JOURNAL OF TRANSPORT

ISSUE 3, 2025 vol. 2
E-ISSN: 2181-2438
ISSN: 3060-5164

SLIB.UZ
Scientific library of Uzbekistan

RESEARCH, INNOVATION, RESULTS

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

JOURNAL OF TRANSPORT

RESEARCH, INNOVATION, RESULTS

E-ISSN: 2181-2438
ISSN: 3060-5164
VOLUME 2, ISSUE 3
SEPTEMBER, 2025

jot.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 2, ISSUE 3 SEPTEMBER, 2025

The **"Journal of Transport"** established by Tashkent State Transport University (TSTU), is a prestigious scientific-technical and innovation-focused publication aimed at disseminating cutting-edge research and applied studies in the field of transport and related disciplines. Located at Temiryo'lchilar Street, 1, office 465, Tashkent, Uzbekistan (100167), the journal operates as a dynamic platform for both national and international academic and professional communities. Submissions and inquiries can be directed to the editorial office via email at jot@tstu.uz.

The Journal of Transport showcases groundbreaking scientific and applied research conducted by transport-oriented universities, higher educational institutions, research centers, and institutes both within the Republic of Uzbekistan and globally. Recognized for its academic rigor, the journal is included in the prestigious list of scientific publications endorsed by the decree of the Presidium of the Higher Attestation Commission No. 353/3 dated April 6, 2024. This inclusion signifies its role as a vital repository for publishing primary scientific findings from doctoral dissertations, including Doctor of Philosophy (PhD) and Doctor of Science (DSc) candidates in the technical and economic sciences.

Published quarterly, the journal provides a broad spectrum of high-quality research articles across diverse areas, including but not limited to:

- Economics of Transport
- Transport Process Organization and Logistics
- Rolling Stock and Train Traction
- Research, Design, and Construction of Railways, Highways, and Airfields, including Technology
- Technosphere Safety
- Power Supply, Electric Rolling Stock, Automation and Telemechanics, Radio Engineering and Communications
- Technological Machinery and Equipment
- Geodesy and Geoinformatics
- Automotive Service
- Air Traffic Control and Aircraft Maintenance
- Traffic Organizatsion
- Railway and Road Operations

The journal benefits from its official recognition under Certificate No. 1150 issued by the Information and Mass Communications Agency, functioning under the Administration of the President of the Republic of Uzbekistan. With its E-ISSN 2181-2438, ISSN 3060-5164 the publication upholds international standards of quality and accessibility.

Articles are published in Uzbek, Russian, and English, ensuring a wide-reaching audience and fostering cross-cultural academic exchange. As a beacon of academic excellence, the "Journal of Transport" continues to serve as a vital conduit for knowledge dissemination, collaboration, and innovation in the transport sector and related fields.

Calculation methods for station tonal current receiving rail circuits

M.M. Aliev[1][a], R.M. Aliev[1][b]

[1]Tashkent state transport university, Tashkent, Uzbekistan

Abstract: Currently, phase-sensitive and tonal track circuits are mainly used for monitoring station sections at stations. One of the disadvantages of currently used tonal track circuits without isolating links is that when a train approaches a controlled section, it begins to close this section at a certain distance before entering it. This distance depends on many variables and is constantly changing depending on these variables. To overcome this disadvantage, it is proposed to use a current track receiver instead of a traditional potential receiver with a clear threshold to record the entry of a train into a controlled section. To date, methods for determining the main analytical expressions for analyzing and synthesizing tonal track circuits with potential receivers in various operating modes have been developed and applied. Although the theoretical issues of tonal rail circuits with current collectors have not been considered in practice, in this regard, the article considers the issues of developing mathematical models for determining the absolute shunt sensitivity of tonal rail circuits without isolating the links with current collectors and methods for calculating the critical point of the minimum shunt sensitivity. The expressions obtained differ from the known equations of absolute shunt sensitivity and the critical point of the minimum value of shunt sensitivity and allow for the analysis, synthesis and design of tonal rail circuits without isolating the links with current collectors, which increases the safety of train traffic.

