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Results of Union Pacific Concrete Tie Track Panel Shift Tests

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Summary

Track panel shift behavior of Union Pacific (UP) Railroad concrete tie track was characterized by measuring lateral panel strength with the Track Loading Vehicle (TLV) operating in stationary test mode. Lateral ballast resistance was also measured using the Single Tie Push Test (STPT) technique. Test results indicated the existing lateral strength and resistance of the track was extremely high and that reducing the shoulder width from the 18-inch design to 12 inches did not reduce the lateral track strength. Further reduction of the shoulder width to 8 inches brought the STPT resistance down to values typical of well consolidated track.

The project also looked into the effects of track surfacing, stabilization, and traffic on lateral track strength and ballast resistance with the following results:

- Surfacing the track significantly reduced the existing lateral track strength allowing a 0.22-inch residual lateral displacement of the track panel under a TLV lateral load of 40,000 pounds compared to a negligible (less than 0.03 inch) residual displacement under the same lateral load for the existing nonsurfaced track. Surfacing also caused an 80 percent reduction in the existing lateral resistance as measured with the STPT technique.
- Use of the dynamic track stabilizer (DTS) with the surfacing operation increased the resistance values of the surfaced track by 65 percent and reduced the residual panel shift displacement from 0.22 inch to 0.07 inch.
- The application of 0.1 million gross tons (MGT) caused a 49 percent increase in the lateral resistance of the surfaced zone. The same traffic caused a reduction in the DTS zone resistance from 3,050 pounds to 2,725 pounds. The residual displacement, however, changed only slightly with the DTS zone still showing about half the residual displacement of the surfaced only zone.

The TLV applied a 20,000-pound vertical force to both rails and a 40,000-pound lateral force to one rail. The lateral displacement of the tie being loaded was measured as the lateral load was applied. The tests were performed in consecutive test zones on the UP South Morrill subdivision that carries over 200 MGT of coal traffic annually.

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INTRODUCTION

Track panel shift tests were performed near milepost 47 on the UP South Morrill subdivision in October 2010 to measure the lateral strength of concrete tie track. The South Morrill subdivision is the UP's primary heavy haul coal route and carries an excess of 200 MGT of traffic annually. The tests were performed using TTCI's TLV operating in a stationary test mode and were intended to measure the following:

- The baseline strength of concrete tie track with a full and well consolidated ballast section.
- The effects of reduced ballast shoulder widths on the baseline condition.
- The effects of track surfacing, DTS, and accumulation of 0.1 MGT of traffic over the surfaced track and stabilized track.

A number of STPTs were also performed in conjunction with the panel shift tests to provide lateral track resistance data.

TEST PROCEDURE

The TLV split-axle load bogie, as Figure 1 shows, was used to apply the panel shift force. The TLV tests followed the procedure shown in Figure 2 that was used during panel shifts tests performed by TTCI in 1997:[1]

1. The wheel of the load bogie was located directly over a tie and a 20,000-pound vertical force was applied to both rails.
2. A 40,000-pound lateral force was applied to one rail, while holding the vertical force constant and measuring the lateral displacement of the tie being loaded. The lateral force was applied incrementally until the maximum force was reached or until a tie displacement of 0.30 inch was measured. The lateral force was then removed followed by removal of the vertical force.

Figure 1. TLV Load Bogie

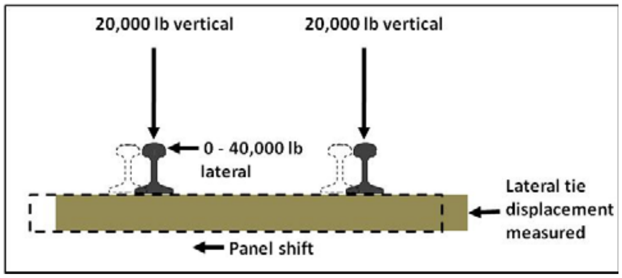

Figure 2. TLV Panel Shift Measurement

Figure 3 shows the typical track panel response of high and low strength track during a stationary TLV test. The key indicator of lateral strength that was used in this test was the residual lateral tie displacement, or panel shift, present after the lateral force has been removed. Increasing residual displacement correlates with decreasing lateral track strength.

