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 Temiryoʻlchilar 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.

The effect of reinforcement with geosynthetic materials on the redistribution of vertical stresses and increased stability of the foundation in the rail joint area

O.M. Mirzakhidova[1][a], K.S. Lesov [1][b], M.K. Kenjaliev [1][c]
[1]Tashkent state transport university, Tashkent, Uzbekistan

Abstract: This study focuses on identifying and evaluating vertical dynamic stresses that arise in the rail joint zones of railway tracks under the influence of trains traveling at speeds of 160–200 km/h. The calculations account for impact loads resulting from wheel–rail interactions, joint gaps, structural irregularities, and uneven load distribution across sleepers. Static and dynamic stress components are superimposed to determine the total stress profile. The effectiveness of local reinforcement using geosynthetic materials is assessed based on the reduction of stress with depth. Calculations are performed within a zone extending 6 to 10 sleepers on either side of the rail joint (a total of 12–20 sleepers). The results are used to enhance the deformation resistance of the subgrade, ensure compliance with regulatory stress limits, and determine the optimal length of the reinforced zone.
Keywords: rail joint zone, vertical dynamic stresses, geosynthetic materials, geotextile, planar geogrids, local reinforcement, impulse attenuation, efficiency coefficient, subgrade stability

Yer polotnosi asosiy maydonchasini mahalliy armirlashni hisobga olgan holda rels choklari zonasidagi dinamik kuchlanishlarni hisoblashning takomillashtirilgan metodikasi

Mirzaxidova O.M.[1][a], Lesov K.S.[1][b], Kenjaliyev M.K.[1][c]
[1]Toshkent davlat transport universiteti, Toshkent, O‘zbekiston

Annotatsiya: Ushbu maqolada temir yo‘l rels choklari zonasida 160–200 km/soat tezlikda harakatlanayotgan poyezdlar ta’sirida yuzaga keladigan vertikal dinamik kuchlanishlarni aniqlash va baholashga qaratilgan. Hisoblashlar g‘ildirak–rels o‘zaro ta’siridagi zarbali yuklanishlar, chokdagi tirqishlar, vibratsion effektlar va yukning shpallar bo‘yicha notekis taqsimlanishini inobatga olgan holda olib boriladi. Metodika asosida statik va dinamik kuchlanishlar ustma-ust qo‘yilib, to‘liq kuchlanish aniqlanadi. Geosintetik materiallar bilan lokal armirlashning samaradorligi chuqurlik bo‘yicha kuchlanishlarni kamaytirish orqali baholanadi. Hisoblashlar rels chokining har ikki tomonida 6–10 ta shpal oralig‘ida (jami 12–20 ta) amalga oshiriladi. Olingan natijalar yer polotnosining deformatsiyaga chidamliligini oshirish, me’yoriy kuchlanish chegaralariga rioya etilishini ta’minlash va armirlash zonasining optimal uzunligini aniqlashda qo‘llaniladi.
Kalit so‘zlar: rels choklari zonasi, vertikal dinamik kuchlanishlar, geosintetik materiallar, geotekstil, yassi geopanjaralar, lokal armirlash, impuls so‘nishi, samaradorlik koeffitsiyenti, yer polotnosi mustahkamligi

1. Kirish

Rels choklari an’anaviy ravishda temir yo‘lning eng zaif uchastkalari hisoblanadi. Mazkur zonada harakatlanuvchi tarkibdan kelib chiqadigan dinamik yuklanishlar to‘planadi, bu esa ballast qatlami hamda yer polotnosining asosiy maydonchasida vertikal kuchlanishlarning mahalliy ortishiga olib keladi. Natijada shpallar va ballastning tezroq eskirishi, qoldiq deformatsiyalarning to‘planishi yuz beradi hamda bu holat ta’mirlashlar orasidagi muddatning qisqarishi va ekspluatatsion xarajatlarning oshishiga sabab bo‘ladi [1–4].

