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Sanitary and hygienic evaluation of working conditions and noise characteristics of equipment in the metalworking shop of the Tashkent passenger railcar construction and repair plant

S.S. Sulaymanov¹^a, Sh.G. Musayev¹^b

¹Tashkent state transport university, Tashkent, Uzbekistan

Abstract:

The article evaluates noise pressure levels at workplaces in the forging shop of the Tashkent Passenger Railcar Construction and Repair Plant in accordance with the requirements of GOST 12.1.050–86. Measurements were conducted using “Assistent” and “Octava–110A” noise meters, both certified and compliant with GOST 17187–81. The noise pressure levels emitted from the equipment were measured after identifying the background noise from adjacent shops. Background noise levels were recorded at three key points: the geometric center of the shop, opposite the open door of the adjacent mechanical shop, and 1 meter inside the entrance gate. Based on the collected data, tables, graphs, and diagrams were analyzed. The analysis revealed that the background noise from the mechanical shop exceeds sanitary norms by 1–12 dB in the 125–8000 Hz frequency range. At low frequencies, the noise pressure from the forging hammer was relatively evenly distributed, while at medium and high frequencies, it was predominantly directed toward the operator's position and the rear side of the equipment. Due to the rear side's proximity to a wall, sound waves reflected from the surface combined with direct noise, resulting in increased pressure levels. In such cases, to effectively reduce noise, it is recommended to use acoustic barriers and sound-absorbing screens. Placement of these elements should be based on the analysis of noise propagation directions, particularly in areas where high-frequency noise is concentrated—such as around the operator and near the rear wall of the equipment.

Keywords:

sound pressure level, noise level, working conditions, forge shop, octave bands, geometric mean frequencies, machine noise characteristics, noise measurement methods

Toshkent yo‘lovchi vagonlarni qurish va ta‘mirlash zavodi temirchilik sexi dastgohlari shovqin darajasi tavsiflari va ish o‘rinlaridagi mehnat sharoitini sanitar gigiyenik baholash

Sulaymanov S.S.¹^a, Musayev Sh.G.¹^b

¹Toshkent davlat transport universiteti, Toshkent, O‘zbekiston

Annotatsiya:

Maqolada Toshkent yo‘lovchi vagonlarni qurish va ta‘mirlash zavodining temirchilik sexidagi ish o‘rinlarida shovqin bosimi darajalari GOST 12.1.050–86 talablariga muvofiq baholangan. O‘lchovlar GOST 17187–81 standartiga javob beradigan, davlat guvohnomasiga ega “Assistent” va “Oktava–110A” shovqin o‘lchash asboblari yordamida amalga oshirilgan. Dastgohlardan tarqalayotgan shovqin bosimi darajalari boshqa sexlardan kelayotgan fon shovqini aniqlangandan so‘ng o‘lchangan. Fon shovqin bosim darajalari sexning markaziy qismida, yondosh mashinasozlik sexining ochiq eshigi qarshisida va kirish darvozasidan 1 metr ichkaridagi nuqtalarda aniqlangan. Olingan natijalarga asoslangan jadvallar, grafiklar va diagrammalar tahlil qilingan. Tahlilga ko‘ra, mashinasozlik sexidan fon shovqini bosim darajalari 125–8000 Hz chastotalarda sanitariya me‘yorlaridan 1–12 dB ortiqligi aniqlangan. Temirchilik bolg‘asidan tarqalayotgan shovqin bosimi darajasining past chastotalarida uning tarqalishi nisbatan teng taqsimlangan, o‘rta va yuqori chastotalarda esa shovqin bosimi darajasining asosiy tarqalish yo‘nalishlari operator o‘rni va dastgohning orqa tomoniga qaratilgan. Orqa tomonning devorga yaqinligi sababli, aynan shu yo‘nalishda yuqori chastotalarda tarqalayotgan hamda devordan qaytgan shovqin bosimlari darajalari o‘zaro qo‘shilishi tufayli ortishi qayd etilgan. Bunday hollarda shovqinni samarali pasaytirish maqsadida akustik to‘siqlar va shovqin yutuvchi ekranlardan foydalanish tavsiya etiladi. Ularni joylashtirishda shovqin bosimi darajasi tarqalayotgan yo‘nalishlarning tahliliga asoslanish, ya‘ni ekranlarni ayniqsa operator o‘rni va orqa devor yo‘nalishida yuqori chastotali shovqinlar intensiv qayd etilgan hududlarda o‘rnatish maqsadga muvofiqdir.

