The Technical Center at JR East is making efforts to be able to contribute to transport stability and improvement of maintenance skill of field personnel. Our field support activities include on-site investigation into the causes of and technical assistance for turnout failures and other maintenance problems in the field.

In addition to such activities, we make efforts in field support from various approaches. Those approaches include development of a switch rod for double slip switches as a preventive measure against track short circuiting at special layout turnouts. Another example is creation of an installation and maintenance manual for CWRs in turnouts with an aim of spreading use of CWRs in turnouts that are effective in to further improving safety and transport stability and reducing track maintenance work.

Keywords: Switching failure, Electric point machine, Special layout turnout, Locking shift, CWR

1 Introduction

The Technical Center at JR East is making efforts to be able to contribute to transport stability and improvement of maintenance skill of field personnel. Our field support activities include on-site investigation into the causes of and technical assistance for turnout failures and other maintenance problems in the field.

In addition to such activities, we make efforts in field support from various approaches. Those approaches include development of a switch rod for double slip switches as a preventive measure against track short circuiting at special layout turnouts and creation of an installation and maintenance manual for clearing concerns and questions in the field related to CWRs in turnouts. Through those activities, we aim to spread use of CWRs in turnouts that are effective in further improving safety and transport stability and reducing track maintenance work. This article will introduce examples of those field support approaches.

2 Cause Investigation and Technical Assistance for Turnout Failures and Other Problems

2.1 Overview

We carried out on-site cause investigations into and technical assistance for turnout failures and other maintenance problems. In those activities, we made out investigation reports as needed to prevent similar events. A total of 17 on-site and other investigations were conducted in fiscal 2011. Table 1 lists the breakdown of those. Fig. 1 shows the results of specific field support activities including sending instructors for training on turnouts, etc.

<table>
<thead>
<tr>
<th>Date</th>
<th>Day/night</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10</td>
<td>Night</td>
<td>Investigation of projection of Shinkansen movable nose crossing</td>
</tr>
<tr>
<td>May 17</td>
<td>Day</td>
<td>On-site investigation of tongue rail that caused pitching</td>
</tr>
<tr>
<td>June 1</td>
<td>Day</td>
<td>Investigation of derailing in rolling stock depot</td>
</tr>
<tr>
<td>June 2</td>
<td>Day</td>
<td>Investigation of derailing in rolling stock depot</td>
</tr>
<tr>
<td>June 29</td>
<td>Day</td>
<td>Investigation of locking shift of special layout turnout</td>
</tr>
<tr>
<td>July 12</td>
<td>Day</td>
<td>Investigation of non-switching of movable DC</td>
</tr>
<tr>
<td>July 14</td>
<td>Night</td>
<td>Investigation of non-switching of movable DC</td>
</tr>
<tr>
<td>July 25</td>
<td>Night</td>
<td>Investigation of locking shift of special layout turnout</td>
</tr>
<tr>
<td>August 5</td>
<td>Night</td>
<td>Investigation of ball bearing base plate flaw</td>
</tr>
<tr>
<td>August 17</td>
<td>Day</td>
<td>Investigation of non-switching of turnout</td>
</tr>
<tr>
<td>September 12</td>
<td>Day</td>
<td>Investigation of derailing of flat bogie wagon</td>
</tr>
<tr>
<td>September 13</td>
<td>Day</td>
<td>Investigation of derailing of flat bogie wagon</td>
</tr>
<tr>
<td>October 17</td>
<td>Night</td>
<td>Investigation of locking shift of special layout turnout</td>
</tr>
<tr>
<td>October 20</td>
<td>Day</td>
<td>Investigation of locking shift of special layout turnout</td>
</tr>
<tr>
<td>December 27</td>
<td>Day</td>
<td>On-site investigation of turnout switching error</td>
</tr>
<tr>
<td>January 12</td>
<td>Day</td>
<td>On-site investigation of turnout switching error</td>
</tr>
<tr>
<td>February 14</td>
<td>Night</td>
<td>Flaw detection of pressure welded crossing</td>
</tr>
</tbody>
</table>

Table 1 On-site Turnout Investigation in Fiscal 2011

Fig. 1 Actual Number of Days of Field Support in Fiscal 2011

2.2 Example of Activities Conducted

We will introduce here the case of locking shift investigation at Musashi-Koganei Station, one of the cases of on-site investigation and technical assistance carried out in fiscal 2011.
2.3 Overview of Investigation into Locking Error at Musashi-Koganei Station

Locking errors repeatedly occurred with the 104 Ro & Ha and 117 Ro & Ha electric point machines (put in service in December 2009: 60k movable obtuse crossing) in Musashi-Koganei Station on the Chuo line from July 2010, requiring ad hoc inspection six times in addition to the periodic inspection three times a year. In that investigation, we temporarily attached displacement gauges and thermometers to the 104 Ha point machine from October 25 to 28, 2011 to measure the amount of displacement round-the-clock. Fig. 2 shows the measurement points.

