SH.M.ISABOYEV

PhD.M.B.BOYTEMIROV

Materiallar qarshiligi fanidan

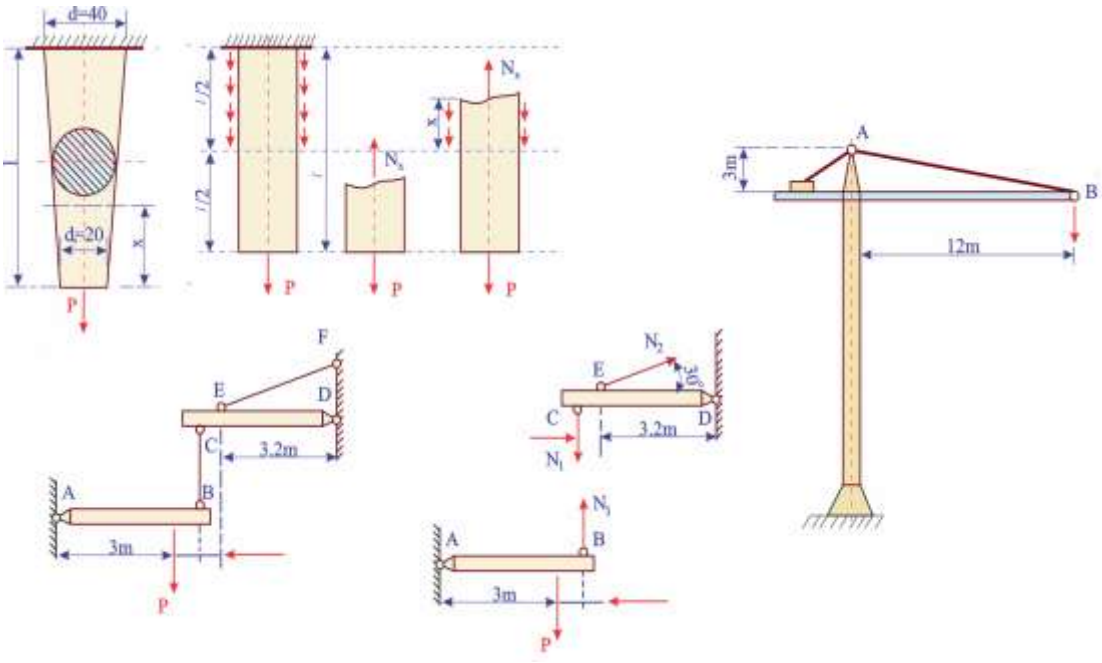
“Cho`zilish va siqilishda statik aniq masalalarni hususiy hollari”

mavzusida amaliy mashg`ulot uchun tayyorlangan

USLUBIY KO`RSATMA

60711300-Metrologiya, standartlashtirish va mahsulot sifati menejmenti(tarmoqlar bo`yicha)

(sirtqi bo`lim talabalari uchun)



Namangan-2022 y

Mazkur uslubiy ko`llanma, oliy texnika o‘quv yurtlarining tegishli dasturlariga mos ravishda tuzilgan bo`lib, u cho`zilish va siqilish deformatsiyasi bo`limidagi static aniq masalalarni hususiy hollari mavzusiga oid tayyor ishlangan masalalar hamda mustaqil ishlash uchun topshiqlar keltirilgan.

Ushbu uslubiy qo`llanma oliy texnika o‘quv yurtlarini *60711300-Metrologiya, standartlashtirish va mahsulot sifati menejmenti(tarmoqlar bo`yicha) (sirtqi bo`lim talabalari uchun)* mo‘ljallangan.

Tuzuvchilar: PhD. M.B.Boytemirov

Sh.M.Isaboyev

Taqrizchilar: **t.f.n. U.G`.Dexqonov-**
“Materiallar qarshiligi va mexanika”
kafedrasi dotsenti

Phd.N.Nishonov- Mexanika va inshootlar seysmik mustahkamligi instituti laboratoriya mudiri, texnika fanlari boyicha falsafa doktori

Uslubiy ko`rsatma “Materiallar qarshiligi va mexanika” kafedrasining umumiy yig`ilishida muhokama qilingan.

Bayon: _____ “__” _____2022 yil.

Ushbu uslubiy ko`rsatma institut o`quv-uslubiy kengashining “__” _____ 2022-yildagi __ - sonli yig`ilishida ko`rib chiqilgan va chop etishga tavsiya etilgan.

KIRISH

Oliy ta’lim tizimini kelgusida yanada takomillashtirish va kompleks rivojlantirish bo‘yicha eng muhim vazifalar etib, yangi avlod o‘quv adabiyotlarini yaratish va ularni oliy ta’lim muassasalarining ta’lim jarayoniga keng tatbiq etish, oliy ta’lim muassasalarini zamonaviy o‘quv, o‘quv-metodik va ilmiy adabiyotlar bilan ta’minlash, shu jumladan, eng yangi xorijiy adabiyotlar sotib olish va tarjima qilish, axborot-resurs markazlari fondlarini muntazam yangilab borish alohida belgilab berilgan.

Qarorning bir qator bandlari ijrosini ta`minlash va amalga oshirish, oliy ta`lim muassasalari professor-o`qituvchilar jamoasiga ham bir qator mas`uliyatli vazifalar belgilangan.

Ayniqsa “Materiallar qarshiligi” fanining barcha bo`limlari bo`yicha talabalar tomonidan o`z bilimlarini mustaqil tekshirish, o`zlashtirib olishlariga, ko`nikma va malakalarni ularda shakllantirish, kerakli o`quv materialini mustaqil izlash va topishga, amaliy faoliyatlarida mazkur o'quv-uslubiy qo`llanma samara beradi deb hisoblaymiz.

O'quv-uslubiy qo`llanma Oliy va o`rta maxsus ta`lim vazirligi tomonidan tasdiqlangan «Materiallar qarshiligi» fani bo`yicha davlat ta`lim standarti, namunaviy va ishchi dasturlari asosida tayyorlangan. Oliy texnika o`quv yurtlari talabalarining tasavvurini kengaytirishga, bilimlarni mustaqil o`zlashtirib olishga, dastlabki bilimlarini rivojlantirishga va chuqurlashtirishga mo`ljallab tayyorlandi

Semestr davomidagi topshiriqlarining maqsadi nazariy bilimlarni mustahkamlash, mustaqil ish ko'nikmalarini va konstruksiyalarning mustahkamligi va bikrligigini baholash muammolarini hal qilish tajribasini egallashdir.

MATERIALLAR QARSHILIGI FANIDA FOYDALANILADIGAN KATTALIKLAR VA ULARNING O‘LCHOV BIRLIKLARI

Bugungi kunda asosiy fizik kattaliklarni o‘lchashda Xalqaro SI birliklar sistemasining o‘lchov birliklarini ishlatish to‘g‘ri deb hisoblanadi. SI sistemasining mexanik kattaliklarni o‘lchash uchun ishlatiladigan birliklarini MKGSS sistemasidan prinsipial farqi shundaki, SI sistemasida massa birligi asosiy o‘lchov birlik bo‘lib, kuch birligi undan kelib chiqadigan birlik hisoblanadi. MKGSS sistemasida esa buning aksidir.

Materiallar qarshiligida ishlatiladigan SI sistemasining asosiy birliklari quyidagilardan iborat: uzunlik – metr (m) da, massa – kilogram (kg) da, vaqt – sekund (sek) da, yassi burchak – radian (rad) da o‘lchanadi.

Bu sistemada qo‘shimcha birliklar esa quyidagi o‘lchov birliklarda o‘lchanadi:

Yuza (F) – metr kvadrat (m^2) da

Hajm (V) – metr kub (m^3) da

Zichlik (ρ) – kilogram bo‘lingan metr kub (kg/m^3) da

Tekis shaklning statik momentlari (S) va qarshilik momentlari (W) – metr kub (m^3) da

Tekis shaklning inersiya momentlari (I) – metr to‘rtinchi daraja (m^4) da

Tezlik (v) – metr bo‘lingan sekund (m/sek) da

Tezlanish (w) – metr bo‘lingan sekund kvadrat (m/sek^2) da

Burchak tezligi (ω) – radian bo‘lingan sekund (rad/sek) da

Burchak tezlanishi (w) – radian bo‘lingan sekund kvadrat (rad/sek^2) da

Kuch (P) – Nyuton (N) da

Kuch momenti (M) – Nyuton ko‘paytirilgan metr ($N \cdot m$) da

Kuchlanish (σ yoki τ) – Nyuton bo‘lingan metr kvadrat (N/m^2) da

Ish, energiya (A, P, T) – joul (j) da

Quvvat (N) – vatt (vt) da

Solishtirma og‘irlik (γ) – Nyuton bo‘lingan metr kub (N/m^3) da

Chastota (f) – gers (gs) da

Davr (T) – sekund (sek) da

Elastiklik (Yung) moduli (E) – Nyuton bo‘lingan metr kvadrat (N/m^2) da

Siljishdagi elastiklik moduli (G) – Nyuton bo‘lingan metr kvadrat (N/m^2) da

Absolyut deformatsiya ($\Delta\ell$) – metr (m) da

Nisbiy deformatsiya (ε) – o‘lchovsiz kattalik

Puasson koeffitsienti (μ) – o‘lchovsiz kattalik

Bu birliklarning ba’zilarini karrali yoki ulushli birliklari mavjud bo‘lib, ular shu birliklarning oldiga quyidagi qo‘shimchalarni qo‘shish orqali, ya’ni: Mega (M) – 10^6 ga , kilo (k) – 10^3 ga, detsi (d) – 10^{-1} ga, santi (s) – 10^{-2} ga, milli (m) – 10^{-3}ga, mikro (mk) – 10^{-6} ga ko‘paytirish orqali hosil qilinadi.

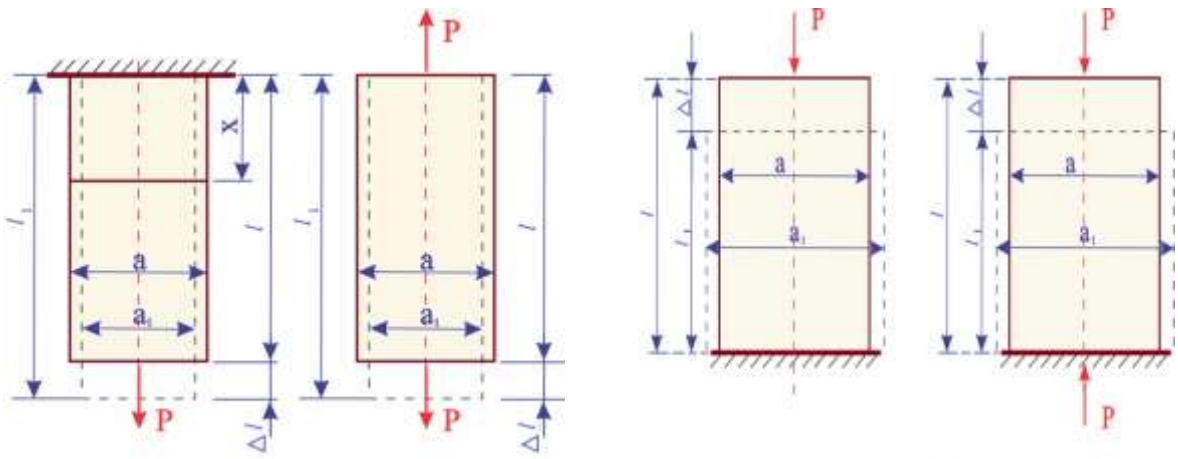
Materiallar qarshiligida uchraydigan ba’zi kattaliklarni odatdagi sistemaga kirmagan birliklarda o‘lchanishi ham amaliyotda ko‘p uchrab turadi. Bu holda bu birliklar orasida o‘zaro quyidagicha bog‘lanish borligini e’tiborga olish kerak.