Kalit so‘zlar:

tovush bosimi darajasi, shovqin darajasi, ish sharoitlari, temirchilik sexi, oktava diapazonlari, o‘rtacha geometrik chastotalar, stanoklar shovqinining xususiyatlari, shovqinni o‘lchash usullari

^a <https://orcid.org/0000-0001-5275-5200>

^b <https://orcid.org/0009-0004-5339-2180>



1. Kirish

Toshkent yo'lovchi vagonlarni qurish hamda ta'mirlash zavodi ishlab chiqarish sexlarida foydalaniladigan texnologiyalar va texnik jixozlar, o'z navbatida ishlab chiqariladigan mahsulotlarni sifatli bo'lishini ta'minlaydi, ish unimini oshiradi, shu bilan bir vaqtni o'zida ular(texnologiyalar va texnik jixozlar) xavfli (zararli va jarohatlovchi) ishlab chiqarish omillarini manbasidir[1]. Ishlab chiqarishdagi xavfli (zararli va jarohatlovchi) omillarning ish o'rinlaridagi qiymatlarini sanitar-gigienik qoidalar talablariga ko'ra o'rnatilgan chegaraviy qiymatlardan ortiq bo'lishi, zavodda faoliyat yuritadigan jami 705 nafar muxandis-texnik xodimlarni, jumladan sexlarni 478 nafar ishchi xodimlarini kasb kasalliklariga chalinish ehtimolini kechinib oshirishga olib keladi.

So'ngi yillarda o'tkazilgan ish o'rinlaridagi mehnat sharoitlari zavoddagi ish o'rinlaridagi mehnat sharoitini sanitar gigiyenik baholash bo'yicha o'tkazilgan attestatsiya natijalariga ko'ra aksariyat ish o'rinlari 3 ya'ni zararli 3.4 sinfga tegishli ekanligi qayd etilgan. Ayniqsa temirchilik sexida shovqin darajasi ruxsat etilgan me'yorlardan 20-25 dB yuqori ekanligi, sexda o'zidan issiqlik energiyasini ajratib chiqaradigan dastgohlari mazkur sexdagi ish o'rinlaridagi mehnat sharoitlarini yanada yomonlashishiga olib kelishi ko'rsatilgan[1].

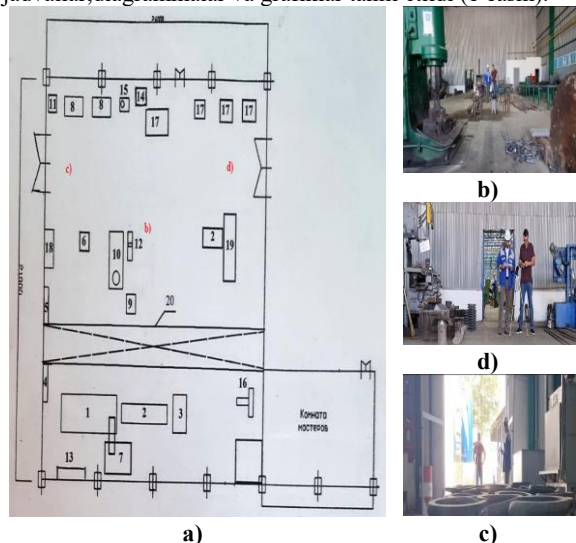
Temirchilik va presslash ustaxonalarida noqulay va zararli mehnat sharoiti, jumladan, ish joylaridagi shovqin darajasi bosimining 100 dB va undan yuqoriligi ushbu sexda muntazam faoliyat yuritadigan xodimlarni kasb kasalliklariga chalinish ehtimolini yanada oshiradi[6].

Yuqoridagilarni hisobga olib, temirchilik sexidagi ish o'rinlarida shovqin darajasini pasaytirish imkonini beradigan innovatsion yechimlar ishlab chiqish lozim. Innovatsion yechimlarni ishlab chiqish sexdagi ish o'rinlaridagi dastgohlarni shovqinini tasniflarini o'rganishni taqozo etadi. Buni hisobga olgan holda, sexdagi ish o'rinlari shovqin bosimi darajasini shakllanishiga olib keladigan dastgohlarni shovqinlarini tasniflari aniqlandi. Ya'ni shovqin bosimining umumiy darajasi, me'yorlanadigan oktava diapozoni polosalaridagi shovqin bosimi darajalari, dastgohlardan chiqayotgan shovqinning tarqalish yo'nalishlari, shovqin quvvatining darajasi aniqlandi va o'lchangan shovqin bosimi darajalari bo'yicha ish o'rinlaridagi shovqin bosimi darajasini sanitar gigiyenik baholash amalga oshirildi[2].

