IMPROVING THE METHODS OF POLAR CRANE RUNWAY RAIL PARAMETERS DURING A GEODESIC CONTROL [1]

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The purpose of this work is to show that using electronic flexible rulers, digital gradienters, electronic motometers and other special-purpose tools effectively solves the problem of automating the measuring process of polar crane runway rails geodesic parameters. It is recommended to use the special modifications for eliminating appreciable and systematic errors.

The existence of radiation in the Atomic Power Station premises offers insights into the process of geodesic works. People can access the reactor building only when the reactor is not working. That's why the developed methods of geodesic measurements should provide the highest quality and reliability of obtained results, as well a partial or full measurements automation. The results of geodesic measurements are influenced by the air vibration, oscillation, and temperature drops between the floor and runwail rails levels [1–3]. During this, the contractor has to take the necessary measurements as fast as possible, which can decrease the quality and cause raw miscounts. There are a lot of methods for determining the planned-high-altitude positions of runway rail. The most famous among them are Ruskov [4, 5] and Burak methods.[6, 7]. According to the Burak method, the rail axis is marked as the middle of the surveying rod and the distances between the rail axis points are measured. According to the measurements, the radius of rail axis and the deviation of rail axis points from the radius are determined. However, this famous method is too time-consuming. It requires using 50m tape measures for measuring the distances between the rail points. It doesn't provide efficiency of measurements and further control of rail lining. Except this, you have to lift or drop the crane mechanisms to take the measurements.

Deformations of runway rails may lead to the outage of works. The geometric runway rail parameters are checked in the first days of PPR, before starting the technological repair operations [7, 8]. The periodicity of defining the runway rail parameters depends on the conditions of its operation and reliability of under the crain constructions. In average, it is one cycle a year during the PPR according to the requirements in regulatory documents. That's why increasing the efficiency of geodesic checking of runway rails reliability by incorporating new methods and technologies is a significant task.

Keywords: digital gradienters, electronic total station, electronic tape-measure, forced centering, polar crane, reactor department, runway rail.

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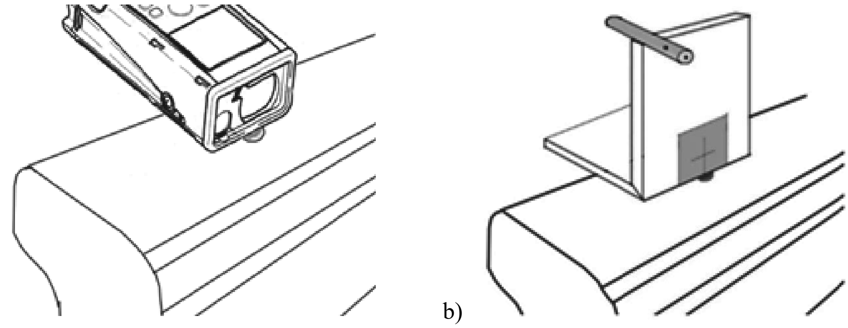
1. INTRODUCTION

Usually, time spared for measuring the runway rail is limited, that's why it's important to quickly and precisely activate the equipment . For this purpose, the electronic tape-measures are used. [1, 3] . For efficient distance measuring, the tape-measure beginning should be straight in the middle of drilled Ø3 mm hole, as shown at the Fig. 1a. In the same way, beacon is installed right on the middle of the hall on the other end of the measured chord. (Fig. 1b).



a) b)

Fig 1. Forced centering on the rail [Source: own study]

2. PURPOSE

The purpose of this work is to effectively solve the task of measuring geometric parameters of polar crane runway rails according to the accuracy requirements. This task is solved with the help of special modifications for eliminating rough and systematic mistakes when using electronic tape-measures, digital gradienters, electronic tachometers, and special-purpose equipment.

3. METHOD

Based on practice, electronic tape-measure as DistoClassic 5a can measure distances less than 30m without using special reflective film. There are different constructions of rejector that are adapted to the measuring conditions (rail width, head of rail pollution level, intertrack space dirtiness). But the main base of any rejector is the rejector surface, light laser (for correct navigation of rejector surface towards the tape-measure to eliminate the error of inaccurate directing of tape-measure laser beam on the surveying target) and level, to get the rejector into horizontal state.

The best solution to this problem is to use the digital sighting device with the display indication. This opportunity is enabled in the latest modules, starting from Distro-8.

To increase the accuracy of measurement result and to avoid mistakes, each chord has to be measured at least 3 times. Before measuring it is important to write down the chord length from the previous investigations in a special magazine and take on the polar crane. It will give an opportunity to additionally control the results of chords measuring on-site, and, if necessary, re-measure the distances that contradict with the previous set of observations.

