TECHNOLOGY DIGEST

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Turnout and Crossing Diamond Grinding Best Practices for Heavy Haul Operations

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Summary

In a survey of turnout and crossing diamond grinding best practices for heavy haul operations, railroads agreed that grinding increases the life of components in turnouts and crossing diamonds, but economic benefits or optimal grinding policies had not been documented. The survey was conducted by Terrill Track Consultants for the Transportation Technology Center, Inc. (TTCI). The objective of this survey is to determine the best practices for grinding special track work.

Opinions were offered that proper grinding could double the life of switches and frogs. However, there is little documentation to support the expert opinions that grinding significantly extends the life of special track work. One railroad suggested that the return on frog and switch grinding was about 3 to 1, indicating a good economic basis for grinding. However, most railroads surveyed remarked that their grinding plans were driven by budget (or cash flow) rather than based on life cycle costs.

The approach to switch and frog grinding planning varied by railroad. Several railroads have preventive grinding programs. They were removing very little metal per grinding visit. Other railroads were concentrating efforts on their heaviest traffic lines, and doing more corrective grinding over the rest of the system as budgets allowed.

The reasons for grinding are to restore the proper profile to the running surface and to repair the effects of hollow tread wheels. Some worn wheel profiles cause damage at the critical wheel transfer areas of frogs and switches. These include frog points, frog wings, switch point tips, and stock rails in the wheel transfer areas.

Best practices for grinding special track work include:

- Pre-grinding track maintenance and repair.
- Accurate measurement of the pre-grind running surface using portable optical measurement devices.
- Restoring running surface to produce a contact band centered on the railhead: An 8-inch crown radius profile was preferred.
- Use of flexible, accurate grinding machines.
- Adoption of a preventive grinding policy.

The use of premium materials in special track work for heavy axle loads is a best practice that minimizes the amount of grinding needed.

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Suggested Distribution:

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

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INTRODUCTION

AAR member railroads were surveyed to determine the best practices for special track work running surface grinding. The results of the survey were similar to those found for rail grinding in open track. There are railroads that are doing preventive grinding and others that are doing repair and restoration grinding. The best practices are described in subsequent sections. In addition, a list of potential follow-up projects is included.

METHODOLOGY

A survey of switch and frog grinding practices was funded by AAR and conducted by Terrill Track Consultants for TTCI.[1] Working with TTCI, they developed a set of questions to help determine current methodology and materials used in switch and frog grinding. Additional questions attempted to elicit the philosophy and economics of switch and frog grinding. Finally, an attempt was made to identify areas for additional research and improvements.

The questionnaire was sent to the chief engineers with a request to appoint a project representative knowledgeable in the areas of special track work and grinding. Amtrak, BNSF, CN-IC, CP, CSX, NS, QCM, and UP were represented. Responses to the survey were solicited and follow-up questions were asked when needed.

RESULTS

A variety of switch and frog grinding practices are employed by the railroads surveyed. Some of the variation is due to the variety of operations, special track work designs, and maintenance and budgeting philosophies employed. One group of railroads uses a semi-automated production grinding program for special track work. These railroads are striving to reach the status of doing only preventive work (i.e., keeping the system in optimum condition). The other group relies on an as-needed restore and repair program. The special track work grinding programs on these roads are determined by budget, with prioritization based on line importance. Interestingly, the railroads who are the largest users of advanced design special track work are the ones in the latter group. This may reflect some of the benefits they are getting out of the advanced designs. It may also reflect capital vs. operating expense decisions.

Despite the philosophical differences, all railroads agree that grinding is effective in extending the life of special track work. One suggested that a proper grinding program could extend the life of special track work components by up to 100 percent on heavy haul lines. Due to the daunting challenges and numerous uncontrolled variables involved with such a field trial, little documentation of the effectiveness of grinding exists.

The surveyed railroads agree the main reasons for grinding are to restore the proper running surface profile and to repair the effects of hollow tread wheels. Respondents were also asked to rank the causes and mechanisms they felt were most critical to induce grinding as shown in Exhibit 1. Certain worn wheel profiles cause damage soonest at the critical wheel transfer areas of frogs and switches. The wheel transfer areas are designed for cone-shaped wheels. Hollow-worn wheels cause impacts and high-stress contact or both in these areas. These include frog points, frog wings, switch point tips and stock rails in the wheel transfer areas.