2. Tadqiqot metodologiyasi

Tanlab olingan sexda joylashgan dastgohlarning hosil qilayotgan (tarqatayotgan) shovqin bosimi darajalari qiymatlarini o'lchash (1-rasm) GOST 12.1.050 – 86 standart talablari bo'yicha amalga oshirildi, shovqinni o'lchashda GOST 17187-81 standarti talablariga to'liq javob beradigan, davlat guvohnomasiga ega, "Assistent" hamda "Oktava-110A" shovqin o'lchash asbobidan foydalanildi va qayd qilingan natijalar "microsoft excel" amaliy dasturi vositasida qayta ishlandi va olingan natijalar asosida diagrammalar hamda grafiklar ishlab chiqildi[2]. Dastgohlardan tarqalayotgan shovqin bosimi darajasi ko'rsatgichlarini o'lchash, boshqa yondosh sexlar dastgohlaridan temirchilik sexiga kirib kelayotgan shovqinlar emissiyasini foni aniqlangandan so'ng amalga oshirildi. Boshqa yondosh sexlar dastgohlaridan temirchilik sexida hosil bo'ladiga fon

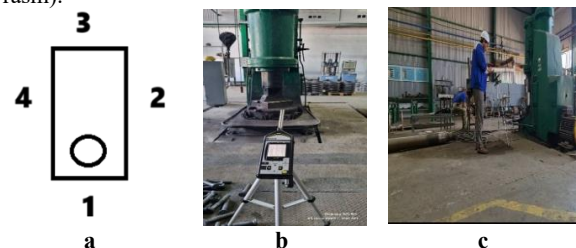
shovqinining umumiy va oktava diapazolari o'rtageometrik chastotalaridagi bosimi darajalari sexni ishlab chiqarish maydonini geometrik markazida (b), unga yondosh bo'lgan mashinasozlik sexini ochiq xolatdagi eshigidan (d), sexga kirish-chiqish darvozasidan (c) 1 m ichkaridagi nuqtalarda o'lchandi[3]. Olingan natijalar asosida ishlab chiqilgan jadvallar, diagrammalar va grafiklar tahlil etildi (1-rasm).



1-rasm. Temirchilik sexidagi fon shovqini o'lchangan joylar tarxi:

a-temirchilik sexi tarxi (1-gaz pechi; 2-harakatlanuvchi konveyer; 3-prujinalar o'rash uchun stanok; 4-shkaf; 5-stellaj; 6-yog' vannasi; 7- shkaf; 8-elektr pech; 9-sandon; 10-temirchilik bolg'asi; 11-suv vannasi; 12-gidravlik press; 13-asboblari uchun stellaj; 14-tekshirish plitasi; 15-sinov stendi; 16-prujinalar o'rash uchun opravka; 17-frezlangan stanogi; 18-temirchilik pechi, 19-mexanik arra; 20-kran-balka; b, c, d -fon shovqinini bosimi darajasi o'lchash joylari va ishlari.

Sexda joylashgan dastgohlarni shovqin bosimi darajalarini va uning shovqin tasniflarini o'rganishda ISO 3745, ISO 11201 kabi xalqaro standartlarda ko'rsatilgan "erkin maydon usulidan" foydalanilgan holda, belgilangan nuqtalarda dastgohlarning umumiy shovqin bosim darajasi, oktava diapazoni polosasining o'rtageometrik chastotalaridagi shovqin bosimi darajalari o'lchandi (2-rasm).



2-rasm. Temirchilik bolg'asining shovqin bosimi darajasini o'lchashni tarxi:

a-temirchilik bolg'asi; 1,2,3,4- temirchilik bolg'asini ish o'rmi, o'ng tomoni, orqa tomoni, chap tomoni; b, c-shovqin darajasini o'lchash jarayonlari

3. Tadqiqot natijalari

Sexdagi dastgohlar ishlaymay turgan holatdagi shovqin darajasini o'lchov natijalari qayta ishlanib (1,2-jadvallar,