Ushbu metodika temir yo‘l rels choklari zonasida 160–200 km/soat tezlikda harakatlanayotgan poyezdlar ta’sirida yuzaga keladigan vertikal dinamik kuchlanishlar aniqlash va baholashga qaratilgan. Bunday kuchlanishlar g‘ildirak–rels o‘zaro ta’siridagi zarbali yuklanishlar, chokdagi tirqishlar va konstruktiv notekisliklar, shuningdek, yukning shpallar bo‘yicha notekis taqsimlanishi natijasida yuzaga keladi. Hisoblash natijalari yer polotnosining chuqurlik bo‘yicha kuchlanish holatini baholash, geosintetik materiallar bilan lokal armirlash samaradorligini aniqlash va konstruktiv yechimlarning me’yoriy talablarga muvofiqligini tekshirish uchun xizmat qiladi. [5-6]

[a] https://orcid.org/0000-0001-6247-1869
[b] https://orcid.org/0000-0002-9434-0713
[a] https://orcid.org/0000-0003-4622-5937

2. Tadqiqot metodologiyasi

Armirlash zonasi chokdan har ikki tomonga 6–10 ta shpallik (jami 12tadan 20 tagacha) masofada amalga oshiriladi. Hisoblashda statik tashkil etuvchi σ(z) va qo‘shimcha dinamik ta’sir $\Delta\sigma_{dyn}$ ustma-ust qo‘yiladi. Olingan natijalar yer polotnosini kuchaytirish loyihasini ishlab chiqishda, armirlangan zona uzunligini tanlashda hamda kuchlanishlar bo‘yicha belgilangan mezonlarning bajarilishini tekshirishda qo‘llaniladi. [15]. Yo‘l konstruksiyasi va material parametrlari R-65 relslari, BF-70 shpallari, Pandrol Fastclip mahkamlagichlari, 25–60 mm (h=0,40 m) maydalangan toshdan tayyorlangan ballast, h=0,20 m qumli ballast osti qatlami va asos sifatida loyli qum gruntidan iborat. Yuklanish 18 t/o‘q bo‘lib, epyura 2000 dona/km ni tashkil etadi. Chok tuguni geometriyasida haqiqiy tirqish Δl va notekisliklar inobatga olinadi. Ushbu metodika temir yo‘lning ishonchliligini oshirish, yer asosining deformatsiyasini kamaytirish va tekis yuk taqsimotini ta’minlashga qaratilgan.

Z chuqurlikdagi statik kuchlanish quyidagi formula orqali aniqlanadi:

$$\sigma_{st}(z) = \frac{P_{ц}}{A}\, e^{-\alpha z}$$

bu yerda $P_{ц}$ - g‘ildirak o‘qidan shpalga tushadigan hisobiy yuklama (qo‘shni shpallarga taqsimlanishini hisobga olgan holda),

A - shpalaning ballastga tayanish maydoni,

α - konstruksiya qatlamlari bo‘yicha so‘nish koeffitsiyenti

Ulanish joyida yuzaga keladigan qo‘shimcha dinamik kuchlanish quyidagicha ifodalanadi:

$$\Delta\sigma_{dyn}(z) = \sigma_{st}(z)\, k_{dyn}$$

bu yerda k_{dyn} - chokning holati va tezlikni hisobga oluvchi dinamik o‘sish koeffitsiyenti.

Odatda:

soz chok uchun: k_{dyn}=0.2÷0.3;

o‘rtacha yeyilish uchun: k_{dyn}=0.3÷0.5;

nuqsonli chok uchun: k_{dyn}=0.6÷0.8 gacha qabul qilinadi

To‘liq kuchlanish quyidagi formulada ifodalanadi:

$$\sigma_{tot}(z) = \sigma_{st}(z) + \Delta\sigma_{dun}(z) = \sigma_{st}(z)\,(1 + k_{dyn})$$

Dinamika koeffitsiyentining harakat tezligiga bog‘liqligi quyidagi formula bilan aniqlanadi:

$$k_{dyn} = k_0 + m\,\frac{V}{100}$$

kichik tezliklar uchun bazaviy koeffitsiyent (≈0.15–0.20),

bu yerda: m - empirik koeffitsiyent (≈0.05-0.10),

V - harakat tezligi, km/soat.

