Railway track and structures

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Les dernières nouveautés de FAST pour les lourdes charges à l'essieu.

HS

FAST heavy-axle-load update

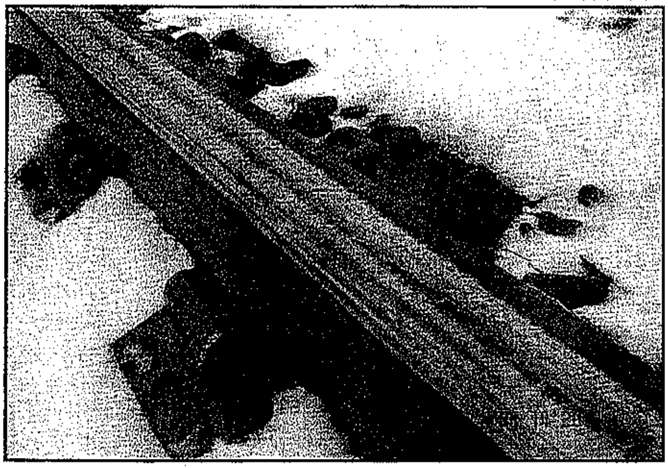


Figure 1, left and right, shows rolling contact fatique in test rails.

TTCI provides an update of what's going on at the facility that has provided the industry with invaluable information on rail performance, welding, bridges and other track components.

The Association of American Railroads increased the budget this year for testing at the Facility for Accelerated Service Testing, Pueblo, Colo., in order to increase tonnage accumulation for the year and to provide critical results faster to the railway industry.

The HAL program

At the end of June 2005, 98 mgt of traffic had accumulated on the High Tonnage Loop (HTL) at FAST, when a scheduled Summer pause in train operations began. Total accumulation of tonnage since the inception of the heavy-axle-load program in 1988 is 1,700 mgt.

The program has provided the industry with valuable information on the performance of improved materials and techniques for minimizing and managing adverse effects of heavy axle loads. The Federal Railroad Administration and AAR jointly fund this program, with significant contributions from the railroad supply industry and individual railroads. The latest results of FAST experiments are reported here.

Rail performance

The most recent rail performance evaluation was completed this past Summer. Premium 141-pound rails from six leading suppliers–Corus America, ISG (formerly PST), JFE (formerly NKK), Nippon Steel, Rocky Mountain Steel and Voest Alpine—were in track for 477 mgt. The average hardness of the rails was 395 HB. The test was conducted in a five-degree curve that has only light, indirect lubrication on the high rail. A major result included 12 percent average reduction in wear compared to rails in previous tests (average hardness 365 HB). There were minor variations in wear performance among the rails in the most recent test.

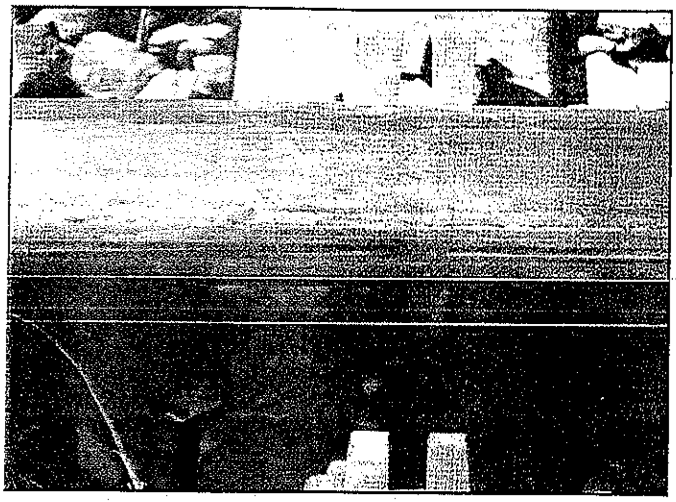
The rails required no grinding and surface conditions remained generally good, with the exception of some rolling contact fatigue that began to appear about 300 mgt into the test (Figure 1). There were more rail breaks that initiated in the base during this test than in previous ones. Preliminary analysis showed that the higher hardness rails have reduced fracture toughness compared to rails previously tested. The effect of fracture toughness on the increase in base breaks requires further investigation.

