

KARYER AVTOSAMOSVALLARIGA GORIZONTAL TEKISLIKDA EKSPLUATATSIYA JARAYONIDA TA`SIR ETUVCHI KUHLAR NAZARIYASI

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Anatatsiya. Maqolada avtosamosvallarning konstruktiv va ekspluatatsion parametrlarini optimal nisbatini aniqlash, avtoyo`llarning notekis, chuqur joylaridan o`tishda uning harakati barqarorligini ta`minlash imkonini beruvchi matematik ishlanma keltirilgan. Karyerning notekis bo`lgan yo`llarida avtosamosvalni harakatlanishida yo`l notekisligining ta'siridan yuk mashinalari uzatmalarining shikastlanishi nazariyasi va eksperimental tadqiqotlar natijalari keltirilgan.

Kalit so`zlar. Avtomobil ramasi, differentsial tenglama, lagranj funksiyasi, matematik model, garmonik tebranishlar, chastota, mustahkamlik chegarasi.

ABSTRACT

The article presents a mathematical development that allows you to determine the optimal ratio of constructive and operational parameters of Motor Vehicles, ensure the stability of its movement when passing through uneven, deep areas of highways. The results of the theory and experimental studies of damage to truck transmissions from the effects of road unevenness in the movement of the motor vehicle on the uneven roads of the carrier are presented.

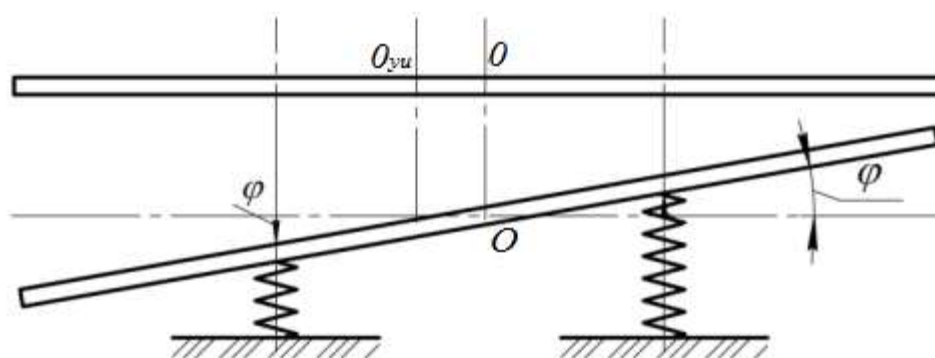
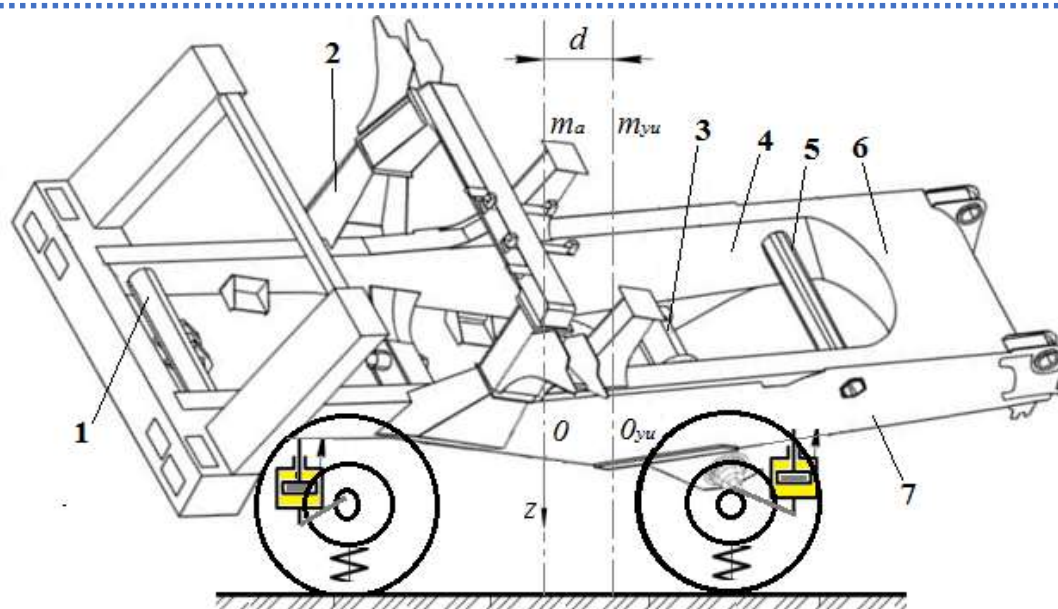
Keywords: Car frame, differential equation, LaGrange function, mathematical model, harmonic fluctuations, frequency, strength limit.