Dastlab, birinchi metodika asosida σ(z) — statik kuchlanish taqsimoti aniqlanadi. Keyinchalik, harakat tezligi (160 va 200 km/soat) hamda relslar ulanish holatiga bog‘liq holda dinamik o‘sish koeffitsiyenti k_{dyn} hisoblanadi. Ushbu koeffitsiyent asosida qo‘shimcha dinamik kuchlanishlar $\Delta\sigma_{dyn}$ va to‘liq kuchlanish $\sigma_{tot}(z)$ aniqlanadi. Olingan natijalar amaldagi me’yoriy talablarga muvofiqligi bo‘yicha baholanadi. Jumladan, shpal ostida kuchlanish σ ≤ 0,50 MPa, yer polotnosi asosiy maydonining ustki qatlamida (chuqurligi 0,60 m) esa σ ≤ 0,12 MPa bo‘lishi lozim. Armirlashning turli variantlari (armirlanmagan, geotekstil bilan, geotekstil+yassi geopanjara) uchun dinamik kuchlanishlarning pasayish darajasi aniqlanadi. Bu holatda har bir armirlash usulining samaradorligi solishtirma tahlil asosida baholanadi. Hisoblash faqat rels choklari zonasida har bir tomonga 6–10 ta shpal (jami 12/16/20 ta) zonaning uzunligini hisobga olgan holda amalga oshiriladi. Yer polotnosi asosiy maydonchasining lokal armirlash sharoitida rels choklari zonasidagi kuchlanishlar baholanadi.

Armirlash effektining uzunlik bo‘yicha masshtablanishi ham ko‘rib chiqiladi. Zona qanchalik katta bo‘lsa, armirlash samarasi “to‘liq o‘lchamli” holatga shunchalik yaqinlashadi. Bu yondashuv real sharoitda qo‘llaniladigan konstruktiv yechimlarning fizik asoslanganligini ta’minlaydi.

3. Tahlil va muhokama

Rels choklari zonalari uchun kuchlanishlarni baholash uslubi quyidagi formulaviy asosga tayangan holda takomillashtiriladi**.** Ulanish bazasi avvalgidek saqlanadi:

$$\sigma_{tot}(z) = \sigma_{st}(z)\,(1 + k_{dyn})$$

Bu yerda $k_{dyn} = k_0 + m\,\frac{V}{100}$ (chokning zarbali dinamikasini ifodalaydi,).

Armirlash k_{dyn} ga emas, balki chuqurlik bo‘ylab so‘nishga ta’sir qiladi (impulsni yaxshiroq "so‘ndiradi"):

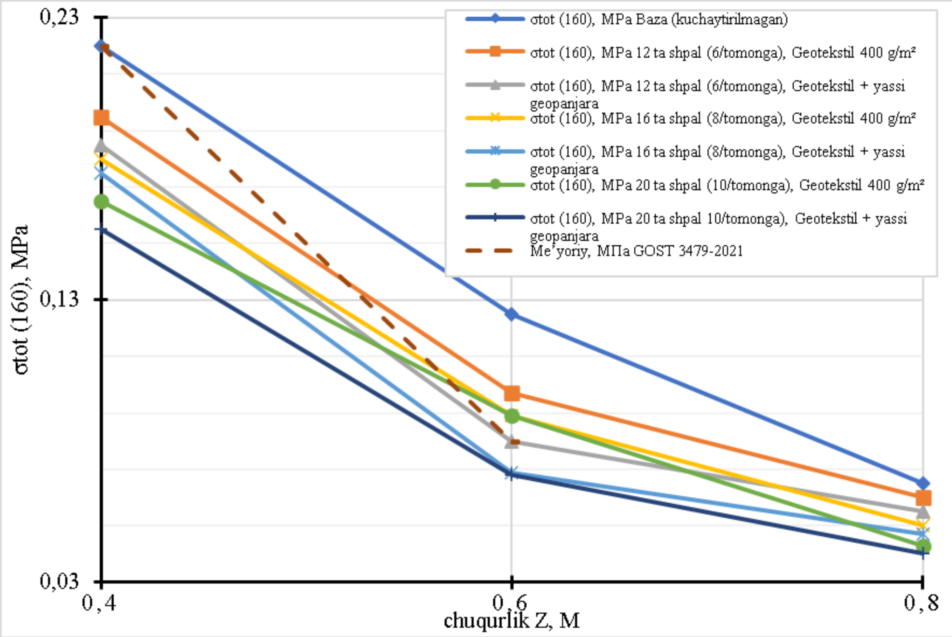
$$\alpha_{арм} = \alpha\left(1 + c_i k_g^{eff}\right),\ \text{bu yerda } k_g^{eff} = k_g * \eta_L$$