The analysis of conducted research of distance measuring on the polar crane with the Burak method indicated, that using electronic tape-measures Disto with specially designed rejector and measurements scheme effectively automates the processes of polar crane measurements.

At present, it is recommended to use high precision electronic gradienters instead of optical gradienters, applied for line leveling of runway rail polar cranes. High precision electronic gradienters have a lot of benefits such as

Easy of use, higher work efficiency, absence of errors during measuring process, etc.

Permissible value of defining excess between the rail antipodes is ±5 mm. As the diameter of polar crane is 41,5 m, the shoulder length of polar crane should not excess 20 m when using the Burak method. This method of measuring allows to define the excess between the diametrical opposite rail points $m_h = \pm 2$ mm with the precise electronic gradienter Sprinter 150 m and large-precise gradienter TOPCONDL – 501 [2].

The work [2] provides the mathematical dependencies, that allow to calculate the necessary amount of readings to provide the accuracy of measuring excess with Sprinter 150 M on the setup $m = 0{,}1$ mm when shoulder length is 20 m.

$$m_{\text{відл}} = 0.00387 \times D - 0.00749 \times n + 0.04196 \qquad (1)$$

When the observations are equally accurate on back and front rails (n1=n2=n), we receive the following:

$$m_{\text{відл}} = \frac{m}{\sqrt{2}} = 0.07 \qquad (2)$$

$$n_{(s)} = \frac{(0.00387 \times D + 0.04196 - 0.07\ )}{0.00749} = 6.4 \qquad (3)$$

In this case, n=6.4. It means that ,7 readings are required for accurate results.

For large-precize gradienter TOPCONDL-501, 1 reading is enough for the precise accuracy mentioned before.

$$n_{(T)} = \frac{(0.00144 \times D + 0.001565 - 0.07\ )}{0.00079} = -40.8 \qquad (4)$$

To decrease the amount of rough errors, the observations have to be read at least three times.

The error of surveying rod installation on the runway rail occurs when leveling on the polar crane. In such a way, the “rod base” is the sheet, as the rod head isn`t always in horizontal state, errors may occur because of the incorrect surveying rod installation. (Fig 2a). That's why it is important to mark the points where rod will be installed before starting the work.

The special metal ball is attached to the rod base. It will allow installing the rod on the appropriate point even if the rod head is inclined. (Fig 2b)

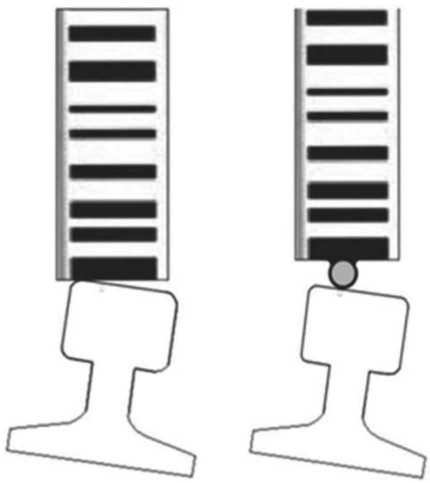


Fig 2. Installing the grade rod on the gage [Source: own study]

With the advent of modern electronic total stations [12], the new methods of measuring polar crane runway rail should be implemented.

The new method is described in the patent №109673 in Ukraine. The method of defining the geometric parameters of runway rails (Authors: K.O. Burak, M.Y.Hrynishak, V.M.Kovtun, V.P.Mychailyshyn, O.P. Shpakivskyi).

When measuring the geodesic parameters with electronic total station, three methods of taking observations are used: “without rejector”, “with the tape”, “with the domatic crystal”. When using the electronic total station South NTS-325R [11], the accuracy of measuring without the rejector is 5+2ppm;. The accuracy of measuring on the rejector is 2+2ppm; the accuracy of angles measuring is 2.

When measuring without the rejector, the laser ray is pointed on the rail itself. In such approach, the work may be done by one contractor. However, this method does not allow to accurately define the access between the points, as it’s not always possible to direct the total station on the right point. As a result, the accuracy of measurements decreases depending on the angle of ray reflection from the rail.

To increase the accuracy, one has to use the method with the tape or dometic crystal. The authors [4] has designed the special rejectors for measuring the runway rails with the electronic total station. However, they are not appropriate for measurements on the polar crane.

Special rejectors, that can be centered on the rail, should be used. There are different types and modifications of rejectors (Fig 3.). As it is known, the holes with the 3mm diameter are drilled on the rail. When installing the rejector in this hole, the maximum accuracy should be provided. Installation of the rejector on the surface with the help of laser and gauge can put it perpendicular to the total station in the right working position.

