

JOURNAL OF TRANSPORT



ISSUE 4, 2025 vol. 2

E-ISSN: 2181-2438

ISSN: 3060-5164



RESEARCH, INNOVATION, RESULTS



**TOSHKENT DAVLAT
TRANSPORT UNIVERSITETI**

Tashkent state
transport university



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E-ISSN: 2181-2438

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VOLUME 2, ISSUE 4

DECEMBER, 2025



jot.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 2, ISSUE 4 DECEMBER, 2025

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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.

Problems arising on metroways and their solutions

P.A. Begmatov¹, Sh. Jonkobilov¹

¹ Tashkent state transport university, Tashkent, Uzbekistan

Abstract: This article presents the current role of metropolitan roads in public transport and the work that needs to be done to develop it. At the same time, the operation of the ballast prism, which is one of the main elements of the overpass structure of subway roads, is described. A complex of works aimed at increasing the load-bearing capacity of the ballast prism on metropolitan roads has been studied, and the main reasons for its failure have been identified. The causes of ballast prism deformation on subway tracks are presented, and modern methods of measures to combat them are presented.

Keywords: roadbed, constructions, slope strengthening, geosynthetic materials, assessment, technological scheme, solution, method, soil, geofence, module, lifting, non-woven materials, protective layer

Metropoliten yo'larida yuzaga kelayotgan muammolar va ularning yechimi

Begmatov P.A.¹, Jonqobilov Sh.¹

¹ Toshkent davlat transport universiteti, Toshkent, O'zbekiston

Annotatsiya: Ushbu maqolada metropoliten yo'llarining hozirgi kundagi jamoat transportidagi o'rni, uni rivojlantirish bo'yicha olib borilishi kerak bo'lgan ishlar keltirilgan. Shu bilan birgalikda metropoliten yo'llarining yo'l ustki qurilmasining asosiy elementlaridan biri bo'lgan ballast prizmasining ishlashi keltirib o'tilgan. Metropoliten yo'llarida ballast prizmasini ko'tarishqobiliyatini oshirishga qaratilgan ishlar kompleksi o'rganilgan va uning ishdan chiqishining asosiy sabablari keltirib o'tilgan. Metropoliten yo'llarida ballast prizmasining deformatsiyalanish sabablari keltirilgan va ular bilan kurashish chora-tadbirlarining zamonaviy usullari keltirib o'tilgan.

Kalit so'zlar: subway roads, rails, ballast prism, overpass, public transport

1. Kirish

Megapolis shaharlar uchun transport infratuzilmasini rivojlantirish orqali shahar aholisiga qulaylik yaratish juda muhim ahamiyatga ega. Markaziy Osiyoning eng yirik shaharlaridan biri bo'lgan Toshkent shahrida ham aholi turar joylari hamda transport infratuzilmasini rivojlantirish, yangi loyihalarni hayotga tadbiq etishga alohida e'tibor qaratilmoqda [1, 2].

Bugungi kunda transport infratuzilmasini rivojlantirish har bir zamonaviy shaharning ustuvor vazifalaridan biriga aylangan. Shu yo'nalishda jamoat transportlari orasida metropoliten – eng samarali, tezkor va ekologik toza transport turi sifatida alohida ahamiyatga ega [3].



1-rasm. Toshkent metropolitening yer usti metro liniyasi

Metro nafaqat odamlarni tez va xavfsiz manziliga yetkazishga xizmat qiladi, balki shaharning iqtisodiy, ijtimoiy va ekologik rivojiga ham kuchli ta'sir ko'rsatadi.

2. Tadqiqot metodologiyasi

Ballast prizmasida yuzaga keluvchi nosozliklar va ular bilan qarshi kurashish chora-tadbirlar

Bugungi kunda butun jahonda metropolitenlarda poyezdlar harakati xavfsizligini ta'minlash uchun yo'lining ustki qurilmasi elementlarini to'g'ri tanlash, loyihalash va hisoblash masalalariga, shuningdek mustahkamligi yuqori bo'lgan yo'l ustki qurilmasi elementlarini yaratishga yo'naltirilgan ilmiy-tadqiqot ishlari olib borilmoqda.

