



# PO‘LAT YUZASIGA PLAZMA NITRIDINI TA‘SIR ETTIRISH NATIJASIDA UNING ISHQALANISHGA BARDOSHLIGINI OSHIRISH VA PARAMETRLARINI ASOSLASH

Kengboyev S.A. [0009-0000-1050-2133]

Toshkent kimyo-texnologiya institutining Shahrisabz filiali katta o‘qituvchisi,  
E-mail: [sirojmagistrstudent@gmail.com](mailto:sirojmagistrstudent@gmail.com)

**Annotasiya:** Maqolada tikuv mashinalarining moki va naychasining harorat kuchlanishini va deformatsiyasini baholashning matematik modeli ishlab chiqilgan, buning uchun moki ichi g‘ovak silindr sifatida qaraladi, qatlamlardagi haroratning kesishishi va elastik moduli, haroratdan kengayish koeffitsiyentlari nazariy jihatdan o‘rganiladi, moki silindrining yon yuzalarida o‘q yo‘nalishidagi va tangensial kuchlanishlarni hisoblash uchun kerakli formula berilgan. Olingan matematik ifoda natijalari mokining butun tanasi bo‘ylab yemirilishi va tarqalishini va moki va g‘altakning yon chekkalari bo‘ylab mo‘rt kristallararo yemirilishni aniqlash imkonini beradi. Bundan tashqari, normal kuchlanishga perpendikulyar bir nechta tekisliklar bo‘ylab tarqaladigan to‘liqni strukturaning yaltiroq kristalli darzlariga xos bo‘lgan mo‘rt sinish va tangensial kuchlanishlar tufayli plastik deformatsiyalar paytida yuzaga keladigan siljish shaklidagi egiluvchan sinish tahlil qilindi.

**Tayanch iboralar:** tikuv mashinalari, mokik, naycha, matematik model, harorat, kuchlanish, deformatsiya, ichi bo‘sh silindr, nazariy, ko‘ndalang kesma, qatlam, elastiklik moduli, koeffitsiyentlar, issiqlikdan kengayish, hisob-kitoblar, o‘q yo‘nalishidagi va tangensial kuchlanishlar, sirt.

**Аннотация:** В статье разработана математическая модель оценки температурного напряжения и деформации шатуна и трубки швейных машин, для которой шатун рассматривается как пористый цилиндр, теоретически изучены температурное сечение и модуль упругости в слоях, коэффициенты расширения от температуры, дана необходимая формула для расчета осевых и тангенциальных напряжений на боковых поверхностях шатунного цилиндра. Полученные результаты математического выражения позволяют определить распад и распределение по всему телу шатун и хрупкое межкристаллическое распад по боковым краям шатун и катушки. Кроме того, были проанализированы хрупкое преломление, характерное для блестящих кристаллических трещин волновой структуры, распространяющихся по нескольким плоскостям, перпендикулярным нормальному напряжению, и упругое преломление в виде сдвига, возникающее при пластических деформациях из-за тангенциальных напряжений.

**Базовые слова:** швейные машины, мокик, трубка, математическая модель, температура, напряжение, деформация, полый цилиндр, теоретический, поперечное сечение, слой, модуль упругости, коэффициенты, тепловое расширение, расчеты, направленные и касательные напряжения оси, поверхность.

**Annotation:** The article develops a mathematical model for estimating the temperature stress and deformation of the connecting rod and tube of sewing machines, for which the connecting rod is considered as a porous cylinder, the temperature cross section and modulus of elasticity in layers, expansion coefficients from temperature are theoretically studied, the necessary formula for calculating axial and tangential stresses on the side surfaces of the connecting rod cylinder is given. The obtained results of the mathematical expression allow us to determine the decay and distribution throughout the body of the shuttle and the brittle intercrystalline decay along the lateral edges of the shuttle and the coil. In addition, brittle refraction, characteristic of shiny crystalline cracks of the wave structure, propagating along several planes perpendicular to normal stress, and elastic refraction in the form of shear, which occurs during plastic deformations due to tangential stresses, were analyzed.

**Basic words:** sewing machines, mokik, tube, mathematical model, temperature, stress, deformation, hollow cylinder, theoretical, cross section, layer, modulus of elasticity, coefficients, thermal expansion, calculations, directional and tangential stresses of the axis, surface.

