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Reserves of resource saving in the track facilities by increasing the reliability of the track

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Abstract. The article analyzes the problems of resource saving reserves in the track facilities by increasing the reliability of the track, associated with the failure of the rails for defects 52.1, 53.1 and 30. B and the presence of an excess elevation of the outer rail in curves. The appropriate recommendations are issued based on the analysis.

Keywords: *track reliability; track rigidity; rail joint; rail defect; outer rail elevation*

1. INTRODUCTION

The most important direction in the practical implementation of the reserves for improving the reliability of the track is the use of scientifically based on technical and technological solutions to reduce failures and increase the durability of existing track structures, also improvement the safety of train traffic. Creating a solid track structure is the main goal of trackers.

2. MAIN PART

Over the past 50 years, railway track stiffness has been increased by about three times due to an almost double increase in the average linear mass q, an increase in the diagram and stiffness of reinforced concrete sleepers compared to wooden sleepers, and also due to an increase in the thickness and density of crushed stone ballast under the sleepers. This is a natural process, due to the need to improve the reliability of the track to reduce its failures and damage during operation.

Prevention of rail failures due to defects 52.1, 53.1, and 30.B

If the track and wheels were free of roughness, then increasing the stiffness of the track would be useful up to infinity due to the reduction in train traction costs due to reduced resistance to movement and, most importantly, due to a sharp decrease in breakdowns and damage to the track due to reducing the dynamic (vibration) impact of the wheels. However, due to the presence of sliders, dents, welds and other irregularities on the wheels, as well as rail joints, saddles, boxes, wave-like wear and other irregularities on the rails, the dynamic (vibratory) effect on the hard track increases sharply and optimization of the three main technical parameters is not ensured:
• unevenness on the road and wheels;
• rigidity of the track-crew system;
• speed of freight trains.

The simultaneous existence of elevated values of all three of these parameters leads to an intensive accumulation of disorders and damage not only to the track, but also to the rolling stock.

Most often (about 30% of all breaks) on railways, rail breaks occur at the joints due to defects 52.1 and 53.1. More than 80% of such breaks occur in winter at negative air temperatures. Fatigue cracks are not always detected by flaw detectors, especially if the crack is located in the shadow of the bolt hole. Naturally, a rail fracture in the presence of a fatigue crack in the neck at the bolt hole or at the end, or a fracture in a fresh place (without a fatigue crack) occurs under wheels with a maximum dynamic load. Such a dynamic load, as a rule, is caused by a slide under a full-load car, especially in winter, when the rigidity of the rail base is much greater.

A common and very typical cause of wheel derailment is a break in the rails along the inner thread due to the formation during operation of a longitudinal vertical fatigue crack inside the head along defect 30.B. In steep curves, most wheels move with their flange pressed against the head of the outer rail thread. On the inner thread, the wheels are in contact with the rail mainly, causing increased hardening of the metal in the middle part of the head. At the same time, the hardness of the metal in the middle part of the head at a depth of 3-8 mm increases sharply and residual compressive stresses are formed, and at a greater depth, residual tensile stresses that balance them. Since part of the wheels acts on the head of the inner rail, as evidenced by the hardening of the metal (visor) on the inner and outer edges of the head, and after a significant tonnage is passed, an internal fatigue crack 30.B.

The main reserve of resource saving by increasing the safety of train traffic and a sharp reduction in rail failures due to defect 30.B consists in the timely profile grinding of the inner rails in curves and the adjustment of flaw detectors for the timely guaranteed detection of a vertical internal longitudinal fatigue crack on the inner rails of steep curves with $R \leq 600$ m.

Elimination of excess elevation of the outer rail in curves

The elevation of the outer rail h in curves affects the distribution of the load from the vehicle on the outer and inner rails. This is especially clearly seen when the movement of existing freight cars with a central support of the body on the bearing of the bolster. When moving along a curve with an excess of elevation, the car body rests on thrust bearings and internal bearings. There is a gap between the outer bearings of the bolster and the body. In this case, the load on the rail from the wheels following the outer rail can be significantly less than the load from the wheels following the inner rail (up to 40%). Therefore, when longitudinal forces occur in the train (for example, during braking), especially in curved sections, a significant, in addition to the central force, horizontal transverse load H occurs on the thrust bearing, which contributes to the derailment of the wheels (rolling the ridge onto the outer rail, especially in the presence of lateral wear) or due to the spacing of the gauge with the slope of the outer rail and the failure of the inner wheels.

