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Evaluation of Switch Inspection Gauges

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Summary

Transportation Technology Center, Inc. (TTCI) evaluated two sets of prototype switch inspection gauges. One set was recently developed by University of Delaware and built by Norfolk Southern Railway (NS). The second set was manufactured by Geismar for Burlington Northern Santa Fe Railway (BNSF) and has been in use for several years. Both sets of gauges were designed for track inspectors to use in determining the operational safety limits of switch points. The gauges were tested at the Facility for Accelerated Service Testing (FAST) at the Transportation Technology Center in Pueblo, Colorado. TTCI also tested the gauges at a nearby industrial railroad property.

The prototype gauges were effective in conservatively detecting the following safety critical switchpoint conditions (1) The gauges have the ability to assess wheel contact on any switch point they are used on and (2) The gauges provide the ability to measure wheel contact on switch points that are worn, chipped, and in some instances gapped. For inspectors in the field these conditions are some of the most difficult to identify properly.

The gauges that TTCI evaluated were successful in providing guidance in determining if an inspected switch point had a condition that should be a cause for concern to the inspector. The gauges are portable and easy to use which contribute to their effectiveness.

The inspection of switch points is typically completed with a combination of visual and hand tool based measurements. These measurements are somewhat subjective and, due to the three dimensional nature of the wheel/switch point contact, there exists natural variability in how individual inspectors categorize the condition of switch points. Although defects that are obviously condemnable can and do occur, it is more common to identify conditions that are not condemnable.



INTRODUCTION

In a recent study, TTCI evaluated two sets of prototype switch inspection gauges. Both sets were portable, easy to use, and provided guidance in determining if an inspected switch point had a condition that should be a cause for concern to a track inspector.

The methods used in the inspection of switch points are largely qualitative and can be influenced by the experience of the inspector. One common method is to determine the location of first wheel contact. By determining the longitudinal distance from the end of the switch point and the vertical distance from the top of the stock rail, an assessment of the potential for picking the point and wheel climb are made.

Today's track inspector prefers to use techniques and tools that are definitive in their measurements. The gauges described below are quantitative and remove most of the subjectivity of wear band assessment.

Most non-mainline turnout derailments can be traced back to an underlying issue with a switch point along the derailed train's intended path. Typically, these derailments are flange climb events where the flange of the leading wheelset climbs up on top of the switch point. The wheel will then roll on top of the rail for a distance before it drops in between the switch point and stock rail and causes the subsequent derailment of the rolling stock.

There are a wide range of factors that can combine together to create the potential for a flange climb derailment. Even by using visual inspection and observing recommended maintenance criteria it is still possible for field personnel to miss or incorrectly identify a condition that could lead to flange climb.

NS PROTOTYPE GAUGE DESIGN

Under a Federal Railroad Administration research project funded through the Transportation Research Board committee, the University of Delaware developed a set of switch inspection gauges. NS built and provided a set of two gauges to TTCI for evaluation. The gauges share many similarities to a typical track gauge used to measure cross level and track gauge. This provides a new user a level of familiarity with the gauges even if they have no prior experience.

The NS gauges provide the ability to perform four individual measurements depending on the orientation of the gauges on top of the rail. The four measurements

indicate the presence of conditions that will likely contribute to a flange climb event. The measurements include broken or worn switch points, AAR 1B wheel contact, severely worn wheel profile, and gage-face wear angle. The gauges provide a go/no-go reading for each measurement. If, during the course of a typical visual inspection, the inspector finds a switch point that he/she considers to be questionable, using this gauge to perform follow-up measurements would prove beneficial.



Figure 1. NS Inspection Gauge at FAST

Work performed by Shu and Davis¹ discusses criteria for safely rating switch points with chips in them. The AREMA *Manual of Railway Engineering*, Chapter 5 requires that chips lower than 7/8 inch from top of rail be repaired regardless of chip length.² Clearly, the lower the chip defect is from the rail top, the easier a wheel with a lower flange contact angle can catch the chip and climb up to the top of the rail. The AREMA Chapter 5 criteria, which are based on a 7/8-inch chip depth regardless of chip length, are only conservative (safe) for switches with chips reaching 7/8 inch or lower from the top of rail, but not conservative enough for long chips even though their depths are smaller than 7/8 inch.¹

One of the best features of the NS gauges based on the inspections TTCI conducted is their ability to provide a clear picture of a switch point that is severely worn and has the potential to cause flange climb. Figures 2 and 3 show the results of an inspection performed by TTCI at a local industrial railroad property. Using just visual methods, the switch point seen in Figure 2 appears to meet the AREMA Chapter 5 criteria for chips at first appearance. Using the inspection gauge however, clearly shows that the switch point presents an opportunity for a wheel flange to climb.



