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Assessment of public transport safety and the technical parameters of lifting and handling equipment

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Abstract: The article analyzes the safety issues observed in modern urban and regional transport systems, analyzing and systematically classifying their causes by factor. It also addresses the scientific justification for the hydraulic and structural parameters of lift-and-tip mechanisms designed for heavy-duty trailers. The research employed statistical analysis, the diagram construction method, hydraulic calculations, and comparative analysis. Results: It was determined that 62% of traffic accidents are caused by human factors and 18% by technical malfunctions. For the lift-and-tip mechanism, the maximum resistance force was calculated to be 57,890.7 N, and the bending moment was 12,748 N·m. Conclusion: A comprehensive approach that simultaneously implements technical modernization and driver qualification enhancement is necessary to improve safety.

Keywords: road traffic incident, public transportation safety, the human factor, lifting and tipping mechanism, hydraulic drive, trailer, epyura

Jamoat transporti xavfsizligi va ko'tarib-ag'darish qurilmalarining texnik parametrlarini baholash

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Annotatsiya: Ushbu maqolada zamonaviy shahar va mintaqaviy transport tizimlarida kuzatilayotgan xavfsizlik muammolari ko'rib chiqilib, ularning kelib chiqish sabablari omillar bo'yicha tizimli tasniflab tahlil etilgan. Shuningdek, og'ir yuk tashuvchi tirkamalar uchun mo'ljallangan ko'tarib-ag'darish qurilmalarining gidravlik va konstruktiv parametrlarini ilmiy asoslash masalalari yoritilgan. Tadqiqotda statistik tahlil, epyura qurish metodi, gidravlik hisob va taqqoslash tahlili qo'llanildi. Natijalar: YTH larning 62% inson omilidan, 18% texnik nosozliklardan kelib chiqishi aniqlandi. Ko'tarib-ag'darish qurilmasi uchun qarshilik kuchining maksimal qiymati 57 890,7 N, eguvchi moment 12 748 N·m ekanligi hisoblandi. Xulosa: Xavfsizlikni oshirishda texnik modernizatsiya va haydovchilar malakasini oshirishni birgalikda amalga oshiruvchi kompleks yondashuv zarurligi imkonini beradi.

Kalit so'zlar: yo'l-transport hodisasi, jamoat transporti xavfsizligi, inson omili, ko'tarib-ag'darish qurilmasi, gidravlik yuritma, tirkama, epyura

1. Kirish

Zamonaviy shaharlar va mintaqalarning barqaror rivojlanishida transport tizimi muhim infratuzilmaviy omillardan biri hisoblanadi. Aholining harakatchanligini ta'minlash, iqtisodiy aloqalarni rivojlantirish, ishlab chiqarish va xizmat ko'rsatish jarayonlarining uzluksizligini saqlash transport tizimining samarali faoliyat yuritishiga bog'liqdir. Transport sohasi mamlakat iqtisodiyotining asosiy tarkibiy qismlaridan biri bo'lib, uning rivojlanishi hududlar o'rtasidagi integratsiyani kuchaytirish, logistika samaradorligini oshirish hamda aholining turmush sifatini yaxshilashda muhim ahamiyat kasb etadi.

[1].

So'nggi yillarda dunyo miqyosida transport vositalari sonining ortishi, urbanizatsiya jarayonlarining jadallashuvi

va yuk hamda yo'lovchi tashish hajmlarining ko'payishi yo'l harakati xavfsizligi masalasini yanada dolzarb muammoga aylantirmoqda. Jahon sog'liqni saqlash tashkiloti ma'lumotlariga ko'ra, har yili dunyo bo'yicha 1,2 milliondan ortiq inson yo'l-transport hodisalari oqibatida vafot etadi [2-3]. millionlab odamlar esa turli darajadagi tan jarohatlari oladi. Yo'l-transport hodisalari nafaqat inson hayoti va salomatligiga zarar yetkazadi, balki davlat iqtisodiyotiga ham sezilarli ta'sir ko'rsatadi. Tadqiqotlar natijalariga ko'ra, ayrim mamlakatlarda yo'l-transport hodisalari tufayli yuzaga keladigan iqtisodiy yo'qotishlar yalpi ichki mahsulotning 2-3 foizigacha qismini tashkil etadi. Shu sababli transport vositalarining texnik holatini takomillashtirish va xavfsizlik ko'rsatkichlarini oshirishga qaratilgan ilmiy tadqiqotlarni olib borish muhim ilmiy-amaliy ahamiyatga ega. [4]