Keywords: tone rail circuit without insulating joints, potential receiver, current receiver, equivalent circuits, shunt sensitivity

Stansiya tonal tok qabul qiluvchi rels zanjirlarni hisoblash usullari

Aliev M.M.[1][a], Aliev R.M.[1][b]

[1]Toshkent davlat transport universiteti, Toshkent, O‘zbekiston

Annotatsiya: Hozirgi vaqtda fazaga sezgir va tonal rels zanjirlari asosan stansiyalarda stansiya uchastkalarini kuzatish uchun ishlatiladi. Hozirgi vaqtda qo'llaniladigan ohangli yo'l sxemalarining izolyatsiyalovchi bo'g'inlari bo'lmagan kamchiliklaridan biri shundaki, poyezd nazoratladigan uchastkaga yaqinlashganda, unga kirishdan oldin bu uchastkani ma'lum masofadan yopishni boshlaydi. Bu masofa ko'plab o'zgaruvchilarga bog'liq va doimiy ravishda bu o'zgaruvchilarga qarab o'zgarib turadi. Ushbu kamchilikni bartaraf etish uchun poezdning nazoratladigan uchastkaga kirishini qayd etish uchun aniq chegaraga ega bo'lgan an'anaviy potentsial qabul qilgich o'rniga tok yo'l qabul qilgichdan foydalanish taklif etiladi. Bugungi kunga qadar turli xil ish rejimlarida potentsial qabul qiluvchilar bilan tonal rels zanjirlarini tahlil qilish va sintez qilish uchun asosiy analitik ifodalarni aniqlash usullari ishlab chiqilgan va qo'llanilgan. Tok qabul qiluvchilar bilan tonalli rels zanjirlarining nazariy masalalari amalda ko'rib chiqilmagan bo'lsa-da, shu munosabat bilan maqolada tok qabul qiluvchilar bilan bo'g'inlarni izolyatsiya qilmasdan tonal rels zanjirlarining mutlaq shunt sezgirligini aniqlashning matematik modellarini ishlab chiqish masalalari va minimal shunt sezgirligining kritik nuqtasini hisoblash usullari ko'rib chiqiladi. Olingan ifodalar mutlaq shunt sezgirligining ma'lum tenglamalaridan va shunt sezgirligining minimal qiymatining kritik nuqtasidan farq qiladi va tok qabul qiluvchilar bilan bo'g'inlarni izolyatsiya qilmasdan tonal rels zanjirlarini tahlil qilish, sintez qilish va loyihalash imkonini beradi, bu esa poyezdlar harakati xavfsizligini oshiradi..

Kalit so‘zlar: izolyatsion bo'g'inlarsiz tonal rels zanjiri, potentsial qabul qiluvchi, tok qabul qilgich, ekvivalent sxemalar, shunt sezgirligi

1. Kirish

Rossiya temir yo'llarida va bir qator xorijiy mamlakatlarda (Germaniya, Frantsiya, Ispaniya, Angliya) signal oqimi chastotasi f = 25, 50, 75 Gts bo'lgan qo'shma yo'l sxemalari stantsiya yo'l uchastkalarining holatini kuzatish uchun keng qo'llaniladi. So'nggi paytlarda signal tok chastotasi f = 420, 480 Gts bo'lgan tonal rels zanjirlari ham qo'llanildi [4, 5, 6, 13]. Statistik ma'lumotlarga ko'ra [5, 6] yil davomida relsl zanjirining nosozliksiz ishlash ehtimoli P = 0,82 ni tashkil qiladi va rels zanjirlarning o'rtacha ishlamay qolish vaqti 5 yilni tashkil etadi, ya'ni o'rtacha har besh rels zanjirida yiliga bitta nosozlik sodir bo'ladi.

Ish paytida nosozliklar umumiy sonidan izolyatsion bo'g'inlarning noto'g'riligi sababli rels zanjirlarining

[a] https://orcid.org/0009-0005-4410-3479
[b] https://orcid.org/0009-0008-2010-1905

ishlashidagi nosozliklar peregon uchastkalarda taxminan 28% va stantsiyalarda 40-50% ni tashkil qiladi.

Izolyatsiya qiluvchi bo'g'inlarning past ishonchliligi, shuningdek, uzluksiz payvandlangan yo'lni joriy etish, izolyatsion bo'g'inlarni rels zanjirlarida yo'q qilish muammosini keltirib chiqaradi; izolyatsion bo'g'inlarni yo'q qilish poezdlar oralig'ini boshqarish qurilmalarining ishonchliligini sezilarli darajada oshiradi. Bundan tashqari, "O'zbekiston temir yo'llari" davlat aksiyadorlik temir yo'l kompaniyasi Signalizatsiya va aloqa markazi ma'lumotlariga ko'ra, O'zbekiston Respublikasi temir yo'llarida foydalanilayotgan rels zanjirlari 74 foiz eskirgan va zamonaviyroq tizimlarga almashtirishni talab qilmoqda.

