TECHNOLOGY DIGEST

TD-06-011

©APRIL 2006

TIMELY TECHNOLOGY TRANSFER

Methodology for More Efficient CWR Management through Improved De-Stressing and Neutral Temperature Readjustment

Part 2 of 2

David Read, TTCI, and Andrew Kish, PhD, Kandrew, Inc. Consulting Services

Summary

Recent research activity by the Transportation Technology Center, Inc. and Kandrew, Inc. Consulting Services has focused on the development of a new methodology for continuous welded rail (CWR) to improve rail neutral temperature (Tn) readjustment. This methodology provides a technique to estimate the existing rail Tn and required length of track to be de-anchored (influence zone length L_d) during Tn readjustment and de-stressing operations. This methodology determines the Tn from track parameter relationships that have been generated from empirical data on rail break/cut movement versus rail longitudinal force (or temperature difference). Similarly, the length of rail requiring adjustment is determined from field test information on measured rail break/cut influence zone lengths versus fastener longitudinal restraint and longitudinal force.

The new methodology offers immediate economic advantages to repairing/readjusting broken rail. Specifically, it affords a quick temporary rail break repair to facilitate rapid resumption of traffic and provides an easy science-based procedure to perform the permanent Tn readjustment at a later time.

This *Technology Digest* (TD) is the second of two parts presenting an improved methodology for Tn readjustment that allows the track maintainer to estimate the Tn and adjustment length from the rail gap width and the rail temperature at the time the rail is cut or broken. In Part 1, critical parameters affecting the readjustment procedure and key relationships that have been developed analytically and verified through tests were presented. In this TD, applications of the methodology are described along with an example of how it can be used.

It is expected that additional testing will further fine tune these procedures in line with specific industry requirements and will result in improved industry maintenance practices for a more effective rail Tn management.

Please contact **Dave Read (719) 584-0559** with questions or concerns regarding this *Technology Digest.* E-mail: Dave_Read@ttci.aar.com.

INTRODUCTION

A methodology for improved continuous welded rail (CWR) longitudinal force management through more efficient de-stressing and neutral temperature (Tn) readjustment practices is being developed in conjunction with Dr. Andrew Kish of Kandrew, Inc. Consulting Services. This new methodology provides a technique to estimate the existing rail Tn and required length of track to be adjusted (total influence zone length $2L_d$) during Tn readjustment and de-stressing operations. These two parameters are critical for effective Tn maintenance, but in most cases cannot be directly measured in the field. The methodology enhances current maintenance practices by providing a tool to determine the required gap width and de-anchoring length necessary to readjust and restore the Tn to a target value.

As Part 1, *Technology Digest* (TD 06-010)[1] presents the track parameters relating to Tn maintenance and the relationships that have been found to exist between these parameters based on analytical and test data. Key relationships that provide the basis of the methodology include: (1) the rail movement as a function of the difference between the existing rail temperature and the Tn (ΔT) in Figure 1 and (2) the influence zone length as a function of rail longitudinal resistance and ΔT (Figure 2). This TD describes and gives an example of how this methodology, shown schematically in Figure 3, can be applied to typical Tn readjustment scenarios.