Figure 2. Worn Switch Point Inspected Using NS Gauges



Figure 3. Gauge Caught on Condemnable Worn Switchpoint

Results of Testing NS Gauge

The gauges TTCI received from NS to examine performed very well. They provide a conservative reading of switch point condition for any inspector in the field. The gauges are straight forward to use and are portable. One drawback is that there are two gauges, which means an inspector has twice the amount of equipment to carry, and depending on space limitations on an inspection vehicle/truck, this is a potential problem. TTCI believes that the gauges could be combined into one apparatus in future iterations, which would increase the tool's usefulness and cut down on the storage space required when not in use.

BNSF Developed Gauge Design

In conjunction with Geismar, BNSF developed a switch inspection gauge that offers a different method of measurement and, unlike the NS gauges, does not provide a go/no-go indication. Instead, the BNSF gauge quantifies

the measurement and has a chart summarizing the values that would be considered condemnable for one of the measurements. The instructions for the second measurement that can be performed using this gauge refer to the condemning limit.

The BNSF gauge provides the ability to measure for chipped switchpoints and gage face wear of the switchpoint. The gauge was tested under similar conditions as the NS gauge. Figure 4 shows the gauge being used to measure for a gage face wear defect on a No. 8 yard turnout at the industrial railroad property near Pueblo, CO.



Figure 4 Measuring Gauge Face Wear Angle on an Industrial Turnout

Results of Testing BNSF Gauge

The BNSF gauge performed adequately during trials. It is limited in the types of defects it can detect, because it only checks for chipped points and gage face wear. It does not have the ability to detect a gapped or extremely worn switch point in its current configuration.

The gauge is compact, which is a definite upside when considering storage requirements. TTCI found the gauge to be a bit unwieldy when making measurements, especially for chipped switchpoints. Two people were needed to perform the measurements (one to hold the gage steady on the switch point, the other to take the actual measurements).

The gage does not check for worn switch points, which limits its use. This gage was developed to address a specific subset of the overall grouping of measurements that can be performed on a turnout.

CONCLUSIONS

TTCI evaluated two different sets of switch inspection gauges provided by NS and BNSF. The gauges provide track inspectors a useful method of checking for defects that are subjective in nature. In a revenue service environment, these gauges could potentially assist track inspectors in identifying switches that require maintenance attention. The ability for a track inspector to make a reliable measurement of switch point condition has significant advantages. By being able to quantify parameters, the need for maintenance can be prioritized. By removing subjectivity, a more uniform set of maintenance standards can be applied across large territories and for railroads with numerous inspectors. If changes in switch point condition are tracked over time, it might be possible to move towards a more predictive maintenance policy.

The gauges have the most potential upside when used in a switching yard or industrial track applications. Typically switches in these environments are in worse condition than mainline switches. They also have longer intervals between regular maintenance due to high usage. In yards, some switches may see regular usage on a 24-hour continuous cycle depending on operational conditions.

This makes performing quality inspections more difficult as these tracks can be hard to get access to in some cases, especially with switching operations ongoing. With tools such as the switch inspection gauges that were tested, the time required to perform a quality inspection of switches in these environments should decrease.

TTCI engineers believe that with further refinement to some of the features, gauges of this type could be just as important as a tape measure to today's track inspector.



Figure 5. Typical Yard Ladder Track Arrangement

The proper use of such gauges have the potential to significantly reduce the number of switch points in revenue service that pose an increased derailment risk. Evaluation results indicate the rail industry would benefit from continued refinement and innovation of these types of inspection aids.

REFERENCES

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2. American Railway Engineering and Maintenance-of-Way Association. *AREMA Manual of Railway Engineering*. Vol. 1 Chapter 5, Track. 2016.

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