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ОЦЕНКА НАДЕЖНОСТИ РЕЛЬСОВЫХ СКРЕПЛЕНИЙ
RELIABILITY ASSESSMENT OF RAIL FASTENINGS

Аннотация: при расчете показателей надежности рельсовых скреплений различных типов рассматриваются структурные схемы, включающие последовательные и параллельные соединения элементов. С учетом климатических особенностей в республике Узбекистан и учитывая влияние на различные области районов, в статье проводится исследование скреплений на разные возмущающие факторы и обеспечения безотказной работы узлов системы.

Целью работы ставилось разработка алгоритма для определения оптимальных параметров. В результате было предложена оценка параметров распределения, с учетом долговечности элементов узла скрепления. Разработаны аналитические выражения и представлен график.

Abstract: When calculating the reliability indicators of rail fastenings of various types, structural diagrams are considered, including serial and parallel connections of elements. Taking into account the climatic features in the Republic of Uzbekistan and taking into account the impact on various areas of the region, the article conducts a study of fastenings for various disturbing factors and ensuring trouble-free operation of system components.

The goal of the work was to develop an algorithm for determining optimal parameters. As a result, an assessment of the distribution parameters was proposed, taking into account the durability of the elements of the fastening unit. Analytical expressions were developed and a graph was presented.

Ключевые слова: стыковые соединители, анкеры, прокладки, подкладки, железнодорожный транспорт

Keywords: butt connectors, anchors, gaskets, linings, railway transport

When calculating the reliability indicators of rail fastenings of various types, structural diagrams are considered, including serial and parallel connections of elements [1-3]. The sequentially connected elements of the fastening unit are taken to be elements that do not have backup elements [4-6]. Failure of any of these elements greatly reduces the efficiency of the fastening unit, causes intense wear of adjacent parts and increases the cost of maintaining the track [6-9].

The probability of failure-free operation of a node of such a system is estimated by the formula:

$$P_y\ (t_i) = \prod_{j=1}^{n} P_j\ (t_i) \tag{1}$$

where

$P_j\ (t_i)$ is the probability of failure-free operation of the i-th element at time or operating time t_i.

The probability of failure-free operation of parallel-connected circuit elements is determined by the derived analytical expressions:

$$P_y(t_i) = 1 - [1 - \prod_{j=1}^{n} P_j(t_i)]^2 \quad (2)$$

Based on data on failures of fastening elements, samples are compiled in the following sequence:

1) an operating interval is assigned, and the number of failed elements is grouped in increasing order of missed tonnage;

2) for each j and i-th operating interval, the failure rate of the j and i-th element $R_j\ (t_i)$ is calculated on an accrual basis;

3) according to the frequency $R_j\ (t_i)$, the value of the j and i-th element of the fastening unit $F_j\ (t_i)$ is determined by the formula:

$$F\ (t) = \frac{R_j\ (t_i)}{n} \quad (3)$$

4) the quantile U_p is found by frequency $F\ (t)$ using tabulated values of the Laplace functions.

Table 1

Data on failures of elements of the Pandrol Fastclip fastening unit

Node element	Operating time t, mln.t gross	Frequency $R(t_{n+1})$, pcs/km	Probability of failure $F_j(t_i) = \frac{R_j\ (t_i)}{n}$	Probability of failure-free operation $P(t_i) = 1 - F(t)$	Quantile U_P
Cleat	100	1,2	0,000174	0,999826	3,576
	250	3,6	0,000523	0,999477	3,278
	400	4,9	0,000712	0,999288	3,190
Clamp insulators	100	4,8	0,000698	0,999302	3,196
	250	17,9	0,002602	0,997398	2,794
	400	24,7	0,003590	0,996641	2,688
Side insulators	100	0,1	0,000015	0,999985	4,181
	250	0,03	0,000044	0,999956	3,924
	400	0,4	0,000058	0,999942	3,854
Lining	100	0,9	0,000262	0,999738	3,469
	250	2,3	0,000670	0,999330	3,207
	400	3,4	0,001000	0,999000	3,090
Anker	100	0,1	0,000015	0,999985	4,181
	250	0,3	0,000044	0,999956	3,924
	400	0,7	0,000102	0,999898	3,715

The probability of failure-free operation of a node is determined in accordance with the block diagram using the formula:

$$P_y = [1- (1- \prod_{i=1}^{4} P_i)^2]\ P_i \quad (4)$$

Calculations are made depending on the operating time of the tonnage and a graph is constructed of changes in the probability of failure-free operation of the fastening unit depending on the tonnage (Figure 2).

For a given class of track, the percentage of unusable fastenings is determined in the additional criteria for assigning major repairs to the track, and the operating time at which the required percentage of fastenings will be released is determined on the constructed graph. For this purpose, the probability value is shown on the graph P_y = (1-% of unusable fasteners).

Thus, the tonnage operating time is determined, at which it is necessary to carry out a partial revision of the fastening units with the replacement of failed parts.