Rail slot welding

An alternative method of repairing rail defects has been developed by The Holland Company (Feb. 2005 *RT&S*). The process uses robotic gas metal arc welding (GMAW) to repair defects up to 1-3/8 inches deep in the head of the rail. The defect is milled from the railhead, leaving the web and base of the rail intact. The GMAW process then replaces the removed metal.

Fourteen slot welds have been installed at FAST, 12 in 2004, and two in 2005. Nine of the 12 welds installed in 2004 remain in track after 194 mgt. Two were removed due to the propagation of fatigue defects, as indicated by ultrasonic inspection. None of the welds failed. Both welds installed in 2005 remain in track after 54

by Joseph LoPresti, principal investigator, and Semih Kalay, senior AVP research and development, TTCI



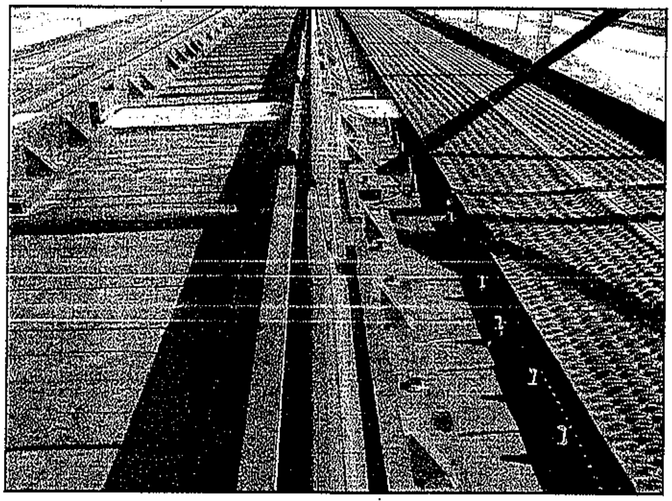


Figure 2, left, is a slot weld after 194 mgt. Figure 3 is a miter rail joint on the FAST steel bridge.

mgt. The condition of the welds in track is good, with little flow or deformation (Figure 2). Testing at FAST has helped Holland identify weld process issues. They have been addressing the issues to ensure weld cleanliness and improve the in-track welding process. Slot welds are now being tested in revenue service.

Reduced consumption EFB welds

Another weld process, with the potential of increasing the applicability of welding, is the reduced consumption electric flash butt weld (EFB), also developed by The Holland Company. This process consumes about 3/4 inch of rail instead of the 1-1/2 inch typically consumed. The reduced consumption decreases the amount of rail that has to be unclipped for welding. Laboratory tests have shown that the welds meet AREMA guidelines for slow-bend testing.

Six reduced consumption welds, produced at a Holland Company facility, were installed at FAST in 2004 and have accumulated 194 mgt. Twenty-two more were installed in-track in 2005. Most of those have accumulated 54 mgt. The rest, installed later or on the portion of the HTL with a siding track, have accumulated 24-30 mgt. All welds have performed well, with no maintenance or removal needed. Appearance of the welds is similar to standard EFB welds.[1]

Concrete bridge

Two concrete bridges were constructed in 2003. A three-span bridge features a 42-foot high-performance concrete double-cell box span designed by CN Rail as the center span. The flanking spans are a 30-foot double-cell box span and a 15-foot slab span, both designed to the new Union Pacific Railroad and BNSF Railway (BNSF) joint standard designs. The two-span bridge, with 24- and 32-foot spans, is more representative of the existing railroad concrete bridge inventory. Tests include the effect of tie type and ballast depth on bridge impacts. Early results have shown that a mechanical joint significantly increases impacts into a concrete bridge with concrete ties and the need for track geometry maintenance. Concrete ties with rubber pads on the bottom of the tie reduced vertical track modulus on the bridge, reduced impacts measured in the bridge, and reduced track surfacing maintenance required.

