Development of a Switch Rail with Improved Wear Resistance

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1. Introduction

Switch rails quickly wear and require replacement at extremely short frequencies in turnouts where a number of cars run on the diverging route. Development of a new switch rail that will retard wear and extend the replacement frequency will cut maintenance and replacement costs. Thus, we developed a new switch rail featuring improved wear resistance and tested it in turnouts on a revenue service line.

2. An outline of the wear resistant switch rail

One method to suppress the wear of switch rails is to increase hardness by heat treatment. However, increases in hardness can lower toughness to cause switch rails to break. In setting the conditions for heat treatment for the wear resistant switch rail, therefore, we aimed at increasing hardness of the surface layer to improve wear resistance and suppressing hardness below the surface to ensure toughness. As the raw material to manufacture the wear resistant switch rail, we used the HH340 rail material (existing heat-treated rail) because of its heat treatment characteristics. Figure 1 shows the distribution of hardness of the switch rail subjected to heat treatment under the newly set conditions. According to Fig. 1, hardness has been attained in the surface layer and suppressed below the surface as targeted. To suppress plastic deformation and decrease the contact pressure at the contact surface with wheel flanges, we profiled the cross section of the wear resistant switch rail above the gauge line to the same inclination as that of wheel flanges.

3. Tests of the wear resistant switch rail installed at the turnouts of a revenue service line

Figure 2 compares the changes over time in the wear depths of the wear resistant rail (hereinafter referred to as the "new switch rail) and the existing switch rail installed at the turnout of the same category. Immediately after installation, wear tends to quickly progress with the existing switch rail but not with the new switch rail. After about 200 days, the wear depth of the new switch rail is only half of the wear depth of the existing switch rail. Regarding the worn rail profile, the existing switch rail shows plastic deformation on the rail top surface and at the side of the head, while no plastic deformation is seen with the new switch rail. See Fig. 3.

As a next step, we measured the wear depths of four new switch rails installed for test purposes at several places. See Table 1 for the particulars of the switch rails surveyed in this study and Fig. 4 for the results of the wear depth measurement. The first new switch rail signified by the symbol A in Table 1/Fig. 4 (hereinafter referred to simply as the "switch rail A") survived for 349 days until it was replaced. This represents a life that is approximately 2 times longer than the average time (days) in which the existing switch rails of the same category had been in use, according to the data on the replacement frequency during the past 10 years. The new switch rail B has been in use for 354 days and will have approximately 1.5 times longer life than existing switch rails when it is replaced in the near future. The other two new switch rails C and D have survived for approximately the same time as the average time (days) of existing switch rails in the same category of turnout (according to the 10-year-record in the past), and yet the wear depths are only half or less of the replacement standard of 6 mm.

Base on the above findings, it is thought that the newly developed switch rail featuring high wear resistance will extend the replacement frequency to 1.5 to 2 times that of the existing switch rails.

4. Conclusion

The newly developed wear resistant switch rail is thought to:

(1) Suppress wear, thereby extending the replacement frequency previously limited by wear.

(2) Prevent horizontal splits and breaks at the top due to plastic deformation, thereby extending the replacement frequency previously limited by damage.

(3) Cut maintenance costs as a result.

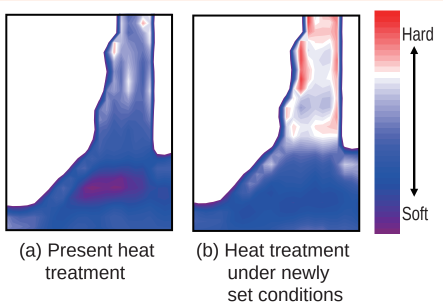

Fig. 1 Distribution of hardness

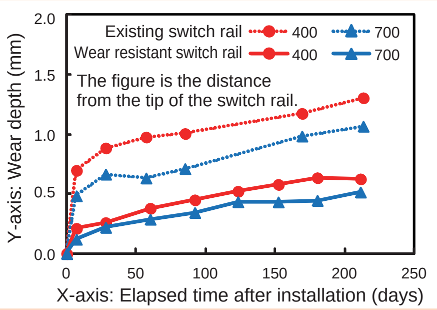

Fig. 2 Progress of wear depth

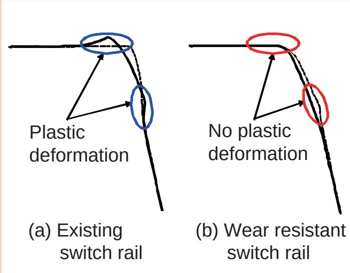

Fig. 3 A comparison of the worn rail top profiles

Table 1 Switch rails surveyed in the study

Symbol	Turnout No.	Time in use (days)	Average time in use (days) *	Remarks
A	8	349	181	Replaced
B	12	354	237	To be replaced
C	8	182	190	
D	8	174	180	

* Records of the existing switch rails of the same category in the past 10 years.
Note: Switch rails A,B, C and D are new switch rails

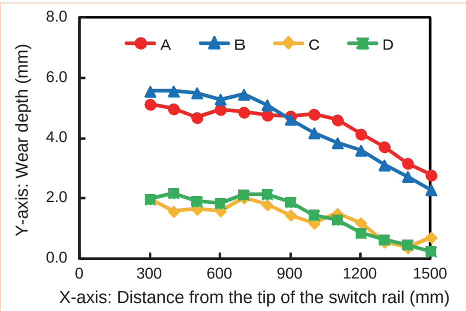

Fig. 4 Results of the survey of wear depths of the new switch rails