## Kirish

Yuqori kuchlanishlar tufayli mashina va mexanizmlarning detallarida deformatsiya kuchayadi, natijada darzlar paydo bo'ladi va ularda tarqaladigan bo'lsa, metallarning yemirilishiga olib keladi. Darzning kritik o'lchami tufayli uning o'sishi ixtiyoriy sodir bo'ladi. Mo'rt yemirilishda o'tkir va tarmoqlangan darz paydo bo'lib, juda katta tezlikda o'sadi.

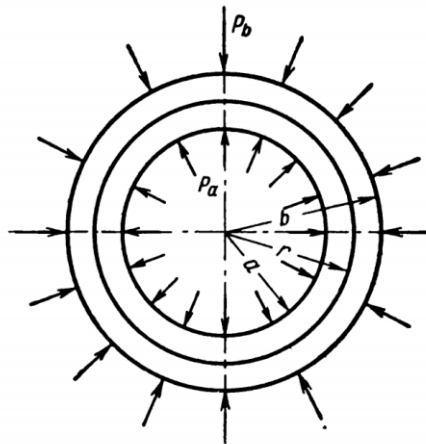
Darzlar hosil bo'lishi detal tanasi bo'ylab tarqaladigan transkristallik yemirilish va detal chegaralari bo'ylab mo'rt kristallararo yemirilish natijasida yuzaga keladi. Mo'rt yemirilish normal kuchlanishga perpendikulyar bir nechta tekisliklar bo'ylab tarqaladigan to'liqinli strukturaning yaltiroq kristalli yemirilishi bilan tavsiflanadi. Urinma kuchlanishlari tufayli plastik deformatsiyalar paytida kesim ko'rinishida qovushqoq yemirilish sodir bo'ladi [1].

Katta plastik zona sekin tarqaladigan va yuqori energiya sig'imi bilan o'tmas ochilgan darz oldida paydo bo'ladi. Notekis, sinishning tekisligi odatda ma'lum bir burchak ostida joylashgan. Metallning plastiklik darajasini aniqlash uchun mustahkamlik va oquvchanlikning chegaraviy qiymatlari solishtiriladi. Farq qancha ko'p bo'lsa, plastiklik shunchalik yuqori bo'ladi. Mo'rt metallar uchun mustahkamlik va oquvchanlikning bu ko'rsatkichlari deyarli tengdir, shuning uchun yemirilish plastik deformatsiya bilan deyarli bog'liq emas. Metallarning yuqori haroratgacha qizdirilishi tufayli oquvchanlik va mustahkamlik chegaralari mos kelishi mumkin.

## Asosiy qism

Oddiy va murakkab kuchlanish holatlarida jismni qismlarga ajratish usuli yordamida masalalarni yechishning umumiy qoidasini ko'rib chiqamiz.

Har xil jinsli silindrlarda aylana (tangensial) kuchlanishlar uchun formulalarni olish uchun ushbu qoidadan foydalanamiz. 1-rasmda tashqi radiusi  $b$  va ichki radiusi  $a$  bo'lgan yupqa devorli bir jinsli bo'lmagan silindrning ko'ndalang kesimi ko'rsatilgan. Silindrga tashqi bosim  $P_b$  va ichki bosim  $P_a$  ta'sir qiladi.



1-rasm. Turli jinsli yupqa devorli silindr ( $r = b$ ).

Bu masala yechimi materiallar qarshiligi kursidan ma'lum [2]. Ushbu yechimdan foydalanib, har xil jinsli silindrlarda kuchlanish va siljishlarni aniqlashning taxminiy formulalarini chiqaramiz.

Silindrlarni yuklashning quyidagi maxsus holatlarini ko'rib chiqaylik:

a) Silindr faqat ichki  $P_a$  bosimga duch keladi.

Materiallar qarshiligi kursidan ma'lum bo'lgan yechimga ko'ra, ko'ndalang kesimning istalgan nuqtasidagi aylana kuchlanishlari (2-rasm) quyidagilarga teng:

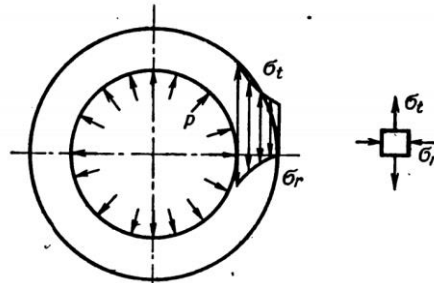
$$\sigma_t = \frac{P_a a^2}{b^2 - a^2} \left[ 1 + \left( \frac{b}{r} \right)^2 \right], \quad (1)$$