MKGSS va SGS birliklar sistemalari va sistemaga kirmagan birliklar	SI birliklar sistemasi	MKGSS va SGS birliklar sistemalari va sistemaga kirmagan birliklar	SI birliklar sistemasi
1	2	3	4
Yuza birligi		**Hajm birligi**	
1 sm^2	10^{-4} m^2	1 sm^3	10^{-6} m^3
Tekis shaklning statik va qarshilik momentlari o‘lchov birligi		**Kuch momenti va juft kuch momentining birliklari**	
1 sm^3	10^{-6} m^3	1 kilogramm-kuch×metr (*kgk·m*)	9,81Nm≈10 *Nm*
		1 kilogramm-kuch× santimetr (*kgk·sm*)	0,0981 *Nm*≈ ≈10^{-1} *Nm*
Tekis shakl inersiya momentlarining o‘lchov birligi		**Solishtirma og‘irlik birliklari**	
1 sm^4	10^{-8} m^4	1 tk/m^3yoki 1 gk/sm^3	9,81.10^3 *N*/m^3 ≈ ≈ 10^4 *N*/m^3
		1 kgk/sm^3	9,81.10^6 *N*/m^3 ≈ ≈ 10^7 *N*/m^3

1	2	3	4
Massa birliklari		**Ish va energiya birliklari**	
1 tonna (*t*)	10^3 kg	1 kilogramm-kuch ·metr (*kgk · m*)	9,81≈ 10 *J*
1 sentner (*s*)	10^2 kg	1 *kvt/ soat*	3,6 . 10^6 *J*
		1 *erg*	10^{-7} *J*
Burchak tezligining o‘lchov birliklari		**Quvvat birliklari**	
1 minutda aylanish soni (*ayl/min*)	$\frac{\pi}{30}$ *rad/sek*	1 kilogramm-kuch×metr bo‘lingan sekund (*kgk· m/sek*)	9,81≈ 10 *vt*
		1 ot kuchi (o.*k.*)	735,5 *vt*
1 *ayl/sek*	2π *rad/ sek*	1 *erg/sek*	10^{-7} *vt*
Kuch birliklari		**Bosim yoki kuchlanishning o‘lchov birliklari**	
1 tonna-kuch (*tk*)	9,81.10^3≈10^4 *N*	1 bar	10^5 *N*/m^2
1 kilogramm-kuch (*kgk*)	*9,81*≈10N	1 kgk/sm^2 = 1 *atm*	9,81.10^4≈10^5 *N*/m^2 ≈ ≈0.1MPa
1 dina (*dina*)	≈10^{-5} N	1 *kgk/*m^2	9,81≈ 10 *N*/m^2 ≈ ≈10Pa
		1 *tk/*m^2	≈10000Pa

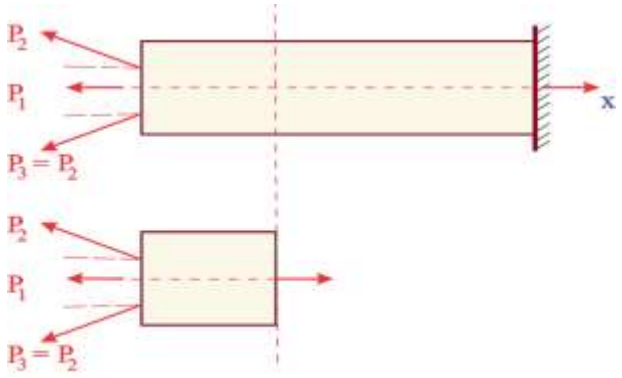
1. Asosiy tushuncha va bog`lanishlar

1.1-rasmda brusning chozilishi, 1.2-rasmda esa siqilishining eng oddiy hollari ko`rsatilgan. Chozilish-siqilish brus ko`ndalang kesimida hosil bo`ladigan vaqtincha bo`ylama (normal) kuchga keltiriladi va N_x (yoki N) bilan belgilanadi.



1.1 1.2

Bo`ylama kuch $N_x$ kesimlar usuli bilan aniqlanad; u son jihatidan fikran o`tkazilgan kesimning (1-3 rasm) bir tomonida joylashgan barcha tashqi kuchlarning brus bo`ylama o`qi (Ox)ga proyeksiyalarining algebraic yig`indisida teng. Cho`zilishda $N_x \succ 0$ siqilishda esa $N_x \prec 0$ deb hisoblash qabul qilingan.



1.3

Cho`zilish-siqilishda brusning ko`ndalang kesimida faqat normal kuchlanish hosil bo`ladi va u ushbu formula yordamida aniqlanadi;

$$\sigma = \frac{N_x}{F};$$

bu yerda; F-brus ko`ndalang kesimining yuzasi,

N_x uchun ishoralar qoidasi qanday tadbiq etilsa, -normal kuchlanish uchun ham shunday tadbiq etiladi. Kuchlanishning o'lchami: kuch/uzunlik^2 bo`lib, o`lchov birliklar kg/sm^2 yoki kg/mm^2.

Xalqaro birliklar tizimida foydalanilgan baziy birlik-n/m^2, shuningdek, karrali va ulushli birliklar kN/m, MN/m^2, N/mm^2, N/sm^2. Brusning endi nisbiy uzayishi (yoki siqilishi) 1.1-rasm (yoki 1.2)dan aniqlanadi: $\varepsilon = \frac{\Delta l}{l}$

bu yerda $\Delta l = l_1 - l$ - brusning absolyut uzayishi (yoki absoyut qisqarishi);

l-brusning dastlabki uzunliga.

Brus ko`ndalang o`lchamining nisbiylik o`zgarishi:

$$\varepsilon^I = \frac{\Delta a}{a};$$

bu yerda $\Delta a = a_1 - a$

Cho`zilishda endi $\varepsilon \succ 0$ deb hisoblanadi, binobarin $\varepsilon \prec 0$ siqilishda esa, aksincha.

ε va ε^I kattaliklar chiziqli deformasiyalar ham deb ataladi.

ε^I ning ε ga nisbatining absolyut kattaligi ko`ndalang deformatsiya koeffitsienti yoki Puasson koeffitsienti deyiladi.

$$\mu = \frac{\varepsilon^I}{\varepsilon};$$

Barcha uzatrop materiallar uchun Puasson koeffitsientining kattaligi

$$0 \le \mu \le 0{,}5$$

Nisbiy uzayish bilan normal kuchlanish orasida bog`lanish mavjuddir:

$$\sigma = E\varepsilon$$

bu munosabat cheklanish Guk qonuning analitik ifodasidir.

Bu yerda E-bo`ylama elastiklik moduli yoki birinchi tur elastiklik moduli; E-ning o`lchami huddi kuchlanish kabidir.

Brusning mutloq uzayishi (qisqarishi) F=const va $N_x = const$ bo`lganda quyidagi formula yordamida aniqlanadi:

$$\Delta l == \frac{N_x \cdot l}{EF};$$

N_x va F o`zgaruvchaan (yoki, ulardan bir o`zgaruvchi) bo`lganda

$$\Delta l = \int \frac{N_x \cdot dx}{EF};$$

umumiy xolda, N_x va F ning o`zgarish qonuni brusning alohida uchastkasi uchun turlicha b`olganda

$$\Delta l == \sum_{i=1}^{i=k} \int_i^l \frac{N_x \cdot dx}{EF};$$

Bundan xususiy hol sifatida quyidagi formula hosil bo`ladi:

$$\Delta l = \sum_{i=1}^{i=k} \int_i^l \frac{N_{xi} \cdot l_i}{E_i F_i};$$

bu formula bo`ylama kuch va kesim yuzi brusning alohida uchastka oralig`ida o`zgarmas deb hisoblanganda islatiladi (1.1-misolga qarang).

Brusning qandaydir ikki ko`ndalang kesimning o`zaro siljishi uning shu kesimlar orasidagi qismining uzayishi (qisqarishi)ga teng bo`ladi.

Mustahkamlik sharti:

$$\sigma = \frac{N_x}{F} \le [\sigma];$$

bu yerda σ , N_x -havfli ko`ndalang kesim (ya`ni eng katta kuchlanish hosil bo`ladigan kesim)dagi normal kuchlanish va bo`ylama kuch;

F-havfli kesim yuzisi;

$[\sigma]$-ruxsat etilgan kuchlanish.

Ko`ndalang kesimning kerakli yuzi quyidagi formula yordamida aniqlanadi:

$$F \ge \frac{N_x}{[\sigma]};$$

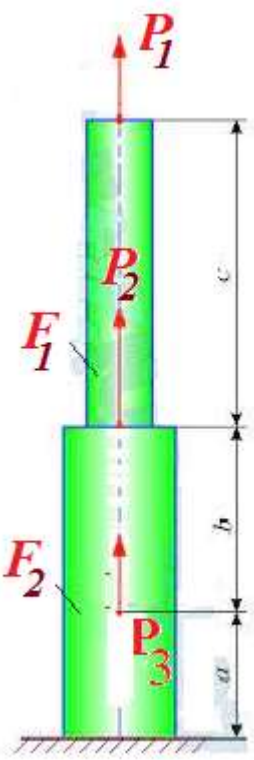
Bo`ylama kuchning ruxsat etilishi mumkin bo`lgan(xavfsiz) miqdorini aniqlash formulasi:

$$[N_x] = F \cdot [\sigma]$$

Kesish usuli asosida bo`ylama kuch $N_x$ni aniqlaymiz.

2. Cho`zilish va siqilishning statik aniq xollari.

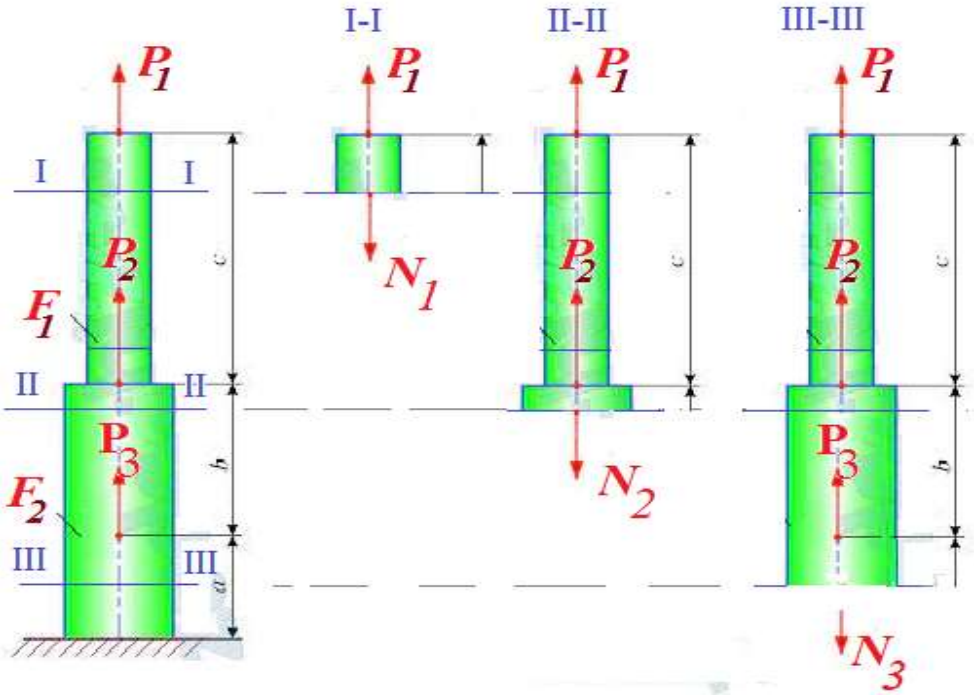
1.misol. Bizga $P_1 = 80kN$, $P_2 = 100kN$, $P_3 = 200kN$ siquvchi tashqi kuch ta`sirida turgan ustun berilgan bo`lsin. Ustunda hosil bo`ladigan bo`ylama kuch –Nning miqdori aniqlansin.