Yuqoridagilardan ko'rinib turibdiki, hozirgi vaqtda rels zanjirlarini shunday takomillashtirish dolzarb bo'lib bormoqdaki, ular zanjirlardan eng ishonchsiz elementlardan biri - izolyatsion birikmani yo'q qilish va yo'l uchastkasi holatini nazorat qilish qurilmalarida mikroprotsessorga asoslangan zamonaviy komponentlardan foydalanish va shu bilan ularning ishonchli ishlashini ta'minlash mumkin. Bu intervalli boshqaruv tizimlarini qurish va ulardan foydalanish xarajatlarini sezilarli darajada kamaytiradi va poyezdlar harakati xavfsizligini oshiradi.

Izolyatsion bo'g'inlar bilan yo'l zanjirlarini loyihalash va ishlatishda standart parametrlardan biri ballast izolyatsiyasining solishtirma qarshiligi bo'lib, u ri = 1 Ohm*km sifatida qabul qilinadi, lekin O'zbekiston temir yo'lining turli uchastkalarida o'tkazilgan o'lchovlar [4] ko'rsatganidek, u keng miqyosda o'zgarib turadi va iqlim sharoitiga bog'liq. Rels zanjirlarining ishlashiga salbiy ta'sir ko'rsatadigan asosiy bezovta qiluvchi omillardan biri bu yil va kun davomida doimiy ravishda o'zgarib turadigan yo'l liniyalarining izolyatsiyalash qarshiligi. Shunday qilib, temir rels liniyasining sharoitlarini kuzatishning ishonchliligiga ta'sir qiluvchi muhim omil - bu izolyatsiya qarshiligining tebranishlari diapazoni, ularning chegaralari va izolyatsiya qarshiligining o'zgarish tezligi keng chegaralarda o'zgarib turadi, shuningdek, izolyatsiya qarshiligining uzunlamasına assimetriyasi.

Yuqorida aytilganlarning barchasidan kelib chiqadiki, temir rels liniyalari holatini monitoring qilish uchun izolyatsiya qarshiligining minimal ruxsat etilgan qiymatini kamaytirish, shunt sezgirligini oshirish, izolyatsion bo'g'inlarni rels zanjirlaridan olib tashlash va ularga texnik xizmat ko'rsatishni soddalashtirish imkonini beradigan bunday usullar va qurilmalarni ishlab chiqish muhim va dolzarb muammodir. Potensial qabul qiluvchi bilan izolyatsiyalangan bo'g'inlarsiz tonal rels zanjirlarini ishlatish muammoni hal qilmaydi, chunki ular qisqa va ko'proq yo'lga o'rnatilgan qurilmalarni talab qiladi. Bularning barchasi rels liniyalari monitoringi tizimlarini rels uzunligini oshiradigan, qurilish va foydalanish xarajatlarini kamaytiradigan, minimal ruxsat etilgan izolyatsiya qarshiligini kamaytiradigan, shunt sezgirligini yaxshilaydigan va yo'lga o'rnatilgan qurilmalar sonini kamaytiradigan yangi usullardan foydalangan holda amalga oshirilishi kerakligini ko'rsatadi.

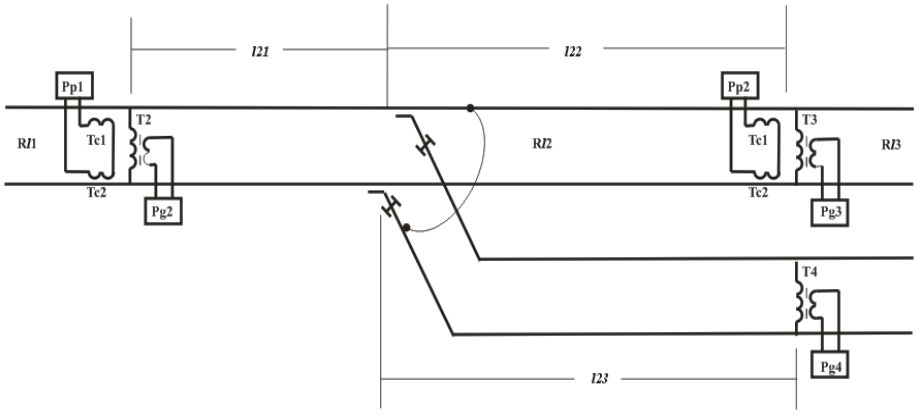
2. Tadqiqot metodologiyasi

Normal rejimda tok qabul qilgich bilan uzluksiz tarmoqlangan rels zanjirining matematik modeli

Tarmoqlangan uzluksiz rels zanjirlarini tok qabul qilgichlari bilan tahlil qilish va sintez qilishda rels zanjirlarining umumiy nazariyasidan foydalanish mumkin[1,2,3], ammo izolyatsion bo'g'inlarning yo'qligi va tok qabul qiluvchilardan foydalanish natijasida yuzaga keladigan ba'zi o'ziga xos xususiyatlarni hisobga olish kerak.

