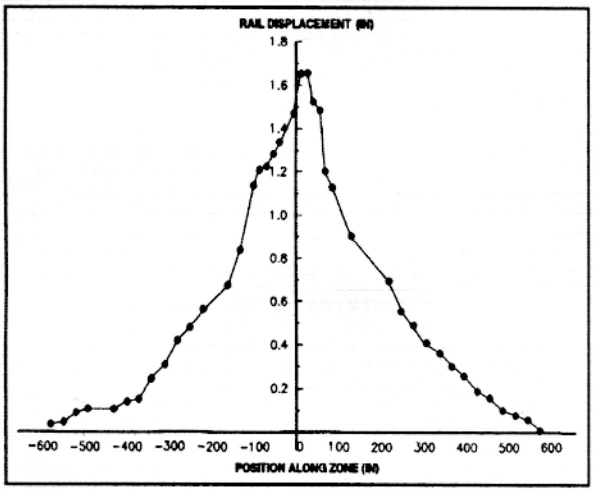

Exhibit 2. Longitudinal Rail Displacement WRB1Test

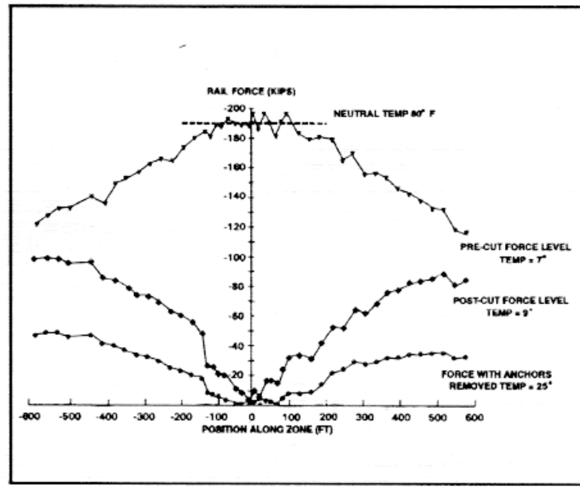

Exhibit 3. Longitudinal Force Distribution During WRB1 Test

Exhibit 3 shows the tensile rail force throughout the zone before the rail was cut, immediately after the cut was made (before rail anchors were removed), and after rail anchors were removed within the zone. The data in Exhibit 3 indicates a significant change in the existing force level due to cutting, which resulted in a lower neutral temperature throughout the zone. Lowering the neutral temperature increases the potential for buckled track during hot weather.

A second test, WRB2, was conducted with the rail temperature 46° F below neutral and with 115,000 pounds of tension in the rail.

WRB2 was followed by a summer rail de-stress test (SRD1) to simulate adjustment of "tight rail" or buckled track. Using the same test zone, the rail was cut at 44° F above neutral with 111,000-pound compression in the rail.

In Exhibit 4, the change in existing longitudinal force as a result of rail cutting is plotted as a function of test zone distance for the WRB2 and SRD1 tests.

Although initial levels of tension and compression were nearly identical for the two tests, cutting the rail in tension affected the existing force over a much longer length of rail than the compressive force cut. Total length of rail in which the force changed more than 20,000 pounds was 890 feet during the WRB2 test and 480 feet for the SRD1 test. The 20,000-pound threshold represents a change in neutral temperature of 8 °F to 10 °F.

The measured response implies that the "effective longitudinal rail restraint " is lower when the rail is in tension than when it is in compression. One possible reason for the difference is the rate of rail force transfer to the rail anchors. When the rail breaks under tension, the existing force is relieved almost instantaneously. In compression, however, the rail is being cut with a torch relieving the force slowly and gradually.

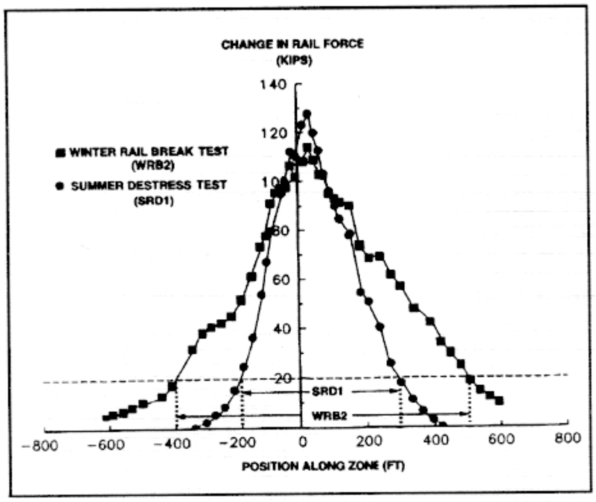

Exhibit 4. Comparison of SRD1 and WRB2 Rail Force Changes

During the WRB tests, anchors near the rail cut were observed to have slipped slightly on the rail after cutting. However, the same anchors showed no signs of slipping when the rail was cut under comparable levels of compression. This evidence suggests that the sudden change in tensile force causes the anchors to slip rather than transmit the longitudinal rail force to the tie and ballast section. By allowing the rail to slip through, the effective restraining force provided by the anchor is reduced.

One of the practical implications of these tests is that a longer de-anchored zone is necessary to de-stress rail following a rail break in cold weather than is required to relieve buckling forces during hot weather. VNTSC is in the process of developing a user friendly computer model and look-up tables to define rail gap and de-anchoring lengths for rail readjustment.

Future tests are being planned by VNTSC and AAR to better define rail anchor behavior and to include other variables such as curved track and concrete ties with elastic rail fasteners.

Note: Contact David Read at (719) 584-0559 with questions or comments about this document.

A MORE DETAINED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, WILL BE AVAILABLE AT A LATER DATE THROUGH THE DOCMENTATION DISTRIBUTIONCENTER, CHICAGO TECHNICAL CENTER, 3140 SO. FEDERAL STREET, CHICAGO, ILLINOIS 60616. PHONE: BETTY J. VAUGHAN (312) 808-5421. A REPORT LIST IS AVAILABLE UPON REQUEST.