Armirlashning ta’siri bevosita k_{dyn} qiymatiga emas, balki impulsning chuqurlik bo‘ylab so‘nish darajasiga taalluqlidir. Armirlash materiallari impulsni samarali “so‘ndiradi”, ya’ni kuchlanish tarqalishini vertikal yo‘nalishda kamaytiradi. Bu holat quyidagi formulada ifodalanadi:

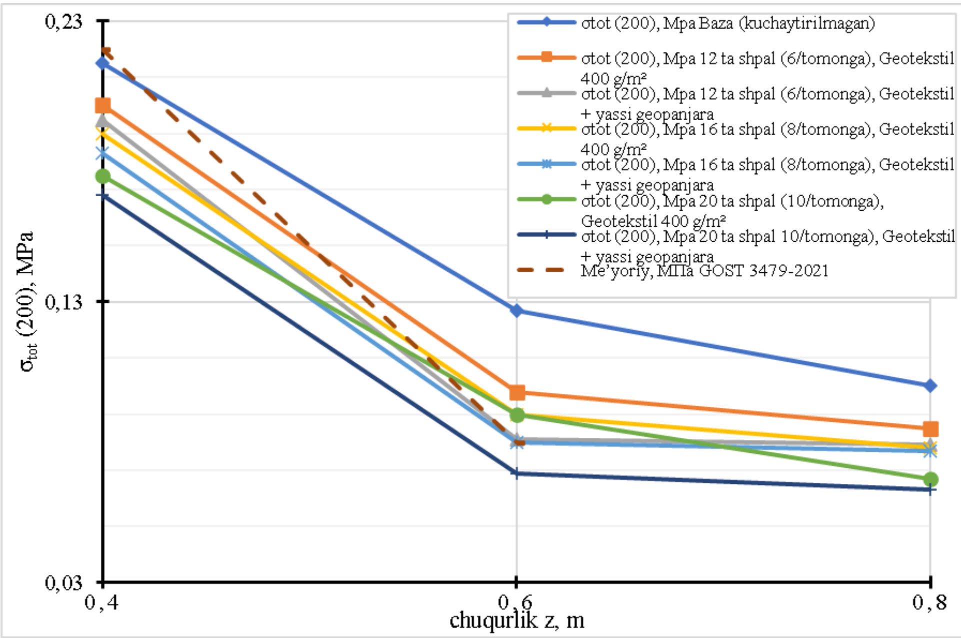
$$\alpha_{арм} = \alpha\left(1 + c_i k_g^{eff}\right),$$

Bu yerda -$k_g^{eff} = k_g \cdot \eta_L$. geosintetikning samaradorlik koeffitsiyenti.

Bo‘ylama samaradorlik koeffitsiyenti $\eta_L = \min(1,\ N_{сб}/8)$–. bu yerda $N_{сб}$ har bir tomonga shpallar soni. Agar zona har ikki tomonga 8 ta shpalni qamrab olsa, armirlash “to‘liq o‘lchamli” samaraga yaqinlashadi.



