WAGON DELAY MECHANISMS ON THE SORTING HILL OF THE SORTING STATION WORK IMPROVEMENT

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Abstract: *This article is devoted to one of the main tasks of improving the control devices of automation and telemechanics of the railway sorting slide. Control methods are proposed that allow automating the operation of the slide station moderator, as well as its modernization. A device has been developed that automatically slows down the car using an automated microprocessor control system based on strain and optical sensors. A correlation graph of the deceleration time of the car relative to the weight of the car was also constructed.*

Key words: *Sorting hill, tenzo sensor, microprocessor block, optical sensor, carriage retarder.*

СОВЕРШЕНСТВОВАНИЕ РАБОТЫ МЕХАНИЗМОВ ЗАМЕДЛЕНИЯ ВАГОНОВ НА СОРТИРОВОЧНОЙ ГОРКЕ СОРТИРОВОЧНОЙ СТАНЦИИ

Анотация: *Данная статья появящена одной из главных задач по совершенствованию устройств управления автоматики и телемеханики железнодорожной сортировочной горки. Предложены методы управления, позволяющие автоматизировать работу замедлителя горочной станции, а также его модернизации. Разработано устройство, которое автоматически замедляет вагон с помощью автоматизированной микропроцессорной системы управления на основе тензо- и оптичеких датчиков. Также был построен график корреляции времени замедления вагона относительно веса вагона.*

Ключевые слова*:* *Сортировочная горка, тензодатчик, микропроцессорный блок, оптический датчик, вагон замедлитель.*

САРАЛАШ СТАНЦИЯСИНИНГ САРАЛАШ ТЕПАЛИГИДАГИ ВАГОН СЕКИНЛАШТИРГИЧ МЕХАНИЗМЛАРИНИ ИШИНИ ТАКОМИЛЛЛАШТИРИШ

Анотация: *Ушбу мақолада темир йўл саралаш тепалиги автоматика ва телемеханика назорат қурилмаларини такомиллаштириш юзасидаги долзарб муоммолардан бирига қаратилган. Тепалик вагон секинлаштиргич механизми ишини автоматлаштириш ва уни ривожлантириш ҳамда замонавийлаштириш бўйича бошқарув усуллари таклиф этилган. Темир йўл саралаш тепалигида автоматлаштирилган микропроцессорли бошқариш тизими усули асосида узилмаларни оғирлиги ҳамда тезлигига мос равишда вагон секилаштиргич механизми орқали автоматлаштирилган тарзда секинлаштирадиган ва тўхтатадиган қурилма ёритилган. Вагон секинлашиш вақтини вагоннинг оғирлигига нисабатан боғланиш графиги ишлаб чиқилган.*

Калит сўзлар: *Саралаш тепалиги, тензодатчик, микропроцессорли блок, оптик датчики, вагон секинлаштиргич.*

The wagon deceleration mechanism in the existing complex automated system for sorting stations in railway transport operates mechanically, which causes certain inconveniences, as it must work reliably and without failures based on the technical operation safety rules for movement [10]. Given that the automated systems in the sorting yard do not directly connect with control devices and the wagon deceleration mechanism, it is necessary to improve this system [7].

To solve the above-mentioned problems, the algorithm for controlling and monitoring the automation and telemechanical control devices in the railway sorting yard has been improved [5]. During the development of the system, strain gauges were used to determine the weight of the nodes approaching the wagon deceleration mechanism based on an automated microprocessor-based control system in the railway sorting yard [13] (see Figure 1). Currently, strain gauges are widely used in many industries, including railway transport lines [11]. In the proposed method, the strain gauges are installed in pairs on each side of the rail, and they work by measuring the force as the wagon wheel pairs pass over the strain gauges, sending the detected weight to the central control system [8].