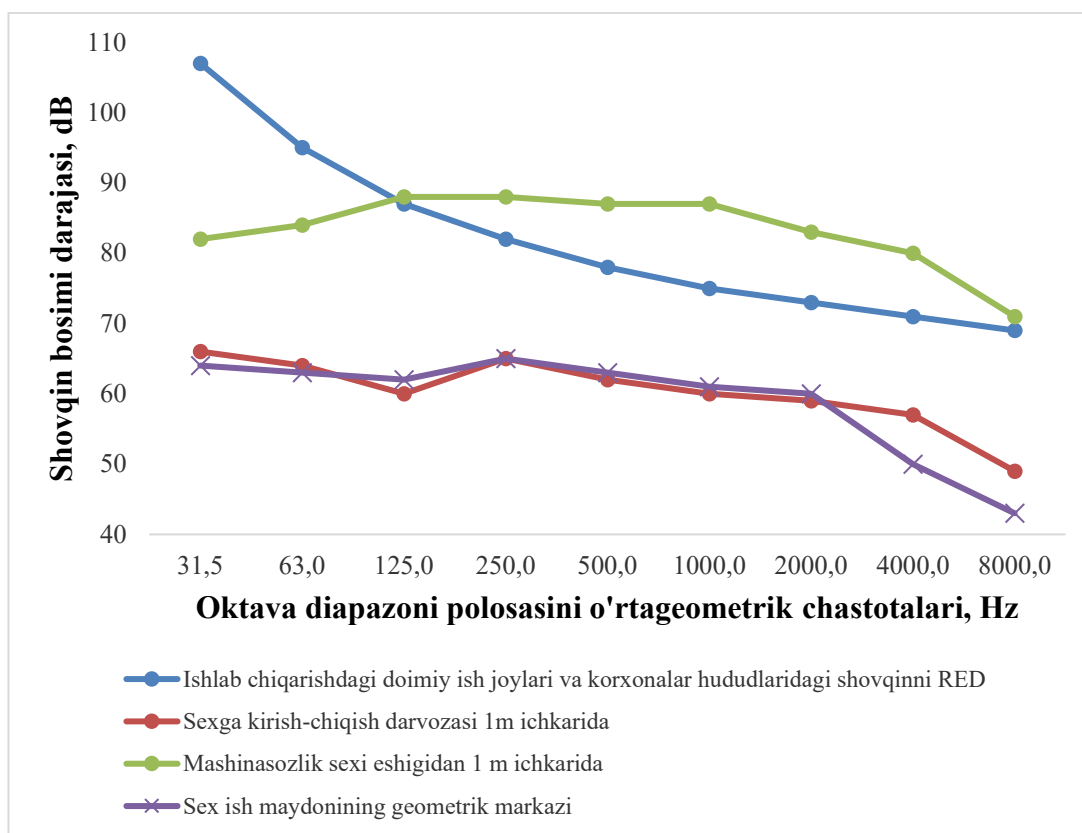
3,4-rasmlar) ko'rinishida tartibga solindi va olingan natijalar bo'yicha sexga tutash sexlar va hovlidan kirib keladigan fon shovqini bosimi darajasi sanitar gigiyenik baholandi.

Shovqin bosimi darajalarini dastgoh atrofida tarqalishini tahlil qilish uchun xar bir oktava diapazoni polosasi

o'rtageometrik chastotalari diapazonidagi shovqin bosimi darajalarining qiymatlari o'lchandi va olingan natijalar bo'yicha diagrammalar qurildi (3,4 jadval, 5-rasm).

1-jadval

Temirchilik sexidagi fon shovqini bosimi darajalari natijalari (o'lchash asbobini "slow" rejimida)											
T/r	O'lchash joyi nomi	Tovush darajasi, dB (A)	Oktava polosalarini o'rtageometrik chastotalarida, Hz shovqin bosimi darajalari, dB								
			31,5	63	125	250	500	1000	2000	4000	8000
1	Sex ish maydonining geometrik markazi	56,5	61,5	61,6	60,9	60,3	58,3	54,3	54,0	48,4	43,3
2	Sexga kirish-chiqish darvozasidan 1 m ichkarida	60,3	64,5	63,3	57,2	59,5	59,1	60,2	58,0	56,4	48,9
3	Mashinasozlik sexi eshigidan 1 m ichkarida	84,5	82	84	86	85	85	84	81	78	68