Silindrning tashqi yuzasida:

$$\sigma_t = 2 \frac{P_a a^2}{b^2 - a^2} \quad (2)$$

Endi muammo quyidagicha ifodalangani: 1-rasmdagi mutlaqo qattiq AB va CD ko'ndalang kesimlari orasidagi tolalar (sterjenlar) uzunligini tanlash mumkin, bunda tolalardagi kuchlanishlarning taqsimlanishi quyidagi formula bilan hisoblangan kuchlanishlarga to'g'ri kelishi kerak:

$$\sum_1^n \sigma_i F_i = \sum_{i=1}^n \varepsilon_i E_i F_i = P \quad (3)$$



### 2-rasm. Bir jinsli yupqa devorli silindrda tangensial ( $\sigma_t$ ) va radial ( $\sigma_r$ ) kuchlanishlarning taqsimlanishi.

Umuman olganda, kuchlanishlar formulasiga kiruvchi  $\gamma$  funksiyani ko'rishni aniqlash kerak:

$$\sigma_i = \varepsilon_i E_i = \left[ -\delta_i + \frac{P + R\delta}{R_0} \gamma_i \right] \quad (4)$$

bu yerda sterjenlarning yakuniy soni  $n$  va brusning siljishida:

$$\Delta_{(AB)} = \frac{P + R\delta}{R_0} \gamma_i l_i = e_i l_i \quad (5)$$

Bu murakkab (tekis) kuchlanganlik holatida kuchlanishlar va siljishlarni aniqlash bo'yicha muammoni oddiy (chiziqli) kuchlanganlik holatiga keltirish imkonini beradi. [2]

Ta'riflarga muvofiq:

$$\gamma_i = \frac{l_1}{l_i} = \frac{(\varepsilon_i + \delta_i)}{(\varepsilon_1 + \delta_1)} = \frac{(\frac{\sigma_i}{E_i} + \delta_i)}{(\frac{\sigma_1}{E_1} + \delta_1)} \quad (6)$$

Ko'ndalang kesimning istalgan  $m$  nuqtasi uchun

$$\frac{1}{\gamma_m} = \frac{l_m}{l_1} = \frac{(\frac{\sigma_1}{E_1} + \delta_1)}{(\frac{\sigma_m}{E_m} + \delta_m)} \quad (7)$$

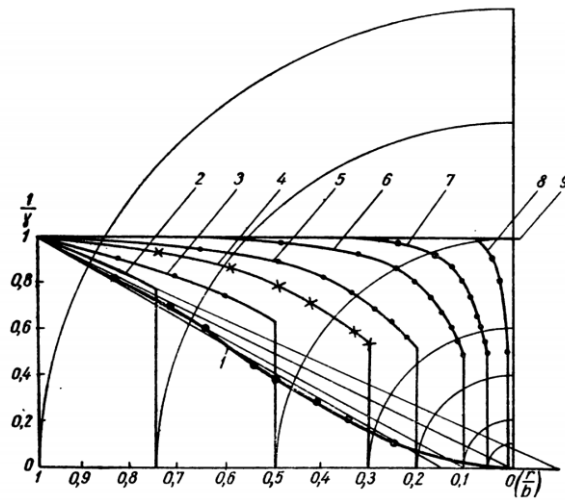
bu yerda  $l_1$  – ko'ndalang bruslar AB va CD orasidagi tola uzunligi, uzunlikning o'lchov birligi sifatida qabul qilinadi.

Sterjenli tizimdan yaxlit jismga o'tsak, unda ma'lumki,  $\frac{1}{\gamma_m}$  funksiya ko'rib chiqilayotgan bosh kuchlanish va jismning yuklanish holati uchun gipotetik kesim turini aniqlaydi.

Demak, agar ko'rib chiqilayotgan masalada silindrning tashqi sirtidagi tola uzunligi  $l_1$  ni o'lchov birligi sifatida qabul qilsak, unda (1) – (7) tenglamalardan quyidagini aniqlaymiz:

$$\frac{1}{\gamma} = \frac{2}{1 + \left(\frac{b}{r}\right)^2} \quad (8)$$

Har xil  $\left(\frac{b}{r}\right)$  nisbatlar uchun  $\frac{1}{\gamma}$  ning (7) tenglama bo'yicha hisoblangan qiymati 1-jadvalda va 3-rasmda (1 egri chiziq) keltirilgan.



3-rasm.  $\left(\frac{b}{r}\right)$  nisbatga bog‘liq ravishda yuqqa devorli silindr uchun  $\frac{1}{\gamma}$  funksiyaning qiymatlari.

