TECHNOLOGY DIGEST

Timely Technology Transfer — 00-005

Development of an Improved Switch Point for Heavy Axle Load Service

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Summary

Transportation Technology Center, Inc. (TTCI) has designed a switch point/stock rail pair which is intended to lower life-cycle costs while improving safety and reliability for a lateral No. 20 American Railway Engineering and Maintenance of Way Association (AREMA) switch geometry.

The new switch-point design, developed under a research program sponsored by the Association of American Railroads (AAR), will have about a 40 percent larger cross-sectional area at the point of switch than the conventionally used AREMA design. The larger cross-section and stock-rail contact areas are intended to lower stresses in the critical stock and rail switch point transfer areas therefore lengthening switchpoint life. The stock rail life may be decreased by a lesser amount as a result of reducing its cross section; however, the average life of the pair should be longer.

The following boundaries were established for this study:

- Switch point and stock rail to be machined from RE section rail.
- Switch point and stock rail pair must be interchangeable with existing designs.
- Switch point must remain within the AREMA lead length.

Anticipated benefits to be derived from this switch point/stock rail design include:

- Lower stresses on the switch point.
- Better ability to resist chipping due to larger head section.
- Longer switch-point life and longer point/stock rail pair life.
- More stability in the switch point from a larger flat base.
- Less chance of accidents from splitting the switch.

A prototype curved switch point stock rail pair will be built for testing in an AREMA geometry No. 20 turnout at FAST. The design is based on the results of field observations, the use of TTCI's analytic tools, and the experience of railroad and supplier engineers.

Suggested Distribution:

- ❑ Maintenance of Way
- ❑ Planning & Analysis
- ❑ Track Maintenance
- ❑ Safety

Work performed by TTCI Transportation Technology Center, Inc.
a subsidiary of the Association of American Railroads
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INTRODUCTION AND CONCLUSIONS

Switch points are the key traffic control elements in turnouts, allowing trains to move from one track to another. While much work has recently been conducted in an effort to improve turnout performance, the effort has focused on frogs and switch geometry.

Special track works (turnouts and crossing diamonds) are vital links in the track system. They are key components in train operations, affecting more than one track. They are also the most expensive and complicated track components. U.S. railroads spend about $320 million annually on turnouts. And, turnouts consume a disproportionately large part of every railroad's track maintenance budget. About $98 million is spent on turnout maintenance annually. Additionally, 6,800 frogs are replaced at a cost of $120 million per year. The load environment on these components is quite severe, making them the shortest lived track components in the system. Improved performance is needed from special track work to improve system reliability and efficiency.

The new switch-point design, developed under a research program sponsored by the Association of American Railroads (AAR), will have about a 40 percent larger cross-sectional area at the point of switch than the conventionally used AREMA design. The larger cross-section and stock-rail contact areas are intended to lower stresses in the critical stock and rail switch point transfer areas therefore lengthening switchpoint life. The stock rail life may be decreased by a lesser amount as a result of reducing its cross section; however, the average life of the pair should be longer. A switch point/stock rail pair will be built for testing in FAST under HAL traffic. Performance will be monitored and results compared to the AREMA switch point now in the turnout.

BACKGROUND

A 1996 study done for AAR showed that approximately 12 percent of annual maintenance spending for turnouts is on switch points. Exhibit 1 shows the major maintenance categories. Frog and tie/fastener maintenance are the major consumers of turnout maintenance expenditures, with switch points ranking third.

The purchase cost of a switch point/stock rail pair can range from 10 to 20 percent of the cost of the turnout. The life of a switch point is considerably shorter than the life of the surrounding rail. A recent AAR survey of member railroads revealed that the average life of switch points in mainline turnouts (No. 14 and larger) is about 300 million gross tons. Exhibit 2 shows the survey results. It is expected that the average life of switch points will decrease under heavy axle load traffic.