When the car moves along a curve with a deficit of elevation **h** of the outer rail, the body rolls over (leans) on the outer bearings. There is a gap between the inner side bearings of the body and the bolsters. In this case, the load on the rail from the wheels following the outer rail thread increases due to some unloading of the inner rail thread. At the same time, wheel derailment is significantly hampered due to the rolling of the ridge onto the outer rail (squeezing out the wagons) and due to the inclination (canting) of the outer rail due to the weight of the outer rail (transshipment of the body onto the outer bearings). The results of the studies performed by the authors convincingly indicate that with an excess of elevation **h** of the outer rail in curves, when the outstanding acceleration a_{np} for freight trains is less than +0.2 m/cm^2, rolling the flange onto the head of the outer rail with lateral wear is dramatically facilitated due to the transshipment of the body onto the inner bearings and unloading the outer bearings. In addition, in this case, the inevitable longitudinal slip of the wheels, due to their rigid nozzle on the axle, occurs only along the outer rail thread. There is a "grindstone" effect from the joint longitudinal and circular sliding of the wheel flanges along the side face of the outer rail. As a result of the foregoing, the intensity of lateral wear of the rails and wheel flanges increases, and it is also easier to roll the ridge onto the head of the outer rail with lateral wear. Therefore, it is necessary to reduce the height of the outer rail so that the outstanding acceleration for freight trains is not less than +0.2 m/s ^{2}. This is the lower limit $a_{,,p}$ for freight trains from the standpoint of ensuring the safety of train traffic and resource saving in the track facilities by increasing the reliability of the track in curves (reducing rail failures due to lateral wear, as well as reducing the intensity of wear of wheel flanges). Upper limit limit $\mathbf{a_{np}}$ was installed only for passenger trains from the position of ensuring comfort for passengers. In Russia, for many years, [$\mathbf{a_{np}}$]=0.7 m/s^2 has been used as an acceptable value. Some foreign roads use higher values [$\mathbf{a_{np}}$]. In some cases, and on our roads they allow [$\mathbf{a_{нп}}$] > 0,7 m/s^2, for example [$\mathbf{a_{np}}$]\u003d 1 m/s ^{2} . In freight trains, the actual values of $\mathbf{a}$ $_{np}$ never exceed [$\mathbf{a}$ $_{np}$]= 0.7m/s ^{2} because the speed of freight trains is always less than that of passenger trains. Therefore, to set the upper limit of the restriction [$\mathbf{a}$ $_{np}$] for freight trains not necessary. Attempts to justify the need to limit the upper limit [$\mathbf{a}$„ $_p$] for freight trains to a value less than 0.7 m/^{s} threads of transition curves of turnouts at an elevation **h** = 0, and **a„p~** 0.6-0.7 m/s ^{2} than with a similar radius of curves on the hauls, where **h** = 120-150 mm and $\mathbf{a_{np}}$ < 0.2 m/s^2. Unfortunately, on many curves of Russian railways, freight trains run with $\mathbf{a}$ $_{np}$ < 0.

The most important argument for the need to eliminate the excess elevation h of the outer rail in the curves is the fact that due to the loading of the wheels following the outer thread of the transfer curves of the turnouts due to the transshipment of the body onto the outer bearings, there are practically no derailments within the transfer curve due to for rolling the ridge onto the outer rail (squeezing out the wagons) and due to the canting of the outer rail (gauge spacing). For each curve, there is an individual distribution polygon n (V) depending on the actual values of the train weight, the characteristics of the plan and profile of the line, as well as the traction characteristics of the locomotives.

3. CONCLUSION

Based on the foregoing, the following conclusions can be drawn: the main reserve of resource saving by increasing the safety of train traffic and a sharp decrease in rail failures due to defect 30.B consists in the timely profile grinding of the inner rails in curves and the adjustment of flaw detectors for the timely guaranteed detection of a vertical internal longitudinal fatigue crack on the internal rails of steep curves with R ≤ 600 m.

Elimination of excess elevation of the outer rail in the curve with the adoption of the criterion for establishing a rational elevation corresponding to the outstanding acceleration of freight trains $\mathbf{a}$ $_{np}$ >+ 0.2 m/s ^{2} at graphic speeds provides:

• Prevention of wheel derailment in curves due to rolling in of the flange onto the outer rail and due to the outboard rail canting;

• implementation of resource saving due to the reduction of lateral wear of rails and wheel flanges.

References

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