In addition to the lateral resistance provided by the ballast, lateral displacement of the track panel is also influenced by the lateral bending stiffness of the rail, which is influenced by the longitudinal thermal force in the rail. Tensile rail forces will increase the apparent lateral strength, and compressive forces will cause a reduction in the strength. Unfortunately, it was not possible to measure the rail thermal force during this project.

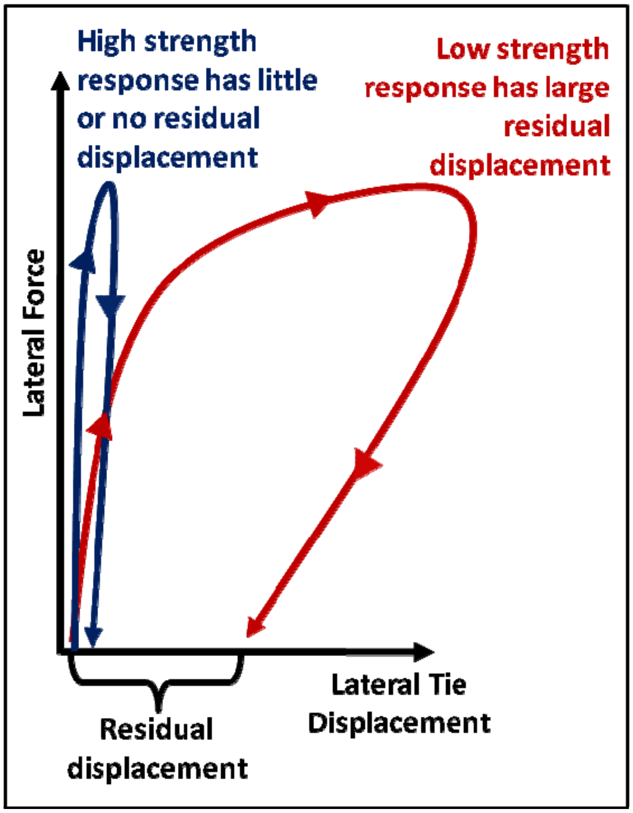

Figure 3. Typical Stationary Track Panel Shift Behavior for High and Low Strength Track

In addition to the TLV tests, STPT measurements were used to characterize the lateral resistance of the ballast. The STPT is a measurement of the force required to displace an individual tie laterally in the ballast section. Because the tie is unfastened from the rail and there is no rail bending or vertical load involved, the STPT technique is strictly a measurement of the ballast resistance for the tie being pushed. Both the TLV and STPT measurements were used during the test; however, they are two very different techniques and only general correlation of the results should be expected.

SCOPE

Table 1 shows the track conditions of the test zones. All the test zones were on tangent track, 300-foot long segments, and consecutive to one another. The concrete ties had scallop shapes on the sides, SAFELOK® rail fasteners, and the rail was 133RE. A total of three TLV tests and four STPT measurements were performed in each test zone.

Table 1. Test Summary

Test Zone	Track Condition
1	Fully consolidated ballast and 18-inch shoulder baseline condition
2a and b	Fully consolidated ballast with 12- and 8-inch ballast shoulders
3	Track surfaced
4	Track surfaced and stabilized
5	0.1 MGT over surfaced track
6.	0.1 MGT over stabilized track

TEST RESULTS

Shoulder Width Comparison

Both the TLV and STPT data indicated the existing concrete tie track with 12- and 18-inch shoulder widths was extremely strong laterally. The STPT data also showed moderately strong resistance with the 8-inch shoulder width. The TLV data in Figure 4 shows the residual displacements for the 18- and 12-inch shoulder were less than 0.03 inch and, therefore, considered to be negligible.