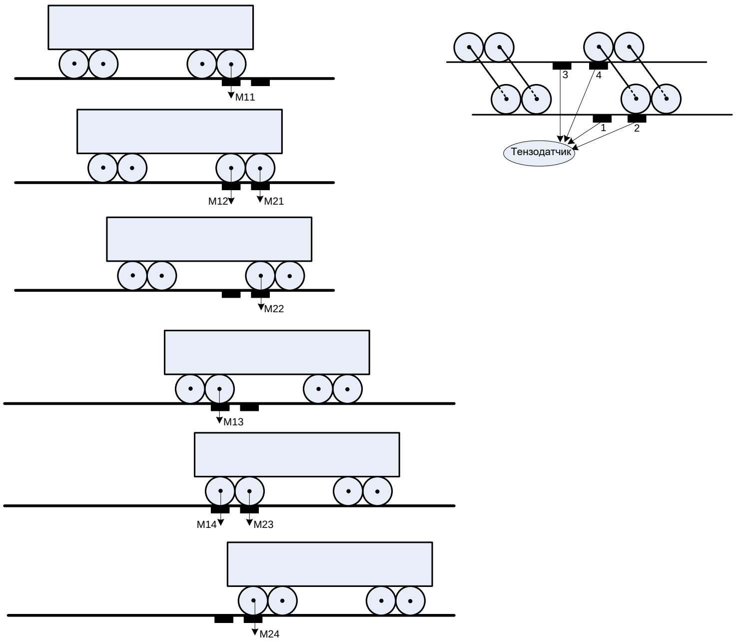

Figure 1. Structural diagram of the method for detecting the wagons at the sorting hump station using load cells.

The total mass determined can be written based on the following expression:

$$M = \frac{M11+\cdots+M14+M21+\cdots+M24+M31+\cdots+M34+M41+\cdots+M44}{2}, \qquad (1)$$

Here, “M11…..M14” are the indicators of the first sensor, “M21…..M24” are the indicators of the second sensor, “M31…..M34” are the indicators of the third sensor, and “M41…..M44” are the indicators of the fourth sensor.

An automated system has been developed to determine the speed of the rolling stock moving downhill using optical sensors and to calculate the wheelset of the rolling stock using inductive track sensors. Each track in the sorting station’s hump yard is controlled using the wagon retardation mechanisms. In the following diagram, the points where the rolling stock is monitored using the sensor method are shown.