Ustunning kesim yuzasi tomonlarini o`lchami a=4sm, b=5sm bo`lgan 1-brus yuzasi-F_1 ekanligi va a=5sm, b=6sm bo`lgan 2-brus yuzasi-$F_2$ ekanligi, u ustun po`lat-3 markali metaldan yasalgan($E = 2 \cdot 10^6 kg/sm^2$) deb olib, qo'zg'almas tayanchga tayanib turuvchi pog'onali brusni o'qi bo'ylab rasmda ko'rsatilganidek kuchlar ta'sir etadi.

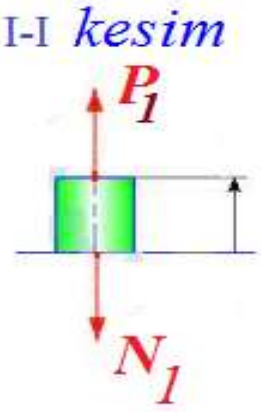
(Hisoblashlar bruslarning xususiy og'irligini hisobga olmay bajarilsin).

Yechish: Brusni erkin uchidan boshlab -rasmda ko'rsatilganidek parallel tekisliklar yordamida kesamiz. Brusning kesilgan yuqori har bir qismi uchun muvozanat tenglamasini tuzamiz.



Nazariy mexnika fanidagi Statikaning muvozanat tenglamalaridan kelib chiqib, qirqib olingan qism uchun muvozanat tenglamasini tuzamiz:

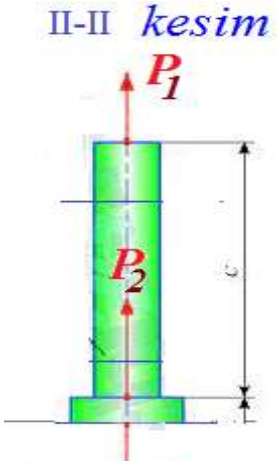
I- qirqib olingan qism uchun muvozanat tenglamasini tuzamiz:



Unga ko`ra $\sum y = 0$ $P_1 - N_1 = 0$

$N_1 = P_1 = 80\kappa N$ **(cho`zuvchi kuch)**

II- qirqib olingan qism uchun muvozanat tenglamasini tuzamiz:

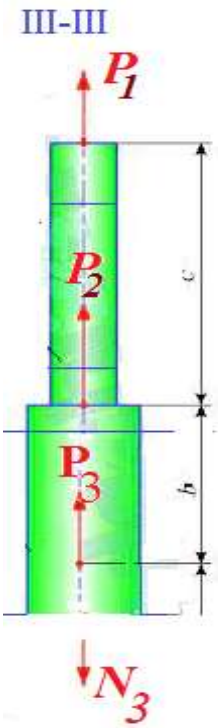


Unga ko`ra $\sum y = 0$ $P_1 + P_2 - N_2 = 0$

$N_2 = P_1 + P_2 = 80 + 100 = 180\kappa N$

(cho`zuvchi kuch)

III- qirqib olingan qism uchun muvozanat tenglamasini tuzamiz:

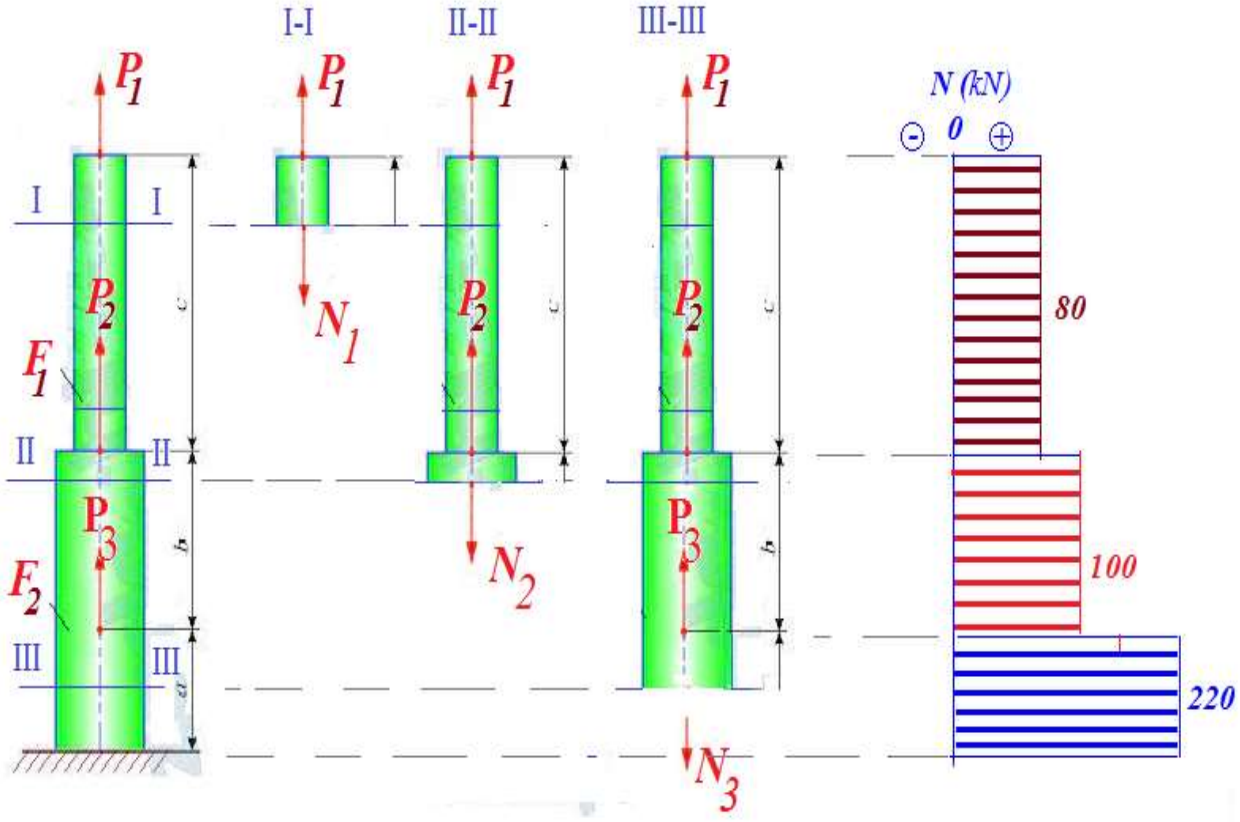


Unga ko`ra $\sum y = 0$ $P_1 + P_2 + P_3 - N_3 = 0$

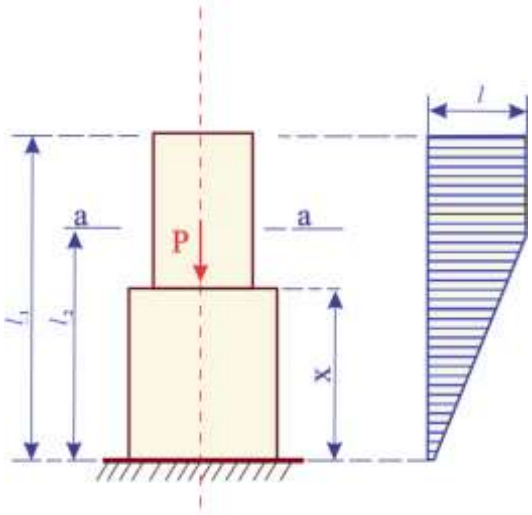
$N_3 = P_1 + P_2 - P_3 = 80 + 100 + 200 = 220\kappa N$

(cho`zuvchi kuch)

Har bir oraliq kesimda hosil bo`lgan bo`ylama kuchlarni, brusning ko`ndalang kesimi bo`yicha o`zgarish grafigi-**epyura**sini quramiz.



1.2-misol. Po'lat brus uchun (1.5-rasm,a) ko'ndalang kesimning ko'chish epyurasi qurilsin. Brusning og`irligi hisobga olinmasin. $E = 2 \cdot 10^6 kg/sm^2$



1.5

Yechish. Ko'chish epyurasini mahkamlangan uchdan boshlab ko'rish kerak. Brusning pastki qismiga tegishli bo'lgan ixtiyoriy *I-I* kesimning ko'chishi $\Delta x = \frac{Px}{EF}$ ya'ni, ko'chish chiziqli qonun bilan (kesim mahkamlangan uchdan uzoqlashgan sari) o'sadi.

C-C kesimning ko'chishi no'lga teng, chunki u mahkamlangan joyga tegishli *a-a* kesimning ko'chishi

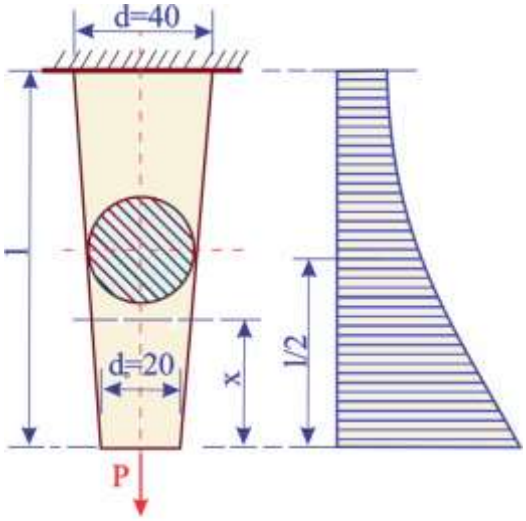
$$\Delta a - a = \frac{Pl_2}{EF} = \frac{40 \cdot 10^3 \cdot 10^2}{2 \cdot 10^6 \cdot 25} = 0.08sm = 0.8mm.$$

Brusning yuqori qismi ($a - a$ kesimdan yuqori) ko'ndalang kesimning ko'chishi bir xil bo'lib, Δ_{a-a} ga teng (chunki brusning bu qismi deformatsiyalanmaydi). Ko'chish epyurasi 1,5 rasm, b da ko'rsatilgan

1.3- misol. Kesik konus shaklidagi po'lat brus (1.6-rasm,a) uchun normal kuchlanish epyurasi qurilsin va erkin uning ko'chishi hisoblansin,

Brus og'irligi hisobga olinmasin.

$$E = 2{,}0 \cdot 10^6 \frac{kg}{sm^2}.$$



1.6

Yechish. Bo'ylama kuch istalgan ko'ndalang kesimda bir xil:

$$N_x = P = 4 \cdot 10^3 kg$$

Ixtiyoriy ko'ndalang kesim yuzi (1.6 rasmga, a ga qarang)

$$F_x = \frac{\pi}{4}(d_0 + \frac{d - d_0}{l} x)^2$$

Normal kuchlanish (ixtiyoriy ko'ndalang kesmda) $\sigma_x = \frac{\pi}{4}(d_0 + \frac{d - d_0}{l} x)^2$

ya'ni σ_x brusning uzunligi giperbolik qonun bo'yicha o'zgaradi.