KIRISH.

Karyerlarda avtosamosvallar avtoyo`llar bo`ylab harakatlanayotganda tebranishlarini tizimli o`rganish katta amaliy ahamiyatga ega. Ushbu muammoni hal qilish avtosamosval jihozlariga ta'sir qiluvchi kuchlarni hisoblash, ularning xavfsizlik chegaralarini, aylanma qarshilik darajasini, shuningdek boshqa ishlash ko`rsatkichlarini aniqlash imkonini beradi. Bundan tashqari, avtosamosvalning konstruktiv elementlariga ta'sir qiluvchi kuchlarning kattaligi va yo`nalishini aniqlagandan so`ng, tebranishlar, turli chuqurlikdagi o`yuqlar bo`lgan karyerlarning texnologik yo`llari bo`ylab harakatlanishida avtosamosvalning asosiy qismi bo`lgan ramasi yoriqlar, sinishlar paydo bo`lishiga olib keladi. Yo`l notekisligidan kelib

chiqadigan kinematik qo'zg'aluvchan avtosamosvallarning osma tebranishlari, shu jumladan avtosamosvalning tekis bo'lmagan yo'l qoplamasidan o'tgan vaqtdagi umumiy ishni hisoblash uchun asosiy energiya munosabatlarini aniqlash va natijada karyer bo'ylab harakatlanishda qo'shimcha yoqilg'i sarfi oshishiga olib keladi. Avtosamosval ramasi va yo'l yuzasi o'rtasidagi bog'lovchi vazifasini osma tizim oldi va orqa osmalar bajaradi. Oldi va orqa osmalar silindrining bo'shlig'idagi gaz bosimi $3,15 \pm 0,025$ va $3,79 \pm 0,028$ MPa ni tashkil qiladi. Osma tsilindrda ishlaydigan suyuqlik sifatida azotli amortizator suyuqligi ishlatiladi [1-7]. Rama ikkita 4 va 7 lonjerondan va ko'ndalang o'rnatilgan metallarni payvandlash yoki shtamplash orqali biriktiriladi (1-rasm).

Lonjeronlar rama uzunligi bo'ylab o'zgaruvchan balandlikdagi qutti shaklidagi qismga ega. Birinchi ko'ndalang metall 1 diametri 245x45 mm bo'lgan trubadan yasalgan va oldingi o'qning markaziy richagi kronshteyn orqali biriktirilgan. Ikkinchi ko'ndalang metall 2 bu rama yon qismlarini birlashtiruvchi pastki ko'ndalang metallardan, oldingi osma ramaga kronshteynlar orqali biriktirilgan [8-14]. Oldingi osma ko'ndalang shtanga pastki ko'ndalang metallga biriktirilgan. Yon lonjeronlarga uchinchi ko'ndalang metall 3 payvandlangan, u ramaning o'rta qismini mustahkamlaydi. Orqa ko'priknining markaziy richagi uchinchi ko'ndalang metallga biriktirilgan. Og'darish mexanizmi tsilindrlarining pastki tayanchlari, kronshteynlar uchinchi ko'ndalang metallning uchlariga payvandlanadi [1-7]. Ulangan ikkita diametri 325x36 mm bo'lgan quyma quvur tayanchdan iborat. Lonjeronlar va ko'ndalang metallar 10HSND GOST19281-89 markali legirlangan po'latdan yasalgan. 10XSND markali legirlangan po'lat rama quyidagi mexanik xossalarga ega: cho'zilish chidamliligi $\sigma_V = 540$ MPa, oquvchanligi $\sigma_T = 400$ MPa, zarba kuchi minus 70 °S da $a_N = 30$ N.m/sm² ga teng. Platforma esa yuqori sifatli, yedirilishga bardoshli 18XGNMFR markali legirlangan po'latdan yasaladi va uning mexanik xususiyatlar quyidagicha: cho'zilish chidamliligi $\sigma_V = 1100$ MPa, oquvchanligi $\sigma_T = 1000$ MPa, zarba kuchi minus 40 °S da $a_N = 30$ N.m/sm² ga teng [1-7].