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Yo'l harakati xavfsizligi ko'pincha yengil avtomobillar va yo'lovchi tashuvchi transport vositalari misolida o'rganilsa-da, og'ir yuk tashuvchi transport vositalari ham ushbu tizimning muhim elementi hisoblanadi. Qurilish, sanoat, qishloq xo'jaligi va logistika sohalarida keng qo'llaniladigan yuk tashuvchi avtomobillar hamda tirkamalar katta hajmdagi yuklarni tashishda asosiy vosita bo'lib xizmat qiladi. Ushbu transport vositalarining samarali va xavfsiz ishlashi ko'p jihatdan ularda qo'llaniladigan maxsus mexanizmlar, xususan, ko'tarib-ag'darish qurilmalarining texnik holati va konstruktiv mukammalligiga bog'liqdir. Mazkur qurilmalar yuklarni ortish va tushirish jarayonlarini mexanizatsiyalash orqali mehnat unumdorligini oshiradi, biroq ularning nosozligi yoki noto'g'ri loyihalaniishi transport vositasining barqarorligi buzilishiga, texnik avariyalarga va yo'l-transport hodisalarining yuzaga kelishiga sabab bo'lishi mumkin [5].

Ko'tarib-ag'darish qurilmalarining ishlash samaradorligi va xavfsizligi ularning asosiy konstruktiv elementlari, gidravlik tizim parametrlari, yuk ko'tarish qobiliyati hamda statik va dinamik yuklanishlarga chidamlilik darajasi bilan belgilanadi. Shu sababli bunday qurilmalarni loyihalash va ekspluatatsiya qilish jarayonida muhandislik hisoblarini ilmiy asosda amalga oshirish muhim hisoblanadi. Xususan, gidravlik silindrning ishchi bosimi, zarur ko'tarish kuchi, yukning joylashuvi va platformaning ag'darilish burchagi kabi parametrlarni to'g'ri aniqlash qurilmaning ishonchli va xavfsiz ishlashini ta'minlaydi [6].

Bugungi kunda dunyoning rivojlangan davlatlarida og'ir yuk tashuvchi tirkamalarining konstruktiv parametrlarini optimallashtirish, ularning ekspluatatsion ishonchligini oshirish hamda energiya sarfini kamaytirishga qaratilgan ko'plab ilmiy izlanishlar olib borilmoqda. Biroq O'zbekiston sharoitida yuk tashuvchi tirkamalar va ularga o'rnatilgan ko'tarib-ag'darish qurilmalarining texnik holati, gidravlik tizimlarining ishlash xususiyatlari hamda konstruktiv parametrlarini ilmiy asoslash bo'yicha tadqiqotlar yetarli darajada amalga oshirilmagan. Natijada mahalliy ekspluatatsiya sharoitlariga moslashtirilgan ilmiy tavsiyalar va hisoblash usullariga ehtiyoj mavjud [7].

Shu munosabat bilan ushbu tadqiqotda yo'l harakati xavfsizligiga ta'sir etuvchi omillar tizimli ravishda tahlil qilinib, og'ir yuk tashuvchi tirkamalar uchun mo'ljallangan ko'tarib-ag'darish qurilmasining asosiy konstruktiv va gidravlik parametrlarini aniqlashga alohida e'tibor qaratildi. Tadqiqot davomida yo'l-transport hodisalarining asosiy sabablarini tasniflash va miqdoriy baholash, ko'tarib-ag'darish qurilmasining statik hamda gidravlik hisoblarini amalga oshirish, shuningdek, transport vositalarining texnik xavfsizligini oshirishga qaratilgan amaliy tavsiyalar ishlab chiqish ko'zda tutilgan. Olingan natijalar og'ir yuk tashuvchi transport vositalarining ekspluatatsion samaradorligini oshirish, ularning texnik ishonchligini ta'minlash va yo'l harakati xavfsizligini yanada yaxshilashga xizmat qiladi.

