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ELEKTROPOEZDLARNING TEBRANISHINI RICHAG-DISKLI ISHQALANUVCHI SO‘NDIRGICHLARI KONSTRUKTSIYASINI HISOB-KITOB MUSTAXKAMLIK USULLARINI YARATISH

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ABSTRACT

Maqolada elektr poyezdlari uchun tutqichli diskli ishqalanish tebranish damperi konstruksiyasining mustahkamligini hisoblashning yangi usuli keltirilgan.

Temir yo‘llarning harakatlanuvchi tarkibining tebranishlarini ishqalanuvchi juftiga qo‘yiladigan asosiy talablar: ishqalanish koeffitsientining barqarorligi, juftlikning yiyilishya bardoshliligi past, materialning elastikligi va qattiqligining past moduli, issiqlik kengayishining past koeffitsienti, yaxshi ishlash - ishqalanish materialida, etarli mexanik quvvat, korroziyaga qarshi, yopishqoqlik, issiqlikka chidamlilik va boshqa ishqalanish xususiyatlari [1,2,3].

Ishqalanish tebranish so‘ndirgichi ishqalanish beqarorligining asosiy omillari: ishqalanish elementlarini ishlab chiqarish texnologiyasini buzish (vulkanizatsiya, issiqlik bilan ishlov berish paytida harorat rejimiga mos kelmaslik); hatto belgilangan toleranslar doirasida ham alohida qismlarning o‘lchamlari bo‘yicha og‘ishlar; ishqalanish koeffitsientining o‘zgarishiga yuqori sezgirlik bilan nomukammal dizayn.

Ishqalanadigan tebranish so‘ndirgichining nominal o‘lchamlarini aniqlash, raqamli hisob-kitoblarni amalga oshirishdagi asosiy vazifadir. Elektropoyezdlari uchun xarakteristikalarning barqarorligi va richagni diskli ishqalanish tebranish so‘ndirgichlarini ishlashi ishonchliligi, ishqalanish yuzasining yuklanish xususiyati bilan belgilanadi [2, 3]. Yuklanishni hisoblash ketma-ketligi va dastak-disk tebranish so‘ndirgich nominal o‘lchamlari algoritmda keltirilgan. Disk tipidagi gidrofriksion so‘ngdirgichlarning dinamik egilish

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siljishlari, deformatsiyalari va kuchlanishlari bo‘yicha raqamli tadqiqotlar algoritmi, sxemasi va metodikasi ER2 (ER-9E) elektropoyezdining ishqalanish amortizatori misolida bajarilgan [4,5,6].

O‘zgaruvchan qattiqlik va disk tipidagi gidrofriksion damperning massasi bo‘lgan elastik val tebranishlarining dinamik modelini yaratish uchun biz quyidagi taxminlarni kiritamiz.