1-rasm. Umumlashtirilgan koordinatalarini hisobiy sxemasi

Differentsial tenglamalar tuzish va avtosamosvalning massa markazidan o‘tadigan gorizontaal o‘q, ya‘ni rama atrofida tebranishlar 1-rasmda umumlashtirilgan koordinatalarini hisobiy sxemasi shaklida keltirilgan. Avtosamosval o‘zining vertikal bo‘ylama tekisligida tebranayotganligi sababli, tizim ikki erkinlik darajasiga ega. Umumlashtirilgan koordinatalar uchun avtosamosvalning O massa markazining vertikal siljishini Z va uning aylanish burchagi φ ni avtosamosval o‘qlariga parallel ravishda o‘tadigan o‘q atrofida olinadi [1-4;8-14].

Avtosamosval harakatlanishida kuzovdagi yuklarning markazdan ma‘lum bir masofaga siljishi natijasida oldi va orqa g‘ildiraklarda markazga nisbatan tebranish harakati vujudga keladi. Bu tebranish jarayoni murakkab bo‘lganligi uchun Lagranj funksiyasi orqali yechimi tahlil qilindi.

$$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{q}} \right) - \frac{\partial L}{\partial q} = 0 \quad (1)$$

bu yerda; L - Lagranj funksiyasi, $L = E_K - E_P$, E_K , E_P - avtosamosval kinetik va potensial energiyasi (Joul), q - umumlashgan koordinatalar sistemasi avtosamosval

kuzoviga yuk ortilgandan keyin tekis parallel harakat qilishi natijasida quyidagi kinetik energiyalar hosil bo‘ladi.

$$E_K = \frac{mv^2}{2} + \frac{J\omega^2}{2} = \frac{Q}{2g}(\dot{x}^2 + \rho^2\dot{\varphi}^2) \quad (2)$$

Potensial energiyalari; $E_P = E_{P1} + E_{P2}$,

E_{P1} - avtosamosval og‘irlik kuchining potensial energiyasi (Joul), E_{P2} - avtosamosval osmalarining potensial energiyasi (Joul).

$$E_{P1} = -Qx \quad (3)$$

$$E_{P21} = \frac{k_1}{2}(x_0 + x - l\varphi)^2, \quad E_{P22} = \frac{k_2}{2}(x_0 + x + l\varphi)^2; \quad (4)$$

bu yerda; Q - yuk va avtosamosval og‘irlik kuchi (kg), x_0 - osmaning muvozanat xolatidagi boshlang‘ich koordinatasi, l - ikki g‘ildirak orasidagi masofa (m), φ - avtosamosval ramasining goorizont bilan tashkil qilgan burchagi (gradus), k_1 - orqa g‘ildirakdagi osmaning bikrligi (N/m), k_2 - oldi g‘ildirakdagi osmaning bikrligi (N/m).