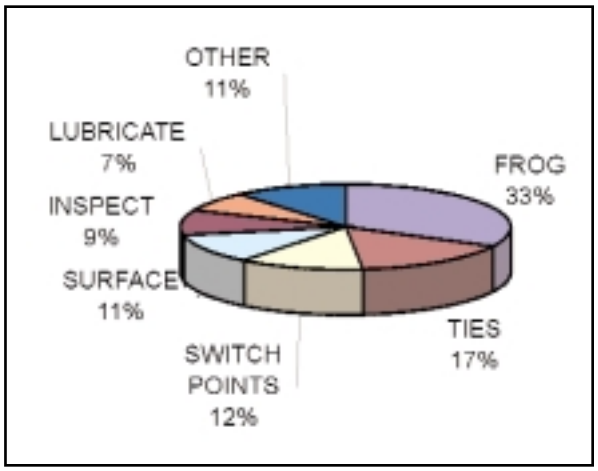

Exhibit 1. North American Turnout Maintenance Spending

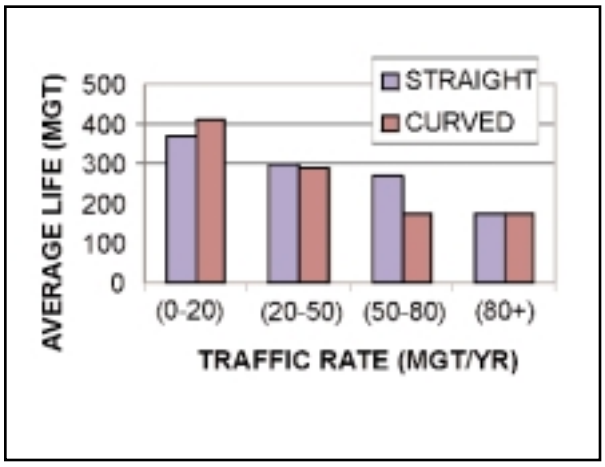

Exhibit 2. Average Switch Point Life in Freight Service

TTCI = Transportation Technology Center, Inc.; AAR = Association of American Railroads

Switch Point Design	Switch Point		Stock Rail	
	Area (sq. in.)	Ratio to AREMA	Area at Point of switch (sq. in.)	Ratio to AREMA
AREMA	5.4	1.0	13.4	1.0
PROPOSED	7.6	1.4	10.7	0.8

Exhibit 3. Comparison of Switch Point and Stock Rail Cross Sectional Areas

FIELD PERFORMANCE OBSERVATION

- Generally, switch points wear out before stock rails.
- The stock rail is often replaced with the switch point to avoid fit problems and to comply with FRA 213.135(c).
- Switches are among the leading causes of track related accidents, with a worn or broken point being the leading cause among switch caused accidents.
- Switch points, because of their reduced cross section, are likely to be adversely affected by an increase in axle loads.

From these observations, the goals of this study were to increase the life of the switch point and to decrease the likelihood of derailment on the switch. It is felt that both of these goals can be accomplished by reapportioning material from the stock rail to the switch point.

Traditionally, the stock rail cross section is a full rail, with the exception of undercutting the gage side of the head in some cases. The switch point is machined to match by cutting away most of the rail base and head. This practice initially produces a switch point that is less stable vertically, torsionally, and laterally than a full section rail, which then has reinforcing bars added in most switch designs. The unaltered stock rail does allow the railroad the option of replacing the stock rail independently of the switch point. And, in emergencies, any rail can be used as a stock rail.

For mainline freight railroad operations, TTCI has observed that most switch point/stock rail pairs are replaced as pairs. With this maintenance policy, the machining of the stock rail becomes acceptable. Removing material from the stock rail foot and additionally from the head (in place of removing it from the switch point) is intended to produce a somewhat weaker stock rail and a stronger, longer lasting switch point. The objective is to balance the lives of the switch point and stock rail while avoiding adding stress-risers to the stock rail which could increase chances of crack formation.

If the material redistribution is carried to the beginning of the switch point or point of switch, an additional safety benefit can be obtained. A "housed" switch is created by recessing the switch point tip into the stock rail. It will be more difficult for sharp/thin flange wheels to "pick the point" of the switch. This is a further development of the undercutting idea now used in some railroad switches. The undercutting protects the switch point from vertical load and allows the point to be thicker at its end. The difference is that the switch point will bear load from the point of switch and provide the rail gage face. The stock rail will have a discontinuity on the gage face at the point of switch. Thus, it will be more important to have good alignment and running surface profiles through the switch to keep wheel flanges away from the stock rails.