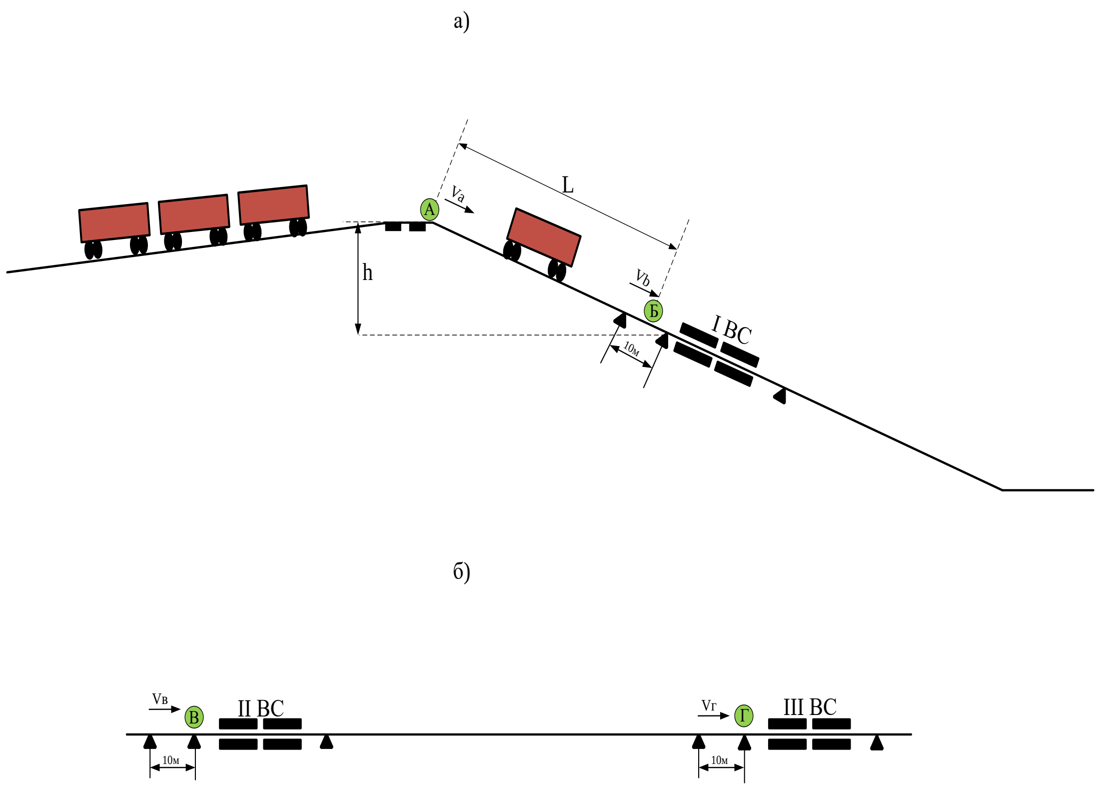

Figure 2. Structural diagram of the method for determining the speed of rolling stock at the calculation points in the sorting hump yard.

Узилмаларни ҳаракатланиш даврида оғирлик кучларини масса ва тезликка нисбатан аниқлаш учун қуйидаги ифодадан фойдаланилди:

$$\frac{mv_b^2 - mv_a^2}{2} = Qh - Qlw \qquad (2)$$

In this expression: m - the mass of the wagon, v_a- the speed of the segment at point A, v_b- the speed of the segment at point B, Q- the gravitational force (weight), h- the height difference between points A and B, l- the distance between points A and B ,$w10^{-3}$ - the coefficients of resistance forces acting against the motion are provided.

A unified system has been developed to manage the entire operation process at the classification yard [2], with signal transmission being carried out through microprocessor-based blocks. This system operates via high-speed digital communication lines and is implemented in the control and monitoring center [6]. The developed system allows integration with existing control units and also makes it possible to connect multiple devices into a local network in order to reduce the required number of communication lines.