Yo'l ustki qurilmasi barcha elementlarining xizmat muddatlarini davomiyligi ballast prizmasiga bog'liq. Agar ballast prizmasini qurish uchun ko'tarish qobiliyati kichik bo'lgan materialdan foydalanilsa, ko'plab notekis botiq cho'kish, silkinish, qiyshayib qolish holatlari kuzatiladi, bu esa relslarni ko'proq umumiy va to'lqinsimon yedirilishiga, ularda kontaktli-charchash oqibatida hosil bo'ladigan nuqsonlarni vaqtdan ilgari paydo bo'lishiga olib keladi.

Ballast prizmasini ishdan chiqishining asosiy sabablari – mustahkamligi, barqarorligi va prizma o'lchamlarini, hamda yo'lni butun bo'ylama yo'nalish bo'ylab bir xil mustahkamligi va bir xil elastikligidagi o'zgarishlardir.

Ballast prizmasidagi nosozliklar yo'lni ham bo'ylama, ham ko'ndalang yo'nalishlarda notekis cho'kishga olib

 <https://orcid.org/0000-0003-0160-9814>



keladi, ayrim hollarda cho'kish kattaligi poyezdlar harakatiga xavf tug'diradigan darajaga yetishi mumkin.

Yo'lni va ballast prizmasini soz holatda saqlashdagi kamchiliklarga yo'lning barcha elementlarini soz holatda saqlash bo'yicha belgilangan me'yorlarni buzish ham kiradi.

Yo'lning jami ekspluatatsiya davrida ballast prizmasini belgilangan o'lchamlariga muvofiq hamda tozalikda saqlash, yo'lning teng elastiklik holatini suvni chetlatish inshootlarini soz holatda saqlash bilan birga bajariladigan ishlarga alohida e'tibor qaratish zarur.

Ballast prizmasi o'lchamlarini o'zgarishi ularni ekspluatatsiya sharoitlariga mos bo'lmaganida, zichlashtirishda ballast prizmasining cho'kish zaxirasiga qo'yiladigan me'yorlarga rioya qilinmaganida, turli ekspluatatsiya sharoitlarida namunaviy ko'ndalang profilardan foydalanishga oid texnik talablarni buzishda, yer polotnosi kengligi yetarlicha bo'lmaganida va yuqorida ballast prizmasi mustahkamligiga putur yetkazish masalalari ko'rib chiqilganda ko'rsatilgan boshqa sabablarga ko'ra sodir bo'ladi [4,5].

Metropolitan yo'llarida ballast prizmasining deformatsiyalanish sabablari bir nechta muhim omillar bilan bog'liq bo'lib, ular texnologik, muhandislik-geologik, va ekspluatatsion omillardan kelib chiqadi:

1. Vagon harakati natijasida hosil bo'ladigan dinamik yuklamalar:

- harakatdagi metro poyezdlari rels va ballastga muntazam tebranuvchi yuklar (vibratsiya) hosil qiladi;
- bu yuklar ballast zarralari orasidagi o'zaro bog'liqlikni zaiflashtiradi;
- natijada ballast zichligi kamayadi, yotqizilgan prizma shakli buziladi.

2. Namlik va suv ta'siri:

- tunnel ichiga suv kirishi yoki kondensatsiya natijasida ballast zarralari namlanadi;

- suv ballast zarralari orasidagi ishqalanishni kamaytiradi, bu esa ularni joyidan siljishga olib keladi;

- suv bilan to'yingan ballast loy holatiga o'tishi mumkin.

3. Notekis zichlashtirish (kompaktatsiya):

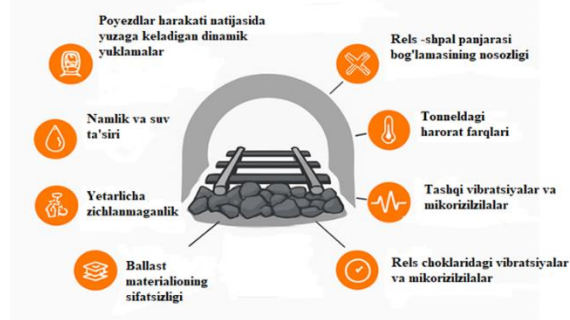
- ballast yotqizish jarayonida bir tekis zichlanmasa, ayrim joylar bo'sh qoladi;

- yuklama ostida bu bo'sh joylar tezda o'tirishga olib keladi, prizma buziladi.