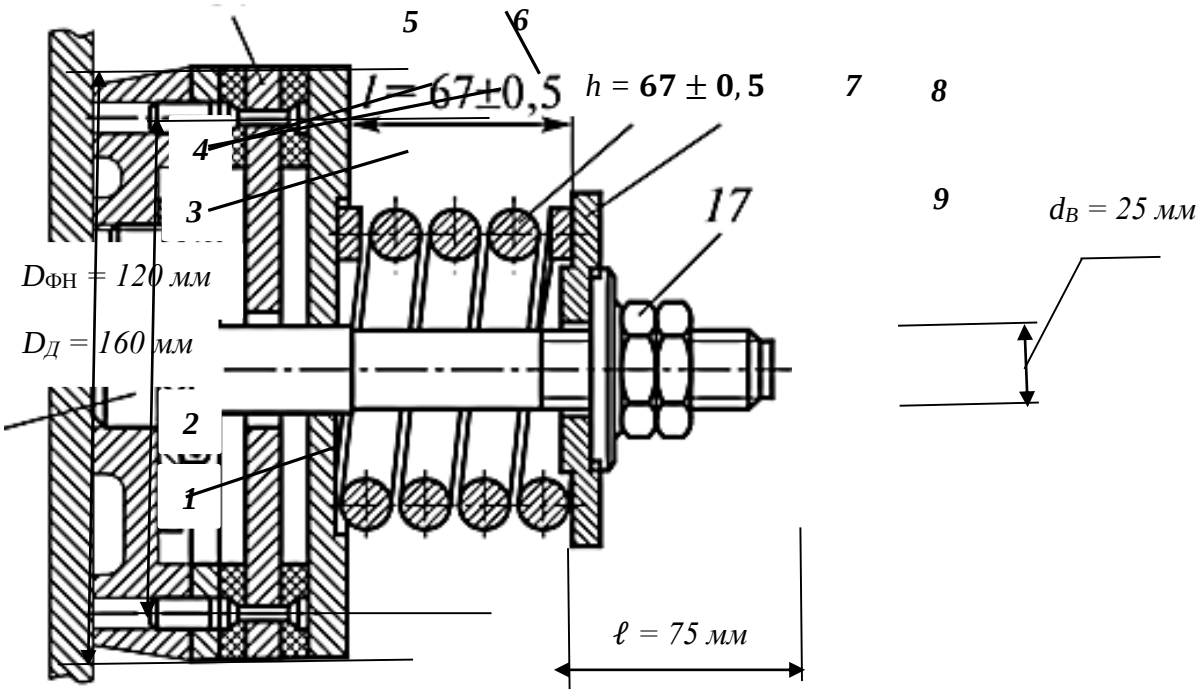
1. Diskli elastik valning modeliga tashqi diametri d_B bo‘lgan aylanuvchi elastik qattiq tayoqcha kiradi, bu konsol Richaglab-quvvatlovchiga ega: val aylanuvchi aylanish tezligiga ega. ω_B. elastik novda qismlarining elastik egilish deformatsiyalari ikki tekislikdagi funksiyalar bilan tavsiflanadi ***YOZ - $y_B(z,t)$*** va ***XOZ -$x_B(z,t)$.*** Ushbu funksiyalar bo‘limlarni valning uzunligi bo‘ylab joylashtirish koeffisientlari ***z*** va o‘rganilgan tebranish jarayonlarining vaqti ***t*** va davomiyligi ishlari bilan taqqoslangan holda hisobga olinadi [4,5,6].

Disk tipidagi gidrofriksion damperning modeli asosida loyihalash sxemasi 1-rasmda ko‘rsatilgan.

Harakatlanuvchi disklar bilan ulanish uchun valda pazlar qilingan. Bunday val konstruktsiyasi bo‘laklarning o‘zgaruvchan egilish qattiqligiga ega bo‘lib, har bir soni z_n da o‘zgarib turadigan funksiya bilan xarakterlanadi, bu yerda ***n=0÷3, $l_{kn} \le z_n \le l_{kn+1}$.***

$$I_B(z) = I_{0B}\left(1 + sin\frac{\pi z}{L}\right) = I_{0B} + I_{0B} \cdot sin\frac{\pi z}{L}\ , \qquad (1)$$

bu yerda $J_{0B} = \frac{\pi d_B^4}{64}$ elastik valning inertsiya momenti, м^4.



1-rasm.- ER -2 elektropoyezdi (ER -9E) uchun RD tipidagi disk tebranish so‘ngdirgichining hisobiy sxemasi RD tipidagi elektropoyezd tebranish ishqalanish so‘ngdirgichi bo‘yicha:

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1-kronshteyn; 2 – bog‘lov bolti (o‘q) - ishqalanuvchi tebranish so‘ngdirgichining valini hisoblashimizda d_B = 25 mm; 3 – qo‘zg'almas (shayba) disk; disk diametri – $D_Д$ = 160 mm; qalinligi – 8 mm (ishlab chiqarish vaqtida); 7-8 mm-kapital ta’mirlash vaqtida; 6-8 mm-uz-3; 4 – ishqalanish nakladkalari , nakladkaning diametri – $D_{ФН}$ = 120 mm-rasional kattaliklarni tanlash uchun hisoblashda turlicha 120-140 mm; 5 - harakatlanuvchi disk (burilish richagi) - disk diametri-160 mm; 6 - ishqalanish qopqog'i-uning diametri - 120 mm; qalinligi -12 mm

7- (ishlab chiqarish paytida); 10-12 mm – kapital ta’mirlash paytida; 8-12 mm – JT-3 bosim prujina-prujinaning maksimal siqilishi h = 67±0,5 mm; 8-shayba, 9-maxsus gayka.