2. Tadqiqot metodologiyasi

Tadqiqotning birinchi qismida jamoat transporti xavfsizligiga ta'sir etuvchi omillar statistik tahlil usuli yordamida ko'rib chiqildi. Xalqaro manbalar (WHO, Jahon Banki, UNECE) va mahalliy statistik ma'lumotlar asosida YTH sabablarining miqdoriy taqsimoti aniqlandi.

Tadqiqotning ikkinchi qismida yuk ko'taruvchanligi 5 tonna bo'lgan tirkamaning ko'tarib-ag'darish qurilmasi

tahlil ob'ekti sifatida tanlandi. Ushbu qurilmaning konstruktiv parametrlari statik hisoblash metodi yordamida aniqlandi.

Ko'tarib-ag'darish qurilmasiga ta'sir etuvchi kuchlar uchta asosiy holat uchun hisoblab chiqildi: (1) platformaning dastlabki yuk tashish holati; (2) ag'darishning boshlanish holati; (3) platformaning to'la ko'tarilgan holati. Har bir holat uchun tashqi kuchlar, kesuvchi kuch (Q), eguvchi moment (M_e) va normal kuchlanishlar (σ) epyuralari qurildi (2.13–2.15-rasmlar).

Gidravlik yuritma parametrlarini aniqlashda klassik gidravlika tenglamalari qo'llanildi. Nasosning bir marta aylanishidagi suyuqlik sarfi, silindr diametri, shrook yo'li va gidravlik quvurlarning o'lchamlari ketma-ket hisoblash orqali aniqlandi [8].

Foydalanilgan me'yoriy hujjatlar

- GOST 22646-77: Avtomobil tirkamalarining ko'tarib-ag'darish qurilmalari uchun texnik talablar
- ISO 3888: Yo'l harakati xavfsizligi bo'yicha xalqaro standartlar
- O'zDSt 2867:2016: O'zbekiston milliy standarti — transport vositalarining texnik holati
- WHO (2023): Yo'l harakati xavfsizligi bo'yicha global hisobot

3. Natijalar

Xalqaro statistik ma'lumotlar asosida yo'l-transport hodisalarining sabablarini to'rtta asosiy guruhga ajratish va ularning ulushini aniqlash imkoni bo'ldi. Natijalar 1-jadvalda keltirilgan:

1-jadval

YTH sabablarining miqdoriy taqsimoti

Omil turi	Ulushi (%)	Asosiy ko'rinishlari
Inson omili	62	Charchoq, qoidabuzarlik, chalg'itish
Texnik nosozlik	18	Tormoz, rul, eskirgan park
Yo'l infratuzilmasi	12	Qoplama, belgilar, svetofor
Tashqi omillar	8	Ob-havo, zichlik, ofatlar

Jadvaldan ko'rinib turibdiki, inson omili barcha sabablarning 62 foizini tashkil etib, boshqa omillardan sezilarli darajada ustun turadi. Texnik nosozliklar 18 foiz bilan ikkinchi o'rinda turadi. Bu ko'rsatkich transport parkining texnik holatini muntazam nazorat qilish va modernizatsiya qilish orqali YTH larning muhim qismini oldini olish mumkinligini ko'rsatadi. Yuk ko'taruvchanligi 5 tonna bo'lgan tirkama uchun o'tkazilgan statik hisob uchta alohida holat bo'yicha epyuralar qurish orqali amalga oshirildi. Ushbu epyuralar lonjeronlarda hosil bo'ladigan