The STPT data in Figure 4 includes a 0-inch shoulder width in addition to the 8-, 12-, and 18-inch widths. Once again, the average STPT values point to the track having very high lateral resistance with the 12- and 18-inch shoulders and moderately high values even without a shoulder.

Effects of Tamping, Stabilization, and Traffic

The track was surfaced with a nominal 1-inch raise to evaluate the lateral track strength effects of surfacing concrete tie tracks. Test zone 3 was surfaced and the adjacent zone 4 was surfaced and stabilized using a Plasser American DYNA-C.A.T. track tamping machine. A significant reduction in lateral strength and resistance was measured with both the TLV and STPT methods, as Figure 5 shows.

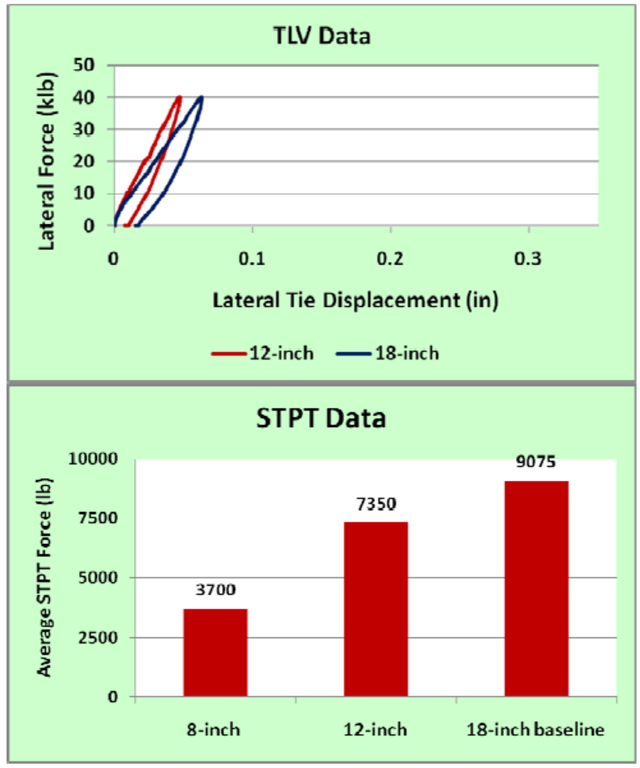

Figure 4. Concrete Tie Ballast Shoulder Width Comparison

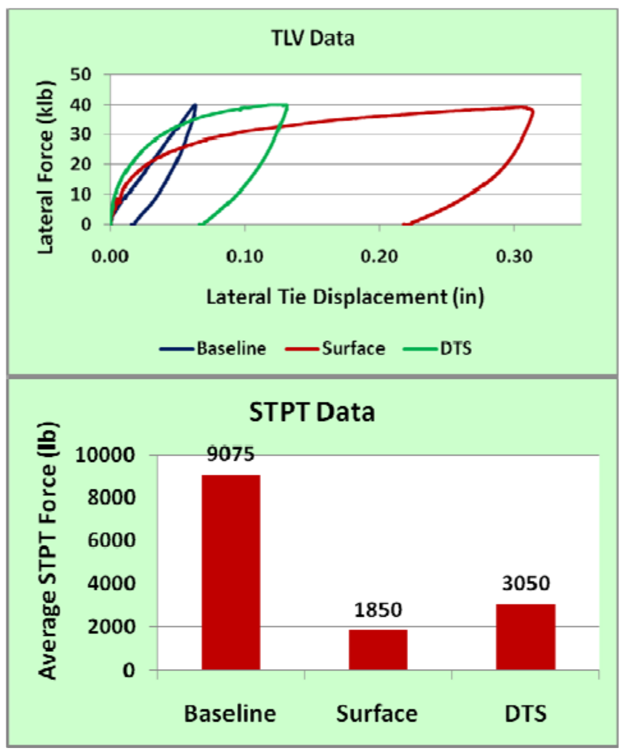

Figure 5. Effect of Surfacing and Stabilization on Baseline Lateral Strength and Resistance Conditions

The STPT data indicated the DTS increased the lateral resistance by 65 percent from an average resistance value of 1,850 pounds for the surfaced track to an average of 3,050 pounds for surfaced and stabilized track. The STPT values after surfacing and stabilization were comparable to results reported for similar tests conducted on Amtrak concrete tie track in 2003.[2]

As pointed out earlier, however, what is noteworthy about the UP data is the extremely high baseline lateral resistance of the concrete tie track before surfacing.