σ_x epyurasini qurish uchun uning uchta xususiy qiymatini hisoblab topamiz:

$$\sigma_{x-0} = \frac{P}{\frac{\pi}{4} d_0^2} = \frac{4000}{\frac{\pi}{4} 2^2} = 1270 \frac{kg}{sm^2}$$

$$\sigma_{x-\frac{1}{2}l} = \frac{P}{\frac{\pi}{4}(\frac{d_0 + d_2}{2})^2} = \frac{4000}{\frac{\pi}{4}(\frac{2+4}{2})^2} = 567 \frac{kg}{sm^2}$$

$$\sigma_{x-l} = \frac{P}{\frac{\pi}{4} d^2} = \frac{4000}{\frac{\pi}{4} 4^2} = 318 \frac{kg}{sm^2}$$

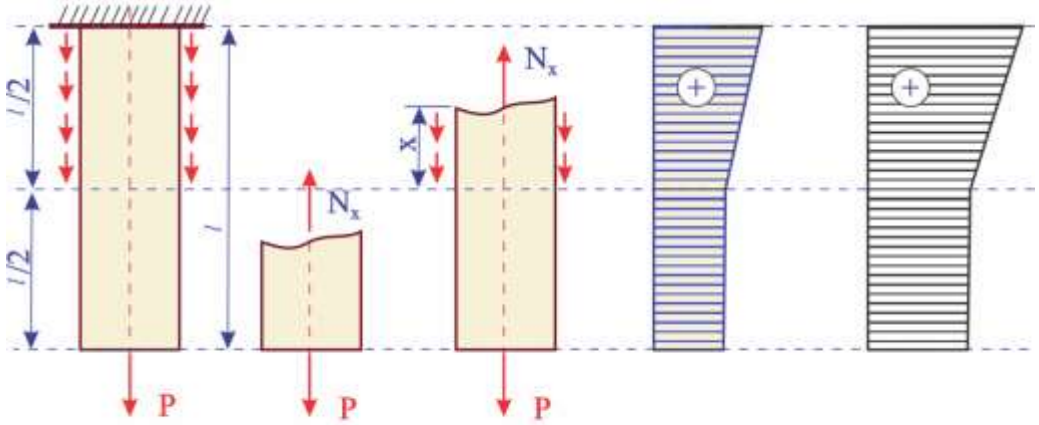
σ epyurasi 1.6 rasm, b da keltirilgan. Bu misolda brus ko'ndalang kesim yuzi bo'ylama kuch o'zgarmas bo'lishiga qaramasdan uning balandligi bo'yicha uzluksz o'zgaradi. Brusning cho'zilishini aniqlash uchun umumiy formulani qo'llash kerak:

$$l = \int_0^l \frac{N_x d_x}{EF_x} = \frac{P}{E} \int_0^l \frac{d}{\frac{\pi}{4}(d0 + \frac{d - d0}{l} x)2} = \frac{4Pl}{E\pi(d - d_0)}(\frac{1}{d_0} - \frac{1}{d}) =$$

$$= \frac{4 \cdot 4 \cdot 10^3 \cdot 400}{2 \cdot 10^6 \pi (4-2)}(\frac{1}{2} - \frac{1}{4}) = 0.127 sm$$

1.4 –misol. Po'lat brus uchun (1.7- rasm, a) bo'ylama kuch, normal kuchlanish epyuralari qurilsin, agar $2\cdot10^5\frac{MN}{m^2}$ bo'lsa brusning absolyut cho'zilishi aniqlansin.

Brusning yuqori qismiga uning uzunligi bo'yicha tekis taqsimlangan va intensivligi $q=10kN$ bo'lgan o'q bo'yicha tekis tarqalgan yuk ta'sir etadi.



1.7

Yechish. Kesimlar usulini tatbiq etib, **bo'ylama kuchni** brus har bir oraliq(uchastkasi)ning uzunligi bo'yicha o'zgarish qonunini topamiz. Birinchi uchaskada (1.7-rasm, b)

$$N_x^{\ 1}=P=20kn$$

Ikkinchi uchastkada (1.7-rasm, v)

$$N_x^{\ 11}=P+qx$$

Bu uchastkada bo'ylama kuch chiziqli qonun bo'yicha o'zgaradi .

Uchastkaning boshida $N_{x=0}^{11}=P=20kn$ oxirida $-N_{x=0.5l}^{11}=P+q_2^l=20+10\cdot1=30kn$

Bo'ylama kuchlar epyurasi 1.7-rasm, g da ko'rsatilgan.

Normal kuchlanishni aniqlaymiz.

Birinchi uchastka va ikkinchi uchastka boshida ($x = 0$ bo'lganda)

$$\sigma^1 = \frac{N_x^1}{F} = \frac{30 \cdot 10^3}{2 \cdot 10^{-4}} = 10 \cdot 10^7 \frac{n}{m^2} = 100 \frac{Mn}{m^2}$$

Ikkinchi uchastka oxirida

$$\sigma^{11} = \frac{N_x^1}{F} = \frac{30 \cdot 10^3}{2 \cdot 10^{-4}} = 150 \frac{Mn}{m^2}$$

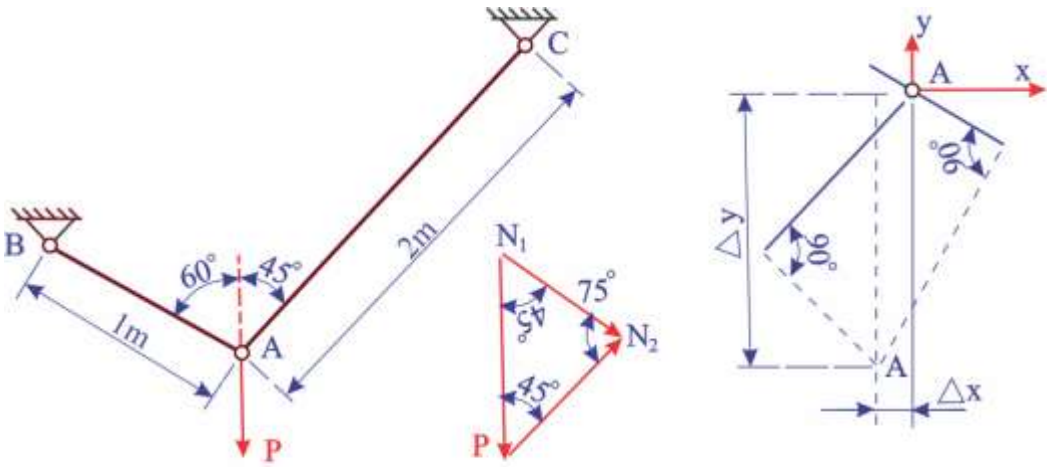
σ epyurasi 1.7-rasmda, ∂ da keltirilgan.

Brusning absolyut cho'zilishi

$$\Delta l = \frac{N_x^1 \frac{1}{2}}{EF} + \int_0^{0.5l} \cdot \frac{N_x^{11} dx}{EF} = \frac{Pl}{2EF} + \int_0^{0.5l} \cdot \frac{(P + qx)dx}{EF} = \frac{Pl}{EF} + \frac{ql^2}{8EF} =$$

$$= \frac{20 \cdot 10^3 \cdot 2}{2 \cdot 10^{11} \cdot 2 \cdot 10^{-4}} + \frac{10 \cdot 10^3 \cdot 10^2}{8 \cdot 2 \cdot 10^{11} \cdot 2 \cdot 10^{-4}} = 1.125 \cdot 10^{-3} m \approx 0.113 sm$$

1.5-misol. Sterjenli sistema (1.8-rasm, a) A tugunining ko'chishi $E_p = 2 \cdot 10^6 \frac{kg}{sm^2}$ $E_m = 1 \cdot 10^6 \frac{kg}{m^2}$ aniqlansin.



1.8

Yechish. A tugunga ta'sir etuvchi berilgan P tashqi kucha va sterjenlardagi

noma'lum N_1 va N_2 zo'riqishlarning muvozanat shartidan kuch uchburchagini yasaymiz (1.8-rasm, b). Sinuslar teoremasidan quyidagilarni aniqlaymiz:

$$N_1 = \frac{P\sin 45^\circ}{\sin 75^\circ} = \frac{3000\cdot 0.707}{0.966} = 220kg$$

$$N_2 = \frac{P\sin 60^\circ}{\sin 75^\circ} = \frac{3000\cdot 0.866}{0.966} = 2690kg$$

Sterjenlarning absolyut cho'zilishi :

$$\Delta l_1 = \frac{N_1 l_1}{E_n F_1} = \frac{2200\cdot 100}{2\cdot 10^6\cdot 5} = 0.022sm = 0.22mm$$

$$\Delta l_2 = \frac{N_2 l_2}{E_m F_2} = \frac{2690\cdot 200}{1\cdot 10^6\cdot 4} = 0.1345sm = 1.345mm$$

A sharnirning deformatsiyadan keyingi holati (A_1 nuqta) ni aniqlash uchun B va C nuqtalardan $l_1+\Delta l_2$ va $l_2+\Delta l_2$ radiusli yoylarni kesishtirish yetarli bo'lar edi, lekin deformatsiyalash kuchi kichik bo'lganligi sababli har sterjenning davomiga o'z cho'zilishlarini joylashtirib, yoylar o'tkazish o'rniga, hosil qilingan nuqtalardan sterjen yo'nalishlariga perpendikulyar o'tkazish bilan aniqlasa bo'ladi.

Shunday qilib , hosil qilingan geometrik yasash (1.8-rasm,v)ko'chish diagrammasi deyiladi. Bu diagrammadan $\Delta l_1 A$ sharnirning gorizontal Δ_x va vertikal Δ_y ko'chishlarining 1-sterjen yo'nalishiga bo'lgan proyeksiyalarning algebraik yig'indinsiga teng ekanligi va Δl_2 esa, Δ_x va Δ_y larning 2-sterjen

yo'nalishiga bo'lgan proyeksiyalarning yig'indisiga teng ekanligi ko'rinadi, ya'ni

$$\Delta l_1 = \Delta_y \sin 30^\circ - \Delta_x \cos 30^\circ$$

$$\Delta l_1 = \Delta_y \sin 45^\circ - \Delta_x \cos 45^\circ$$

yoki

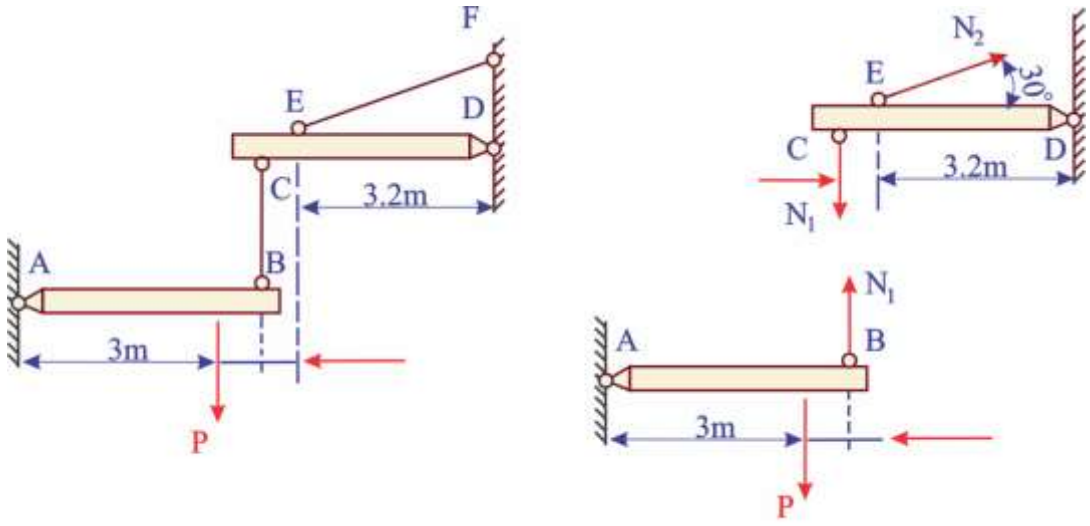
$$5\Delta_y - 0.866\Delta_x = 0.22mm^\circ$$

$$0.707\Delta_y + 0.707\Delta_x = 1.345mm$$

bundan

$$\Delta_x = 0.53mm^\circ \qquad \Delta_y = 1.36mm$$

1.6-misol. Sterjenli sistemadagi (1.9-rasm, *a*) sterjenlar ko'ndalang kesimi diametrlari (d_1 va d_2 ning kerakli mustahkamlik shartidan foydalanib aniqlansin. Sterjen St. 3 $[\sigma] = 1600 \frac{kg}{sm^2}$ po'latidan tayyorlanadi.