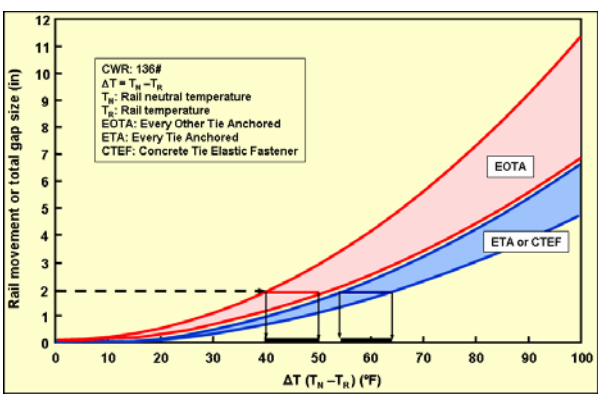

Figure 1. Rail Break Gap vs. ΔT for Varying Longitudinal Resistances

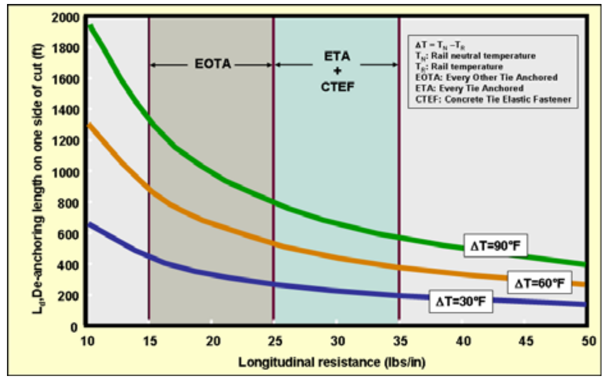

Figure 2. De-anchoring vs. Longitudinal Resistance for Different ΔT Values

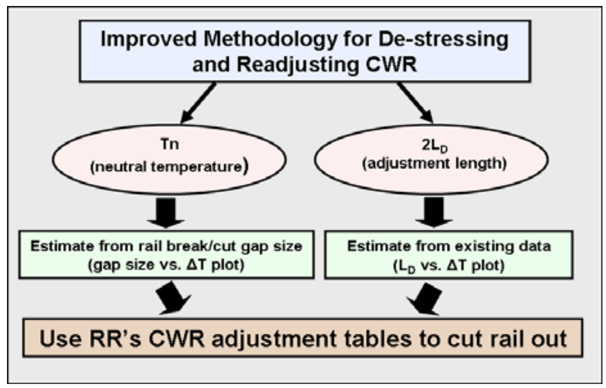

Figure 3. Improved CWR De-stressing/ Readjustment Methodology

Methodology Application: Cold Weather Tn Adjustment

In this case, a rail in tension breaks or is cut to replace a defect and the readjustment is performed as part of the repair. The rail is elongated with a tensor or by heating to remove the break/cut gap and restore the rail to its original longitudinal position. To adequately restore the Tn, the rail should be unfastened on each side of the break for the distance over which the Tn was affected by the release of tension (the influence zone L_d). The issue for the track maintainer is how long an influence zone L_d needs to unfasten. Using the methodology, the L_d can be determined by measuring the gap width or rail movement and rail temperature. This allows determination of ΔT from Figure 1, which is used in Figure 2 to estimate the required L_d.

Deferred Cold Temperature Readjustment

Conditions often make it impractical to readjust the Tn at the time of a cold weather break. A repair plug is bolted or welded in as the repair measure and the Tn adjustment is deferred until the rail is warmer. In this case, the L_d is determined as soon as possible after the break, as if the readjustment were being made at that time. The exact amount of rail added by the plug is also determined for removal during the readjustment. It is important to perform the readjustment well before the onset of hot weather when the rail temperature will not exceed the rail break temperature by more than 60°F to prevent the risk of buckling the track due to the temporarily low Tn.

Hot Weather De-Stress

The hot weather de-stress procedure is performed to remove excess rail when the rail is in compression. The rail is cut and the Tn estimated from the rail movement and corresponding ΔT in Figure 1. The $2L_d$ is determined from the ΔT and assumed longitudinal resistance (Figure 2).

This method can be used and is recommended for a deferred winter rail break adjustment as discussed above, where the rail temperature is higher than, but not more than 60°F above, the temperature at which the temporary repair plug was installed.

Methodology Illustrative Example

The following example illustrates the application of the new methodology to a deferred cold weather rail break scenario. The track is made up of 136RE rail and wood ties with every other tie box anchored. The target Tn is 105°F. The rail is cut at 90°F and the measured rail expansion is 1 inch. The application of the methodology to this hypothetical situation has been summarized in Figure 4, and the procedure is described as follows:

- **Step 1: Determine the existing Tn.** Place two marks on the rail about 12 inches apart and accurately measure the distance between them. Cut the rail about midway between the marks. Since the existing Tn (calculated from the rail movement and rail temperature during repair) is low from the cold weather temporary repair, the rail will be in compression and will require a torch to cut the