1-rasm. Rels choklari zonasida σ(z) kuchlanishlarining taqsimoti grafigi 160 km/soat tezlik uchun (bazaviy holat (armirlashsiz) va lokal armirlash bilan)



2-rasm. Rels choklari zonasida σ(z) kuchlanishlarining taqsimoti grafigi 200 km/soat tezlik uchun (bazaviy holat (armirlashsiz) va lokal armirlash bilan)

Grafiklar (1 va 2-rasmlar) tahlili shuni ko‘rsatadiki, 0,40–0,82 m chuqurlik oralig‘ida “armirlash” egri chiziqlari “asos” holatiga nisbatan pastroqda va barqaror joylashgan. Bu holat so‘nish koeffitsiyenti α ning ortishi hisobiga impulsning tezroq so‘nishini aks ettiradi. Har ikkala profil bo‘yicha “armirlash” egri chiziqlari aynan 0,40–0,82 m chuqurlikda “baza” holatidan pastda joylashgan bo‘lib, bu vertikal kuchlanishlarning samarali so‘nishini tasdiqlaydi.

Shpallar soni bo‘yicha 12, 16 va 20 ta oralig‘idagi farq sezilarli: 16 ta shpal (ya’ni har ikki tomonga 8 tadan) armirlashning “to‘liq” ta’sir chegarasini ifodalaydi, 20 ta shpal esa qo‘shimcha zaxira sifatida baholanadi. Aynan 16–20 ta shpallik armirlash zonasi sharoitida geotekstil va yassi geopanjara kombinatsiyasidan iborat armirlash yechimi kuchlanishlar bo‘yicha me’yoriy shartlarning barqaror bajarilishini ta’minlaydi.

4. Xulosa

Temir yo‘l rels choklari zonasida 160–200 km/soat tezlikda harakatlanayotgan poyezdlar ta’sirida yuzaga keladigan kuchlanishlarning differensial taqsimlanishi σ(z)\sigma(z), dinamik yuklanishlar va geosintetik materiallarning armirlovchi ta’siri hisobga olindi.

Geosintetik materiallardan foydalanish samaradorligini miqdoriy baholash uchun geotekstil, yassi geopanjaralar va ularning kombinatsiyalariga asoslangan hisoblash yondashuvi taklif etildi. Bu yondashuv vertikal kuchlanishlar va cho'kindilarning pasayish darajasini aniqlash imkonini beradi. 400 g/m² zichlikdagi geotekstil kuchlanishni 25–30% gacha, geotekstil va 40×40 mm yassi geopanjara kombinatsiyasi esa 45% gacha kamaytirishi aniqlandi.

Dinamika koeffitsiyenti $k_{dyn} = k_0 + m\,\frac{V}{100}$ va bo'ylama samaradorlik koeffitsiyenti η_L o'rtasidagi bog'liqlikni hisobga olish orqali rels choklari zonasidagi dinamik kuchlanishlarni hisoblash usuli takomillashtirildi. Hisoblashlar shuni ko'rsatadiki, har bir tomonga kamida 8 tadan (jami 16 ta) shpal oralig'ida geotekstil va yassi geopanjara asosidagi kombinatsiyalangan armirlash 200 km/soat tezlikda σ(z=0,60 m)≤0,08 MPa me'yoriga rioya etilishini ta'minlaydi.

Foydalangan adabiyotlar / References

[1] Шахунянц Г.М. Железнодорожный путь. – М.: Транспорт, 1987. – 520 с.

[2] Ашпиз Е.С. Мониторинг земляного полотна, направленный на обеспечение непрерывности движения поездов // В сб.: Современные проблемы проектирования, строительства и эксплуатации железнодорожного пути. Труды XVI Международной научно технической конференции. Чтения посвященные памяти профессора Г.М. Шахунянца. 2020. С.19-24.

