REASONS FOR RAILWAY WEAR AT CURVES

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Abstract. On average in Latvia small radius curvilinear railway sections make up approximately 25 % of the entire network length. An especially urgent problem is ensuring train traffic safety due to premature failure of rails at small radius curves. Analysis shows that the lifetime of rails at curves significantly decreases in comparison to the normative lifetime due to intensive side wear of the outer rail and rapid development of dangerous defects of the head of the inner as well as outer rail. In the article, the results of the analysis of the reasons for premature wear of rails at small radius curves on the Latvian railway are discussed and ways of increasing their lifetime are proposed. In order to analyse the reasons for premature wear of rails, a one-way section of the span Sece - Sēlpils was studied.

Keywords: railway wear, curvilinear railway, traffic safety.

Introduction

This section, according to the data on 01.01.2015, had especially rapid side wear of the outer rail and more than 140 dangerous defects in both rails.

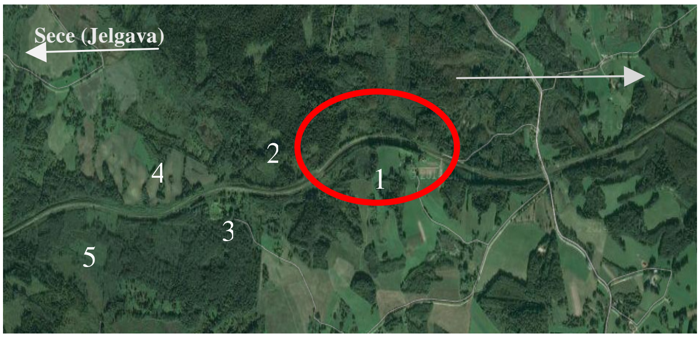

Fig. 1. **Plan of the one-way section of the span Sece-Sēlpils**

The total length of the section studied was 2 km 846 m; the section consists of 5 small radius curves (640 m; 625 m; 754 m; 625 m; and 645 m). This section of the span only has freight traffic; there has been no passenger train traffic at this section for more than 25 years and it is not planned in the future. There is a permanent 60 $km \cdot h^{-1}$ speed limit in force for the train traffic at this section. In the direction Sece-Sēlpils (to Krustpils station, even direction) the main railroad traffic consists of empty trains up to 1700 t. In the direction Sēlpils-Sece (to Ventspils, odd direction) the main railroad traffic consists of loaded tank-cars from 4800 t up to 5500 t.

The condition of the rails at curve No. 1 was examined (Figure 1, Figure 2). The curve in the direction from Krustpils is located on an elevation with the downgrade from 3.5 ‰ up to 6.8 ‰ (other small radius curves – on an inclination). The traffic in gross weight comprises more than 25 million tons a year; according to the norms of the Latvian railway, the maximum side wear for the rails installed at this curve (type R-65) with the given load is 15 mm.

Fig. 2. **Curve No. 1 on the line Sece-Sēlpils 274.5885 km to 275.2570 km; *R* = 640 m; outer rail elevation *h* = 90 mm**

In order to determine the reasons for intensive wear of the rails at curve No. 1, their condition was analyzed from January 2014 to 1 October 2015. The side wear of the rails at this curve during the period of observation reached 16 mm (Figure 3) forming a shelf (which is characteristic of rails with more than 10 mm side wear).

Fig. 3. **Outer rail of curve No. 1 with side wear**

On the surface of the head of the inner rail, peeling and spalling of metal is observed (Figure 4).

Fig. 4. **Inner rail with defect on the surface of the head**

Operational experience shows that the lifetime of the rails installed at this curve is from 2 to 2.5 years, whereas the rails at direct sections of this direction serve up to 14-16 years.

One of the main reasons for the intensive wear of the rails at the examined curves, according to our calculations, is the high elevation value of the outer rail – *h*, which is calculated based on the traffic speeds of passenger trains. In reality, only freight traffic is planned at these sections, which is executed at significantly lower speeds. Therefore, the outer rail elevations – *h* at these sections at actual traffic speeds must be lower. An example of a calculation of the necessary elevation value of the outer rail at curve no. 1 is shown below (Figure 1) based on actual train traffic speeds. For this purpose, using a speed-measuring tape, the actual freight train traffic speeds were analyzed in odd and even directions. On average, the actual speeds of locomotives 2M62 and 2T10M with loaded tank-cars in the odd direction with the average mass of 4750 t at curve no. 1 were 27 $km \cdot h^{-1}$. The actual average speeds of locomotives of the same series with empty cars in the even direction with the average mass of 1500 t at curve no. 1 were 32 $km \cdot h^{-1}$.

Materials and methods

In order to reduce inertia of the train traffic at a curve at maximum speed of freight trains 60 $km \cdot h^{-1}$, the outer rail elevation is calculated using formula (1) [2]:

$$h_{rfr} = 12.5\frac{V_{\max fr}^{2}}{R} - 50, \tag{1}$$

where $V_{\max fr}^{2}$ – maximum traffic speed of freight trains at curve No. 1 in odd direction squared (V = 60 km·h-^{1});
R – radius of the curve (R = 640 m).

The calculated elevation of the outer rail at curve No. 1 for maximum freight train traffic speed is 20 mm.

Conclusions

1. At present, the actual train traffic speeds are not taken into account when calculating the outer rail elevation at small radius curves at freight train traffic sections. The calculation performed based on the actual freight train traffic speeds shows that the existing elevations of the outer rail at small radius curves are significantly higher (90 mm) than the calculated ones (20 mm) This causes uneven distribution of load to the rails, which is one of the main reasons for premature wear of rails at curves of the Latvian railway.
2. Calculation of the elevation heights of the outer rails at small radius curves based on actual average traffic speeds and at other sections of the Latvian railway tracks is recommended.

References

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