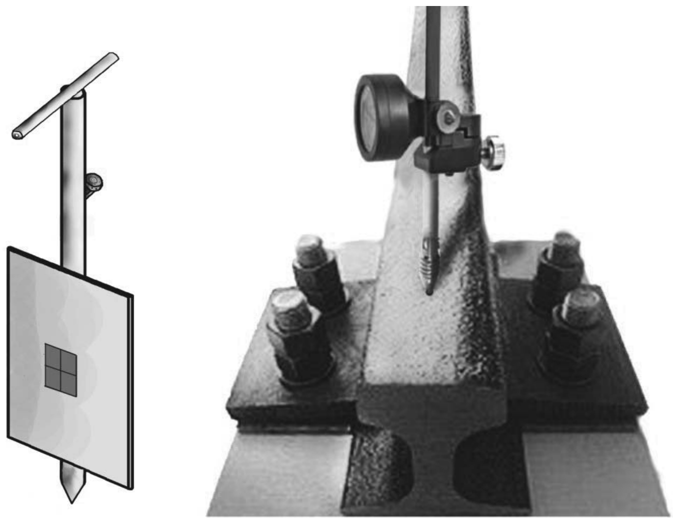


Fig 3. Using the rejector during the tacheometer measurements [Source: own study]

Based on the experience, to measure the coordinates of the runway rail, mini domatic crystal should be used. It is important to mention, that before starting measuring, you need to put the rejector data into the device memory and temperature, after which, the electronic total station will automatically make all the necessary modifications to the measurements.

4. SUMMARY

Incorporating modifications, provided in the work will increase the efficiency of geodesic measurements, eliminate rough and systematic errors, increase the accuracy of geodesic measurements results. This, in turn, will save the resources and costs of the enterprise.

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DOSKONALENIE METODY PARAMETRÓW SZYNY BIEGUNOWEGO ŻURAWIA PODCZAS KONTROLI GEODEZYJNEJ

Streszczenie

Celem pracy jest wykazanie, że zastosowanie elektronicznych elastycznych linijek, cyfrowych gradienterów, elektronicznych motometrów i innych narzędzi specjalnych skutecznie rozwiązuje problem automatyzacji procesu pomiarowego parametrów szyn suwnic dźwigu biegunowego. Zaleca się stosowanie specjalnych modyfikacji w celu wyeliminowania znaczących i systematycznych błędów. Sformułowano problem i jego rozwiązanie w poprzednich pracach. Istnienie promieniowania w pomieszczeniach Elektrowni Atomowej utrudnia proces prac geodezyjnych. Ludzie mają dostęp do budynku

reaktora tylko wtedy, gdy reaktor nie działa. Dlatego opracowane metody pomiarów geodezyjnych powinny zapewniać najwyższą jakość i niezawodność uzyskanych wyników, a także częściową lub pełną automatyzację pomiarów. Na wyniki pomiarów geodezyjnych wpływają wibracje, oscylacje i spadki temperatury między poziomami podłogi i szyny falowej [1-3]. W tym czasie wykonawca musi wykonać niezbędne pomiary tak szybko, jak to możliwe, co może obniżyć jakość i spowodować błędne przeliczenia. Istnieje wiele metod określania planowanych miejsc na dużych wysokościach na torze drogi startowej. Do najbardziej znanych należą Ruskov [4, 5] i Burak [6, 7]. Zgodnie z metodą Buraka oś szynowa jest oznaczana jako środek pręta pomiarowego, a odległości między punktami osi szyny są mierzone. Zgodnie z pomiarami określa się promień osi szyny i odchylenie punktów osi szyny od promienia. Jednak ta znana metoda jest zbyt czasochłonna. Wymaga to użycia taśm 50 m do pomiaru odległości między homologicznymi punktami szynowymi. Nie zapewnia to wydajności pomiarów i dalszej kontroli okładzin szynowych. Oprócz tego musisz podnieść lub upuścić mechanizmy dźwigu, aby wykonać pomiary. Deformacje szyn suwnicy mogą doprowadzić do uniemożliwienia pomiarów. Parametry geometrycznej szyny drogi startowej są sprawdzane w pierwszych dniach przed rozpoczęciem napraw technologicznych [7, 8]. Częstotliwość określania parametrów szyny drogi startowej zależy od warunków jego działania i niezawodności w konstrukcjach ciernych. Średnio jest to jeden cykl w ciągu roku eksploatacji zgodnie z wymogami zawartymi w dokumentach prawnych. Dlatego ważnym zadaniem jest zwiększenie efektywności geodezyjnego sprawdzania niezawodności szyn na pasach przez wprowadzenie nowych metod i technologii.

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