1.9

Yechish. BC va EF sterjenlarni kesib olib tashlangan qismining sistemaning qolgan qismiga ta'sirini N_1 va N_2 bo'ylama kuchlar bilan almashtirib, 1.9-rasm, b da ko'rsatilgan hisoblash sistemasini hosil qilamiz. AB balka uchun muvozanat tenglamasini tuzamiz.

$$\Sigma m_A = 0 \qquad N_1 \cdot 3.75 - P \cdot 3 = 0$$

bundan

$$N_1 = \frac{3P}{3.75} = \frac{3\cdot 4\cdot 10^3}{3.75} = 3.2\cdot 10^3 kg$$

BC sterjen kesimning zaruriy yuzi

$$F_1 \geq \frac{N_1}{[\sigma]} = \frac{3200}{1600} = 2sm^2$$

BC sterjenning kerakli diametri esa,

$$d_1 = \sqrt{\frac{4F_1}{\pi}} = \sqrt{\frac{4\cdot 2}{3.14}} \approx 1.6sm$$

CD balka uchun muvozanat tenglamasini tuzamiz:

$\Sigma m_D = 0$ $\qquad N_1 \cdot 3.8 - N_2 \cdot 3.2\sin 30^\circ = 0$

bundan

$$N_2 = \frac{N_1 \cdot 3.8}{3.2\cdot 0.5} = 7.6\cdot 10^3 kg$$

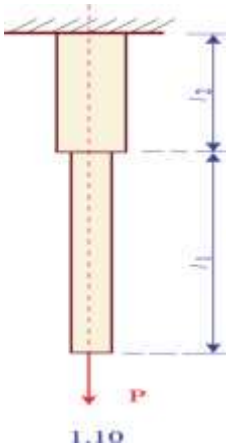
EF sterjen kesimning zaruriy yuzasi

$$F_2 \geq \frac{N_2}{[\sigma]} = \frac{7600}{1600} = 4.75sm^2$$

EF sterjenning kerakli diametri esa,

$$d_2 = \sqrt{\frac{4F_2}{\pi}} = \sqrt{\frac{4\cdot 4.75}{3.14}} \approx 2.5sm$$

1.7-misol. Ikki pog'onali brusning (1.10-rasm) har bir uchastkasi uchun xavfli kesimlardagi kuchlanishlar va uning to'la cho'zilishi brus og'irligini hisobga olgan holda aniqlansin. $\gamma = 7.35\frac{g}{sm^3}$ $E = 2\cdot 10^6 \frac{kg}{sm^2}$



1.10

Yechish. I-II va II-II xavfli kesimlaridir.

$I-I$ kesimdagi bo'ylama kuch max

$$N^1_{x\max} = P + \gamma F_1 l_1 = 1200 + 7{,}85\cdot 10^{-3}\cdot 2\cdot 80\cdot 10^2 = 1326kg$$

I - I kesimidagi normal kuchlanish

$$\sigma_{\max} = \frac{N^I_{x\max}}{F_1} = \frac{1326}{2} = 663\frac{kg}{sm^2}$$

I - I kesimidagi b`oylama kuch

$$N^{II}_{x\max} = P + \gamma F_1 l_1 + \gamma F_2 l_2 = 1200 + 7{,}85\cdot 10^{-3}\cdot 2\cdot 80\cdot 10^2 + 7{,}85\cdot 10^{-3}\cdot 4\cdot 40\cdot 10^2 = 1452kg$$

$$\sigma_{II\max} = \frac{N^{II}_{x\max}}{F_2} = \frac{1452}{4} = 363\frac{kg}{sm^2}$$

Brusning to'la cho'zilishi

$$\Delta l = \frac{Pl_1}{EF_1} + \frac{\gamma F_1 l_1 l_1}{2EF_1} + \frac{Pl_2}{EF_2} + \frac{\gamma F_1 l_1 l_2}{EF_2} + \frac{\gamma F_2 l_2 l_2}{2EF_2}$$

bu yerda $\frac{Pl_1}{EF_1}$ brus ostki qismining P kuch ta'sirida cho'zilishi;

$\frac{\gamma F_1 l_1 l_1}{2EF_1} = \frac{\gamma^{l_1^2}}{2E}$ brus ostki qismining o'z og'irligi ta'sirida cho'zilishi;*

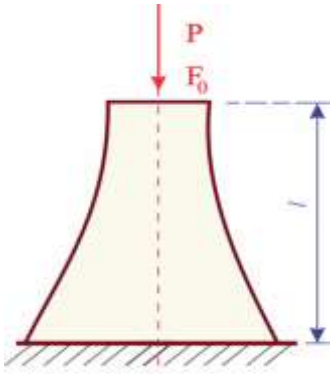
$\frac{Pl_2}{EF_2}$ brus ustki qismining P kuch ta'sirida cho'zilishi;

$\frac{\gamma F_1 l_1 l_2}{EF_2}$ brus ustki qismining ostki qismi og'irligi ta'sirida cho'zilishi, bu og'irlik ustki qism uchun to'plangan kuch bo'ladi;

$\frac{\gamma F_2 l_2 l_2}{2EF_2} = \frac{\gamma l_2^2}{2E}$ brus ustki qismining o'z og'irligi ta'sirida cho'zilishi .

Son qiymatlarini qo'yib, $\Delta l = 3{,}22$ sm ekanligini topamiz.

1.8-misol. Siqilishga teng qarshilikli brus shaklida toshdan ishlangan ustunning (1.11-rasm)



1.11

1) ustki kesimi yuzi F_0;

**Bu yerda o'zgarmas ko'ndalang kesimli brus (brus uchastkasi) ning o'z og'irligi ta'sirida cho'zilishi uning erkin uchiga qo'yilgan va o'z og'irligiga teng bo'lgan to'plangan kuch ta'sirida cho'zilishiga qaraganda ikki marta kichik bo'lishi sababli o'tamiz.*

2) ostki kesimning yuzi $F_{\max}$;

3) termaning og'irligi Q aniqlansin.

Termaning siqilishiga ruxsat etilgan kuchlanishi $[\sigma_c]=10\frac{kg}{sm^2}$

termaning hajmiy og'irligi $\gamma=2.5\frac{T}{m^3}$

Yechish. 1) ustki kesimning kerakli yuzi $F_0=\frac{P}{[\sigma]}=\frac{300000}{10}=30000sm^2=3sm^2$

2) Ostki kesimning kerakli yuzi $F_{\max}$ ni quyidagi formuladan topamiz ;

$$F_{\max}=F_0\cdot e\cdot\frac{\gamma l}{[\sigma]}=3\cdot 2{,}72\cdot\frac{2{,}5\cdot 15}{100}=4{,}37m^2$$ bu yerda $[\sigma]=10\frac{kg}{sm^2}=100\frac{T}{m^2}$

3) Termaning og'irligi

$$Q=F_{\max}[\sigma]-P=4.37\cdot 100-300=137T$$

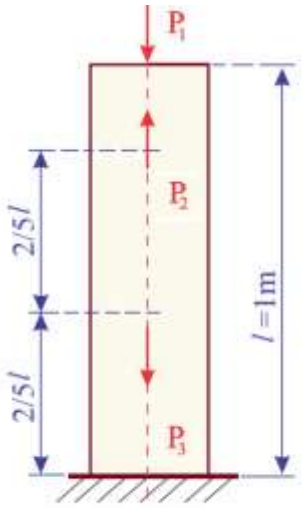
Termaning hajmi

$$V=\frac{Q}{\gamma}=\frac{137}{2.5}=53.8m^3$$

Mustaqil yechish uchun masalalar

1.1. Brusga ta'sir etuvchi (1.12-rasm) bo'ylama kuch va normal kuchlanishning epyurlari qurilsin va brus uzunligining to'la o'zgrishi aniqlansin.

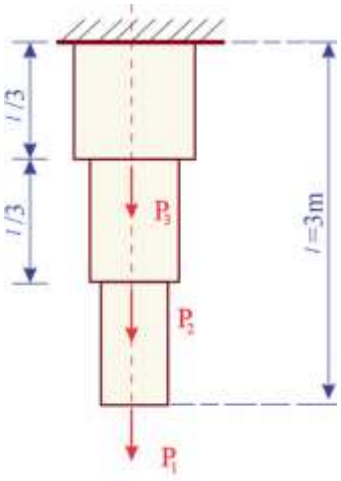
Bunda $E = 2 \cdot 10^5 \frac{Mn}{m^2}$ Javobi : $|N_{x\max}| = 20kN,\ \ \sigma_{\max} = 100\frac{Mn}{m^2},\qquad \Delta l = 0{,}015sm$.



1.12

1.2. Pog'onali brus (1.13-rasm) uchun bo'ylama kuch, normal kuchlanish epyuralari qurilsin va uning to'la uzayishi aniqlansin. Masalani yechishda $E_{al} = 0.7 \cdot 10^5 \frac{Mn}{m^2},\ E_m = 1 \cdot 10^5 \frac{Mn}{m^2},\ E_{po`lat} = 2 \cdot 10^5 \frac{Mn}{m^2}$ deb olinsin.

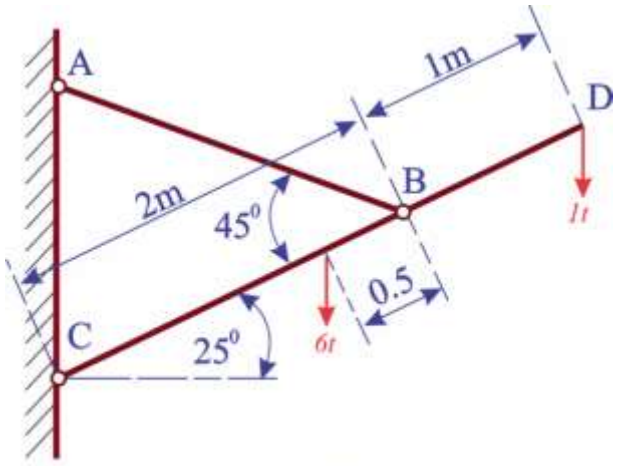
Javobi $\Delta l = 0.318sm$



1.13

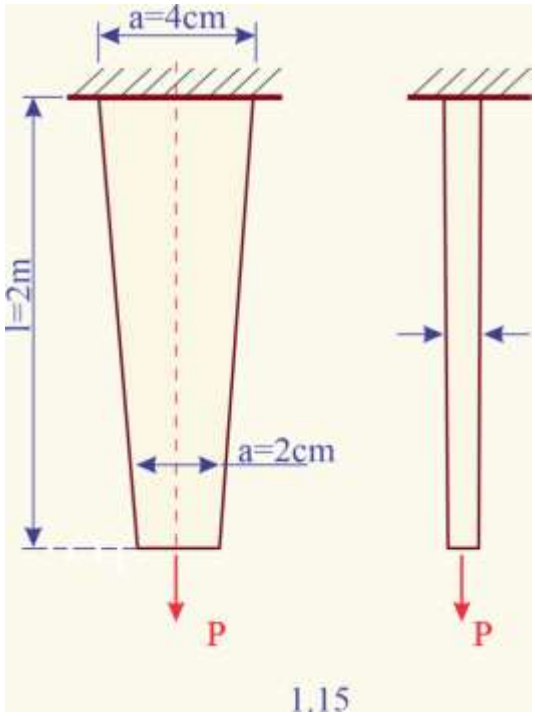
1.3. Kesim yuzi $F = 5sm^2$ bo'lgan AB po'lat tortqi CD balkani tortib turadi (1.14-rasm). Tortqidagi kuchlanish hamda uning absolyut cho'zilishi aniqlansin va CD balka uchun bo'ylama kuch epyurasi qurilsin.