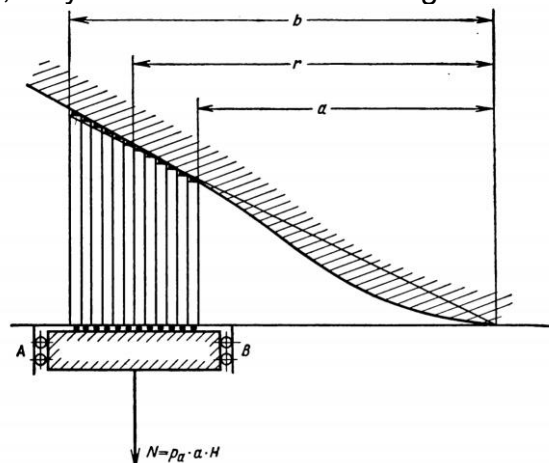
1-jadval

$\left(\frac{b}{r}\right)$  nisbatga bog‘liq ravishda yuqqa devorli silindr uchun  $\frac{1}{\gamma}$  funksiyaning qiymatlari

$\frac{b}{r}$	1	1,2	1,4	1,6	1,8	2,0	2,5	3,0	4	5	10	$\infty$
$\frac{1}{\gamma}$	1	0,8197	0,6757	0,5618	0,4525	0,4000	0,276	0,2000	0,1177	0,0769	0,02	0,00
$\gamma$	1	1,22	1,48	1,78	2,21	2,5	3,63	5,00	8,50	13,1	50	$\infty$

Shunday qilib, silindrdagi (2-rasm) aylanma kuchlanishlarni aniqlash masalasi 4-rasmda keltirilgan sterjenli tizimdagi kuchlanishlarni aniqlash bo‘yicha masalaga almashtirilishi mumkin.

Bu rasmda aylanma kuch  $N$  orqali belgilangan, bu muvozanat shartiga bog‘liq ravishda  $P_a \cdot aH$  ko‘paytmaga teng, bu yerda  $H$  – silindr balandligi.



4-rasm. Statik noaniq sterjen tizimi.

Sterjenli tizimdagi kuchlanishni (4-rasm) agar (8) formula bilan aniqlasak, fikrlarimizning to‘g‘riligiga ishonch hosil qilishimiz mumkin:

$$\sigma_t = \frac{N\gamma}{H \int_a^b \gamma dr} = \frac{P_a a \left[1 + \left(\frac{b}{r}\right)^2\right]}{\int_a^b \left[1 + \left(\frac{b}{r}\right)^2\right] dr} = \frac{P_a a^2}{b^2 - a^2} \left[1 + \left(\frac{b}{r}\right)^2\right],$$

Bu (1) yechim bilan to‘liq mos keladi.



b) Silindr faqat tashqi bosimga duch keladi.  
 Aniq yechimga muvofiq, ko'ndalang kesimning istalgan nuqtasida [10],

$$\sigma_t = -\frac{P_b b^2}{b^2 - a^2} \left[ 1 + \left( \frac{a}{r} \right)^2 \right], \tag{9}$$

Silindrning ichki sirtida ( $r = a$ )

$$\sigma_t = -\frac{P_b b^2}{b^2 - a^2}, \tag{10}$$

Tashqi sirtida esa ( $r = b$ )

$$\sigma_t = -\frac{P_b b^2}{b^2 - a^2} \left[ 1 + \left( \frac{a}{b} \right)^2 \right] \tag{11}$$

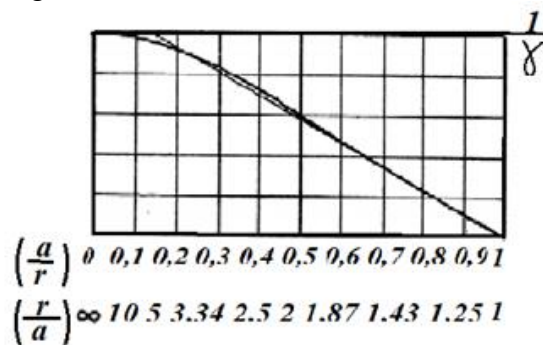
Agar gipotetik kesimlar orasida bog'langan tolalar uzunligining o'lchov birligi sifatida silindrning ichki sirtidagi tolalar uzunligini qabul qilsak, unda:

$$\frac{1}{\gamma} = \frac{2}{1 + \left( \frac{a}{r} \right)^2}, \tag{12}$$

Agar tashqi sirtida bo'lsa,

$$\frac{1}{\gamma} = \frac{1 + \left( \frac{a}{b} \right)^2}{1 + \left( \frac{a}{r} \right)^2}, \tag{13}$$

$\frac{a}{r}$  ning har xil nisbatlari uchun (9) formula bo'yicha hisoblangan  $\frac{1}{\gamma}$  ning qiymati 2-jadvalda va 5-rasmda keltirilgan.