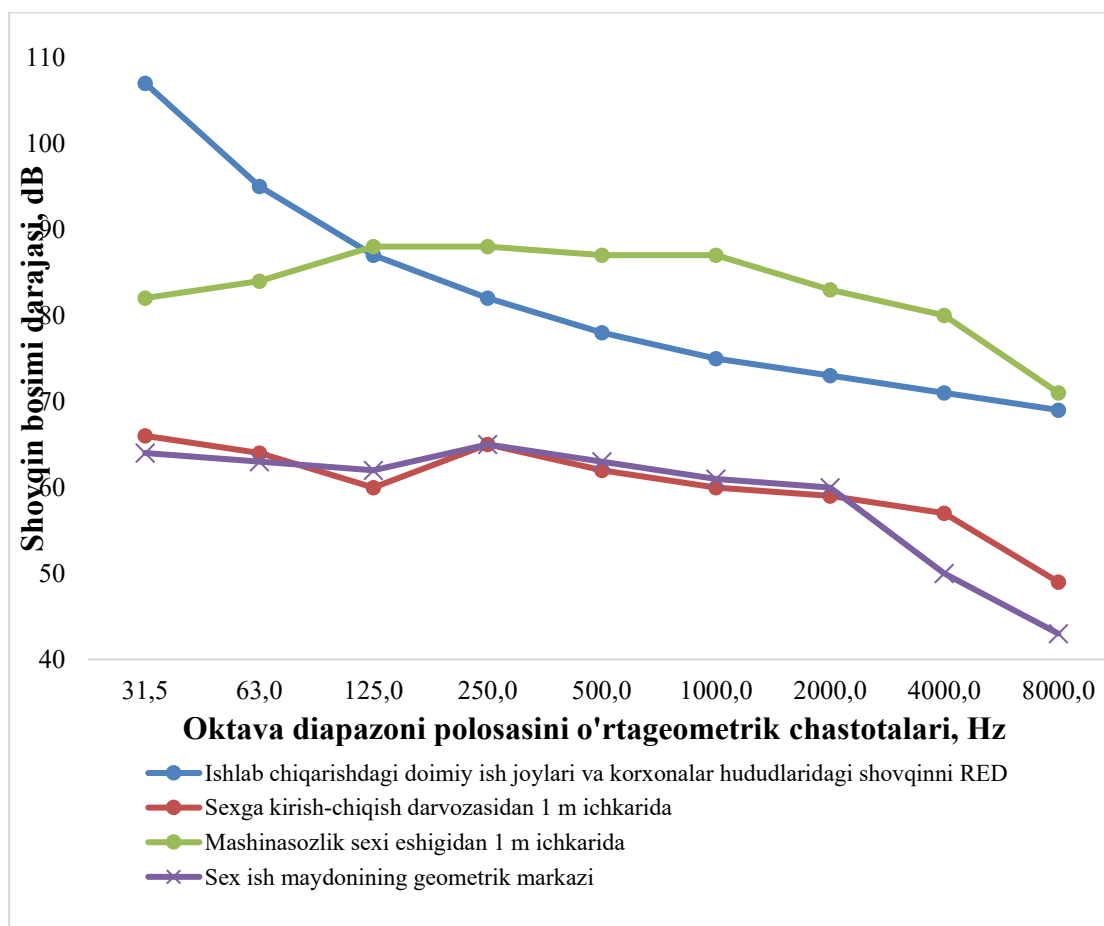


3-rasm. Temirchilik sexidagi fon shovqini bosimi darajalari (o'lchash asbobini "slow" rejimida)

2-jadval

Temirchilik sexidagi fon shovqini bosimi darajalari (o'lchash asbobini "max" rejimida)											
T/r	O'lchash joyi	Tovush darajasi, dB (A)	Oktava polosalarini o'rtageometrik chastotalarida, Hz shovqin bosimi darajalari, dB								
			31,5	63	125	250	500	1000	2000	4000	8000
1	Sex ish maydonining geometrik markazi	59,8	64	63	62	65	63	61	60	50	43
2	Sexga kirish-chiqish darvozasi 1m ichkarida	59,7	66	64	60	65	62	60	59	57	49
3	Mashinasozlik sexi eshigidan 1 m ichkarida	86,8	82	84	88	88	87	87	83	80	71





4-rasm. Temirchilik sexidagi fon shovqini bosimi darajalar (o'lchash asbobini "max" rejimida)

Grafikdan (3,4-rasmlar) ko'rinib turibdiki, temirchilik sexdagi fon shovqin bosim darajasi sexning ish maydonining geometrik markazi va sexga kirish-chiqish darvozasi oldida fon shovqini bosimi darajalari o'lchanganda, sexdagi dastgohlar ishlamay turgan holatda, sanitar gigiyenik me'yorlarda o'rnatilgan qiymatlardan shovqin darajalaridan ortiq emas.

3.4-rasmlardagi grafiklarni tahlili shuni ko'rsatadiki, temirchilik sexida texnologik uskunar ishlamayotgan holatda, sex ish maydonining geometrik markazidagi va sexga kirish-chiqish darvozasi oldidagi, fon shovqini bosimini oktava diapozolari polosasini o'rtageometrik

chastotalaridagi darajalari amaldagi sanitariya-gigiyena me'yorlarida ruxsat etilgan chegaralardan oshiq emas.