Javobi. $\Delta l = 0.318sm$



1.14

1.4. Qalinligi o'zgarmas va eni o'zgaruvchan po'lat polosasining cho'zilishi aniqlansin (1.15-rasm), $E = 2 \cdot 10^6 \frac{kg}{sm^2}$

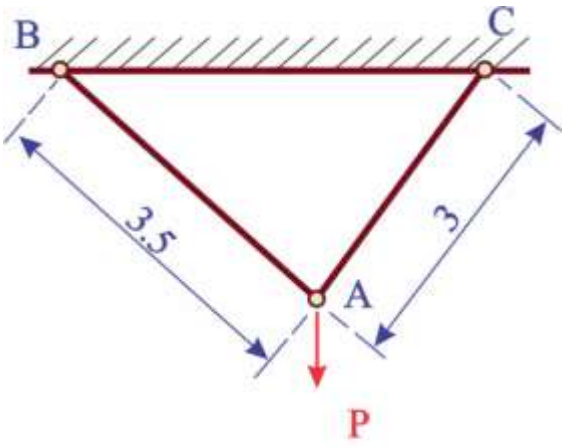


1.15

Polosa og'irligi nazarga olinmasin. Javobi. $\Delta l = 0.87mm$

1.5. A sharnirning to'la ko'chishi hisoblansin (1.16-rasm,)

bunda $E = 2.1 \cdot 10^6 \frac{kg}{sm^2}$

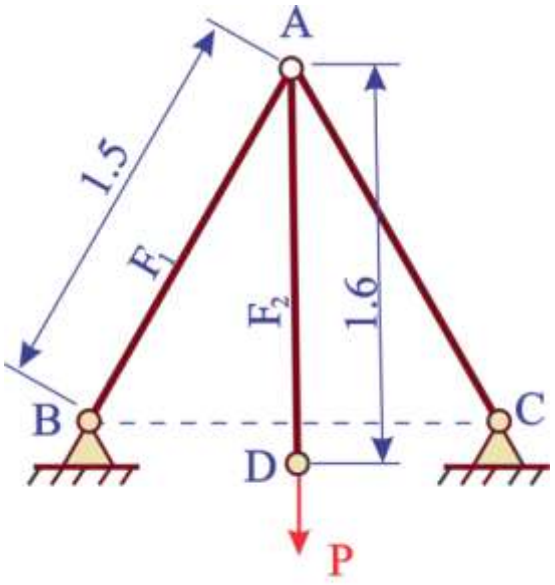


1.16

Ko'rsatma. Masalani grafik usulda yechish tavsiya qilinadi, ya'ni ko'chish diagrammasini yasab, so'ngra izlanayotgan kattaliklar diagrammaning mos kesimlarini o'lchash yo`li bilan aniqlanadi.

1.6. Sterjenli sistema D nuqtasining ko'chishi aniqlansin (1.17-rasm),

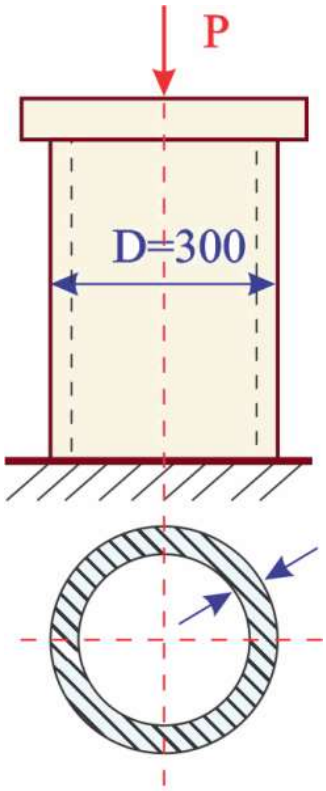
$E_n = 2 \cdot 10^6 \frac{kg}{sm^2}$ $E_m = 1 \cdot 10^6 \frac{kg}{sm^2}$. Javobi. $\Delta_d = 0.126sm$



1.17

1.7. Truba devorining qalinligi aniqlansin (1.18-rasm),

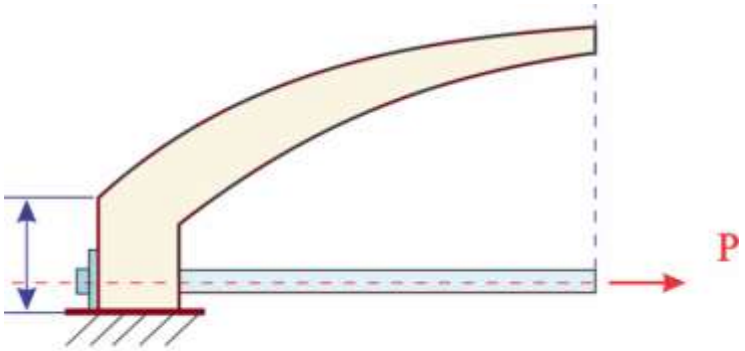
$[\sigma_n]=900\frac{kg}{sm^2}$ Javobi. $t\approx 1.0sm$



1.18

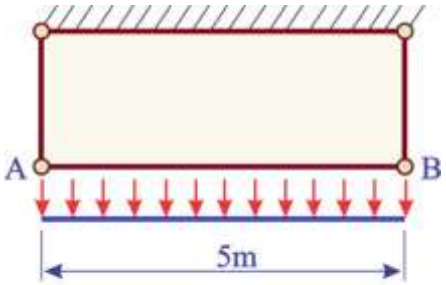
1.8. Arka torqisining diametri $d=30mm$ bo'lib, $P=12T$ kuch bilan tortiladi (1.19-rasm). Kvadrat shaybaning arkaga bo'lgan bosimi $80\frac{kg}{sm^2}$ dan oshmaslik shartidan foydalanib, a uzunligi aniqlansin.

Javobi. $a=12.5sm$



1.19

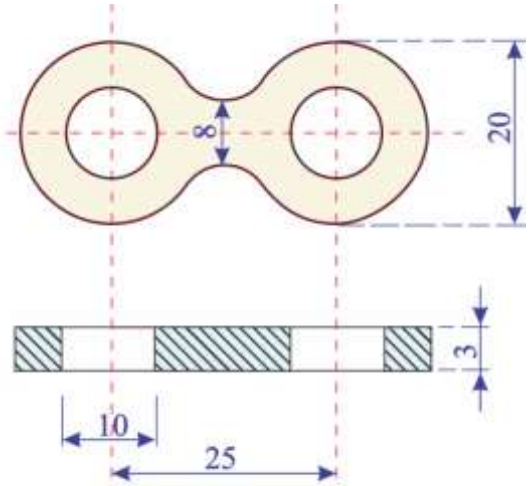
1.9. Agar tortqilar (1.20-rasm) materialning oquvchanlik chegarasi $\sigma_0 = 30\frac{kg}{mm^2}$ berilgan (kerakli) ehtiyot koeffisienti $[n_k] = 2$ bo'lsa, uning talab etilgan diametri aniqlansin. Javobi. $d = 2.35sm$



1.20

1.10. Yuk ko'taradigan plastinkali zanjir cho'zuvchi zo'riqish $P = 600kg$ ta'sirida. Zanjirning har bir zvenosi o'lchamlari 1.21-rasmda ko'rsatilgan ikki plastinkadan tarkib topgan. Plastinkaning xavfli kesimidagi zo'riqish aniqlansin.

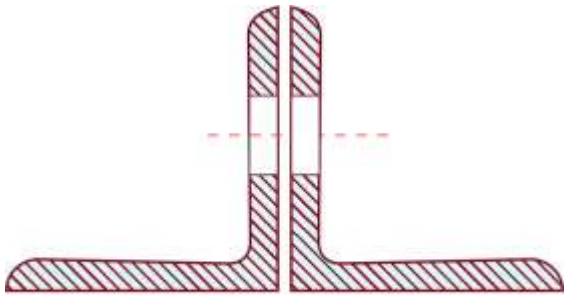
Javobi. $1250\frac{kg}{sm^2}$



1.21

1.11. 32 t zo'riqish bilan cho'ziladigan, ruxsat etilgan kuchlanishi $[\sigma] = 1800\frac{kg}{sm^2}$ bo'lgan metall ferma sterjenlari uchun 8509-57-DAST(GOST) bo'yicha ikkiga teng yonli burchaklik tanlang.

Bunda sterjenning kesimi diametri $20mm$ bo'lgan parchin mix teshigi bilan zaiflashtrilganligini nazarga oling (1.22-rasm).

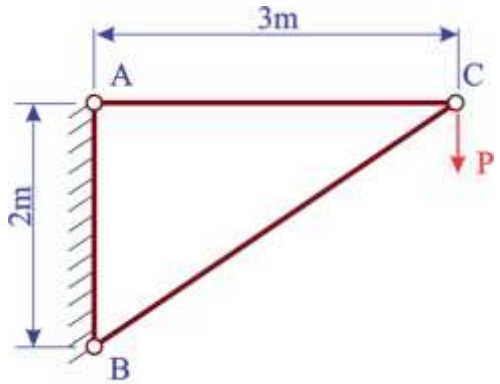


1.22

Javobi.75x75x7 (o'ta kuchlanishi $\approx 2.2\%$ bo'lganda).

1.12.Kronshgeyn sterjenlari ko'ndalang kesimlarining kerakli o'lchamlari aniqlansin (1.23-rasm), po'lat uchun $[\sigma]_p = 1400\frac{kg}{sm^2}$, yog'och uchun $[\sigma]_e = 50\frac{kg}{sm^2}$

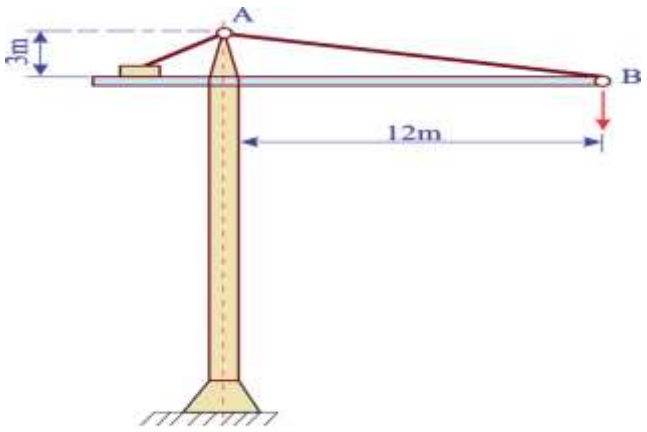
Javobi $d = 3.6sm, a = 17sm$



1.23

1.13. Minorali kranning (1.24-rasm), AB trosidagi C cho'zuvchi zo'riqish va tros to'qish uchun kerak bo'lgan $2mm$ diametri po'lat sim (kanat)larning soni aniqlansin. Kanat simining hisobiy mustahkamlik chegarasi $120\frac{kg}{mm^2}$. Kanat yetti marta mustahkamlik bilan ishlashi kerak.