Steel bridge

The steel bridge at FAST was placed in service in 1997, primarily to address deck and approach issues (July 2005 *RT&S*). By early 1998, several fatigue cracks developed. The primary cause of these cracks is a weld detail which is not consistent with current AREMA guidelines. Thereafter, a fatigue and crack growth test began, with the following results:

[1] *Manual for Railway Engineering*, Chapter 4, Section 2.3.2.6

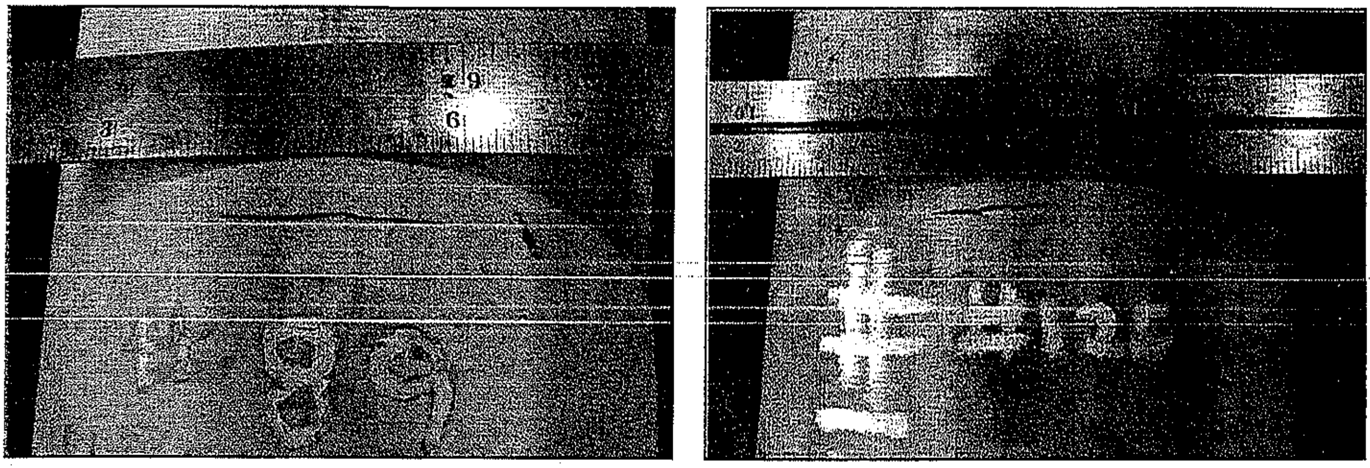


Figure 4, left and right, shows cracked axles in test at FAST.

• Rail joints on the bridge produced impact loads that appear to have initiated several cracks and accelerated crack growth.

• Stop-hole drilling retrofits and bolted splice repairs are both performing well to date.

• Weld details treated with Ultrasonic Impact Treatment (UIT) to prevent cracking are showing no signs of cracking to date.

Strains in lateral bracing were measured this Summer. The results should improve the understanding of bracing performance and may be used to refine AREMA guidelines.

Bridge joint

The current bridge joint test is of an Amtrak-designed miter rail joint (Figure 3). This bridge joint design is used on lines that handle passenger trains traveling up to 80 mph and HAL freight traffic. The joint being tested has accumulated 194 mgt. It has lasted longer, required less maintenance, and reduced dynamic vehicle loads into the bridge compared to bridge joints previously tested at FAST. One of the few problem areas was the proximity switch brackets. Metal brackets failed after less than five mgt. The length and weight of the brackets, coupled with vertical movement under the train, caused the brackets to break. A new bracket, designed and fabricated by TTCI of Delrin® plastic, has been in service for 35 mgt with no sign of failure.