Bunday sxemalarni tadqiq qilish va loyihalash uchun bunday sxemalarning asosiy ish rejimlari uchun analitik ifodalarni chiqarish kerak.

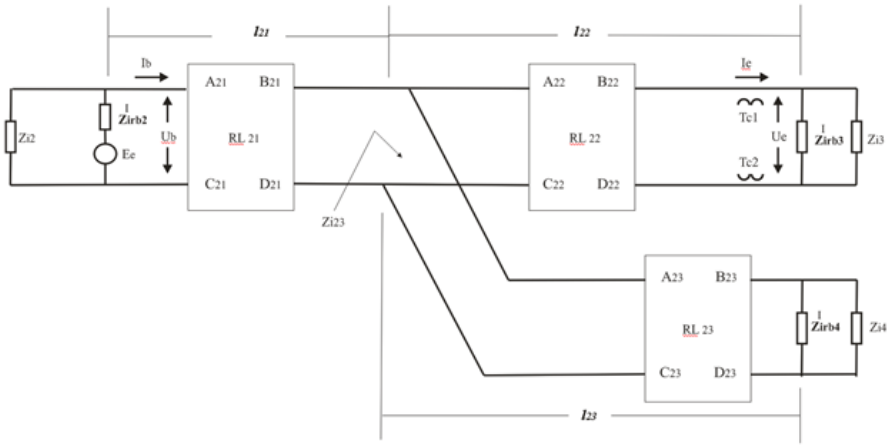
1-rasmda Pg2 yo'l generatori, Tc1, Tc2 qabul qiluvchi g'altaklari va Pp2 qabul qiluvchidan iborat bo'lgan tok qabul qiluvchilari bilan choksiz tarmoqlangan rels zanjir ko'rsatilgan, shuningdek, qo'shni Pg3, Pg4 rels zanjirlarining yo'l generatorlari va Pp1 yo'l qabul qilgichi ko'rsatilgan.



1-rasm. Tok qabul qilgichli stansiyaning tarmoqlangan uzluksiz rels zanjir sxemasi

Ushbu tadqiqotning maqsadi rels zanjirning asosiy ish rejimlarini ta'minlaydigan optimal tarmoq uzunligi l_{23} ni aniqlashdir.

Normal ish rejimida uzluksiz rels zanjiri uchun analitik ifodalarni olish uchun 1-rasmni ekvivalent sxema sifatida keltiramiz (2-rasm).



2-rasm. Tok qabul qilgichli tarmoqlangan uzluksiz rels zanjirining ekvivalent sxemasi

qayerda

RL_{21}, RL_{22} va RL_{23} mos ravishda l_{21}, l_{22} va l_{23} liniyalarining to'rt kutuplari;

Zi_2, Zi_3 va Zi_4 mos ravishda qo'shni trek zanjirlarining kirish empedanslari;

Zi23 - l23 tormog'ning kirish qarshiligi;

$Z^I_{irb2}, Z^I_{irb3}, Z^I_{irb4}$ - mos ravishda quvvat manbalarining teskari kirish qarshiliklari;

T_{c1}, T_{c2} - qabul qiluvchi g'altaklar;

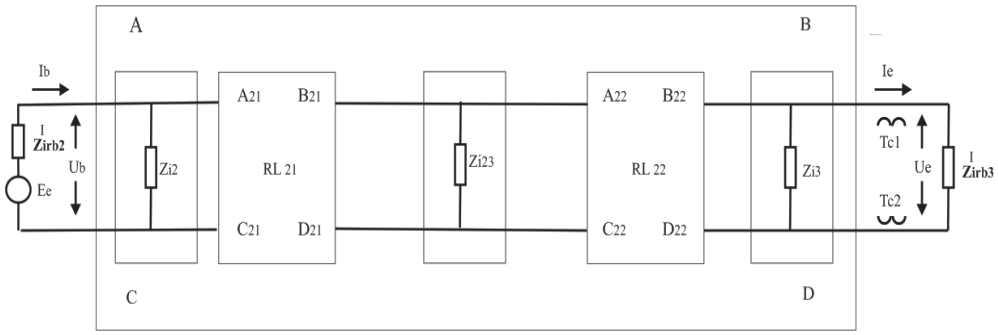
I_b - rels zanjirining ishga tushirish toki;

U_b - rels zanjirining ishga tushirish kuchlanishi;

I_e - rels zanjirining oxiri toki (yo'l qabul qiluvchining ish toki);

U_e - rels zanjirining oxiridagi kuchlanish.