4. Ballast materialining sifatsizligi:

- to'g'ri granula shaklida bo'lmagan, juda mayda yoki yumshoq materiallardan foydalanish;

- maydalanuvchan materiallar yuklama ostida maydalana boradi, bu esa ballast qatlamining zichligini pasaytiradi va deformatsiyaga olib keladi.



2-rasm. Ballast prizmasining nosozligini keltirib chiqaruvchi omillar

5. Rels-shpal bog'lama nosozligi:

- rels va shpallar orasidagi mahkamlagichlar bo'shab qolsa, yuklama bevosita ballastga o'tadi;

- bu esa ballast prizmasining tezroq yemirilishiga va g'ovaklanishiga sabab bo'ladi.

6. Tunnelidagi harorat farqlari:

- issiq va sovuq zonalarining almashinuvi natijasida materiallar kengayadi yoki qisqaradi.

- bu termik deformatsiyalar ham ballastning o'z holatini yo'qotishiga olib keladi.

7. Tashqi vibratsiyalar va mikroizilzilar:

- tunnel yaqinidagi qurilish ishlari, metro ustki qatlamida joylashgan avtomobil yo'llari, qurilish texnikasi va hatto mikroizilzilar ham ballastni beqarorlashtirishi mumkin.

Metropolitan yo'llarida ballast prizmasi deformatsiyalanishi va uni bartaraf etish uslublarini o'rganish odatda yo'lning ishlash sharoitlari, yuklama xususiyatlari va xizmat ko'rsatish texnologiyalarini chuqur tahlil qilishdan boshlanadi.



3-rasm. Merropolitenda yo'lni ta'mirlash jarayoni

Yoqilg'i Ballast prizmasi deformatsiyalanishining sabablari:

1. Mexanik ta'sirlar:

- poyezd g'ildiraklaridan uzluksiz dinamik yuklama;

- tormozlanish va tezlanishdan kelib chiqadigan qo'shimcha kuchlanish.

2. Namlik va drenaj yetishmovchiligi:

- tunnellarda suv oqishlari yoki kondensat tufayli ballastning namlanishi.

3. Zarrachalarning maydalanishi:

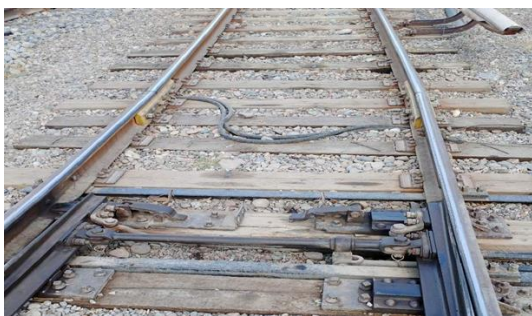
- ballast donachalari poyezd yuklamalari ostida maydalanganda zichlashib, elastiklikni yo'qotadi.

4. Noaniq zichlash:

- dastlabki qurilish yoki ta'mirdan keyin yetarli zichlash ishlari bajarilmagan bo'lsa.

5. Yon surilish va siljish:

- egri uchastkalarda markazdan qochma kuchlar ballastning yon siljishiga olib keladi. Ballastga texnik xizmat ko'rsatish uni shpallar ostida muntazam ravishda ballast qatlamidan suvni to'kish va uning yuzasidan ifloslangan qimrlarini tozalashdan iborat. Shuningdek ballast qatlamining yuqori qismi shpalning yuqorisidan 3 sm pastda bo'lishini ta'minlash kerak [6]. Vaqt o'tishi bilan ezilgan ballast ifloslangan va tiqilib qoladi, shuning uchun u doimiy tozalashni talab qiladi. Stantsiyalardan chiqish joylarida joylashgan yo'l uchastkalari eng kuchli ifloslanishlar yuzaga keladi. Ballast eng ko'p harakatlanuvchi tarkibdan yog' tushishi, g'ildiraklarning ishqalanishi paytida hosil bo'lgan chang va tamping paytida ballastni maydalash bilan ifloslangan