5-rasm.  $\frac{a}{r}$  nisbatga bog'liq ravishda yupqa devorli silindr uchun  $\frac{1}{\gamma}$  funksiyaning qiymatlari.

2-jadval

$\frac{a}{r}$  nisbatga bog'liq ravishda qalin devorli silindr uchun  $\frac{1}{\gamma}$  funksiyaning qiymatlari.

$\frac{a}{r}$	1	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	od	0,0
$\frac{1}{\gamma}$	1	1,105	1,220	1,343	1,471	1,600	1,725	1,835	1,92 4	1,98	2,000,
$\gamma$	1	0,905	0,82	0,745	0,68	0,625	0,58	0,543	0,52	0,505	0,500

$\frac{a}{r}$  va  $\frac{a}{b}$  ning har xil nisbatlari uchun  $\frac{1}{\gamma}$  ning quyidagi formula bo'yicha hisoblangan qiymatlari:

$$\frac{1}{\gamma} = \frac{1 + \left( \frac{a}{b} \right)^2}{\left( \frac{a}{r} \right)^2}, \tag{14}$$



3-jadvalda va 3-rasmda keltirilgan (2 – 8 egri chiziqlar).

**3-jadval**

**Qalin devorli silindrdagi  $\frac{a}{r}$  va  $\frac{a}{b}$  nisbatlarga bog'liq ravishda  $\sigma_t$  uchun  $\frac{1}{\gamma}$  funksiyaning qiymatlari**

$\frac{a}{b}$	$\frac{a}{r}$												
	1	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0,05	0,01	
0,75	0,782	0,863	0,953	-	-	-	-	-	-	-	-	-	-
0,5	0,625	0,691	0,763	0,839	0,919	1,000	-	-	-	-	-	-	-
0,3	0,545	0,602	0,665	0,732	0,801	0,872	0,940	1,000	—	—	—	—	—
0,2	0,520	0,575	0,635	0,698	0,765	0,832	0,897	0,954	1,000	—	—	—	—
0,1	0,505	0,558	0,616	0,668	0,743	0,808	0,871	0,926	0,972	1,000	—	—	—
0,05	0,503	0,556	0,613	0,664	0,740	0,803	0,867	0,923	0,966	0,995	1,000	—	—
0,01	0,500	0,552	0,609	0,672	0,736	0,800	0,862	0,918	0,962	0,991	0,997	1,000	1,000

3- va 5-rasmlardan ko'rinib turibiki,  $\frac{a}{b}$  va  $\frac{a}{r}$  nisbatlar 1 dan 0,6 gacha chegaralarda o'zgarganda  $\gamma$  funksiya quyidagi ifodalardan yanada aniqroq topilishi mumkin: Silindrni ichki bosimdan hisoblashda:

$$\gamma = \frac{b}{r}; \tag{15}$$

silindrni tashqi bosimdan hisoblashda:

$$\gamma = \frac{a}{r} \tag{16}$$

(10) va (11) ifodalar nafaqat (1) va (9) formulalarni soddalashtiribgina qolmasdan, balki tashqi yuklamalar birgalikda ta'sir qilganda va turli jinsli silindr kesimi bo'ylab harorat ixtiyoriy taqsimlanganda silindrdagi kuchlanish va siljishlarni hisoblash uchun qulay formulalarni olish imkonini beradi. [3]

Masalan, agar silindr faqat ichki bosimga duch kelsa, unda (8) formula bo'yicha aylanma kuchlanish:

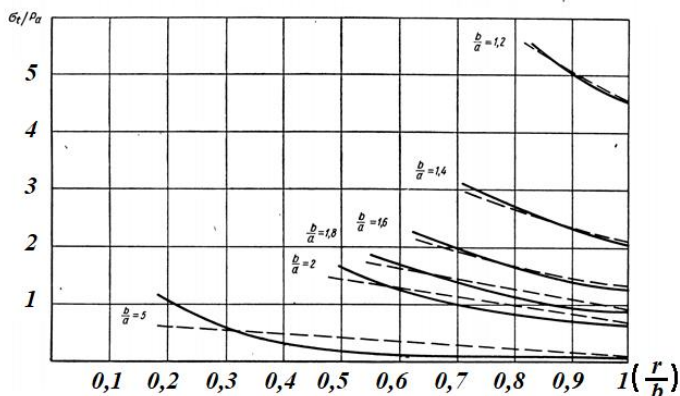
$$\sigma_t = \frac{N_\gamma}{H \int_a^b \gamma dz} = \frac{P_a a \frac{b}{r}}{b \int_a^b \frac{b dr}{r}} = \frac{P_a a}{r \ln \frac{b}{a}}, \tag{17}$$