Rels zanjiri qabul qiluvchisining ish tokini aniqlash uchun to'rt kutupli relsning koeffitsientlarini aniqlash kerak, shuning uchun biz 2-rasmdagi sxemani 3-rasmdagi umumiy ekvivalent sxemaga aylantiramiz.



3-rasm. Normal ish rejimida tok qabul qilgichli tarmoqlangan uzluksiz yo'l zanjirining umumiy ekvivalent sxemasi

qayerda

$$A_{21} = ch\gamma_{21}l_{21}, B_{21} = Z_{v21} * sh\gamma_{21}l_{21},$$
$$C_{21} = \frac{1}{Z_{v21}} * sh\gamma_{21}l_{21}, D_{21} = ch\gamma_{21}l_{21}; \quad (1)$$
$$A_{22} = ch\gamma_{22}l_{22}, B_{22} = Z_{v22} * sh\gamma_{22}l_{22},$$
$$C_{22} = \frac{1}{Z_{v22}} * sh\gamma_{22}l_{22}, D_{22} = ch\gamma_{22}l_{22}; \quad (2)$$
$$A_{23} = ch\gamma_{23}l_{23}, B_{23} = Z_{v23} * sh\gamma_{23}l_{23},$$
$$C_{23} = \frac{1}{Z_{v23}} * sh\gamma_{23}l_{23}, D_{23} = ch\gamma_{23}l_{23}; \quad (3)$$
$$Z_{i23} = \frac{A_{23}*\frac{Z_{i4}*Z^I_{irb4}}{Z_{i4}+Z^I_{irb4}}+B_{23}}{C_{23}*\frac{Z_{i4}*Z^I_{irb4}}{Z_{i4}+Z^I_{irb4}}+D_{23}}. \quad (4)$$

Rels zanjirlari nazariyasidan [2] ma'lum:

$$U_b = A * U_e + B * I_e; \quad (5)$$
$$I_b = C * U_e + D * I_e; \quad (6)$$
$$U_e = I_e * Z^I_{irb3}. \quad (7)$$

(7) tenglamadagi Ue qiymatini (5) va (6) tenglamalarga almashtirib, biz quyidagilarni olamiz:

$$U_b = A * I_e * Z^I_{irb3} + B * I_e; \quad (8)$$
$$I_b = C * I_e * Z^I_{irb3} + D * I_e; \quad (9)$$
$$E = U_b + I_b * Z^I_{irb2} \quad (10)$$

(8.9) tenglamadan Ub Ib qiymatini (10) tenglamaga qo'yib, biz quyidagilarni olamiz:

$$E = A * I_e * Z^I_{irb3} + B * I_e + \left(C * I_e * Z^I_{irb3} + D * I_e\right) * Z^I_{irb2} \quad (11)$$

Normal ish rejimida rels zanjirining uzatish qarshiligi quyidagi formula bilan aniqlanadi:

$$Z_{tn} = \frac{E}{I_e} = \frac{A*I_e*Z^I_{irb3}+B*I_e+\left(C*I_e*Z^I_{irb3}+D*I_e\right)*Z^I_{irb2}}{I_e} = A * Z^I_{irb3} + B + \left(C * Z^I_{irb3} + D\right) * Z^I_{irb2}. \quad (12)$$

RL to'rt kutupli rels koeffitsientlarini quyidagi formula bilan aniqlash mumkin:

$$\begin{vmatrix} A & B \\ C & D \end{vmatrix} = \begin{vmatrix} 1 & 0 \\ \frac{1}{Z_{i2}} & 1 \end{vmatrix} * \begin{vmatrix} A_{21} & B_{21} \\ C_{21} & D_{21} \end{vmatrix} * \begin{vmatrix} 1 & 0 \\ \frac{1}{Z_{i23}} & 1 \end{vmatrix} * \begin{vmatrix} A_{22} & B_{22} \\ C_{22} & D_{22} \end{vmatrix} * \begin{vmatrix} 1 & 0 \\ \frac{1}{Z_{i3}} & 1 \end{vmatrix} = \begin{vmatrix} A_{21} + \frac{B_{21}}{Z_{i23}} & B_{21} \\ C_{21} + \frac{A_{21}}{Z_{i2}} + \left(D_{21} + \frac{B_{21}}{Z_{i2}}\right) * \frac{1}{Z_{i23}} & D_{21} + \frac{B_{21}}{Z_{i2}} \end{vmatrix} *$$