4-rasm. Yeterli donadorlikka ega bo'lmagan metropoliten yo'llarining ballast prizmasi

Ballast prizmasini ta'mirlash va tiklash uslublari:

1. Mexanik zichlash:
 - Maxsus yo'l mashinalari yoki qo'lda ishlaydigan vibrozichlagich yordamida ballast qatlamini zichlash;
 - Shpallar ostidagi bo'shliqlarni to'ldirish.
 2. Ballast to'ldirish va profilni tiklash:
 - Eski ballast ustiga yangi ballast material qo'shish;
 - Profilni tiklash uchun yon tomonlariga ham ballast qo'shish;
 3. Ballast yuvish:
 - namlangan yoki loy aralash ballastni maxsus ballast yuvish mashinalari yordamida tozalash;
 - yuvilgan ballast qayta ishlatiladi yoki yangisi bilan almashtiriladi.
 4. Ballast almashinuvi:
 - kuchli ifloslangan yoki maydalanib ketgan ballastni to'liq olib tashlash;
 - yangi ballast material bilan to'ldirish;
 - bu usul odatda kapital ta'mirlash vaqtida qo'llanadi.
 5. Drenaj tizimini yaxshilash:
 - tunnel devorlarida suv oqishini kamaytirish yoki bartaraf etish;
 - yon kanallar yoki drenaj quvurlarini o'rnatish;
 - ballast namlanishini minimallashtirish.
- Ballast prizmasini tamirlashda zamonaviy texnologiyalarni qo'llash usullari:
1. Geosintetik materiallardan foydalanish: Geotekstil va geosetkalar bilan mustahkamlash.
 2. Kimyoviy mustahkamlash: Polimerlar va boshqa moddalar yordamida ballastni mustahkamlash.
 3. Avtomatlashtirilgan tekislash: Lazer texnologiyalari yordamida aniq tekislash.
 4. Profilaktik chora-tadbirlar: muntazam monitoring va diagnostika, drenaj tizimini yaxshilash, yuk tashish rejimini optimallashtirish.
- Metropoliten yo'llarini ta'mirlash ishlari sifatini texnik nazorat qilish — bu faqat "ko'zdan kechirish" emas, balki qat'iy reglament, o'lchov, hujjatlashtirish va qabul-topshirish tartiblarini o'z ichiga olgan kompleks jarayon. Metro sharoitida (yopiq tunellar, qisqa ish vaqti, yo'lovchi xavfsizligi talablari yuqoriligi) bu nazorat yanada muhim.

3. Xulosa

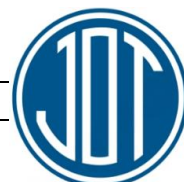
Metropoliten yo'llarida ballast prizmasining deformatsiyalanishi ko'p omilli muammo bo'lib, bu holatlar nafaqat yo'l holatining yomonlashuviga, balki poyezdlarning harakat xavfsizligiga ham salbiy ta'sir ko'rsatadi. Shu sababli, zamonaviy metrolarda ballastsiz (monolit asosli) yo'l konstruksiyalari afzal ko'rilmogda. Metropoliten yo'llarida ballast prizmasining deformatsiyalanishini oldini olish va bartaraf etish kompleks yondashuvni talab qiladi. Zamonaviy materiallar va texnologiyalardan foydalangan holda, shu bilan birga muntazam profilaktik ishlarni olib borish ballast prizmasining uzoq muddatli xizmat qilishini ta'minlaydi.

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Mualliflar to'g'risida ma'lumot/ Information about the authors

Begmatov Pardaboy Abduraximovich / Pardaboy Begmatov	Toshkent davlat transport universiteti, "Temir yo'l muhandisligi" kafedrasida dotsenti (PhD) E-mail: pbegmatov_1986@mail.ru Tel.: +998998747086 https://orcid.org/0000-0003-0160-9814
Jonqobilov Shohjahon Shavkat o'g'li / Shohjahon Jonqobilov	Toshkent davlat transport universiteti magistratura talabasi E-mail: shohjahonjonqobilov17@mail.com Tel.: +998904278077



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