Umumiy potensial energiya Lagranj funksiyasiga quyidagicha bo‘ladi

$$E_P = -Qx + k[(x_0 + x)^2 + l\varphi^2] \quad (5)$$

$$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{\varphi}} \right) = \frac{Q}{g} \rho^2 \ddot{\varphi}, \quad \frac{\partial L}{\partial \varphi} = -2kl^2 \varphi \quad (6)$$

Yuqoridagi tenglamalardan quyidagicha sistema hosil bo‘ladi.

$$\frac{Q}{g} \rho^2 \ddot{\varphi} + 2kl^2 \varphi = 0 \quad (7)$$

$$\text{agar } 2kx_0 = Q \text{ bo‘lsa } \quad \frac{Q}{g} \ddot{x} + 2kx = 0 \quad (8)$$

Garmonik tebranishlar nazariyasiga asosan tebranishlar fazasi va burchagi quyidagicha

$$x = A \sin(\omega_1 t + a); \quad \varphi = B \sin(\omega_2 t + \beta); \quad (9)$$

bu yerda; ω_1 , ω_2 - tebranish chastotasi (rad/s),

oldi va orqa tomondagi osmalarining umumiy bikrligi,

$$k_2 = \frac{c_1 c_0}{c_1 + c_0}; \quad k_1 = \frac{2c_2 c_0}{c_2 + 2c_0} \quad (10)$$

Umumiy og‘irlik kuchi

$$Q = (m_{yuk} + m_a)g; \quad (11)$$

Yuqoridagi garmonik tebranishlar tenglamasidan quyidagi chastotalar aniqlandi.

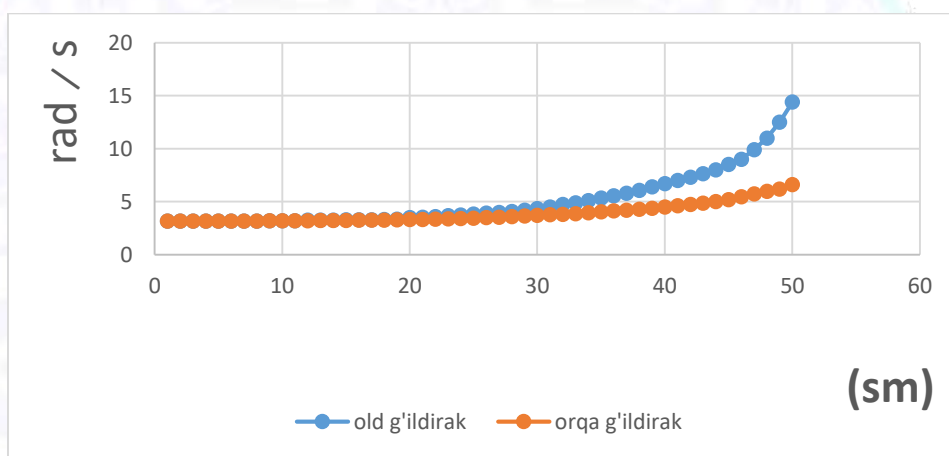
$$\omega_1 = \sqrt{\frac{2k_1 g}{Q}}, \quad \omega_2 = \sqrt{\frac{2k_2 g l^2}{Q \rho^2}}; \quad (12)$$

Avtosamosval uchun orqa va oldi g'ildiraklari uchun tebranish chastotalari quyidagicha,

$$\omega_1 = \sqrt{\frac{2C_1 C_0 g}{(C_1 + C_0)(m_{yuk} + m_a)}} \quad \omega_2 = \sqrt{\frac{4C_2 C_0 g l^2}{(C_2 + 2C_0)(m_{yuk} + m_a) \rho^2}}; \quad (13)$$

Ikki g'ildiraklarni tebranish chastotalari matematik jihatdan ikki xil qonuniyat asosida farqlanadi asosan yuk qo'yilish masofasi bu tebranishlarni turlicha qilishi mumkin. Majburiy tebranma harakat va garmonik (erkin) tebranma harakatda davom etilishi maqsadga muvofiq bo'ladi [8-14].

Agar massa markazi kuzovning massa markazidan $\rho=1\div 50$ sm gacha o'zgarishini, $Q=324$ (tonna), $C_0=2.5 \cdot 10^6$ (N/m), $C_1=2 \cdot 10^6$ (N/m), $C_2=2,2 \cdot 10^6$ (N/m), $l=6.65$ (m), bo'lganda ikki g'ildirakdagi tebranishlar chastotasi 2-rasmda keltirilgan.