2.4 Investigation Results and Considerations

2.4.1 Relation between Temperature and Displacement Amount at Individual Measurement Points

As shown in Fig. 3, each displacement amount at No. 1 (amount of movement of movable rail at normal position side), No. 2 (displacement of lock rod on obtuse crossing side), No. 5 (displacement of lock rod on point machine side), and No. 7 (displacement of gauge tie of electric point machine - rail direct fastener on motor side) were in correlation with No. 3 and 4 (lock rod temperature) and No. 9 (temperature under point machine).

2.4.2 Effect of Thermal Expansion of Lock Rod and Gauge Tie

Fig. 3 shows that the waveform at No. 5 (displacement of lock rod on point machine side) minus No. 7 (displacement of gauge tie on motor side) almost overlaps the waveform at No. 2 (displacement of lock rod on obtuse crossing side). This confirmed that the effect of thermal expansion of the length of the lock rod was cancelled by the gauge tie of the electric point machine - rail direct fastener on each other, thus having no effect on locking shift. As an example, we show in Fig. 4 the relation between the extension of the gauge tie and the extension of the lock rod based on the measurement values at 13:30 on October 25.

2.4.3 Distance of Movable Rail Tip

Next, we considered the effect on locking shift of the distance of the tip of the movable rail. The movable rail tip on the normal position side (No. 1) extends by approx. 4.5 mm in the positive direction and shortens by 2.0 mm in the negative direction along the obtuse crossing wing rail according to temperature change (No. 3, 4). The displacement amount in the sleeper direction that affects locking shift could be around 0.28 mm at maximum in the positive direction and around 0.12 mm at maximum in the negative direction (Fig. 5).

2.4.4 Relation Between Calculated and Measured Amount of Locking Shift

As the relative positional relation between lock piece and lock rod of the electric point machine that the locking error detector checks was not measured, we had to separately consider the

---

Fig. 3 Measurement Results (Extraction from October 25 to 28 period)

Fig. 4 Extension of Gauge Tie and Lock Rod (October 25, 13:30)

Fig. 5 Movement of Movable Rail Toe and Effect in Sleeper Direction
relation between the individual displacement amounts measured and locking shift. We thus acquired video of the locking shift of that electric point machine taken by the Tachikawa Maintenance Center of the Hachioji Signal and Telecommunication Technology Center to crosscheck the locking shift amount and the measured amount. As a result of the crosscheck, we found that, in the daytime when temperature rises, the calculated locking shift value (displacement of lock rod minus effect of thermal expansion: No. 5 - 7) generally shifted almost the same as the value measured from the locking shift movie.

As shown in Fig. 4, No. 2 displacement of the lock rod agrees with the calculated locking shift value (No. 5 - 7). However, we could not quantitatively set out the degree of agreement between the calculated locking shift value and the measurement value due to the resolution of the locking shift movie and other problems.

2.5 Conclusion and Future Issues
In order to investigate the cause of locking error of the 104 Ro & Ha and 117 Ro & Ha electric point machines in Musashi-Koganei Station on the Chuo line, we temporarily attached displacement gauges and thermometers to the 104 Ha point machine and made round-the-clock measurement of displacement amount. The results confirmed that expansion and contraction of the gauge tie and the lock rod did not affect locking shift. We found that the tip of the movable rail moved by approx. 6.5 mm in total along the obtuse crossing wing rail. That affects locking shift, but it was just a part of the effect. We will continue quantitative consideration by introducing electric point machines with a locking sensor and measurement at more measurement points to clarify the mechanism of locking error with an aim of preventing reoccurrence of that error.

3 Development of a Tie Bar for Double Slip Switch

3.1 Background and Purpose
In the operation area of JR East, the number of special layout turnouts such as double slip switches (DSS), single slip switches, and diamond crossovers accounts for just around 2% of the total number of installed turnouts, however the failure rate of those reaches as high as eight times the failure rate of usual turnouts in and around Tokyo. With DSS that have movable rails in a narrow space, track short circuiting often occurred due to contact of components to each other. In light of that, we developed an improved type tie bar based on consultation with field personnel, aiming at prevention of track short circuiting at DSS slip points.

3.2 Overview of Occurrence of Track Short Circuiting
An example of causes of track short circuiting at the toe of DSS slip point is temporary contact of right and left slip tongue rails while switching (Fig. 6) due to the tongue rails having different polarity on the track circuit. Other than contact between the tongue rails, contact between the tongue rail and another component of the turnout (connecting plate, tie bar, connecting plate bolt, hook, hook bolt) can also cause track short circuiting.

Those contacts occur at rail creeping, when items such as sleeper interval, right angle displacement, and track irregularity exceed the limit values, or when multiple conditions occur at the same time.