DESIGN CONSTRAINTS

- Maintain AREMA lead length.
- Switch point and stock rail to be machined from RE section rail.
- Existing turnouts must be convertible to the new design by replacing only the switch panel.

STRENGTH ANALYSIS

The new point design will have about a 40 percent larger cross section area at the point of switch. This is intended to result in lower lateral stresses in the point. The cross sectional area of this switch point is about 7.6 square inches, compared to the cross sectional area of the AREMA switch point at the point of switch which is about 5.4 square inches.

SELECTED DESIGN

Exhibit 4 shows the plan view of the selected design. Note the variations from the existing AREMA design at the point of switch. Exhibit 5 shows a cross section view of the switch point and stock rail at the location noted on the plan view.

This design is based on reapportioning material between the switch point and stock rail to balance the expected life of the pair. As much as possible, the standard AREMA switch point design features were used. This includes a 20 foot length for switch point/stock railhead separation. The stock railhead width will grow from point of switch until it reaches the conventional "Samson" or AREMA Detail 5100 undercut. This undercut will be carried past the point of head separation, as is the current practice. The switch point head will grow to a full rail section at 20 feet.

The switch point and stock rail cross-section designs chosen will be developed for the curved point/straight stock rail pair of a #20 switch. One pair will be built of conventional rail and one pair will be built of bainitic rail. The conventional rail pair will be installed at FAST for performance evaluation under heavy axle load traffic. Results will be compared to a conventional switch point pair currently in test. Among the issues to be addressed in the prototype tests:

- Effect on running surface deformation patterns and rates for the switch point and stock rail.
- Effect of sudden gage change due to higher stock rail undercut on straight moves through the switch.

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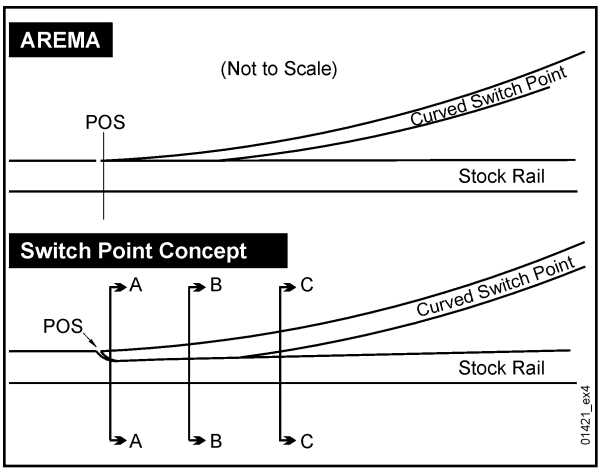

Exhibit 4. Plan View of Proposed Switch Point Design

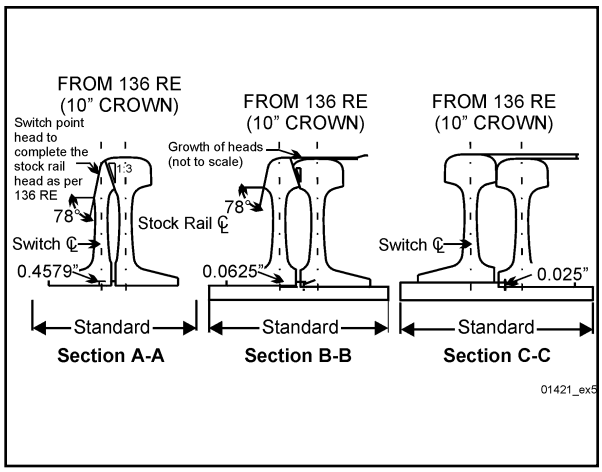

Exhibit 5. Cross section Views of Proposed Switch Point Concept

A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, MAY BE AVAILABLE AT A LATER DATE THROUGH AAR/TTCI, PUBLICATIONS, P.O. Box 79780, BALTIMORE, MD, 21279-0780.