$$\begin{vmatrix} A_{22}+\frac{B_{22}}{Z_{i3}} & B_{22} \\ C_{22}+\frac{D_{22}}{Z_{i3}} & D_{22} \end{vmatrix} = (A_{21}+\frac{B_{21}}{Z_{i23}})*\left(A_{22}+\frac{B_{22}}{Z_{i3}}\right)+B_{21}*\left(C_{22}+\frac{D_{22}}{Z_{i3}}\right)\rightarrow$$

$$(C_{21}+\frac{A_{21}}{Z_{i2}}+\left(D_{21}+\frac{B_{21}}{Z_{i2}}\right)*\frac{1}{Z_{i23}})*(A_{22}+\frac{B_{22}}{Z_{i3}})+(D_{21}+\frac{B_{21}}{Z_{i2}})*\left(C_{22}+\frac{D_{22}}{Z_{i3}}\right)\rightarrow$$

$$(A_{21}+\frac{B_{21}}{Z_{i23}})*B_{22}+B_{21}*D_{22}$$

$$(C_{21}+\frac{A_{21}}{Z_{i2}}+\left(D_{21}+\frac{B_{21}}{Z_{i2}}\right)*\frac{1}{Z_{i23}})*B_{22}+(D_{21}+\frac{B_{21}}{Z_{i2}})*D_{22} \quad (13)$$

qayerda

$$A=(ch\gamma_{21}l_{21}+\frac{Z_{v21}*sh\gamma_{21}l_{21,}}{Z_{i23}})*\left(ch\gamma_{22}l_{22}+\frac{Z_{v22}*sh\gamma_{22}l_{22,}}{Z_{i3}}\right)+\rightarrow$$

$$\rightarrow+Z_{v21}*sh\gamma_{21}l_{21,}*\left(\frac{1}{Z_{v22}}*sh\gamma_{22}l_{22}+\frac{ch\gamma_{22}l_{22}}{Z_{i3}}\right) \quad (14)$$

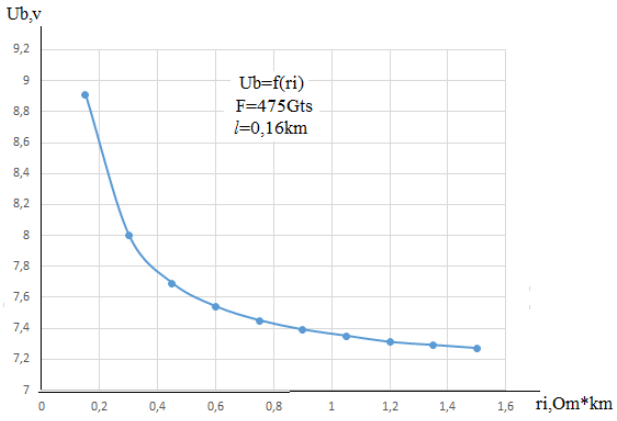
$$B=\left(ch\gamma_{21}l_{21}+\frac{Z_{v21}*sh\gamma_{21}l_{21,}}{Z_{i23}}\right)*Z_{v22}*sh\gamma_{22}l_{22,}+Z_{v21}*sh\gamma_{21}l_{21}*ch\gamma_{22}l_{22}; \quad (15)$$

$$C=(\frac{1}{Z_{v21}}*sh\gamma_{21}l_{21}+\frac{ch\gamma_{21}l_{21}}{Z_{i2}}+\left(ch\gamma_{21}l_{21}+\frac{Z_{v21}*sh\gamma_{21}l_{21,}}{Z_{i2}}\right)*\frac{1}{Z_{i23}})*\rightarrow(ch\gamma_{22}l_{22}+\frac{Z_{v22}*sh\gamma_{22}l_{22,}}{Z_{i3}})+(ch\gamma_{21}l_{21}+\frac{Z_{v21}*sh\gamma_{21}l_{21,}}{Z_{i2}})\rightarrow*\left(\frac{1}{Z_{v22}}*sh\gamma_{22}l_{22}+\frac{ch\gamma_{22}l_{22}}{Z_{i3}}\right) \quad (16)$$

