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# An Alternative to Conventional Concrete Crossties for Bridge Approaches

## SUMMARY

Transportation Technology Center, Inc. (TTCI) is investigating an alternative crosstie design to conventional concrete crossties for bridge approaches. The project is being co-sponsored by the Federal Railroad Administration (FRA) and the Association of American Railroads (AAR).

So far, tests of the half-frame concrete tie (HFT) have demonstrated that this variation of the conventional concrete tie design is able to reduce track transition issues in the heavy-axle load (HAL) revenue service environment. Due to their distinct advantages over conventional concrete ties (i.e., larger footprint, larger rail seat, and increased lateral resistance), the HFTs seem to be ideal for bridge approaches. To determine if this design is a viable alternative to conventional concrete ties in revenue service, TTCI has been actively monitoring the performance of the test HFTs installed at select bridge approaches since 2011. Preliminary results of long-term testing indicate that the HFTs are performing well in this selected application.

Test HFTs that have been installed at the bridge approaches in the western mega site have accumulated more than 800 million gross tons (MGT) as of January 1, 2015. Dynamic testing has compared the performance of a bridge approach with HFTs to a bridge approach with conventional concrete ties under similar loading conditions (i.e., 286-kip gross load cars at 40–50 MPH). Significant differences in tie acceleration, tie deflection variability, and tie bending strain were observed under HAL trains between the two bridge approaches, with HFTs outperforming conventional concrete ties in all measures. The HFTs have nominal 24-inch spacing.

The test HFTs continue to accumulate tonnage in the western mega site, and their performance is still being monitored. Furthermore, the preliminary success of HFTs has prompted the TTCI to establish additional test locations to evaluate their ability to reduce insulated joint (IJ) support issues in control points as compared to conventional concrete ties.

**Figure 1. Half-frame ties installed in revenue service at the western mega site**

## BACKGROUND

Due to the HFTs' under-tie pads and larger footprint, they have the potential to reduce ballast impact loads and minimize the surface deviations typical of bridge transition zones, especially under HAL traffic. To test this hypothesis, test HFTs were installed on three bridge approaches at the western mega site.

Two ballasted deck bridges, located on tangent track on the loaded HAL coal route, were selected for this study. Fifteen ties were installed during summer 2011 at the east and west approach of the bridge near Oshkosh, NE, (the east bridge approach is displayed in Figure 2) and at the west approach of the bridge near Paxton, NE. The test ties were installed using an excavator with a grapple attachment and a standard production switch tamper with split work heads.

All test HFTs at the mega site have been fitted with a Getzner elastomeric under-tie pad and a Vossloh elastic fastening system.

## OBJECTIVES

This test is evaluating the long-term performance of these concrete crosstie alternatives for application in maintenance-intensive track transition areas that are experiencing chronic track degradation, specifically areas which would benefit from the reduced stress and settlement HFTs can provide.

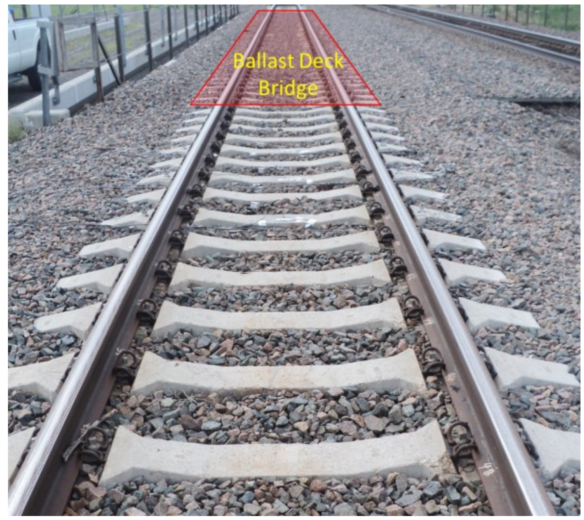



**Figure 2. HFTs on the East Approach near Oshkosh, NE**

## METHODS

To assess the performance of the HFTs for bridge approach applications, the team collected dynamic data, including rail and tie accelerations, tie bending strain, and tie deflection, for both the bridge approaches with HFTs and the approaches with conventional concrete ties. This was achieved through the use of appropriately placed accelerometers on the rail base and tie, bending beams, and strain gages at the mid-center of the test ties. Figure 3 shows the instrumentation setup.

Data was collected on the east approach of both bridges to compare HFT performance against conventional concrete ties after 690 MGT. Due to the predominantly unidirectional (i.e., eastbound) HAL traffic at the western mega site, the east and west approaches may behave differently as traffic approaches these bridges traveling west to east. It was thought that the east approaches would have a more severe loading environment. It should be noted that dynamic measurements at the HFT approaches were conducted approximately one year (~240 MGT) after initial tests with the conventional concrete tie approach.

