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DEVELOPMENT OF A PROMISING SYSTEM FOR DIAGNOSING THE FROGS OF RAILROAD SWITCHES USING THE TRANSVERSE PROFILE MEASUREMENT METHOD

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Розроблено систему інноваційної діагностики хрестовин стрілочних переводів. Проведено експериментально-теоретичні дослідження поздовжнього профілю хрестовин стрілочних переводів залізничної колії, укладених на залізобетонних брусах. Установлено характерні траєкторії руху центра мас колеса по хрестовині залежно від зносу вусовиків та осердя хрестовини. Розроблено математичну модель прогнозування зносу профілю хрестовин залежно від пропущеного тоннажу

Ключові слова: хрестовина, стрілочний перевід, поздовжній профіль, траєкторія руху, рухомий склад залізниць

Разработана система инновационной диагностики крестовин стрелочных переводов. Проведены экспериментально-теоретические исследования продольного профиля крестовин стрелочных переводов железнодорожного пути, установленных на железобетонных брусьях. Установлены характерные траектории движения центра масс колеса по крестовине в зависимости от износа усовиков и сердечника крестовины. Разработана математическая модель прогнозирования износа профиля крестовин в зависимости от пропущенного тоннажа

Ключевые слова: крестовина, стрелочный перевод, продольный профиль, траектория движения, подвижный состав железных дорог

1. Introduction

The railroads of Ukraine currently operate more than 50 thousand railroad switches and blind intersections. Most of them (98 %) are single ordinary railroad switches.

Basic railroad switches that are most common on the railroads of Ukrzaliznytsia after 1990 are the railroad switches that are laid on reinforced concrete bars, of type R65, brands 1/11 and 1/9, designed by PTKB CP MPS – 1740 and 2215 [1]. At present, these basic models of railroad switches are significantly modified. The modifications were introduced to separate structural units while maintaining basic geometric dimensions [2, 3]. There are many pilot designs of railroad switches currently in operation that are based on new structural solutions. These include the introduction of oblique connection, extending rail endings and the implementation of an impact-free rolling surface on the frog [4].

The processing of statistical data on the total weight of the passed cargo revealed that the current profile based on GOST 28370-89 does not meet operational conditions because the average time of a frog life cycle along all the examined routes of Ukrzaliznytsia does not reach a warranted time of operation [3]. In most cases, a frog life cycle is almost twice shorter in terms of failure-free operation.

the simultaneous application of the information technology IoT (Internet of Things). Measurement of parameters of the transverse profile of a frog will be based on programmable microcontrollers of the type ESP. In addition, the system performs preprocessing of data collected and their submission in a user-friendly format, as well as saving them, in order to ensure the long-term monitoring of frogs at railroad switches.

The results of measuring the transverse profile of frogs at railroad switches make it possible to take scientifically-substantiated decisions regarding the need for recovery repair of frogs by the method of surfacing and for control over gradual decrease in their carrying capacity, for establishing their actual technical condition and residual resource.

2. The results of experimental data allowed us to establish that basic parameters, which characterize an irregularity at the frog rolling surface, are the shape, depth and inclination of a given irregularity. When a frog passes more than 50 million tons of cargo, the basic form of an irregularity at the frog changes insignificantly, with changes occurring mostly to the depth, as well as slopes of an irregularity that characterize the steepness.

3. Coefficients of polynomial of the seventh degree, by using which we determine the average motion trajectory of a wheel along the longitudinal profiles of frogs, brand 1/11, after passing 50–65 million tons, take, for a lateral motion direction, the following values: a_0=0.0039, a_1=0.0116, a_2=–0.0001, $a_3=4\cdot10^{-7}$, $a_4=-6\cdot10^{-10}$, $a_5=5\cdot10^{-13}$, $a_6=-1\cdot10^{-16}$, and, for a direct motion direction: a_0=–0.1993, a_1=0.0207, a_2=–0.0002, $a_3=7\cdot10^{-7}$, $a_4=-1\cdot10^{-9}$, $a_5=8\cdot10^{-13}$, $a_6=-2\cdot10^{-16}$. After passing 80–95 million tons, coefficients of polynomial of the seventh degree take, for a lateral motion direction, the following values: a_0=–0.3422, a_1=–0.0115, a_2=0.0001, $a_3=-3\cdot10^{-7}$, $a_4=4\cdot10^{-10}$, $a_5=-1\cdot10^{-13}$, $a_6=1\cdot10^{-17}$; and, for a direct motion direction: a_0=–0.377, a_1=–0.0102, $a_2=8\cdot10^{-5}$, $a_3=-2\cdot10^{-7}$, $a_4=1\cdot10^{-10}$, $a_5=5\cdot10^{-14}$, $a_6=-4\cdot10^{-17}$. The selected polynomial of the seventh degree most accurately describes the vertical motion trajectory of the center of mass of the wheel over a frog of the railroad switch.

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