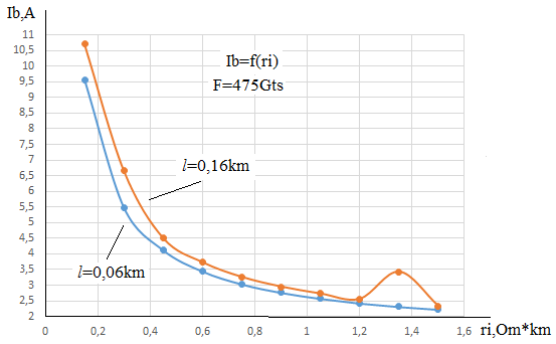
$$D=(\frac{1}{Z_{v21}}*sh\gamma_{21}l_{21,}+\frac{ch\gamma_{21}l_{21}}{Z_{i2}}+\left(ch\gamma_{21}l_{21}+\frac{Z_{v21}*sh\gamma_{21}l_{21,}}{Z_{i2}}\right)*\frac{1}{Z_{i23}})\rightarrow*Z_{v22}*sh\gamma_{22}l_{22}+(ch\gamma_{21}l_{21}+\frac{Z_{v21}*sh\gamma_{21}l_{21}}{Z_{i2}})*ch\gamma_{22}l_{22}. \quad (17)$$

Berilgan analitik ifodalar normal ish rejimida (poyezdning yo‘qligi) tok qabul qiluvchilar bilan stansiya tonal rels zanjirini tadqiqot va amaliy hisob-kitoblarni o‘tkazish uchun asos bo‘ladi.

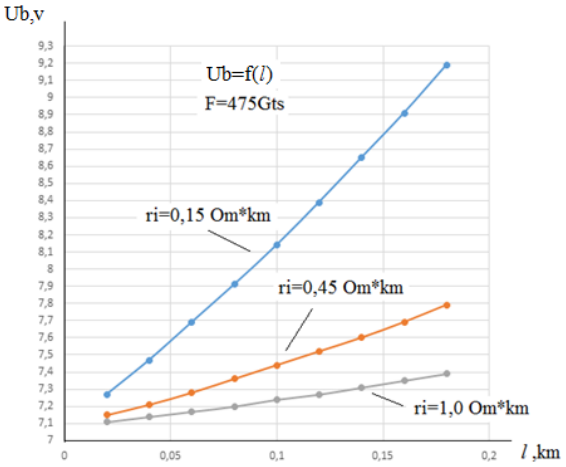
Bu analitik iboralar asosida tokli rels zanjirining normal rejimda ishlashi uchun rels zanjirining quvvat manbai uchida kuchlanish va tokning balast qarshiligiga bog'liqligini hisoblash algoritmi va dasturi ishlab chiqilgan. Hisoblash natijalari 4, 5 va 6-rasmlarda ko'rsatilgan.



4 – rasm. Tok qabul qiluvchisi tonal rels zanjirining quvvat manbaidan kuchlanishining ballast qarshiligiga bog'liqligi grafigi



5 – rasm. Tok qabul qiluvchisi tonal rels zanjirining quvvat manbai tokining balast qarshiligiga bog'liqligi grafigi



6 – rasm. Balast qarshiligining turli qiymatlari uchun tok qabul qiluvchisi bo'lgan tonal rels zanjirining quvvat manbai kuchlanishining yo'l zanjiri uzunligiga bog'liqligi grafiglari

4. Xulosa

Ushbu grafiklarni tahlil qilish natijasida quyidagi xulosalar chiqarish mumkin:

1. Oddiy rejimda tonal chastotali rels zanjirining ishonchli ishlashi uchun standart balast bilan ri=1Om*km rels zanjirning uchida quvvat manbai kuchlanishi Ub=7,35 volt va tok Ib=2,7 amper bo'lishi kerak.

2. Grafiklardan ko'rinib turibdiki, rels zanjirning quvvat manbai uchidagi kuchlanish va tok balast qarshiligining pasayishi bilan ortadi, bu yo'l zanjirlari uchun tabiiydir.