Sexga tutash joylashgan mashinasozlik sexiga o'tish joyidagi fon shovqini bosimi darajasi, oktava diapazoni polosalarining 125-8000 Hz o'rtageometrik chastotalarda, me'yorlarda ruxsat etilgan shovqin bosim darajalaridan, mos ravishda 125Hzda - 1dB, 250Hzda - 6dB, 500Hzda - 9dB, 1000Hzda - 12, 2000Hzda - 10dB, 4000Hzda - 9dB, 8000Hzda - 2dB ortiq. Ushbu holat temirchilik sexidagi ish o'rinlaridagi shovqinni pasaytishda, mashinasozlik sexiga o'tish joyidagi fon shovqini bosimi darajasini pasaytirish bo'yicha qo'shimcha texnik yechimlar ishlab chiqishni va amaliyotga joriy etishni talab qiladi.

3-jadval

Temirchilik bolg'asining shovqin bosimi darajalari (o'lchov asbobining "slow" rejimida)

O'lchash joyi	Oktava polosalarini o'rtageometrik chastotalarida, Hz shovqin bosimi darajalari, dB								
	31,5	63	125	250	500	1000	2000	4000	8000
1	87,8	88,2	89,7	90,4	90,2	90,7	87,9	87,4	82
2	83,7	83,4	84,6	83,7	84,4	89,4	80	77,2	77,5
3	93	91,1	89,9	89,3	86,6	88,2	86,2	79,7	85,3
4	87,1	85,9	88,5	86,9	87,1	83,8	80,8	77,9	70,9

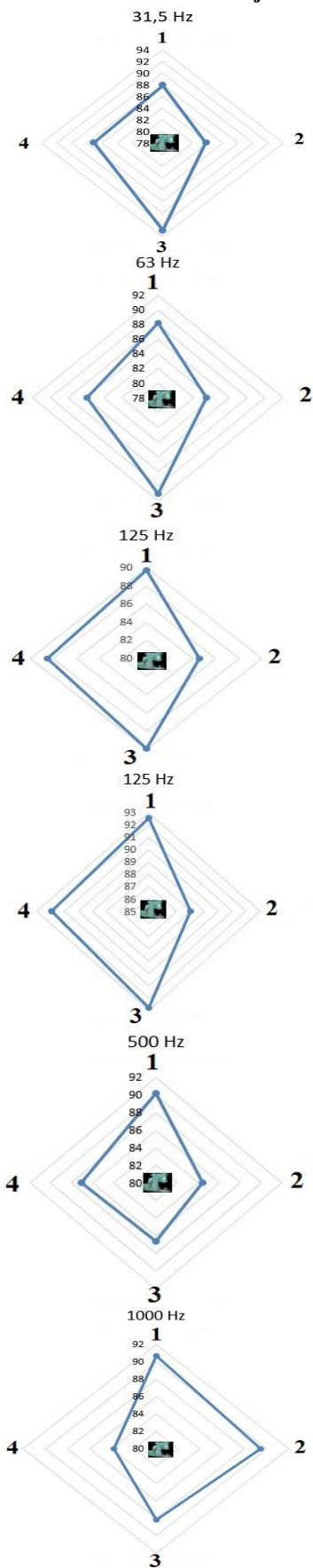
4-jadval

Temirchilik bolg'asining shovqin bosimi darajalari (o'lchov asbobining "max" rejimida)

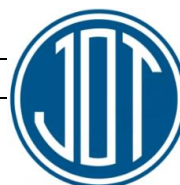
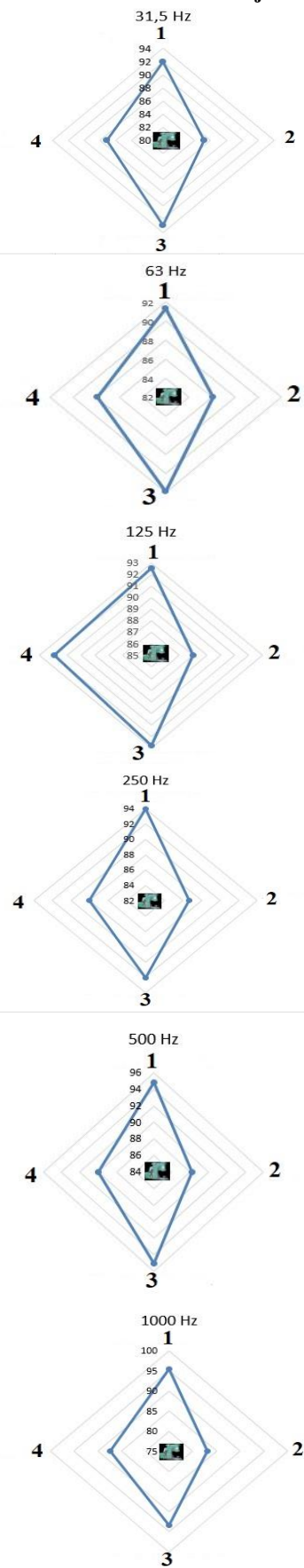
O'lchash joyi	Oktava polosalarini o'rtageometrik chastotalarida, Hz shovqin bosimi darajalari, dB								
	31,5	63	125	250	500	1000	2000	4000	8000
1	92	91,3	92,6	94	94,8	95,4	93,3	94,4	89,2
2	85,2	86,1	88	86,7	88,2	83,1	85,8	83	71,1
3	93	91,9	92,8	92,1	95,1	93,4	92	84,6	90,6
4	87,1	87,9	91,9	88	90	87,4	84	81,8	74,1