Aniq formula (1) va taqribiy formula (8) bo'yicha hisoblangan kuchlanishlarning grafiklari 6-rasmda qurilgan. Aniq yechim (1) ni taqribiy yechim (8) bilan almashtirishdan silindrning tashqi va ichki sirtlaridagi kuchlanishlarni aniqlashdagi xatoliklarning qiymatlari % larda 4-jadvalda keltirilgan.

**4-dajval**

**Kuchlanishlarni (12) formula bo'yicha hisoblashda yo'l qo'yilgan xatoliklar.**

$\frac{b}{r}$ nisbat	1,2	1,4	1,5	1,6	1,8	2	5
Tashqi sirtidagi xatolik, %	-1,02	-3,63	-5,0	-6,78	-10,1	-13,4	-42,67
Ichki sirtidagi xatolik, %	+0,53	+1,9	+2,8	+3,7	+5,9	+8,1	+14,9



**6-rasm. Yupqa devorli silindrdagi tangensial kuchlanish: masalaning aniq va taxminiy yechilishi.**

Shunday qilib, quyidagi formulalardan foydalanib:

$$\gamma = \frac{b}{r}; \tag{18}$$

$$\sigma_t = \frac{N_\gamma}{H \int_a^b \gamma dz} = \frac{P_a a \frac{b}{r}}{b \int_a^b \frac{b dr}{r}} = \frac{P_a a}{r \ln \frac{b}{a}}. \tag{19}$$

amaliy hisoblashlarda  $\frac{b}{r} \leq 1,55$  nisbatni qabul qilish mumkin. Bunda xatolik 5% dan oshmaydi.

Tashqi va ichki bosimdan radial kuchlanish  $\sigma_r$  (6 va 7-rasmlar) silindr kesimining istalgan nuqtasi uchun mos keladigan quyidagi formula yordamida aniqlanadi:

$$A = \sigma_r + \sigma_t = const. \tag{20}$$

Silindrning tashqi sirtidagi radial kuchlanish  $P_b$  ga teng, ichki sirtida esa  $P_a$  ga teng.

Masalan, agar silindr faqat ichki bosim  $P_a$  ga duch kelsa, unda radial kuchlanish  $\sigma_r$  quyidagicha aniqlanadi.

Tashqi srtidagi bosim  $P_b = 0 = 0$ , shuning uchun

$$(\sigma_r)_{r=b} = 0 \text{ i } A = \frac{P_a a}{b \ln \frac{b}{a}}$$

$$A = \sigma_r = +\sigma_t = cons. \tag{21}$$

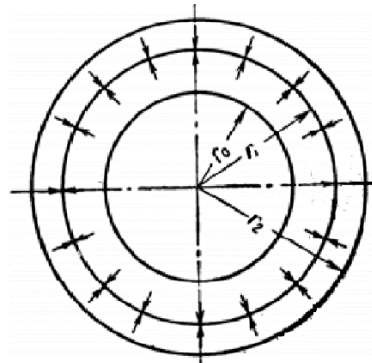
tenglamadan quyidagini topamiz:

$$\sigma_r = A - \sigma_t = \frac{P_a a}{b \ln \frac{b}{a}} - \frac{P_a a}{r \ln \frac{b}{a}}$$

yoki

$$\sigma_r = \frac{P_a a}{\ln \frac{b}{a}} \left( \frac{1}{b} - \frac{1}{r} \right), \tag{22}$$

Bir jinsli silindr yuklanishining har xil holatlari uchun  $\gamma$  funksiyaning qiymatlariga ega bo'lgan holda, elastiklik xossalari silindrning qalinligi bo'yicha o'zgaradigan holatlardagi kuchlanish va siljishlarni tadqiq qilish mumkin.



**7-rasm. Har xil jinsli yupqa devorli silindr**

Ko'ndalang kesimi 7-rasmda ko'rsatilgan silindr uchun kuchlanishlar va siljishlar formulasini yozish talab qilingan bo'lsin. Bu yerda  $r_0, r_1, r_2, \dots, r_m, \dots, r_n$  orqali silindr tayyorlangan har xil jinsli qatlamlarning ichki va tashqi radiuslari belgilangan. Har bir qatlam uchun elastiklik moduli:  $E_1, E_2, \dots, E_m, \dots, E_n$ . Barcha qatlamlar uchun ko'ndalang deformatsiya koeffitsiyentlari bir xil qabul qilinadi, buni quyida keltirilgan yechimlardan foydalanganda nazarda tutish kerak.

