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“QURILISHDA YASHIL IQTISODIYOT, SUV VA ATROF-MUHITNI ASRASH TENDENSIYALARI, EKOLOGIK MUAMMOLAR VA INNOVATSION YECHIMLAR” MAVZUSIDAGI RESPUBLIKA MIQYOSIDAGI ILMIY-AMALIY KONFERENSIYA TASHKILIY QO‘MITASI

The maintenance of rails is a minor factor contributing to the extension of the service life of the railway track

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Abstract: This article discusses the defects that arise in rails, which are one of the main components of railway infrastructure, and their current maintenance. All measures related to the maintenance of railways are primarily aimed at improving the interaction between the rolling stock and the track. Irregularities in the track cause vertical and horizontal dynamic forces, which in turn increase the impact transmitted from the vehicle to the track and lead to the accumulation of residual deformations. This necessitates regular correction of the track in both the longitudinal and transverse profiles.In this regard, studying the rails and their operating conditions is considered a highly relevant issue. Today, many innovations and opportunities are being introduced in the transport sector of our country. Therefore, conducting scientific research using modern methodologies and reliable scientific foundations is highly appropriate.This article presents the scientific basis for the maintenance methods of rail defects.

Keywords: defect, rail, deformation, elasticity, alignment, radius, curvature, deterioration, rail head, longitudinal, vertical.

1. Introduction

Railway infrastructure is one of the main sectors of transport in the road economy. The road economy includes all railway facilities and production enterprises. The road economy accounts for more than half of the value of the main railway assets, operating expenses, and one-fifth of the workforce. Key priorities in the road economy include improving the management system, increasing the efficiency of mechanization during loading and unloading, expanding the use of heavy-duty machinery, and ensuring proportional labor costs in routine maintenance and repair works. The railway is a complex engineering structure operating under challenging conditions. Heavy trains travel at high speeds along the railway. The wheels exert a force of 100-115 kN on the rails, which can increase by 1.5 to 2 times during movement. Irregularities in the rails and wheels, as well as deviations from maintenance standards, cause the horizontal and vertical forces acting on the rails to fluctuate rapidly over time. These forces result in various residual deformations on the railway.

Additionally, climatic changes such as snow, wind, water, and temperature also affect the railway.

Therefore, conditions must be met to ensure safe operation of the railway and resistance to various forces and natural changes. It is essential to keep the railway constantly in a proper state. These issues are addressed by organizing high-quality routine maintenance and repair of the railway.

2. Research methodology

A significant amount of resources and materials are required for the production of rails. Therefore, even a slight extension of the service life of rails yields considerable benefits on a national scale.The service life of rails depends on several factors: the total gross tonnage transported over the railway, the speed of train movement, the type of traction, and the quality of the rails themselves. As a key indicator of rail service life, the total gross tonnage carried over the rails is commonly used.

The operating conditions of the rails have a substantial impact on their longevity. If the gap at the joints exceeds the standard value, the repeated impact of wheel flanges against the rail ends increases, leading to localized deformation. As a result, depressions form at the joints, contributing to defects such as 17.1, 18.1, and 53.1. Therefore, during track inspection, close attention must be paid to ensure that rail joint gaps remain within the prescribed limits.

Settlements at the rail joints, suspended rail ends, and missing or damaged rail pads significantly worsen operating conditions. To improve the performance of rails, it is essential to ensure stable support along their entire length by securing them firmly to the sleepers. This is achieved by consistent tamping of sleepers, compacting the ballast, and ensuring reliable fastening to prevent longitudinal displacement.

Depressions and suspended rails at joints must be promptly and properly eliminated. Worn-out rail pads are replaced, and all bolts at joints are tightly fastened.

Overlay welding to repair worn joint sections and fastenings can significantly extend the rail service life. If vertical wear on the rail does not exceed 1–3 mm on main or arrival/departure tracks, overlay repair is permitted.

The elevation of the outer rail must be regularly monitored and maintained. Deviations from the norm lead to uneven rail wear: on the inner rail, head deformation occurs (defect 43), while on the outer rail, lateral and vertical wear intensifies (defect 44).On curves with a small radius, lateral wear on the outer rail increases rapidly. To reduce this, lubrication of the inner side of the outer rail is widely practiced. Graphite grease is commonly used, which significantly slows down the wear rate of both rails and wheel flanges, thereby extending their service life.Rail lubricators are installed on curves where lateral wear exceeds 2–3 mm after passing 100 million gross tons of traffic. Lubrication is not required year-round and is typically performed in the summer months. This measure reduces lateral rail wear rates by a factor of 4–5.

During rail installation or individual replacement, it is critical to ensure that the rail base does not rest on the edge of the baseplate, which could cause rail breakage.To prevent cracking in the rail web or at the base of the rail head, rail fastenings must fit tightly. Any fastenings that do not meet this requirement should be replaced immediately.The conditions of loading, transporting, and unloading rails also influence their service life. These operations must be carried out using lifting equipment. Dropping rails or hammering them into place is strictly prohibited. When stacking rails, supports should be placed every 1.5 meters, and used sleepers may be employed for this purpose.

Welding any wires or plates to the rail base or web is strictly prohibited. Rail joint welding must only be conducted at positive temperatures (+5°C and above). If the rail temperature is between +5°C and -10°C, the rail ends (150 mm on both sides) must be preheated to 150–200°C before welding. Welding is strictly forbidden when rail temperature is below -10°C.

Defects arising from violations of manufacturing technology, poor-quality metallurgy or heat treatment, and improper rail maintenance contribute significantly to the degradation of rails during operation.