3.3 Improved Tie Bar for Slip Point
3.3.1 Structural Review
Basic preventive measures for the aforementioned contacts are correcting the irregularities mentioned in the previous section and setting switch adjusters appropriately. However, when more than one of such irregularities occur, troubles can occur even within the maintenance limit values of those. Field personnel take temporary measures such as shortening the fastener plate bolts or coating the fastener plate with rubber or other insulating material, but track short circuiting reoccurs.

We therefore devised and tested a new improved tie bar with connecting plates (improved tie bar, Fig. 7). The improved tie bar has insulation between the connecting plate and the tongue rail to electrically neutralize (de-polarize) the tie bar and the connecting plates. Furthermore, we added connecting plates projections. With this structure, only the projections of right and left connecting plates contact if the members contact each other.
3.3.2 Test Installation on Commercial Line
The features of the improved tie bar prototype are as follows.
1) The tie bar and the connecting plates are electrically neutral (nonpolar).
2) The design gap between the projections of the connecting plates is 10 mm and the gap between the connecting plates is 2.4 mm, considering smaller distance between projections than the gaps between other components, gauge widening of 7 mm, production tolerance, and rail creeping of +/- 15 mm.
3) The connecting plates and the tie bar are integrated in the pin structure to eliminate the need of on-site disassembly.
4) Insulation between rails at the center of the tie bar is eliminated, and insulation of the switch adjuster is attached at the angled hinge.
5) A tongue rail hopping preventer using insulating material is added to the tie bar.
6) Replacement of the components of existing DSS is minimized (tie bars, connecting plates, angled hinges, bolts).

Using the improved tie bar prototype, we carried out performance check tests at short circuits in the factory, confirming that the prototype met the required functions. Based on favorable results in the factory, we test-installed the improved tie bar to DSS in Ueno Station on the Tohoku and Joban lines in the night of September 28, 2005.

After the test-installation, the improved tie bar was checked at foot patrols and periodic inspections, and we found no problems both in appearance and function for three years. However, on January 3, 2009, track short circuiting occurred that caused transport disruption. Cause investigation revealed that the improved tie bar had no direct problems, but from the context of the development history, we recognized that electric insulation of the improved tie bar had to be further improved. We thus reviewed the structure of the improved tie bar upon discussion with the field personnel.

3.3.3 Structural Change of Improved Tie Bar
On-site investigation demonstrated that iron powder easily penetrated the toe of the tongue rail around that DSS slip point. We therefore improved the structure of the improved tie bar, focusing on improvement of electric insulation. On March 18, 2009, we installed the reviewed tie bar to that DSS. It has worked without problem up to now.

3.4 Conclusion
The test-installation results of the reviewed tie bar for DSS confirmed it has a large functional effect.

However, it costs much because it uses signaling insulation components such as insulating material for the connecting plate that are produced by cutting in a small lot and in a special shape. In the future, we will design common shape connecting plates and improve the production method for cost reduction, aiming at putting the reviewed tie bar into practical use.

4 Creation of Manual for CWRs in Turnouts

Compared to widespread use of CWRs for usual tracks, use of CWRs in turnouts has not yet seen much progress. The number of installed CWRs in turnouts is 268 as of December 2011, meaning just 3.5% penetration.

We thought that one of the reasons for such slow spread of use was that there were no clear guidelines for standard installation and maintenance of CWRs in turnouts. We thus made out and distributed to all branch offices and track maintenance technology centers an “installation and maintenance manual for CWRs in turnouts” that specified standards of installation and maintenance for those CWRs and showed easy-to-understand explanations of background knowledge and concepts. Our aim is to spread use of CWRs in turnouts.

The manual was mainly created by the Turnout Group of the Technical Center with the cooperation of the Conventional Line Technology Standard Group of the Facilities Department and the Shinjuku Track Maintenance Technology Center. It also incorporated the requests and views of track maintenance engineers in the field in regard to the manual.

The manual is composed of a theory part and a case study part. The theory part covers overall theoretical explanation and guidance, with items from the advantages and disadvantages of use of CWRs in turnouts in terms of the basics, structure, installation, and maintenance as to the methods of management after installation.

The case study part shows actual cases of use of CWRs in turnouts, and for planning reference it sorts out views and precautions with photos and diagrams of planning, preparation, and installation. We are currently working preparation of a version of the manual for the Shinkansen.

We hope the manual will be effectively used in field work, helping progress the spread of use of CWRs in turnouts.

5 Conclusion

This article covers part of field support work of the Turnout Group and the Information Control Group of the Technical Center. For problems such as turnout failures, field maintenance problems, and problems with the product developed and introduced, the groups carry out on-site investigation into causes and give technical assistance as an effort to contribute to transport stability and improvement of maintenance skill of field personnel. We will further address field support, aiming at eradication of turnout failures.

Finally, we would like to express our deepest thankfulness to Yoshiwara Tetsudou Kouyou for their tremendous cooperation on the investigation of locking error at Musashi-Koganei Station.