Javobi $S = 12400kg$, 240 ta sim



1.24

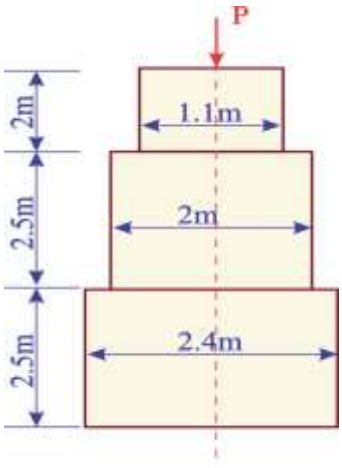
1.14.Dengiz chuqurligini o'lchash uchun diametri $d=1.5mm$ simga, xajmi $V=2400sm^3$ asbob bog'lab tushiriladi. Asbob og'irligi G=17 kg.

Agar simning mustahkamlik chegarasi $[\sigma_B]=6500\frac{kg}{sm^2}$ va xajmiy og'irligi $\gamma=7.8\frac{G}{sm^3}$ bo'lsa, suvga tushurishning sim uziladigan chegaraviy chuqurligi h aniqlansin. Dengiz suvning xajmiy og'irligi $1\frac{G}{sm^3}$ ga teng.

Javobi. $h\approx 9550m$

1.15. Agar $\gamma=2.4\frac{T}{m^3}$ bo'lsa, kesimi pog`onali bo`lgan pog`onali fundamentning (1.25-rasm) $I-I, II-II$ va $III-III$ kesimlarida hosil bo'ladigan kuchlanishlar aniqlansin. Fundamentni o'rab turgan tuproqning ta'siri hisobga olinmasin.

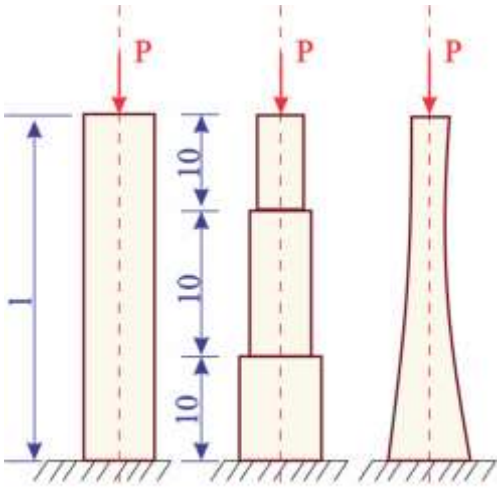
Javobi. $\sigma_{I-I}=7.09\frac{kg}{sm^2}, \sigma_{II-II}=2.75\frac{kg}{sm^2}, \sigma_{III-III}=2.51\frac{kg}{sm^2}$



1.25

1.16. Agar $\sigma_n = 10\frac{kg}{sm^2}$ $\gamma = 2.5\frac{T}{m^3}$ bo'lsa, uchta kalonna (1.26-rasm) asoslarining yuzlari va hajmlari (kubaturalari) solishtirilsin.

Javobi. $F_1 = 4.8m^2$ $V_1 = 144m^3$
$F_2 = 2.82m^2$ $V_2 = 65.5m^3$
$F_3 = 2.54m^2$ $V_3 = 53.6m^3$



1.26

1.17. Diametri 8 mm va uzunligi 12 sm, ko'ndalang kesimi doiraviy shaklidagi ikki rezinkadan yasalgan rogatkadan tosh otish uchun rezinkalarning har biri 10 sm uzaytiriladi.

Toshning og'irligi $0{,}1kg$. Agar rogatkaning F.I.K. ya`ni elastik deformatsiya energiyasidan foydalanish ulushi 0,5 bo'lsa, toshning otilish paytidagi boshlang'ich tezligi aniqlansin.

Rezinkaning bo'ylama elastiklik moduli $E = 10\frac{kg}{sm^2}$ (Kesimining torayishi nazarga olinmasin).

Javobi. $v = 6.4\frac{m}{sek}$

Materiallar qarshiligi fanidan ON va YN uchun test savollari

1.	**Buylama elastiklik modul Ye materialning qanday xususiyatini belgilaydi?**	Materialning qattiqligini	Materialning mustahkamligini	Materialning elastiklik xususiyatini	Materialning bikrligini
2.	**Qanday kuchlanish ruxsat etilgan kuchlanish deb ataladi?**	Proporsionallik chegarasiga mos kelgan kuchlanishga	Oqish chegarasiga mos kelgan kuchlanishga	Vaqtincha qarshilik kuchlanishiga	To'g'ri javob yuk
3.	**Markaziy cho`zilgan yoki siqilgan sterjen ko`ndalang kesimida normal kuchlanishlar qanday taqsimlangan**	Normal kuchlanishlar qavariq parabola shaklida taqsim-langan bo'ladi	Normal kuchlanishlar teng taksimlangan	Normal kuchlanishlar botiq parabola shaklida taksimlangan bo'ladi	To'g'ri javob yo`q
4.	**Materiallarning mustahkamlik ko`rsatkichlari amalda qanday qilib aniqlanadi?**	Fizik qonunlarga asosan hisoblab topiladi	Material namunasini maxsus mashinada sinash yo`li bilan	Kimyoviy tarkibini tekshirish yo`li bilan	Namuna deformiatsiyasini o`lchash bilan
5.	**Puasson koeffitsientining o`zgarish chegarasini ko`rsating**	0 dan 0,5 gacha	Faqat 0 ga teng bo'ladi	Faqat 0,5 ga teng bo'ladi	Faqat 0,25 ga teng bo'ladi
6.	**Sterjen nisbiy deformatsiyasi**	M	Sm	O'lchovsiz kattalik	Gradus

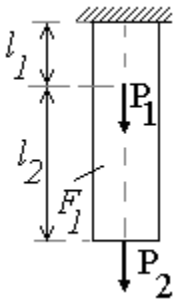
	qanday birlik bilan ulchanadi?				
7.	**Cho`zilish va siqilish deformatsiyasida sterjen bikrligi nimaga teng?**	EG	El	GF	EF
8.	**Cho`zilish va siqilish deformatsiyasida normal kuchlanish qanday o'lchov birlikda o`lchanadi? (N – N`yuton, mm - millimetr, sm - santimetr, t - tonna)**	N	N/mm	$\kappa g / sm^2$	Nm
9.	**Extiyot koeffitsienti nima?**	Ruxsat etilgan kuchlanishni aniqlashda xavfli kuchlanishni kamaytiradigan koeffitsient	Proporsionallik chegarasini aniqlashda uni kamaytiradigan koeffitsient	Vaqtincha qarshilik-ni kamaytiradigan koeffitsi-ent	To'g'ri javob yo`q
10.	**CHo'zilish-siqilishda Guk qonuni qanday ifodalanadi?**	$\tau = \sigma\gamma$	$\sigma = E\varepsilon$	$\sigma = \frac{N}{A}$	$\varepsilon' = -\mu\varepsilon$
11.	**Deformatsiya deganda nimani tushuniladi?**	Jismni tashqi kuch ta'sirida yemirilishi	Jismni muvozanat holatini buzilishi	Tashqi kuch ta'sirida jismni shakli va o'lcham-	Jismni qarshilik ko'rsatish qobiliyatini

				larini o’zgarishi	ng o’zgarishi
12.	**Qanday materiallar izotrop materiallar deyiladi?**	Kamida ikkita yunalishda mexanik xarakteristikalari bir xil bo`lgan materiallar izotrop deyiladi	Barcha yo`nalish-larda mexanik xarakteristikalari bir xil bo`lgan materiallar izotrop materiallar deyiladi	Cho`zilish va siqilish diagrammalari bir xil bo`lgan materiallar izotrop materiallar deyiladi	To’g’ri javob yo’q
13.	**Ichki kuch omillari qanday usul bilan aniqlanadi?**	Mor usuli	Urunma usuli	Kesish usuli	Aniqlash usuli yo’q
14.	**Normal kuchning o’lcham birligi**	N	Nm	m	grad
15.	**Sterjenning deformatsiyagacha bo’lgan uzunligi ℓ deylik, deformatsiya-dan keyingi uzunligi ℓ_1 bo’ldi. Absolyut bo’ylama deformatsiya nimaga teng? Absolyut bo’ylama deformatsiya** $\Delta\ell =$	$\ell - \ell_1$	$\ell_1 - \ell$	$\frac{\ell - \ell_1}{\ell}$	$\frac{\ell_1 - \ell}{\ell}$

16.	**CHo'zilish yoki siqilishdagi bikirlik nima? CHo'zilish va siqilishdagi bikrlik quyidagi ko'paytmaning miqdoriga teng:**	$E \cdot I$	$E \cdot F$	$G \cdot I$	$G \cdot F$
17.	**CHo'zilishdagi mustahkamlik sharti bo'yicha qanday uch xil masalani yechish mumkin?**	Sterjenni mustahkamligini tekshirish, deformatsiyasini aniqlash, ko'ndalang o'lchamlarini tanlash	Sterjenni mustahkamligini tekshirish, deformatsiyasini aniqlash, ko'tara oladigan kuchini topish	Sterjenni mustahkamligini tekshirish, kuchlanishini aniqlash, ko'ndalang o'lchamlarini tanlash	Sterjenning mustahkamligini tekshirish, ko'nda-lang kesim o'lcham-larini tanlash, ko'tara oladigan kuchini topish
18.	**CHo'zilish (siqilish) deformatsiyasida haqiqiy uzayishni aniqlash formulasi qanday ko'rinishga ega?**	$\Delta\ell = \frac{N \cdot \ell}{EF}$	$\Delta\ell = \frac{Q \cdot a}{GF}$	$\Delta\ell = \frac{\sigma}{\varepsilon}$	$\Delta\ell = \frac{M \cdot \ell}{GI_p}$
19.	**Material elastiklik moduli E ning o`lcham birligi nimaga teng?**	$T \cdot M$	M^2	N/M	N/M^2
20.	**Sterjen deb nimaga aytiladi? Sterjen bu -**	Buralishga ishlaydigan brus	Egilishga ishlaydigan brus	Siljishga ishlaydigan brus	CHo'zilish va siqilishga ishlaydigan brus

Masala ko`rinishidagi test savollari

1. Uzunligi $\ell_1 = 1{,}5m,\ \ell_2 = 2{,}0m$ bo`lgan st.3 markali po`lat sterjen P_1=56 kN va P_2=100 kN kuch bilan cho`zilayapti. Sterjenning har bir uchastkasidagi ko`ndalang kesim yuzasi va uning absolyut cho`zilishi aniqlansin.



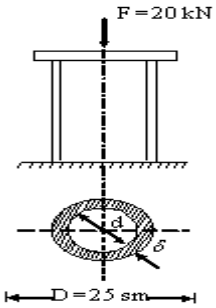
A) $F_1 = 6{,}25sm^2$; $\Delta\ell_1 = 0{,}16sm,\ F_2 = 10{,}75sm^2$; $\Delta\ell_2 = 0{,}12sm$

B) $F_1 = 7{,}25sm^2$; $\Delta\ell_1 = 0{,}16sm,\ F_2 = 9{,}75sm^2$; $\Delta\ell_2 = 0{,}12sm$

C) $F_1 = 6{,}25sm^2$; $\Delta\ell_1 = 1{,}16sm,\ F_2 = 9{,}75sm^2$; $\Delta\ell_2 = 0{,}12sm$

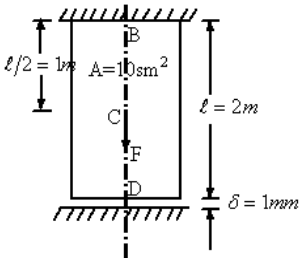
D) $F_1 = 6{,}25sm^2$; $\Delta\ell_1 = 0{,}16sm,\ F_2 = 9{,}75sm^2$; $\Delta\ell_2 = 0{,}12sm$

2. Shaklda ko`rsatilgan, ruxsat etilgan kuchlanishi $[\sigma_c] = 1000\ kg/sm^2$ bo`lgan sho`yan trubaning devor qalinligi topilsin.