BEST PRACTICES

The common features of an effective grinding effort are listed below:

- Pre-grinding track restoration is used for increasing grinding effectiveness. Removing any defects will improve the ability to grind the desired profile gage, surface, and alignment. Proper adjustment of guard rails is also used. Frog cracks, spalls, and excessive flow are repaired prior to grinding. Production grinding programs are more successful when preceded by track repair.

- The ability to accurately measure the running surface profile prior to and during grinding operations is used to optimize the grinding process. The best practice is to use a portable optical profile-measuring device for measuring and checking profiles. This facilitates proper pattern selection.

Overall Rank	Reason for Grinding Special Track Work	Average Ranking (Eight RR's)
1	Restore running surface profile	2.3
2	Remove hollow tread wheel damage	3.5
3	Restore profile in stock rail transfer area	3.9
4	Remove deformation	4.0
5	Remove corrugations	4.6
6	Remove damaged surface on LAHH rail*	5.5
7	Remove conditions not otherwise specified	6.3
8	Remove batter	6.3

* LAHH is Low Alloy Head Hardened

Exhibit 1. Ranking the Reasons for Grinding Special Track Work

- As in rail profile grinding, the objective of special track work profile grinding is to center the wheel contact zone on a broad running surface. This minimizes contact stress and material flow. Railroads surveyed overwhelmingly prefer an 8-inch crown radius profile. This radius provides a reasonably wide worn running band while assuring that contact remains off of the gage corner.

- Grinding equipment has also improved greatly in the recent past. Machines that are more capable of producing the desired profiles, with little excess metal removal, are preferred. Twenty stone grinders are typically used. Due to a lack of accuracy and consistency, production grinders are not used in the critical switch point and frog point areas. Dropping a grinding wheel inaccurately in these areas could chip or break the point.

- Premium materials are recommended for use throughout heavy haul special track work, including closure rails, guard rails, and frogs. Use of premium guard rails and gage plates have also kept wheels and frogs in better alignment. Spring frogs are now standard on two railroads for heavy haul mainline turnouts. Spring frogs eliminate the open flangeway for mainline traffic and reduce the amount of grinding needed on frogs. Elimination of joints with fully welded turnouts has also decreased the amount of grinding required.

- Improved performance from special track work and routine running surface maintenance in rail has led some railroads to adopt a preventive grinding philosophy. In this approach, the running surface profile is maintained at shorter tonnage intervals. The running surface is reshaped to the desired profile with little additional metal removal. This approach also requires more skilled interpretation of profile measurements to minimize grinding metal "loss." Training is essential for field personnel.

OPTIMAL SWITCH POINT OR FROG POINT PROFILE

There is no universal agreement on an optimal running surface profile in areas where the wheel transitions from one running surface to another, such as at the switch point or frog point. Most grinders try to restore the original profiles; recognizing that these profiles are likely to rapidly deteriorate again. Manual post grinding in these areas helps maintain a smooth transition.

RESEARCH AND DEVELOPMENT NEEDS

The intent of the AAR research program is to follow this survey with investigation of the highlighted research needs and appropriate field tests of grinding practices. Among the research and development needs noted were:

- Stronger flow-resistant materials.
- Elimination of open flangeway gaps (e.g. via spring frogs, moveable point frogs and flange bearing frogs).
- Improved production grinders that are more accurate and flexible (i.e., require fewer passes to accomplish task).
  - Production grinders that can work through road crossings.
- Improved easy-on-off grinders are needed to reduce grinding intervals.
- Improved spot grinders that are more accurate and flexible.
- Better accommodation of hollow tread wheels.
  - Larger switch risers, longer frog point slopes.
- Design a better plate to help maintain a solid stock rail/switch point/switch plate-tie seat.
- Redesign of areas that are subject to flow.
- Maintain vehicle wheels to reduce or eliminate hollow treads.
- Design a minimum four grinding stone rack to be used with maximum accuracy as the lead bogie at the approach to the switch and frog transition areas.

FUTURE WORK

Evaluation of frog running surface profiles designed to promote a centered contact band will be conducted at FAST. The high tonnage loop at the Facility for Accelerated Service Testing (FAST), with 39-kip wheel loads, provides an accelerated test of track components and maintenance practices. TTCI is testing flow resistant bainitic frogs and switch points at FAST currently. Tests of a larger cross-section design switch point will also commence in 2000.

REFERENCES

1 Terrill, V.; D. Mesnick; B. Hanson; R. Steele, and C. Deal; “A Survey on Turnout and Diamond Crossing Grinding Practices in Heavy Haul Operations,” TTCI, January 2000.

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