Ushbu konstruksiyaning xususiyatlari kamaytirilgan og’irlikning intensivlik funksiyasining tengsizligini keltirib chiqaradi, bu holat bilan taqqoslanganda (1), shaklni olamiz.

Tekshirilayotgan val bo‘limlari soni $\boldsymbol{n=0\div3,\ \ l_{kn} \le z_n \le l_{kn+1}}$

$$m_B(z) = m_O\left(1 + sin\frac{\pi z}{L}\right), \qquad (2)$$

bu yerda $m_0 = \frac{\pi d_B^2}{4} \cdot \rho_{ст}$ elastik valning kamaytirilgan og’irligi, kg / m;

$m_{ЭД} = \frac{\pi(d_Д^2 - d_B^2)}{4} \cdot \rho_{ст}$ diskning joylashish zonasida disk tipidagi gidrofriksion so‘ndirgich elastik valining kamaytirilgan ekvivalent og’irligi, kg/m; $\boldsymbol{d_∂}$ -disklarning diametri, m.

Professor Xromova G.A. va uning shogirdlari rahbarligida ilgari bajarilgan ishlar asosida [4,5,6], YOZ - $\boldsymbol{y_B(z,t)}$ и XOZ - $\boldsymbol{x_B(z,t)}$ ikkita tekislikda o‘zgaruvchan qattiqlik va og’irlikga ega disk tipidagi gidrofriksion so‘ndirgich valining egilish tebranishlari uchun differensial tenglamalar tizimi $\boldsymbol{t}$ shaklida olingan

$$\frac{\partial^2 y_B}{\partial t^2} + \frac{E}{m_0\left(1 + sin\frac{\pi z}{L}\right)} \cdot \left(-I_{OB}\left(\frac{\pi}{L}\right)^2 \cdot sin\frac{\pi z}{L}\right) \cdot \frac{\partial^2 y_B}{\partial z^2} +$$
$$+ \frac{E}{m_0\left(1 + sin\frac{\pi z}{L}\right)} I_{OB}\frac{\pi}{L} cos\frac{\pi z}{L} \cdot \frac{\partial^3 y_B}{\partial z^3} +$$
$$+ \frac{E}{m_0\left(1 + sin\frac{\pi z}{L}\right)}\left(I_{BO} + I_{BO} \cdot sin\frac{\pi z}{L}\right)\frac{\partial^4 y_B}{\partial z^4} -$$
$$-\left(\omega_B^2 \cdot m_0 - k_{oy}\right) \cdot y_B + 2\omega_B \frac{\partial x_B}{\partial t} = \frac{p_{oy}(1 - cos(3\omega_B t))}{m_0\left(1 + sin\frac{\pi z}{L}\right)}. \qquad (3)$$

$$\frac{\partial^2 x_B}{\partial t^2} + \frac{E}{m_0\left(1 + sin\frac{\pi z}{L}\right)} \cdot \left(-I_{OB}\left(\frac{\pi}{L}\right)^2 \cdot sin\frac{\pi z}{L}\right) \cdot \frac{\partial^2 x_B}{\partial z^2} +$$
$$+ \frac{E}{m_0\left(1 + sin\frac{\pi z}{L}\right)} I_{OB}\frac{\pi}{L} cos\frac{\pi z}{L} \cdot \frac{\partial^3 x_B}{\partial z^3} +$$
$$+ \frac{E}{m_0\left(1 + sin\frac{\pi z}{L}\right)}\left(I_{BO} + I_{BO} \cdot sin\frac{\pi z}{L}\right)\frac{\partial^4 x_B}{\partial z^4} -$$
$$-\left(\omega_B^2 \cdot m_0 - k_{ox}\right) \cdot x_B + 2\omega_B \frac{\partial y_B}{\partial t} = \frac{p_{ox}(1 - cos(3\omega_B t))}{m_0\left(1 + sin\frac{\pi z}{L}\right)}. \qquad (4)$$