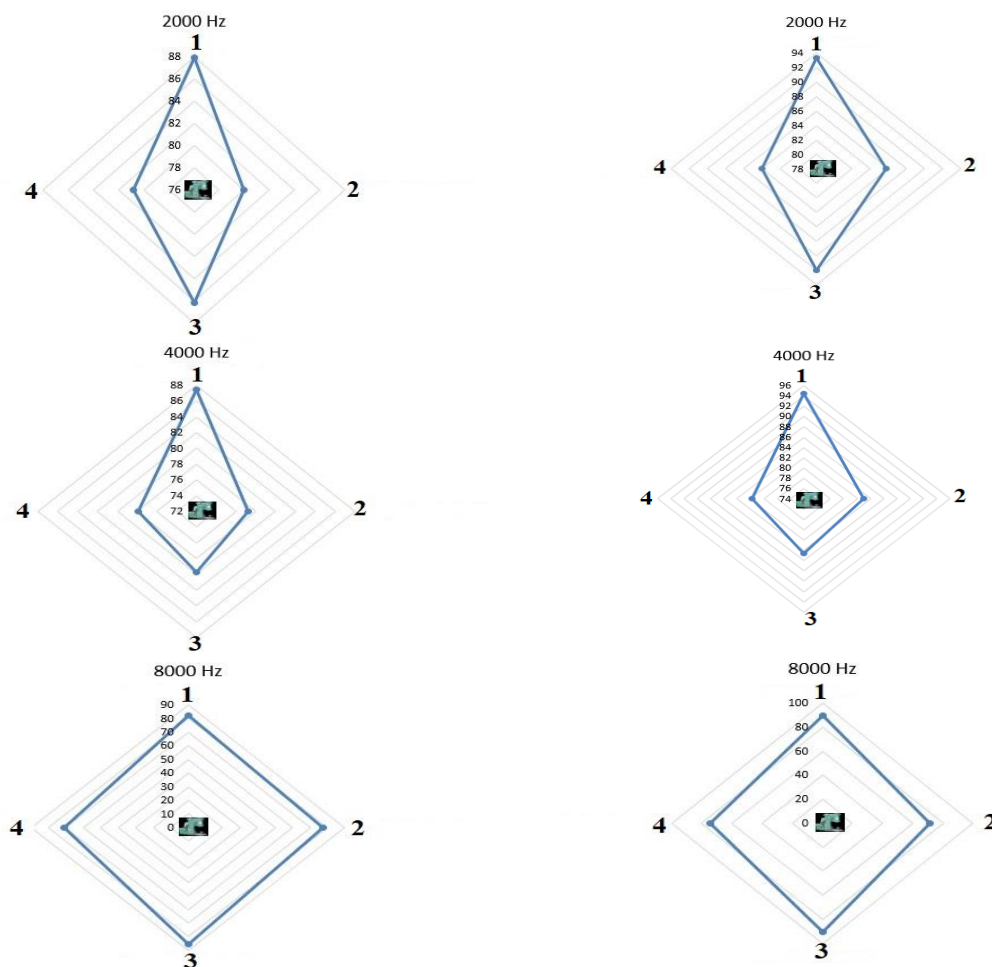


O'lchov asbobini "slow" rejimida



O'lchov asbobini "max" rejimida





5-rasm. Temirchilik bolg'asining shovqin bosimi darajasini atrofga tarqalish yo'nalishining xususiyatlari (o'lchov asbobining "slow" va "max" rejimida): 1,2,3,4- temirchilik bolg'asini ish o'rni, o'ng tomoni, orqa tomoni, chap tomoni

4. Muhokama

Temirchilik bolg'asining shovqin bosimi darajasini atrofga tarqalish yo'nalishining xususiyatlari (o'lchov asbobining "slow" va "max" rejimida) diagrammalaridan ko'rinib turibdiki (5-rasm), temirchilik bolg'asining shovqin bosimi darajasini atrofga tarqalish yo'nalishlari, o'lchov asbobining "slow" va "max" rejimlarida, 31,5-8000 Hz o'rta geometrik chastotalarda bir-biriga o'xshash tavsivga ega[4].