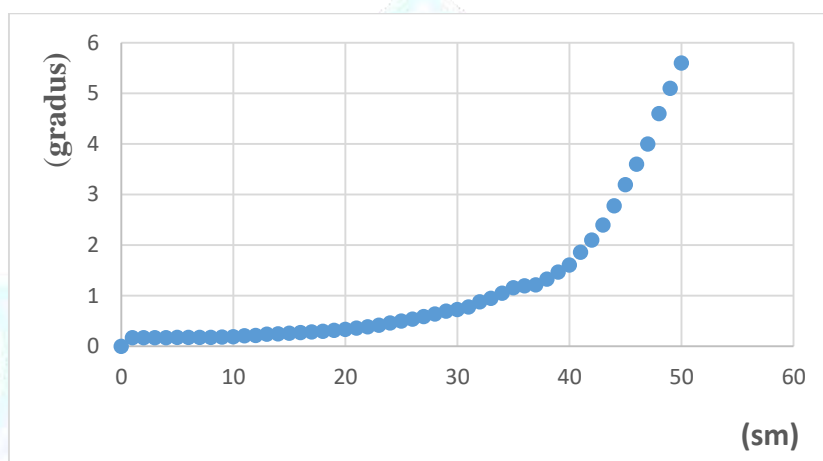


2-rasm. Oldi va orqa g'ildirakda hosil bo'luvchi tebranish chastotasi.

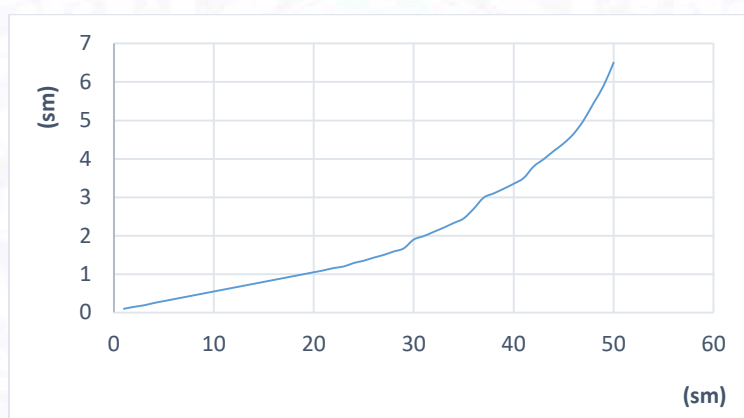
Tezlik o'zgarishida massa markazi muvozanat vaziyatidan ma'lum bir masofaga siljigan onda g'ildiraklarda hosil bo'ladigan tebranish chastotalari 2 - rasmda keltirildi. Oldi g'ildirakda massa markazi muvozanatdan katta santimetrlarga siljiy boshlasa chastotalar farqi bir biridan yuqori darajada farq qila boshlaydi. 1 sm ko'chishda chastota ikki g'ildirakda 3,171 va 3.174 rad/s atrofida bo'la boshlaydi. Agar bu ko'chish 50 sm bo'lsa 14,4 va 6.6 rad/s qiymatlar qayt etildi. Karyer avtosamosvallarining ekspluatatsiya jarayonida gorizontol holatda massa markazining 0 dan 50 sm gacha siljishi orqa g'ildirakning chastotasi 6.6 rad/s ni, oldi g'ildirakning chastotasini 14.4 rad/s ga tenglashishini ko'rsatdi. Ushbu qiymatlar avtosamosvallar ekspluatatsiya jarayonada silkinishlar evaziga og'irlik markazining kochishini bildiradi. Agar qiymatlarni 9 - ifodaga bog'liq holda o'zgarishi hisobga olinsa, tebranishlar fazasi va burchagi 3-rasmdagidek bo'ladi [15-20].