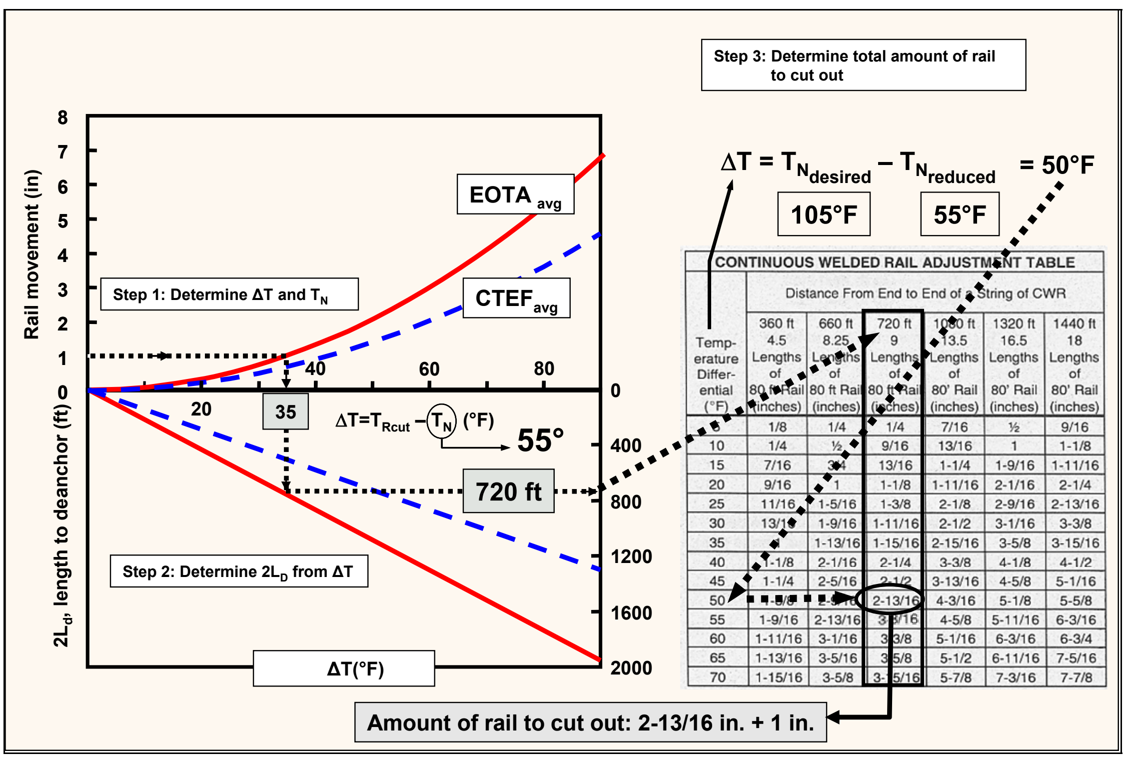

Figure 4. Improved Methodology Application for Illustrative Example

rail. In the example, the total movement is 1 inch. At 1 inch rail movement, the EOTA curve in Figure 4 gives a corresponding ΔT of 35°F. The existing rail temperature (Tr) is 90°F; therefore, the existing Tn = 55°F (90 - 35°).

- **Step 2: Determine the total influence zone $2L_d$ (i.e., length of rail to adjust).** This is done from the bottom part of Figure 4, which is a cross-plot of Figure 2 for EOTA average values. For the ΔT = 35°F obtained in Step 1, $2L_d$ = 720 ft.
- **Step 3: Determine the amount of rail to cut out from railroad adjustment tables using the information from Steps 1 and 2**. The right hand side of Figure 4 shows a typical adjustment table listing the amount of excess rail to remove to correct a given Tn differential (Tn target – Tn existing) for the length of rail being adjusted ($2L_d$). In the example, the adjustment length is 720 feet, which directs us to that column on the table and the Tn differential is 50°F (105°-55°). (Note: if the 2 L_d obtained in Step 2 does not correspond to a column, interpolation between the two closest columns is required). Reading across from the temperature differential column to the 720-foot column, the total amount of rail to remove, which includes the material removed by the torch, is 2 13/16 inches. The weld gap must be added to this value for the final amount to be removed.

If the adjustment table is not available, the following equation is used to determine the amount of rail to remove:

$$RC = [0.0000065\,(2L_d)\,T_{diff}] + WA$$

where:

RC = amount of rail cut-out (inches)

$2L_d$ = total length of rail being adjusted (inches)

T_{diff} = Temperature differential (Tn target – Tn existing) (°F)

WA = weld material allowance (inches)

CONCLUSIONS

Correct adjustment of the rail neutral temperature requires knowledge of the existing neutral temperature and length of rail requiring adjustment. As these parameters are usually not known, current research has developed a method to estimate both items based on established track parameter relationships. It is envisioned that the methodology could be implemented by maintenance personnel inputting the measured gap width or rail movement amount, current rail temperature, tie/fastener type/condition, and target neutral temperature. The output would be the required gap, including weld gap allowance and the length of rail to de-anchor. This method is being used at the Facility for Accelerated Service Testing, and revenue service trials are being planned.

It is expected that additional testing will further fine tune these procedures in line with specific industry requirements and will result in improved industry maintenance practices for a more effective management and improvement of CWR performance.

References

1. By D. Read and A. Kish, "Methodology for More Efficient CWR Management through Improved De-Stressing and Neutral Temperature Readjustment: Part 1 of 2," *Technology Digest* TD06-010, TTCI, Pueblo, Colorado, April 2006.

Glossary of Terms

Tn, T_N, RNT	Rail neutral temperature
T_R, Tr	Rail temperature
ΔT	Temperature difference between T_R and T_N
$T_{Nexisting}$	Neutral temperature of rail being readjusted
$T_{Ntarget}$	Territory's designated T_N
$2L_D$	Total length of rail being readjusted; influence zone; unfastened length; deanchored length
ETA	Every tie anchored
EOTA	Every other tie anchored
CTEF	Concrete tie elastic fastener
f_o	Rail/track longitudinal resistance