31,5 Hz chastotada shovqin keng maydonga tarqalgan bo'lib, "max" rejimida orqa tomonga tarqalayotgan shovqinni bosim darajasi ortgan. 63 Hz chastotada shovqin bosimi darajasi ikki yo'nalishda – operator tomoni va uning qarama-qarshi yo'nalishida tarqalgan, "max" rejimda operator tomoni bo'yicha ortganligi aniqlangan. 125 Hz chastotada shovqin eng avvalo operator o'rni, undan keyin esa chap va orqa tomonga faol yo'nalgan bo'lib, aynan shu zonalarida maksimal darajalar qayd etilgan[5].

250–1000 Hz shovqinning tarqalish yo'nalishi yanada aniq nomoyon bo'lgan. 250 Hz da shovqin bosimi darajasi operator tomoni bo'yicha yuqori bo'lib, "max" rejimda aynan shu nuqtada intensivlik ortgan. 500 Hz da shovqin bosimi darajasi asosan ish o'rni yon tomonlariga – chap va o'ngga tarqalgan. 1000 Hz chastotada esa shovqin bosimi darajasi eng ko'p operator o'rni va o'ng tomonga yo'nalgan[4].

2000–8000 Hz esa shovqin bosimi darajasi operator o'rni, orqa va o'ng tomonga faol tarqalgan. 2000 Hz da shovqin bosimi darajasi aynan orqa tomonda yuqori qayd etilgan bo'lib, bu yerda shovqin bosimi darajasi devor bilan to'qnashib qaytgan. 4000 Hz chastotada shovqin bosimi darajasi operator o'rni yo'nalgan. 8000 Hz da esa shovqin bosimi darajasi eng yuqori darajada orqa tomonda qayd etildi, bu zona yopiq va devorga yaqin bo'lganligi sababli aks etuvchi shovqin bosimi darajasi kuchaygan.

5. Xulosa

Tahlil natijalariga ko'ra, sexga tutash joylashgan mashinasozlik sexiga o'tish joyidagi fon shovqini bosimi darajasi, oktava diapazoni polosolarining 125-8000 Hz o'rta geometrik chastotalarda, me'yorlarda ruxsat etilgan shovqin bosim darajalaridan, mos ravishda 1-12dB ortiq. Ushbu holat temirchilik sexidagi ish o'rinlaridagi shovqin bosimi darajasini pasaytirishda, mashinasozlik sexiga o'tish joyidagi fon shovqini bosimi darajasini pasaytirish bo'yicha qo'shimcha texnik yechimlar ishlab chiqishni va amaliyotga joriy etishni talab qiladi.

Shuningdek temirchilik bolg'asi atrofida shovqin bosimi darajasini tarqalishi o'lchov asbobini "slow" hamda "max" rejimida aniqlangan bo'lib, "slow" rejimi sexdagi barqaror shovqin bosimi darajasi tarqalishini ko'rsatgan bo'lsa, "max" rejimi sexda eng yuqori bosimlar qayerda yuzaga

kelayotganini aniq ko'rsatib berdi. Shovqin bosimi darajasi past chastotalarda teng tarqalgan, o'rta va yuqori chastotalarda esa asosiy tarqalish operator o'rni, chap, o'ng va ayniqsa orqa tomon yo'nalishida aniqlangan. Orqa tomonning devorga yaqinligi sababli, aynan shu yo'nalishda yuqori chastotalarda tarqalayotgan hamda devordan qaytgan shovqin bosimlari darajalari o'zaro qo'shilishi tufayli ortishi qayd etilgan.

Sexdagi shovqin bosimi darajasini samarali pasaytirish uchun shovqin yutuvchi ekranlar va akustik to'siqlarni joylashtirishda, temirchi salomatligini muhofaza qilish, uni ish unumdorligini oshirish va mehnat sharoitini sanitariya-gigiyena talablariga mosligini ta'minlashda, temirchilik bolg'asi ish o'rni va dastgohni orqa tomonida shovqin bosimi darajasini pasaytirishga qaratilgan innovatsion texnik echimlar ishlab chiqish lozim.

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

Sulaymanov Sunnatulla	Toshkent davlat transport universiteti "Texnosfera xavfsizligi" kafedrası
Sulaymanovich / Sulaymanov Sunnatulla	professori, t.f.d., professor Tel.: +998977755179 https://orcid.org/0000-0001-5275-5200
Musayev Shakhridin Gulomovich / Musayev Shakhridin	Toshkent davlat transport universiteti tayanch doktoranti E-mail: musa.shakhridin@mail.ru Tel.: +998332519119 https://orcid.org/0009-0004-5339-2180



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