Silindr ichki bosimga duch kelgan,  $P_a$ .

Masalani ikkita holatlar uchun yechamiz:  $\gamma = \frac{1 + (\frac{b}{r})^2}{2}$  (8) va  $\gamma = \frac{b}{r}$  funksiyalari [taqribiy yechimi (18).]

1-holat.  $\gamma = \frac{1 + (\frac{b}{r})^2}{2}$  funksiyasi.

Istalgan  $t$  qatlam uchun tangensial kuchlanish (8) formulaga mos keladi, ya'ni:

$$\begin{aligned} \sigma_{t(m)} &= \frac{N_{\gamma m} E_m}{H \int_a^b \gamma_i E_i dr} = \frac{P_a r_0 \left(1 + \frac{r_n^2}{r^2}\right) E_m}{r \int_{r_0}^n \left(1 + \frac{r_n^2}{r^2}\right) E dr} \\ &= \frac{P_a r_0 \left(1 + \frac{r_n^2}{r^2}\right) E_m}{E_1 \left[ (r_1 - r_0) + r_n^2 \int_{r_0}^{r_1} \frac{dr}{r^2} \right] + E_2 \left[ (r_2 - r_1) + r_n^2 \int_{r_1}^{r_2} \frac{dr}{r^2} \right] + \dots +} \\ &\rightarrow \frac{P_a r_0 \left(1 + \frac{r_n^2}{r^2}\right) E_m}{E_n \left[ (r_n - r_{n-1}) + r_n^2 \int_{r_{n-1}}^{r_n} \frac{dr}{r^2} \right]} \end{aligned}$$

yoki

$$\sigma_{t(m)} = \frac{P_a r_0 \left[1 + \frac{r_n^2}{r^2}\right]}{E_1 (r_1 - r_0) \left(1 + \frac{r_n^2}{r_0 r_1}\right) + E_2 (r_2 - r_1) \left(1 + \frac{r_n^2}{r_1 r_2}\right) + \dots + E_n (r_n - r_{n-1}) \left(1 + \frac{r_n^2}{r_{n-1} r_n}\right)} \rightarrow \frac{P_a r_0 \left[1 + \frac{r_n^2}{R^2}\right] E_m}{+ E_n (r_n - r_{n-1}) \left(1 + \frac{r_n^2}{r_{n-1} r_n}\right)}$$

Radial kuchlanishni quyidagi shartlardan aniqlaymiz:

1. Har bir  $m$  qatlam chegarasida  $\sigma_{r(m)} + \sigma_{tm} = const.$
2. Ikkita yondosh qatlamlarning tutashish sirtlaridagi radial kuchlanishlar teng.
3. Tarkibiy silindrning ichki sirtidagi radial kuchlanish  $\sigma_{r_0} = -P_a$  va tashqi sirtidagi radial

kuchlanish  $\sigma_{r_n} = -P_b$ .

2-holat.  $\gamma = \frac{b}{r}$  funksiyasi.

$$\sigma_{t(m)} = \frac{N_{\gamma m} E_m}{H \int_{r_0}^{r_n} \gamma_i E_i dr} = \frac{P_a r_0 \frac{r_n}{r} E_m}{r_n \left( E_1 \ln \frac{r_1}{r_0} + E_2 \ln \frac{r_2}{r_1} + \dots + E_n \ln \frac{r_n}{r_{n-1}} \right)}$$

yoki

$$\sigma_{t(m)} = \frac{P_a r_0 E_m}{r \left( E_1 \ln \frac{r_1}{r_0} + E_2 \ln \frac{r_2}{r_1} + \dots + E_n \ln \frac{r_n}{r_{n-1}} \right)}$$

## Xulosa

Shunday qilib, silindrning oxiridagi eng katta cho'zuvchi kuchlanishining qiymati yon yuzadan ma'lum masofada uzoqda joylashgan nuqtalardagi mos keladigan kuchlanishdan 25% ga katta; kesimning silindr yon yuzasidan uzoqlashish kattaligiga qarab silindr sirtlaridagi o'q yo'nalishidagi va tangensial kuchlanishlarning o'zgarishi grafiklari keltirilgan. Silindrning uchlaridagi haroratli o'q yo'nalishidagi va tangensial kuchlanishlarning so'nish grafiklari silindrning yon yuzalaridan teng yoki undan kattaroq masofada joylashgan har qanday kesma nuqtasi uchun mos keladi;





$\sigma_t + \sigma_r = \sigma_z$  sharti  $\sigma_z$  va  $\sigma_t$  ning ma'lum qiymatlarida radial kuchlanishlarni hisoblash va ma'lum bo'lgan o'q yo'nalishidagi kuchlanishda silindr yuzasidagi tangensial kuchlanishlarni aniqlash uchun ishlatilishi mumkin.