Massa markazi qochishi evaziga avtosamosval ramasida gorizontol hosil bo'ladigan burchak o'zgarishi paydo bo'ladi. Ushbu qiymatlar 3 - rasmda keltirilgan bo'lib, og'irlik markazining ko'chishi bilan avtosamosvalning gorizontol tekislikda

qiyalik burchakning hosil bo‘lishi bilan izohlanadi. Albatta ushbu burchakning maksimal qiymati bo‘yicha ish olib boriladi.



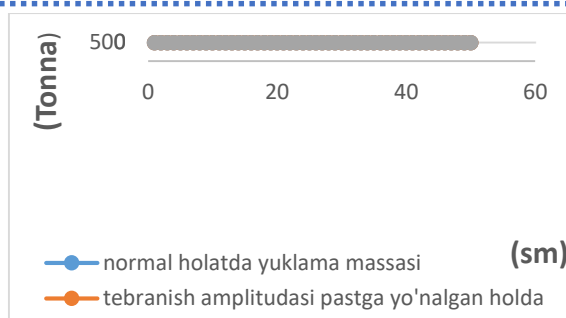
3-rasm. Massa markazi qochishi evaziga avtosamosval ramasida hosil bo‘ladigan burchak o‘zgarishi.



4-rasm. Ramani normal holatidan og‘ish masofasi grafigi.

Avtosamosvalning gorizontall tekislikda ramada hosil bo‘lgan burchak qiymati orqali siqilish masofasini grafigi 4 - rasmda keltirilgan. Demak og‘ish masofasi maksimal 6.5 sm ni tashkil qilsa yuqoridagi 7 - ifoda orqali yuklamalarni erkin tushish tezlanishiga nisbat olgan holda ifodalanadi [15-20].

Notekis yo‘lda avtosamosval harakatlanayotganda massa markazining gorizontall siljishi va massa markazidan o‘tadigan gorizontall o‘q atrofida massaning aylanish burchagi garmonik tebranishlarni ifodalaydi. Yuklangan avtosamosval uchun tabiiy tebranishlarning siklik chastotasi yuklanmaganiga nisbatan bir oz pasayadi, buning sababidan inertsiya kuchlari o‘zgaradi. Tebranishlar amplitudasi yo‘l qo‘yib bo‘lmaydigan darajada katta bo‘ladigan notekis yo‘lda harakatlanayotganda avtosamosvalning harakati har doim keskin tezligi mavjudligi, buning natijasida avtosamosval jihozlariga yuklanish qabul qilinishi mumkin bo‘lmagan darajada oshadi. Tebranishlar natijasida avtosamosval ishchi qismlarida sinish, buralish, cho‘zilish va bir nechta deformatsiya hollatlari kelib chiqishi mumkin.



5-rasm. Tebranma holatda vujudga keluvchi yuklamani massa orqali ifodalovchi grafik.

5 - rasmda avtosamosval 30 km/soat tezlik bilan umumiy yuk miqdori 324 tonnani tashkil qilganda va massalar markazi 50 sm ga farq qilgan avtosamosvalda 441 tonna yuk miqdoriga teng keluvchi yuklama hosil bo'lishi aniqlandi. Maqolada qarab chiqilayotgan avtosamosvalda cho'zilish chidamliligi $\sigma_V = 540$ Mpa tashkil qilsa bu yetarli shart hisoblanadi lekin tezlik 45 km/soat tezlik bilan umumiy yuk miqdori 324 tonnani tashkil qilganda va massalar markazi 50 smgacha farq qiladi. Bunday yuklama hosil bo'lishida ramaning materiali mustahkamlik chegarasi yuqoriroq bo'lmasa sinish, buralish va cho'zilish holatlari kuzatiladi [15-20].

Avtosamosvallar normal holatda yuklash massasidan kelib chiqib, harakatlanish davomida inertsiya kuchi va tortish kuchlari natijasida yuzaga keladigan amplitudaviy tebranishlar yuqori chastotasida nominal kuchning 36% ga oshishi va pastki chastotada esa 24% ga kamayishi umumiy amplitudaning yuqori va pastki chastotalar farqini 60% ni tashkil etdi.

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