[3] Бабков В.Ф. Железнодорожный путь и его эксплуатация. – М.: Маршрут, 2003. – 448 с.

[4] Indraratna B., Salim W., Rujikiatkamjorn C. Advanced Rail Geotechnology – Ballasted Track. – CRC Press, 2011. – 414 p.

[5] Bathurst R.J., Jarrett P.M. Performance of geogrid-reinforced ballast layers in track beds // Canadian Geotechnical Journal. – 1988. – Vol. 25(3). – P. 511–522.

[6] Raymond G.P. Geotextiles and geogrids in railway trackbeds // Transportation Research Record. – 1999. – Vol. 1653. – P. 25–31.

[7] UIC Code 719R. Earthworks and Track-bed Construction for Railway Lines. – Paris: International Union of Railways, 2008.

[8] O`z DSt 3519:2021 Ер қопламаси қатламларини ажратиш учун геосинтетик материаллар. Техникавий шартлар Тошкент: Ўзстандарт агентлиги 2021

[9] ШНҚ 2.05.01-23 "Темир йўллар. Лойиҳалаш талаблари" шаҳарсозлик нормалари ва қоидалар. Ўзбекистон Республикаси Қурилиш вазирлиги- Тошкент, 2024 й.

[10] ҚР 02.01-23 "Ер иншоотлари. Заминлар ва пойдеворлар" қурилиш регламенти Ўзбекистон Республикаси қурилиш ва уй-жой коммунал хўжалиги вазирлиги, Тошкент -2023 й.

[11] Положение о системе ведения путевого хозяйства АО «Узбекистон темир йуллари», введенное в действие приказом № 730-Н от 10 декабря 2024 года.

[12] ВСН 354-Н. Ведомственные технические указания по проектированию земляного полотна железных дорог колеи 1520 мм. Ташкент, 2011. ГАЖК «УТЙ».

[13] Инструкция по устройству и содержанию земляного полотна железных дорог (ЦП-530). – М.: Росжелдор, 2010.

[14] ГОСТ Р 55050–2012. Материалы геосинтетические. Общие технические условия. – М.: Стандартинформ, 2012.

[15] Лесов К. С., Абдужабаров А. Х., Кенжалиев М. К. Технология усиления основной площадки земляного полотна в зонах рельсовых стыков с применением геотекстиля // Известия Транссиба. – 2022. – №4 (52). – С. 106 – 114.

[16] Мирзахидова О.М., Лесов, К.С., Уралов А.Ш., Кенжалиев, М.К, Повышение устойчивости пути в зонах рельсовых стыков за счёт применения геосинтетических армирующих материалов// Journal Engineer. -120-122, Special Issue| 2025

[17] Руководство по применению геотекстиля, георешёток и дренажных труб в транспортном строительстве Республики Узбекистан. – Ташкент: Госкомдорстрой РУз, 2023. – 56.

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

Mirzaxidova Ozoda / Ozoda Mirzakhidova	Toshkent davlat transport universiteti, TDTrU "Temir yo'l muhandisligi" kafedrasi tayanch doktoranti Phone: +99 (897) 443-14-11 E-mail: ozoda_27@mail.ru https://orcid.org/0000-0001-6247-1869
Kenjaliyev Muhamedali / Mukhamedali Kenzhaliyev	Toshkent davlat transport universiteti, TDTrU "Temir yo'l muhandisligi" kafedrasi dotsent v.b., texnika fanlari bo'yicha falsafa doktori (PhD) Phone: +99 (871) 299-03-52 E-mail: mkenjaliyev@mail.ru https://orcid.org/0000-0003-4622-5937
Lesov Kuvandik / Kuvandik Lesov	Toshkent davlat transport universiteti, TDTrU "Temir yo'l muhandisligi" kafedra mudiri, professor, texnika fanlari nomzodi Phone: +99 (871) 299-03-80 E-mail: kuvandikl@mail.ru https://orcid.org/0000-0002-9434-0713

CONTEXT / MUNDARIJA