Depending on the type of defects, rails can be classified as defective or severely defective. The descriptions of defective and severely defective rails are provided in the railway maintenance guidelines. Rails with wear exceeding the specified limits are also classified as defective. In this context, the concept of total wear is used.

The total wear of a rail is defined as the sum of the vertical wear and half of the lateral wear of the rail head (see Table 1).

Table 1

The permissible limits of rail wear, measured in millimeters (mm).

№	Rail Maintenance Tracks and Manifestations of Rail Wear	R75, R65	R50	R43
1	Total Wear (mm)			
1.1	Main lines with passenger train speeds of 120–140 km/h	9	7	-
1.2	Main lines with freight transport intensity ≥ 10 mln t·km/year and freight train speeds ≤ 120 km/h	12	10	8
1.3	Main lines with freight transport intensity < 10 mln t·km/year and receiving-dispatch lines with freight transport intensity ≥ 10 mln t·km/year	16	13	9
1.4	Other receiving-dispatch lines	20	16	12
1.5	Other station tracks	-	19	15
2	Rail head lateral wear (mm)			
2.1	Main lines with passenger train speeds of 120–140 km/h	7	6	-
2.2	All main and receiving-dispatch lines with freight transport intensity ≥ 10 mln t·km/year	15	13	10
2.3	Other receiving-dispatch lines	18	16	13
2.4	Other station tracks	-	18	15

Transverse fractures and broken rail heads prohibit the passage of trains on the affected rails.

Until preparations are made to replace cracked rails, it is permitted to allow trains to pass over them at a reduced speed of no more than 25 km/h. The schedule for train passage is determined by the track brigade chief.

The passage of trains over rails with cracks located in tunnels and on bridges is strictly prohibited under any circumstances.

During the rail replacement process, environmental temperature must be taken into account, since at positive temperatures rails may be pushed into the free space, while at negative temperatures rails tend to move away in both directions. To evaluate the impact of freight and passenger trains on rails, the mixed-traffic railway line between Tashkent and Samarkand was examined. This allowed for the analysis of the quantity and severity of defects present on the line. The data is presented in Table 2 below.

Table 2

Summary Data of the Tashkent–Samarkand High-Speed Line

Stations		Section Length (km)	Avg. Transported Freight (mln t, gross)	Average Train Speed (km/h)		Number of Defects (units)
				Passenger	Freight	
		L	**G**	**V_{pass}**	**V_f**	**N**
1	Toshkent yo'l.- To'qimachi	4,43	74,3	120	66	3
2	To'qimachi – Toshkent janubiy	2,07	74,3	130	60	5
3	Rahimova – O'rtaovul	8,72	74,3	167	60	12
4	O'rtaovul – O'zbekiston	4,28	74,3	167	60	8
5	O'zbekiston – Yangiyo'l	6,4	87,8	167	60	7
6	Yangiyo'l - Navruz	8,2	123,57	167	60	5
7	Navruz - Paxta	6,82	123,57	167	60	7
8	Paxta - Olmazor	4,49	123,57	167	60	12
9	Olmazor - Chinoz	9,27	123,57	187	60	11
10	Chinoz – Yangi Chinoz	6,14	123,57	187	60	8
11	Yangi Chinoz - Sirdaryo	12,43	91,57	187	60	11
12	Baxt - Oqoltin	12,11	90,1	187	60	4
13	Guliston - Boyaut	6,3	90,1	187	60	3
15	Boyaut - Yangiyer	9,35	72,4	187	60	6
16	Yangiyer - Hovos	8,25	32,12	223	60	8
17	Hovos – Rzd.3	22,4	32,12	223	60	9
18	Рзд. 3 - Dashtabod	17,4	32,12	223	70	19
19	Dashtabod – Rzd.6	15,93	32,12	173	70	2
20	Rzd. 6 - Zarbdor	15,14	32,12	173	70	5

The above table provides an overview of both passenger and freight train operations. It shows the average operating speeds of trains and the volume of freight flow passing through each section. In addition, the number of defects identified on each segment is also indicated. Based on this data, we will construct a graph illustrating the relationship between freight volume and train speed.

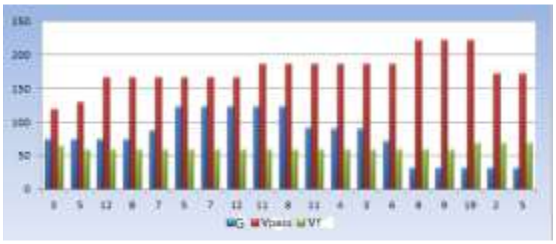

Fig. 1. Dependency graph of rail defects on passenger train speed (V_{pass}), freight train speed ($V_{freight}$), and total transported freight volume (G)

3. Conclusions and suggestions

1. It is essential to develop a dedicated fastening system design for high-speed rail routes.
2. The strategy for introducing high-speed passenger train operations highlights the necessity of broadening the traditional concept of infrastructure readiness. This expanded approach includes not only general condition assessments but also the integration of key performance indicators such as train speed levels, the number of accelerated train movements, and the physical state of the rails. These factors are critical in ensuring safety, optimizing performance, and extending the service life of railway components under increased dynamic loads typical of high-speed traffic.
3. In order to minimize defects in track superstructures arising from the introduction of a specified volume of accelerated passenger train operations, it is essential to consider modern design principles of rail joints that are characteristic of the intensification of the transportation process. This intensification aims to increase the mass of freight trains and enhance the railway's freight traffic throughput capacity.

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