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Endi o‘zgaruvchan qattiqlik va massaga ega bo‘lgan valning eguvchi tebranishlari uchun (3) - (4) tenglamalar sistemasini birgalikda yechishga to‘g‘ri keladi. Biz so‘ngdirgich valining butun qismini ($\boldsymbol{0 \le z \le L}$) k kesimlar bo‘yicha o‘zgaruvchi kesimni ajratamiz, $\boldsymbol{k = 7}$, shart bilan $\boldsymbol{0 \le z \le L}$, bu yerda L -so‘ngdirgich valining umumiy uzunligi

$$A_1(z) = \frac{E\cdot\left(-I_{OB}\left(\frac{\pi}{L}\right)^2\cdot sin\frac{\pi z}{L}\right)}{m_0\left(1+sin\frac{\pi z}{L}\right)}, \qquad A_2(z) = \frac{E\cdot I_{OB}\frac{\pi}{L}\cdot cos\frac{\pi z}{L}}{m_0\left(1+sin\frac{\pi z}{L}\right)},$$

$$P_{oy}(z) = \frac{p_{oy}}{m_0\left(1+sin\frac{\pi z}{L}\right)}, \qquad A_3(z) = \frac{E}{m_0\left(1+sin\frac{\pi z}{L}\right)}\left(I_{BO} + I_{BO}\cdot sin\frac{\pi z}{L}\right),$$

$$A_4(z) = \omega_B^2\cdot m_0 - k_{oy}, \qquad B_1(z) = A_1(z), \qquad B_2(z) = A_2(z),$$

$$B_3(z) = A_3(z), \qquad P_{ox}(z) = \frac{p_{ox}}{m_0\left(1+sin\frac{\pi z}{L}\right)}, \qquad B_4(z) = \omega_B^2\cdot m_0 - k_{ox}.$$

Kiritilgan belgilashlarni hisobga olgan holda disk tipidagi gidrofriksion so‘ndirgichlarning elastik valining egilish tebranishlarini differensial tenglamalari tizimi (3) - (4).

$$\frac{\partial^2 y_B}{\partial t^2} + A_1(z)\cdot\frac{\partial^2 y_B}{\partial z^2} + A_2(z)\cdot\frac{\partial^3 y_B}{\partial z^3} + A_3(z)\frac{\partial^4 y_B}{\partial z^4} - A_4\cdot y_B +$$
$$+2\omega_B\frac{\partial x_B}{\partial t} = p_{oy}(z)\cdot(1-\cos(3\omega_B t)), \qquad (5)$$

$$\frac{\partial^2 x_B}{\partial t^2} + B_1(z)\cdot\frac{\partial^2 x_B}{\partial z^2} + B_2(z)\cdot\frac{\partial^3 x_B}{\partial z^3} + B_3(z)\frac{\partial^4 x_B}{\partial z^4} - B_4\cdot x_B +$$
$$+2\omega_B\frac{\partial y_B}{\partial t} = p_{ox}(z)\cdot(1-cos(3\omega_B t)). \qquad (6)$$

(5) tenglamalar sistemasini birgalikda yechish bilan ko‘pincha (6) o‘zgaruvchan qattiqlik va massali valning eguvchi tebranishlari uchun biz damper valining butun qismini ajratamiz ($\boldsymbol{0 \le z \le L}$) uchastkalarda o‘zgaruvchan kesma, uchastkaning ettita bo‘lish sharti bilan esa $k = 7$, biz uzunlikdagi o‘zgaruvchilar koeffisientlari uchun belgini kiritamiz $\boldsymbol{0 \le z \le L}$, bu yerda L - damper valining umumiy uzunligi.

Diskli tebranish so‘ngdirgichlarning elastik valining chegara shartlari bilan bog‘liq bo‘limlari egilish tebranishlarining tabiiy chastotalari tugunlarni mahkamlash shartlariga qarab chastota tenglamalari bilan aniqlanadi [6] iteratsiya usuli bilan. Chegaraviy shartlar bo‘yicha bog‘lash (siqish) (5) – (6) tenglamalar asosida kompyuter yordamida bo‘lakli chiziqli approksimatsiya qilish orqali amalga oshiriladi.

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