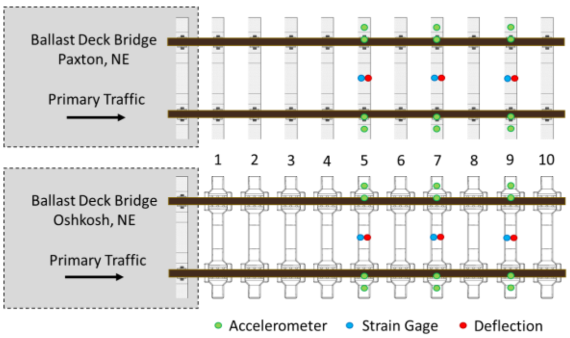
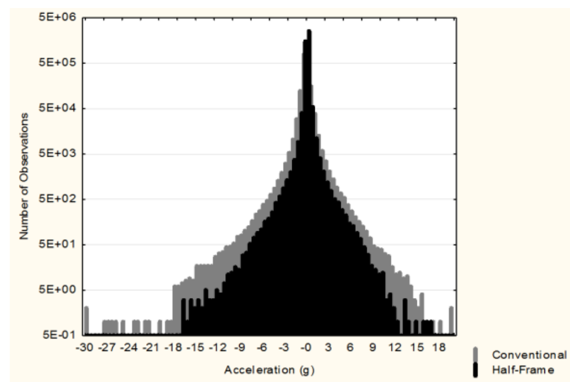



**Figure 3. Instrumentation on the Crossties in the Approaches**

## RESULTS

Significant differences in tie acceleration, tie deflection variability, and tie bending strain were observed under HAL trains between the two bridge approaches, with HFTs outperforming conventional concrete ties in all measures. Figure 4 shows the frequency distribution for all tie acceleration channels collected under five HAL unit coal trains at each approach. Results show a significant reduction in vibration on the HFTs over conventional concrete ties in a similar dynamic environment. Furthermore, results from this testing show significantly lower tie peak bending strains.

Test results for the conventional ties show lower, but more variable, deflections under HAL wheel loads. The larger deflections observed for the HFTs should probably be attributed to the lower overall track modulus provided by the HFT's under-tie pads. There is a significant reduction in deflection variability, which suggests more consistent deflection for the HFTs under HAL traffic than the conventional concrete ties (Figure 5).




*Significant difference ($p < 0.005$)

**Figure 4. Frequency Distribution of Tie Accelerations**

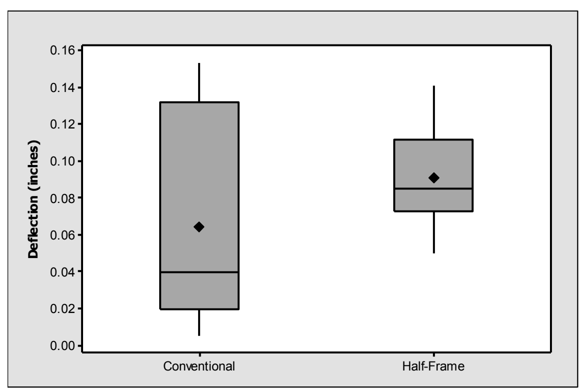



**Figure 5. Box plot of Tie Deflection for Three Representative HAL Train Passes over each Approach**

The HFTs at these bridge approaches have been in service for more than 800 MGT of traffic as of January 1, 2015. To date, no tie cracking or fastener issues have been observed and no track geometry (i.e., surfacing) spot-maintenance has been reported beyond regularly scheduled operations in the area. Visual indication of ballast abrasion and degradation on the revenue service installations are minimal.

## CONCLUSIONS

Long-term testing efforts at the western mega site have shown that significant improvements in tie acceleration, tie deflection variability, and tie bending strains have occurred before the HFTs were implemented for bridge approaches in the HAL revenue service environment. Results suggest that the HFTs are effective in mitigating the adverse conditions associated with track transitions and providing an effective alternative to conventional concrete ties. Furthermore, the reduction in bending strains suggest that regularly scheduled tamping, using conventional equipment, is more than sufficient in preventing the HFTs from becoming center bound.

## FUTURE ACTION

As the HFTs continue to accumulate tonnage in western mega site, their performance will be monitored. TTCI is currently working closely with the host railroad to design and implement additional test locations to better evaluate their effectiveness in reducing issues related to IJ support in control points against conventional concrete ties. Installation is expected to be completed in 2015.

## ACKNOWLEDGEMENTS

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## KEYWORDS

crossties, concrete ties, heavy axle load