After completing the TLV and STPT measurements on the surfaced and surfaced/DTS test zones, five loaded coal trains passed over the zones applying just under 0.1 MGT of tonnage and the measurements were repeated. The STPT data indicated that after 0.1 MGT of traffic, the lateral resistance values for the surfaced and stabilized zones were basically equal (Figure 6). However, the TLV data showed the residual displacement of the surfaced zone with 0.1 MGT was still about twice the residual displacement of the DTS zone with 0.1 MGT.

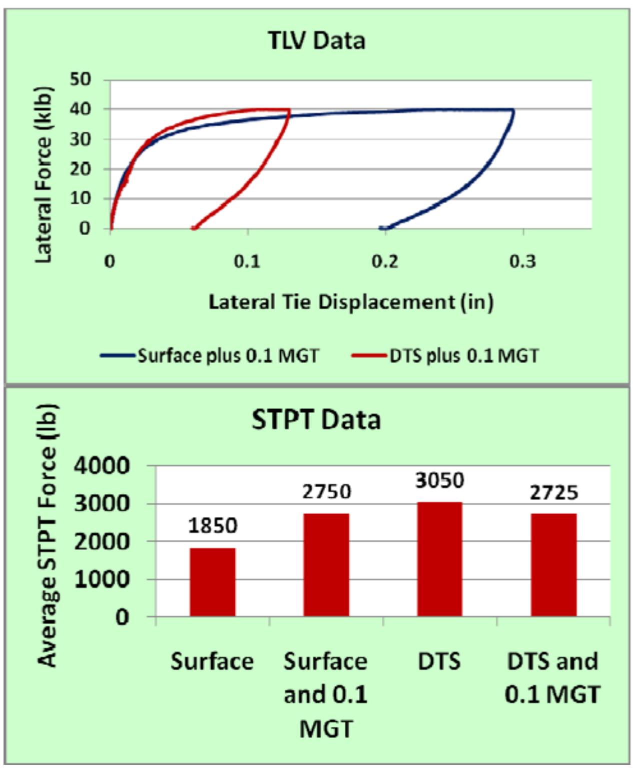

Figure 6. Effect of 0.1 MGT of Traffic on Lateral Strength and Resistance Values

CONCLUSIONS

The track panel shift behavior of concrete tie track on the UP South Morrill subdivision was characterized by measuring lateral track strength with the TLV and lateral ballast resistance using the STPT measurement technique. Results included:

- The existing lateral strength and resistance of the track was extremely high. Reducing the shoulder width from the 18-inch design to 12 inches slightly reduced the resistance, but had no effect on the residual lateral tie displacement. Further shoulder reduction to 8 inches brought the resistance down to values typical of well consolidated track.
- Surfacing the track significantly reduced the lateral strength and resistance values. The resistance of the zone after surfacing was comparable to values measured during other concrete tie lateral resistance tests.
- Use of the DTS with the surfacing operation increased the resistance values of the surfaced track by 65 percent and decreased the residual lateral tie displacement from 0.22 inch to 0.007 inch.
- The application of 0.1 MGT caused a 49 percent increase in the lateral resistance of the surfaced zone. The same traffic caused a reduction in the DTS zone resistance from 3,050 pounds to 2,725 pounds. The residual displacement, however, changed only slightly with the DTS zone still showing about half the residual displacement of the surfaced only zone.

AKNOWLEDGEMENTS

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