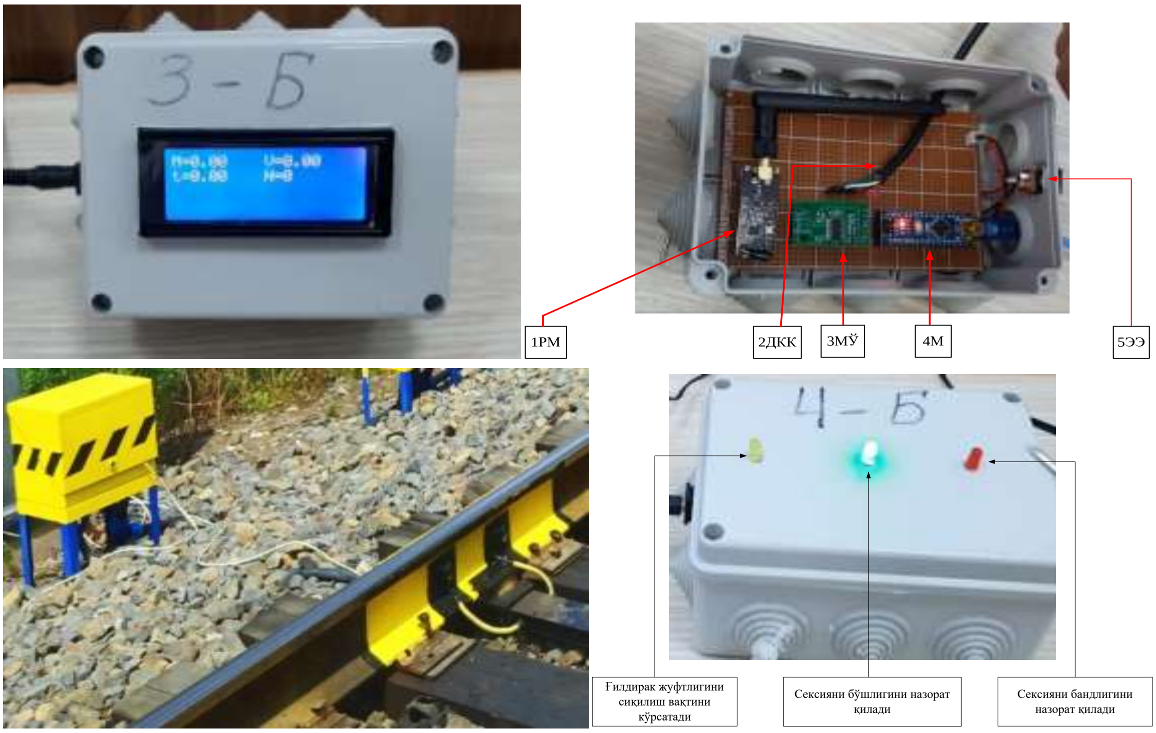

Figure 3. General view of microprocessor-based blocks

The control system consists of several blocks: a radio module for data exchange within a radius of one kilometer (1RM), a wired communication line connecting the block with the sensor (2DKK), a microcontroller-based device that processes data received from the sensor (3MO), a control microcontroller (4M), and electrical source blocks (5EE).The created device addresses several issues such as prolonged standing of wagons at railway sorting stations, unchanging train formation schedules, low sorting yard throughput, outdated equipment, violations of movement safety, low qualifications of employees, labor protection concerns, manual coupling and decoupling of wagons, and the slowing down of wagons.By using modern management methods and element base applications, it is possible to achieve high economic efficiency. The quantitative indicators of economic efficiency were determined during the testing process at production enterprises and were calculated during the project documentation stage, including the calculation of limited costs.The achieved technical and economic indicators include reducing costs for maintaining the trackbed, reducing cable consumption, reducing the number of employees, preventing accidents, and improving turnout operations.When using the wheel axle calculation device (single or dual-channel), the possibility of reducing its cost relative to train movement speed or safety requirements is identified and is presented in the following expression: (6).At the sorting yard, the average weight of each wagon (m1, m2, m3, m4) is determined through four sensors, and the deceleration times of the wagons are calculated. In the following figure (4), a graph is presented that shows the relationship between the deceleration time of the wagon and its weight.

$$m_{ўрт} = \frac{(m_1 + m_2 + m_3 + m_4)}{4} \quad (6)$$

At the sorting hump, the average weight of each wagon (m1, m2, m3, m4) was determined using four strain gauges, and the compression times of the wagon retarders were measured. In the following Figure 4, a graph is presented showing the relationship between the wagon's deceleration time and its weight.

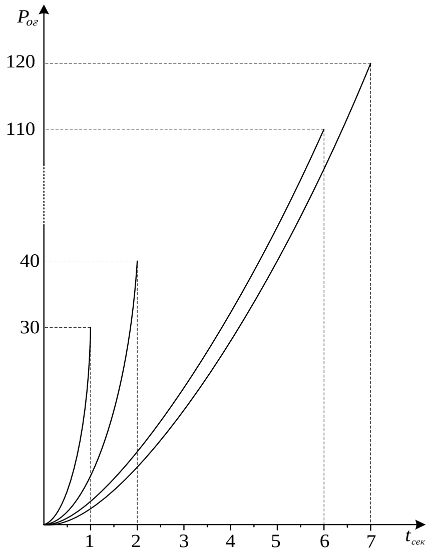

Figure 4. Graph showing the relationship between the car's deceleration time and its weight.

The wagon deceleration time, in relation to the weight of the wagon, is calculated according to the following expression:

$$t_{сек} \approx \left\{ P_{огир}, v_0, v_B, n_0^n, l_я, l_ё \right\} \quad (7)$$

Using the expression, a table was developed to determine the deceleration time of the wagon based on its weight. This is presented in Table 1 below.

Table 1

Wagon weight retarder time duration table

T/p	$Q_х$, [т]	$t_{сек}$, [сек]

1	23=<30	3
2	<=40	4
3	<=50	5
4	<=60	5
5	<=70	6
6	<=80	6
7	<=90	6
8	<=100	6
9	<=110	7
10	<=120	7

The results of the scientific research showed that, by taking into account the weight, speed, and wheel axle pair of the wagons released from the sorting yard, the operation of the wagon decelerating mechanism can be automated based on a microprocessor control system. This leads to a significant reduction in the waiting time of trains at the sorting yard, a notable decrease in the time intervals between wagons, and the elimination of human factors, with the implementation of a fully automated system.

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