A) $\delta = 1{,}88sm.$ B) $\delta = 3{,}88sm.$ C) $\delta = 4{,}88sm.$ D) $\delta = 2{,}88sm.$

3. Shaklda ko`rsatilgan ustunning ko`ndalang kesim yuzasi $A = 10\,sm^2$ bo`lsa, agar $E = 2\cdot 10^6\ kg/sm^2, l = 2sm$ ma`lum bo`lsa, uning qanday kuch bilan $\delta = 1mm$ ga uzaytirish kerak.



A) $P = 1000kN$ B) $P = 1200kN$

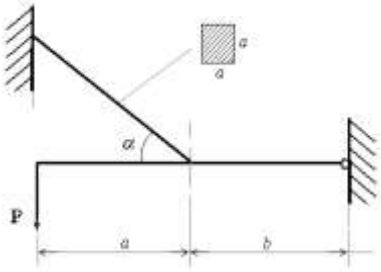
C) $P = 1400kN$ D) $P = 800kN$

4. Ko`ndalang kesimi kvadratdan iborat bo`lgan po`lat-3 markali sterjen shaklda ko`rsatilganidek to`sin(balka)ni tortib turibdi. Balka uchiga og`irligi P=100 kN yuk osilgan va uning o`lchamlari a=2m, b=3m, $\alpha$ = 45ga teng. Shu to`sinning muvozanatda bo`lishi uchun tortqi sterjenining ko`ndalang kesim yuzasi hamda uning o`lchamlari aniqlansin.

A) $F=16{,}7\,sm^2,\ a=3{,}8\,sm$ B) $F=14{,}7\,sm^2,\ a=3{,}8\,sm$

C) $F=14{,}7\,sm^2,\ a=4{,}8\,sm$ $F=16{,}7\,sm^2,\ a=4{,}8\,sm$

D)



5. Ko`ndalang kesim yuzasi $A=4sm^2$ va uzunligi 10 sm bo`lgan namuna $F=20kN$ kuch bilan cho`zilganda absolyut uzayishi, normal kuchlanish qiymati va materialining elastiklik moduli aniqlansin.

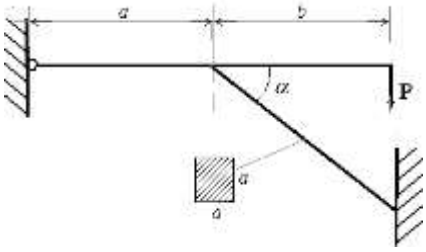
A) $\varepsilon=0{,}025sm;\quad \sigma=500kg/sm^2;\quad E=2\cdot10^6\ kg/sm^2$

B) $\varepsilon=0{,}225sm;\quad \sigma=500kg/sm^2;\quad E=2\cdot10^6\ kg/sm^2$

C) $\varepsilon=0{,}025sm;\quad \sigma=600kg/sm^2;\quad E=2\cdot10^6\ kg/sm^2$

D) $\varepsilon=0{,}025sm;\quad \sigma=500kg/sm^2;\quad E=2\cdot10^5\ kg/sm^2$

6. Ko`ndalang kesimi kvadratdan iborat bo`lgan po`lat-3 markali sterjen shaklda ko`rsatilganidek to`sin(balka)ni tortib turibdi. Balka uchiga og`irligi P=900 kN yuk osilgan va uning o`lchamlari a=3.5m, b=1.75m, $\alpha=$ 45ga teng. Shu to`sinning muvozanatda bo`lishi uchun tortqi sterjenining ko`ndalang kesim yuzasi hamda uning o`lchamlari aniqlansin.

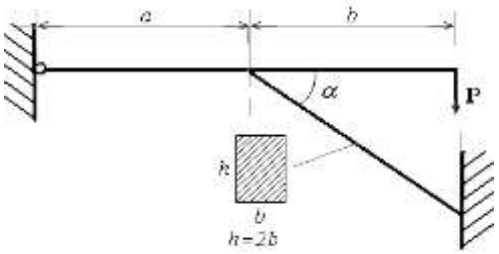


A) $F=1999{,}5\,sm^2,\ a=19{,}9\,sm$ B) $F=1999{,}5\,sm^2,\ a=10{,}9\,sm$

C) $F=1909{,}5\,sm^2,\ a=19{,}9\,sm$ D) $F=1909{,}5\,sm^2,\ a=10{,}9\,sm$

7. Diametri $d=25sm$ bo`lgan doiraviy ko`ndalang kesimli yog`osh ustunining ko`ndalang kesimidagi siquvshi kuchlanish $50kN/sm^2$ dan oshmasa, uning qansha Yuk ko`tara olishi aniqlansin. A) 10,19.kN. B) 12,19.kN. C) 14,19.kN. D) 16,19.kN.

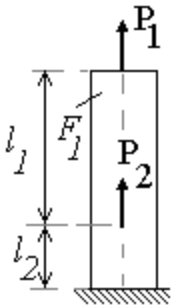
8. Ko`ndalang kesimi tog`ri to`rtburchakdan iborat bo`lgan po`lat-3 markali sterjen shaklda ko`rsatilganidek to`sin(balka)ni tortib turibdi. Balka uchiga og`irligi P=550 kN yuk osilgan va uning o`lchamlari a=1m, b=2m, $\alpha =$ 60ga teng. Shu to`sinning muvozanatda bo`lishi uchun tortqi sterjenining ko`ndalang kesim yuzasi hamda uning o`lchamlari aniqlansin.



A) $F=199{,}08sm^2,\ b=7{,}97sm$ B) $F=199{,}08sm^2,\ b=7{,}7sm$

C) $F=119{,}08sm^2,\ b=7{,}97sm$ D) $F=119{,}08sm^2,\ b=7{,}7sm$

9. Uzunligi $\ell_1=2m, \ell_2=1{,}5m$ bo`lgan st.3 markali po`lat sterjen P_1=56 kN va P_2=100 kN kuch bilan cho`zilayapti. Sterjenning har bir uchastkasidagi ko`ndalang kesim yuzasi va uning absolyut cho`zilishi aniqlansin.



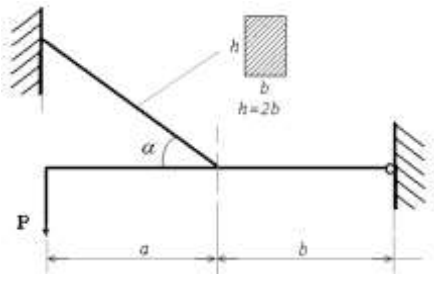
A) $F_1=3{,}5sm^2;\ \Delta\ell_1=2{,}16sm, F_2=9{,}75sm^2;\ \Delta\ell_2=0{,}12sm$

B) $F_1=3{,}5sm^2;\ \Delta\ell_1=0{,}16sm, F_2=9{,}75sm^2;\ \Delta\ell_2=0{,}12sm$

C) $F_1=3{,}5sm^2;\ \Delta\ell_1=0{,}16sm, F_2=12{,}75sm^2;\ \Delta\ell_2=0{,}12sm$

D) $F_1=3{,}5sm^2;\ \Delta\ell_1=0{,}16sm, F_2=9{,}75sm^2;\ \Delta\ell_2=1{,}12sm$

10. Ko`ndalang kesimi to`g`ri to`rtburchakdan iborat bo`lgan po`lat-3 markali sterjen shaklda ko`rsatilganidek to`sin(balka)ni tortib turibdi. Balka uchiga og`irligi P=200 kN yuk osilgan va uning o`lchamlari a=3m, b=4m, $\alpha =$ 60ga teng. Shu to`sinning muvozanatda bo`lishi uchun tortqi sterjenining ko`ndalang kesim yuzasi hamda uning o`lchamlari aniqlansin.



A) $F=28{,}3sm^2,\ b=3{,}85sm$ B) $F=28{,}3sm^2,\ b=3{,}55sm$

C) $F=25{,}3sm^2,\ b=3{,}85sm$ D) $F=25{,}3sm^2,\ b=3{,}55sm$

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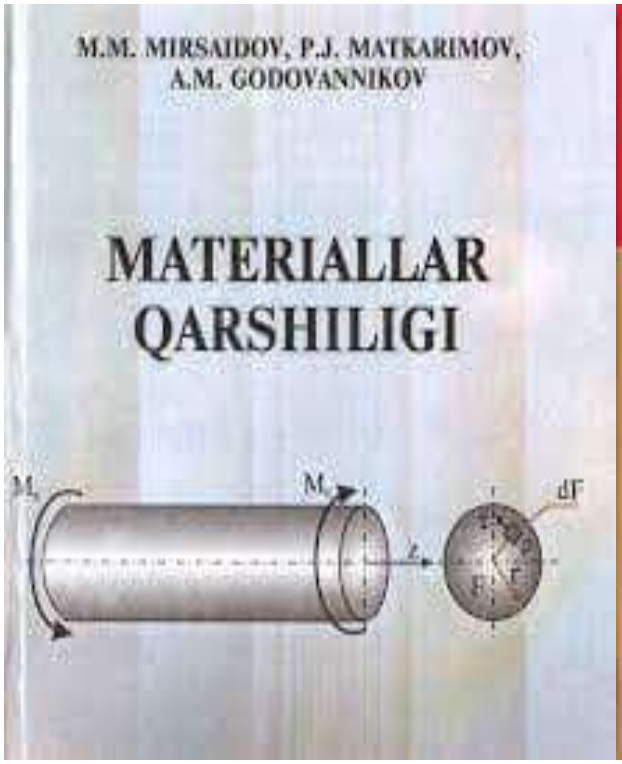

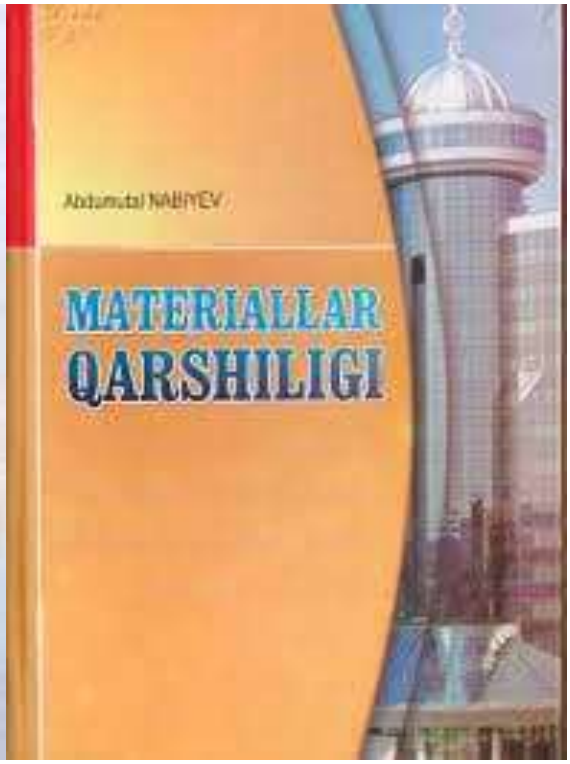

Taklif va izohlar uchun