### Foydalanilgan adabiyotlar ro'yxati:

[1], Писаренко Г.С., Квитка О.Л., Уманский Е.С. Сопротивление материалов. – Киев: Высшая школа, 2004. – 655 с.

[2], Корн Г. Справочник по математике / Г. Корн, Т. Корн. – М.: Наука, 1978. – 832 с.

[3], Башкатов А.В. Напряжения и деформации при сварке. Воронеж. Изд. ВГТУ. 1999.

[4], Hosford, William F. 2005. "Residual Stresses." In Mechanical Behavior of Materials, 308–321. Cambridge University Press.

[5], Cary, Howard B. and Scott C. Helzer (2005). Modern Welding Technology. Upper Saddle River, New Jersey: Pearson Education.

[6], Shajer, Gary S. 2013. Practical Residual Stress Measurement Methods. Wiley.

[7], Самуль В.И. Основы теории упругости и пластичности / В.И. Самуль. – М.: Высшая школа, 1982. – 264 с.

[8], Устиненко В.Л. Основы проектирования деталей машин / В.Л. Устиненко, Н.Ф. Киркач, Р.А. Баласанян. – Харьков: Вища школа, изд-во при Харьк. ун-те, 1983. – 184 с.

[9], Постольник Ю.С., Тимошпольский В.И., Трусова И.А., Дубина О. В. Тепловые процессы при затвердевании крупных стальных слитков // Литье и металлургия. 2000. № 1. С. 53-55.

[10], Постольник Ю.С., Огурцов А. П. Нелінійна прикладна термомеханіка. Киев: НМЦ ВО МОНУ, 2000.

[11], Тимошпольский В.И., Постольник Ю.С., Андрианов Д.Н. Теоретические основы теплофизики и термомеханики в металлургии. Мн.: Беларуская навука, 2005.

[12], Закономерности образования трещин в сортовых заготовках при нагреве в печах с шагающими балками / В.И. Тимошпольский [и др.] // Сталь. 2004. № 7. С. 49-52.

[13], Nazirjon Safarov, Akbar Abrorov, and Laziz Abdullaev AAPM-2023 "Dynamik analysis of physical and mechanical forces of acting on the needle of a shoe sewing mashine in the process of sewing leather" Journal of Phvsics: Conference Series. 2573 012036 View the article online for updates and enhancements 244th ECS Meeting Gothenburg, Sweden. Oct.8-12.2023 Register and join us in advancing science 2573(2023) 012036.

[14], Akbar Abrorov, Nazirjon Safarov, Fazliddin Kurbonov, Matluba Kuvoncheva, Khasan Saidov Mathematical model of hardening the disk-shaped saw teeth with laser beams. Participated in the II International Scientific Conference on "ASEDU-II 2021: Advances in Science, Enjineering Digital Education" on Oktober 28. 2022 / Krasnoyarsk. Russia.

[15], Nazirjon Safarov, Ilkhomjon Mirsultonov Development of Mathematical Model of Drying the Raw Cotton During Transportation In Pipeline By Hot Air Flow. Participated in



the II International Scientific Conference on “ASEDU-II 2021: Advances in Science, Engineering Digital Education” on October 28. 2022 / Krasnoyarsk. Russia.

**[16]**, Nazirjon Safarov, Iroda Mukhammadjanova, Mukhammadali Kabulov  
Mathematical model of the process of vertical drying of raw cotton in the hot airflow. Participated in the II International Scientific Conference on “ASEDU-II 2021: Advances in Science, Engineering Digital Education” Krasnoyarsk. Russia.

**[17]**, Nazirjon Safarov, (phd) Abduvali Majidov, Ilxom Mirsultanov. Calculation of change of stock moisture content of the drying agent in the process of drying raw cotton in solar drying equipment. Participated in the III International Scientific Conference on Metrological Support of innovative Tehnologies (ICMSIT-III-2022) on March 3-6, / St. Petersburg-Krasnoyarsk. Russia.