Shu sababli, stansiyalarda foydalanish uchun tonal rels zanjirlari tavsiya etiladi, bu poezdlar harakatining ishonchliligi va xavfsizligini oshiradi

Foydalangan adabiyotlar / References

[1] Aliev, R., Aliev, M., Talipova, G., & Yuldasheva, M. (2025). AJ “O‘zbekiston temir yo‘llari” yo‘llarning uchastkalarida poyezdlar yaqinlashishning xavfli zonasini tadqiqotning matematik modeli. Вестник транспорта - Transport Xabarnomasi, 2(2), 41-45. https://doi.org/10.56143/2181-2438-2025-2-41-45

[2] Aliev, M., Talipova, G., & Aliev, R. (2025). Method for calculating the coefficients of intelligent sensors of automation in transport. Вестник транспорта - Transport Xabarnomasi, 2(1), 232-236. https://doi.org/10.56143/jot-journal.v2i1.313

[3] Ravshan Aliev (2021) Analysis of the track sections control system a rolling stock axle counting sensor AIP Conference Proceedings. Vol. 2439. No. 1. AIP Publishing LLC https://doi.org/10.1063/5.0068348

[4] Ravshan Aliev Trends in Improving Sensors for Controlling the Condition of Track Sections E3S Web of Conferences 264, 05045 (2021) https://doi.org/10.1051/e3sconf/202126405045

[5] R Aliev (2023) Method inductive communications for interval traffic control //AIP Conference Proceedings. – AIP Publishing LLC, 20232, 2612(1), 060002. https://doi.org/10.1063/5.0113212

[6] Zorin V.I. (2003) Microprocessor-based locomotive systems for ensuring the safety of train traffic of a new generation / V. I. Zorin, E. E. Shukhina, P. V. Titov // Railways of the world No7. PP. 61 – 69

[7] Alessio Trivella, Francesco Corman, (2023) Modeling system dynamics of interacting cruising trains to reduce the impact of power peaks, Expert Systems with Applications, 230, 2023. https://doi.org/10.1016/j.eswa.2023.120650.

[8] [8]. Albrecht et al., 2016 The key principles of optimal train control—Part 1: Formulation of the model, strategies of optimal type, evolutionary lines, location of optimal switching points Transportation Research, Part B (Methodological), 94 (2016), pp. 482-508 https://doi.org/10.1016/j.trb.2015.07.023.

[9] Banić, M., Miltenović, A., Pavlović, M., & Ćirić, I. (2019) Intelligent machine vision based railway infrastructure inspection and monitoring using UAV. Facta Universitatis, Series: Mechanical Engineering, 17(3), 357-364. DOI: 10.22190/FUME190507041B

[10] M. P. Mohandass, D. N. Sri. N, S. r. Y and S. A, "An Automated Railway Unguarded Level Crossing using Lab View," 2024 International Conference on IoT Based Control Networks and Intelligent Systems (ICICNIS), Bengaluru, India, 2024, pp. 574-580, doi: 10.1109/ICICNIS64247.2024.10823211

[11] Goncharov, K.V. (2011) Research of the digital track receiver of tonal rail chains / K.V. Goncharov // Visnik Dnipropetr. nat. Un-tuzalizn. transp. im. Acad.V. Lazaryan. - D., VIP. 37, pp. 180–185 https://cyberleninka.ru/article/n/issledovanie-tsifrovogo-putevogo-priemnika-tonalnyh-relsovyh-tsepey

[12] Vantuono. Control systems trains in USA. International Railway Journal, 2009, №10, p. 32-34,36.

[13] DEWIANI R. P. N. M. Design Of 4-way RF power splitter for wireless communication system at 5 Ghz frequency.

[14] M. Sokolov and A. Khodkevich, "Application of Conformal Mappings to Determine the Location of Rolling Stock on a Section of a Rail-Wire Line," 2025 International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM), Sochi, Russian Federation, 2025, pp. 935-939, doi: 10.1109/ICIEAM65163.2025.11028456.

[15] 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.

[16] R.M. Aliev at all. Mathematical model and algorithms for research and diagnostics of the track control sensor to create an expert system// 2022 International Conference on Information Science and Communications Technologies (ICISCT).

Mualliflar to‘g‘risida ma’lumot/ Information about the authors

Aliev Marat Muhamedovich / Ulugbek Shermukha-medov	Toshkent Davlat Transport University, Axborot tizimlari va texnologiyalari kafedrasi dotsenti E-mail: Aliyev_m@tstu.uz https://orcid.org/0000-0002-7676-1127
Karimova Anora Baxtiyarovna / Anora Karimova	Tashkent Davlat Transport University, Axborot tizimlari va texnologiyalari kafedrasi, professori, E-mail: silara@mail.ru Tel: +998903726455 https://orcid.org/0000-0002-0165-3789

CONTEXT / MUNDARIJA