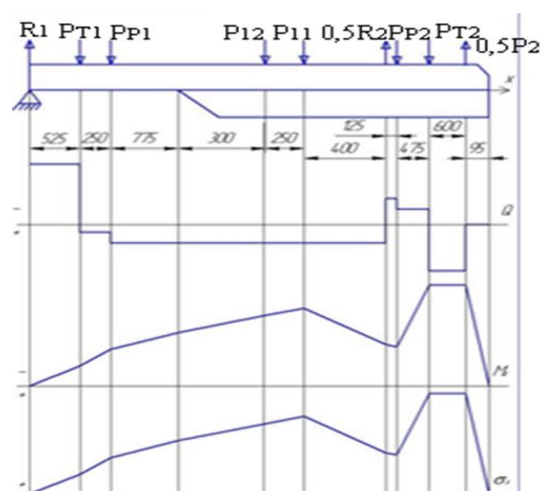


tashqi kuchlar, kesuvchi kuch (Q), eguvchi moment (M) va normal kuchlanishlar (σ) taqsimotini ko'rsatadi [9].

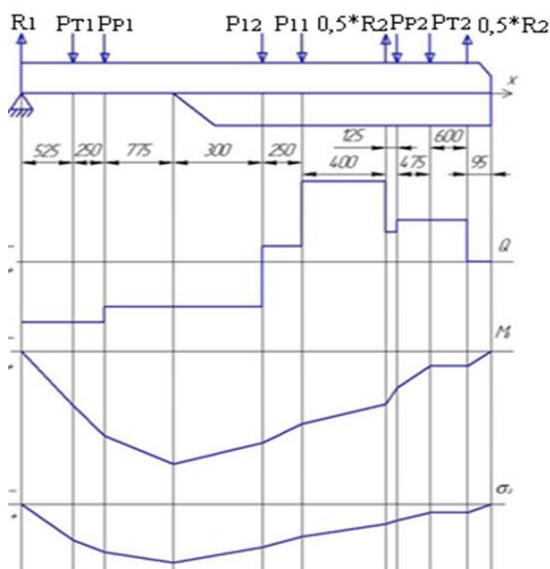
1-rasmda tirkamaning oddiy yuk tashish holatida lonjeroniga ta'sir etuvchi kuchlar va mos epyuralar keltirilgan.

2-rasmda ag'darishning boshlanish holatida lonjeroniga ta'sir etuvchi kuchlar va epyuralar tasvirlangan. Bu holat konstruktiv jihatdan eng og'ir yuklanish holati hisoblanadi.

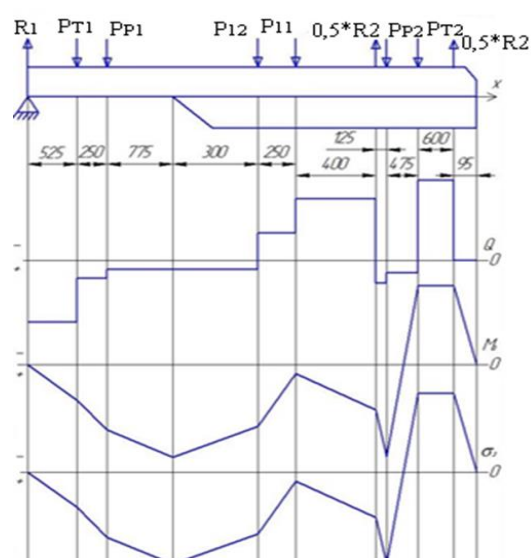
3-rasmda platformaning to'la ko'tarilgan holatidagi kuch taqsimoti va epyuralar ko'rsatilgan. Kesuvchi kuchning maksimal qiymati aynan ushbu holatda qayd etilgan.



1-rasm. Tirkamalar da yuklarni tashish holatida uning lonjeronida hosil bo'ladigan tashqi kuchlar hamda kesuvchi kuch, eguvchi moment va normal kuchlanishlarning epyuralari



2-rasm. Ag'darishning boshlanish holatida hosil bo'ladigan tashqi kuchlar hamda kesuvchi kuch, eguvchi moment va normal kuchlanishlarning epyuralari



3-rasm. Platforma to'la ko'tarilgan holatdagi tashqi kuchlar hamda kesuvchi kuch, eguvchi moment va normal kuchlanishlarning epyuralari

Olingan natijalar bo'yicha epyuralar taqqoslanishi natijasida quyidagi ko'rsatkichlar aniqlandi:

2-jadval

Ko'tarib-ag'darish qurilmasining statik hisob natijalari

Ko'rsatkich	Qiymat
Qarshilik kuchining maksimal qiymati (P_{∞})	57 890,7 N
Qarshilik momentining qiymati (M_{qar})	48 628,18 N·m
Shtokni yurituvchi kuch (P_{yu})	86 773,51 N
Kesuvchi kuch maksimumi (Q) — 2.15-rasm	18 286 N
Eguvchi moment maksimumi (M_e) — 2.14-rasm	12 748 N·m
Normal kuchlanish maksimumi (σ) — 2.14-rasm	$120,7 \cdot 10^6 \text{ N/m}^2$

Jadvalda berilgan qiymatlardagi 1-3-raslarda keltirilgan epyuralar taqqoslanishi shuni ko'rsatadiki, har uch holat uchun kuch taqsimotining tabiati tubdan farqlanadi. Yuk tashish holatida kuchlanishlar nisbatan tekis taqsimlangan bo'lsa, ag'darishning boshlanish bosqichida eguvchi moment va normal kuchlanishlar keskin ortadi [10].

Ag'darishning boshlanish bosqichi eng og'ir yuklanish holati ekanligi ($M_e = 12 748 \text{ N·m}$, $\sigma = 120,7 \text{ MPa}$) konstruktiv hisoblashlarda ushbu holatni asosiy hisob varianti sifatida qabul qilish zarurligini ilmiy jihatdan isbotlaydi. Bu natija mavjud adabiyotlar [5] bilan to'liq mos keladi.



Tadqiqot natijalari mavjud xalqaro adabiyotlar bilan to'liq mos keladi. Inson omilining ustunligi (62%) barcha rivojlangan va rivojlanayotgan mamlakatlarda kuzatilgan universal holat hisoblanadi. Texnik nosozliklarning 18 foizlik ulushi, ayniqsa O'zbekiston kontekstida, alohida e'tiborni talab etadi.

Ushbu tadqiqotda faqat statik yuklanish holatlari ko'rib chiqilgan. Amaliy sharoitda dinamik yuklanishlar, ayniqsa notekis yo'llarda harakatlanish yoki tormozlash paytida, statik qiymatlardan farq qilishi mumkin. Dinamik tahlil kelajakdagi tadqiqotlar uchun muhim yo'nalish hisoblanadi [11].

4. Xulosa

Ushbu tadqiqotda jamoat transporti xavfsizligi va og'ir yuk tashuvchi tirkamalar uchun ko'tarib-ag'darish qurilmalarining texnik parametrlari birgalikda ko'rib chiqildi.

YTH larning 62 foizi inson omilidan kelib chiqadi haydovchilarni tayyorlash tizimini kuchaytirish ustuvor vazifa hisoblanadi. Texnik nosozliklar ulushi (18%) transport parki texnik holatini yaxshilash zarurligini ko'rsatadi. Epyuralar tahlili ag'darishning boshlanish bosqichini eng og'ir yuklanish holati sifatida tasdiqladi: $M_e = 12\,748\text{ N}\cdot\text{m}$, $\sigma = 120,7\text{ MPa}$. Kesuvchi kuchning maksimal qiymati ($Q = 18\,286\text{ N}$) platformaning to'la ko'tarilgan holatida (2.15-rasm) qayd etilgan. NShG-32U-3 markali nasos va P80-3/1-222 markali gidrotaqsimlagich kombinatsiyasi 5 tonnalik tirkama uchun optimal texnik yechim hisoblanadi [12]. Kompleks xavfsizlik yondashuvi: texnik modernizatsiya + haydovchi tayyorgarligi + raqamli monitoring tizimlarini uyg'un birlashtirish. Kelajakdagi tadqiqotlarda dinamik yuklanishlar tahlilini kengaytirish, iqlim sharoitlarining gidravlik parametrlarga ta'sirini o'rganish va sun'iy intellekt asosidagi diagnostika tizimlarini ko'tarib-ag'darish qurilmalariga integratsiya qilish tavsiya etiladi.

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