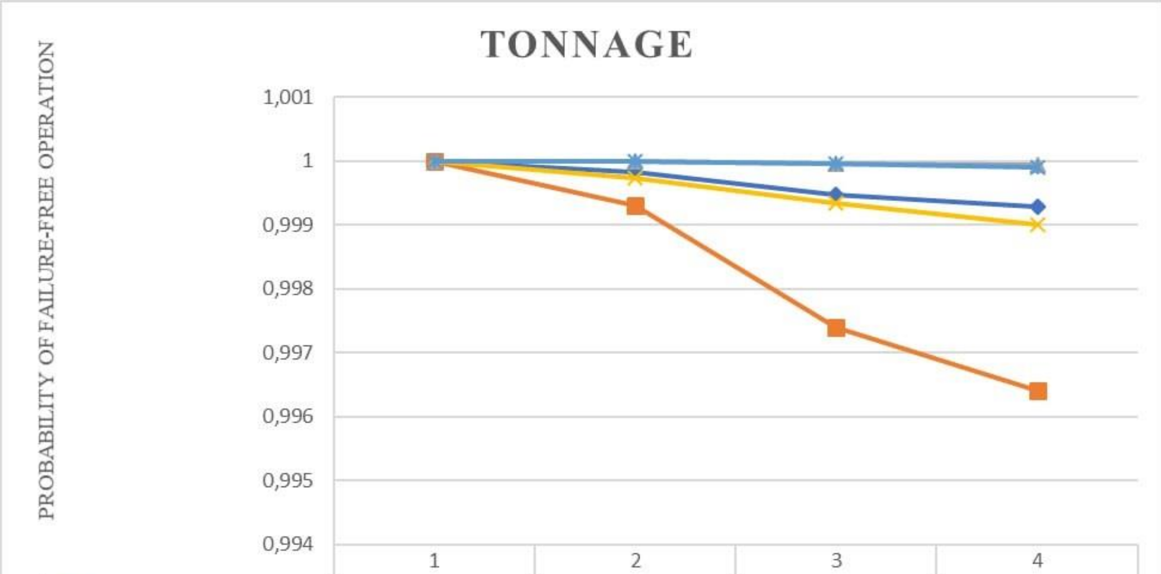
We determine the operating time at which 15% of the metal pads and under-rail rubber pads in the Pandrol Fastclip fastening units will fail, i.e. it is necessary to find ti at which $F(t) = 0.15$, respectively $P_j = 1 – F(t) = 0.85$. Analyzing Table 1, we find the Pandrol Fastclip fastening elements with the highest failure rate: for example, clamping insulators. Then we find the quantile $U_{0,85}$ = 1.036

For cleat T_{mid}=2615.7 million tons gross, σ_t =707 million tons gross:

$t_1 = T_{mid} - U_{0,85} \cdot \sigma = 2615{,}7 - 1{,}036 \cdot 706{,}66 = 1883{,}2 \approx 1883$ million tons gross.

For clamping insulators. T_{mid} = 1786.8 million. t gross, σ_t = 531.26 million. t gross: $t_2 = T_{mid} - U_{0,80} \cdot \sigma = 1786{,}8 - 1{,}036 \cdot 531{,}26 = 1236{,}4 \approx 1236$ million tons gross.

Thus, after passing 1000 million tons of gross cargo, it is necessary to carry out a partial revision of Pandrol Fastclip units with replacement of failed parts.



	1	2	3	4
terminals	1	0,999825581	0,999476744	0,999287791
pressure insulators	1	0,999302326	0,997398256	0,996409884
side insulators	1	0,999985465	0,999956395	0,99994186
pads	1	0,999738372	0,99933	0,999
anchors	1	1	0,999956395	0,999898256

Figure 1. Failure-free operation chart for Pandrol Fastclip fasteners

The measurement results showed that the values of the pressing forces of the Pandrol Fastclip intermediate rail fastening terminals are within the normalized range established for these fastenings.

Список литературы:

1. Gali-Askar R. Khalfin CONTROL OF THE PRESSING FORCES OF THE PANDROL FASTCLIP FASTENING TERMINALS ON THE SOLE OF THE RAILS/ Transsib News 4 (52) 2022
2. Sh. Khakimov R. Aliev, M. Aliev, E. Toxirov O‘q xisoblagich yordamida poyezdning temir yo‘l kesishmasiga yaqinlashish nazorat metodi Интернаука 2 (272), 2022, стр. 12-15
3. Алиев Р. М., Хакимов Ш. Х. Модель определения оптимальных длин неограниченных рельсовых цепей тональной частоты на перегонах //Цифровая трансформация транспорта: проблемы и перспективы. – 2022. – С. 241-247.

4. Tokhirov E. T., Aliev R. M., Aliev M. M. Methods of monitoring the condition of track sections //НАУКА, ОБЩЕСТВО, ТЕХНОЛОГИИ: ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ ВЗАИМОДЕЙСТВИЯ В СОВРЕМЕННОМ МИРЕ. – 2022. – С. 204-220.

5. Gulyamova M. K., Aliev R. M. Pedagogical sciences //Distance Education as a Method of Efficiency of Education Under Various Form Factors//Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft. – 2022. – Т. 29. – С. 38.

6. Tokhirov E., Aliev R. Exploring the influence of high-speed train traffic on sustainable economic growth in the region //Актуальные вопросы развития инновационно-информационных технологий на транспорте. – 2021. – Т. 2021. – С. 12-16.

7. Aliev R., Aliev M., Toxirov E. Turli Rejimlarida Poyezdning Kesishmaga Yaqinlashishini Kuzatish Uchun Datchikning Optimal Parametrlarini Aniqlashning Matematik Modeli // Интернаука: электрон. научн. журн. 2023. № 2 (272)

8. Ravshan A., Davron M. Development Of A Program And Algorithm For Determining The Resource Of Relays Of Automatic And Telemechanics In Railway Transport //Universum: технические науки. – 2022. – №. 11-6 (104). – С. 56-58.

9. Ravshan A., Davron M. Development Of An Algorithm And Program On Mysql To Create A Database To Control The Turnover Of Railway Automation Relays //Universum: технические науки. – 2022. – №. 11-6 (104). – С. 59-62.