Turnouts

An advanced design turnout with tangential/double spiral geometry with kinematic gauge optimization (KGO), hollow switch ties, non-metallic switch rods, and a solid (no wrap rails) welded-heel frog is being tested. The KGO allows for larger cross-section switch points while maintaining tangential geometry at the points. The larger cross section has prolonged point life compared to previous, thinner, tangential points tested. Dynamic lateral and vertical loads measured at the turnout are at least as low as those for any turnout previously tested at FAST.

Bonded insulated joints

Working with an AAR Strategic Research Initiative Program on bonded insulated joints, a series of tests at FAST have focused on the effects of foundation and joint design on joint deflection. Stronger designs and improved support have reduced vertical deflection. Effect on joint life is yet to be determined.

Ties and fasteners

Crossties and fasteners are tested (primarily) in a six-degree curve to determine their performance under 39-ton axle loads. To date, plastic composite ties have performed well, but are more sensitive to pilot-hole size than wood ties. Too small (or no) pilot holes increase the likelihood of tie cracking. The first plastic ties installed at FAST have accumulated over 900 mgt. The only ties removed from that test zone were damaged in a derailment. Nearby wood ties showed a similar degree of damage.

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(TTCI continued from page 21)

Two new types of new fastening systems, Pandrol VICTOR and NorFast, have performed well, though both had some instances of infant mortality. Track strength is similar to other types of elastic fastener track.

Axle crack growth

Between 1998 and 2002, there were three derailments at FAST caused by axle failure. These occurrences prompted a test to measure the growth rate of axle cracks. Data collected and analyzed are being used to set criteria for axle inspections and axle crack detection systems.

Two axles (Figure 4), with cracks detected during annual axle inspections at FAST, are under a car in the train. One crack measured two inches long x 1/8 inch deep at the start of the test, and the other measured 1 1/4 x 1/16 inches. Several procedures are in place to minimize the risk of a catastrophic failure: The axles are instrumented to send an alarm if the cracks reach 30 percent of cross sectional area; the axles are visually inspected and the cracks measured every other day of train operations (daily inspections will start after crack growth is noted); and the car with the cracked axles is always at the end of the train.

The axle with the 1/8-inch crack has accumulated 25,000 miles since the start of the test, and the axle with the 1/16 -inch crack has accumulated 24,000 miles (mileages from crack initiation until the start of the test are unknown). There has been no measured growth in either of the cracks. This is consistent with crack growth modeling performed by TTCI, which predicts that it may take aver 60,000 miles for the cracks to grow to 2-1/2 inches deep, with most of the growth in the last 2,000 miles. The test will continue until the cracks reach roughly 30 percent of cross sectional area, with expected completion in 2006.

Lightweight trucks

Three cars in the heavy-axle-load train at FAST are equipped with lighter weight truck for 315,000-pound cars (January 2005 *Railway Age*). The primary suppliers of components were ABC-NACO, Standard Steel and Timken. The truck sets, with their reduced weight castings, shorter bearings and axles, smaller diameter wheels, and shorter wheelbases, weigh about 1,200 pounds less than the typical FAST truck set.

Two of the cars have accumulated 81,000 miles and the third car 69,000 miles. Wheel wear and surface conditions of the 36-inch wheels are similar to those of the 38-inch wheels under the rest of the cars in the train. One wheelset has been prepared for testing on TTCI's wheel dynamometer. The test will determine the effect of heavy braking on the wheels. A similar test will be conducted on wheels at the end of their wear life.

Curving performance of the cars and truck component performance has been similar to that in the rest of the train.

New tests

A new rail performance evaluation with state-of-the-art rails began in the Fall. Rail hardness ranges from about 400 to 420 HB. A completely new design of insulated joint will be installed for testing this Fall. And a new generation of gas pressure rail welds will be installed early next year.□