

4. MASALALAR VA MAShQLAR TO'PLAMI.

**O'ZBEKISTON RESPUBLIKASI OLIY VA O'RTA MAXSUS
TA'LIM VAZIRLIGI**

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**«Materiallar qarshiligi va qurilish mexanikasi»
kafedrasi**

«MATERIALLAR QARShILIGI»

fanidan

MASALALAR VA MAShQLAR TO'PLAMI

S A M A R Q A N D– 2012

MATERIALLAR QARSHILIGI FANIDAN MASALALAR VA MASHQLAR TO'PLAMI.

CHO'ZILISH VA SIQILISH.

1.1 - 1.10. Shakllarda ko'rsatilgan sterjenlar uchun bo'ylama kuch epyuralari qurilsin. Yoyilgan kuchlar chiziqli qonun bilan o'zgaruvchidir.

1.11. Uzunligi $\ell = 1,5m$ bo'lgan st.3 markali po'lat sterjen 56 kn kuch bilan cho'zilayapti. Sterjen ko'ndalang kesim yuzasi va uning absolyut cho'zilishi aniqlansin.

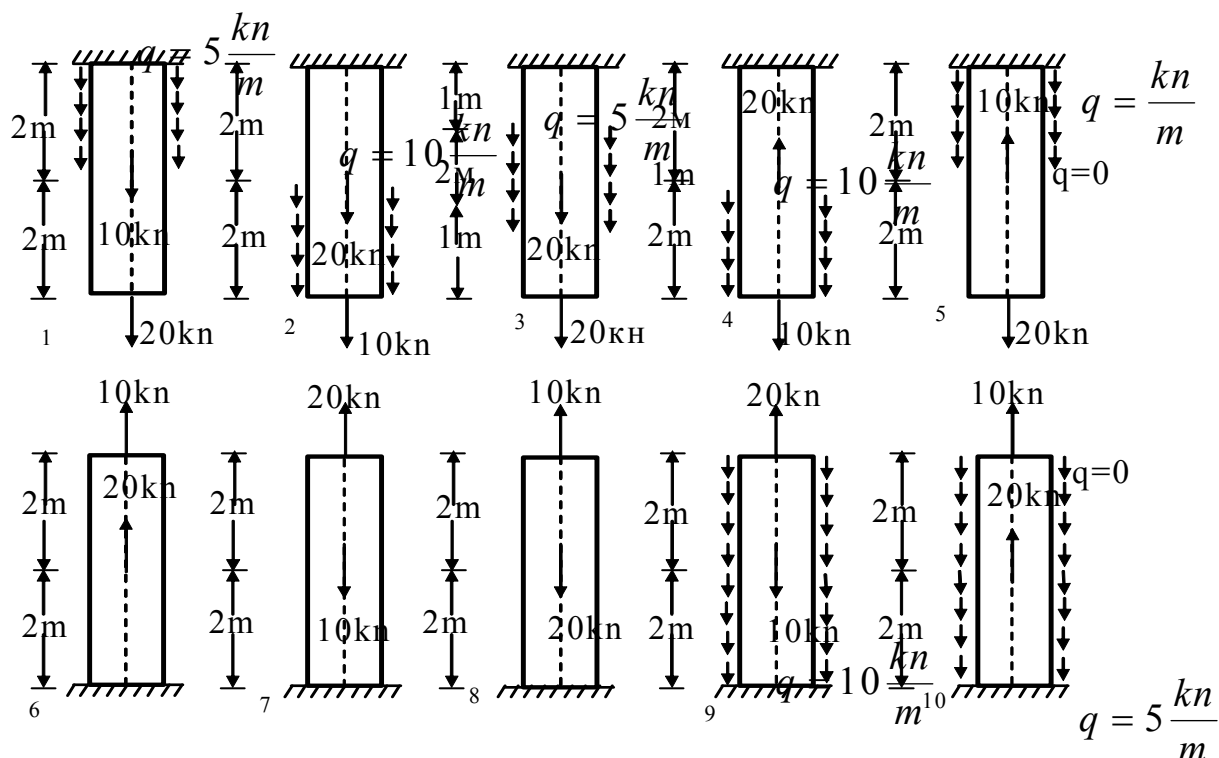
Javobi: $F = 3,5 \text{ sm}^2$; $\Delta\ell = 0,12 \text{ sm}$.

1.12. Ko'ndalang kesim yuzasi $F = 4 \text{ sm}^2$ va uzunligi 10 sm bo'lgan namuna $P = 20 \text{ kn}$ kuch bilan cho'zilganda absolyut uzayishi, normal kuchlanish qiymati va materialining elastiklik moduli aniqlansin.

Javobi. $\varepsilon = 0,025$; $\sigma = 500 \text{ kg/sm}^2$; $E = 2 \cdot 10^6 \text{ kg/sm}^2$

1.13. Diametri $d = 25 \text{ sm}$ bo'lgan doiraviy ko'ndalang kesimli yog'och ustunining ko'ndalang kesimidagi siquvchi kuchlanish 50 kn/sm^2 dan oshmasa, uning qancha yuk ko'tara olishi aniqlansin.

Javobi: 10,19 kn.



1.1 – 1.10-misollar uchun

1.14 Ko'ndalang kesimi doira bo'lgan po'lat sterjen $P=100\text{ kn}$ kuch ta'sirida cho'ziladi. Uning ko'ndalang kesimida hosil bo'ladigan kuchlanish 1290 kg/sm^2 dan, nisbiy uzayish esa $0,0005$ dan oshmasligini ta'minlovchi eng kichik diametri aniqlansin.

Javobi: $35,6\text{ mm}$.

1.15. Ko'ndalang kesim yuzasi $F=12\text{ sm}^2$ bo'lgan po'lat sterjen shaklda ko'rsatilgandek yuklangan. Xavfli ko'ndalang kesimidagi normal kuchlanish $\sigma = 2400\text{ kg/sm}^2$ bo'lishi uchun R kuchning qiymati aniqlansin.

Javobi: $R=72\text{ kn}$.

1.16. Ko'ndalang kesimi to'g'ri to'rtburchakdan iborat bo'lgan mis sterjen shaklda ko'rsatilgandek yuklangan. Uning uchun eng katta normal kuchlanish va to'la uzayish qiymatlari aniqlansin.

Javobi: $\sigma_{\max}=312,5\text{ kg/sm}^2$, $\Delta\ell=0,0125\text{ sm}$.

1.17. O'zgarmas ko'ndalang kesimli $(6\times6\text{ sm}^2)$, uzunligi $\ell=30\text{ sm}$ bo'lgan po'lat sterjen $P=300\text{ kn}$ kuch bilan cho'zilayapti. $\mu=0,3$ bo'lganda sterjenning hajmiy o'zgarishi aniqlansin.

Javobi: 0.017% .

1.18. $q\frac{x}{\ell}$ bo'ylama kuch bilan cho'zilayotgan sterjenning to'la uzayishi va deformasiyaning potensial energiyasi topilsin.

Javobi: $\Delta\ell = \frac{q\ell^2}{6EF}$; $U = \frac{q^2\ell^3}{40EF} = \frac{(q\ell)^2 \cdot \ell}{40EF}$.

1.19. Shaklda ko'rsatilgan po'lat sterjenning V va S kesimlarining bo'ylama ko'chishi topilsin.

Javobi: $\delta_B=0,005\text{ sm}$; $\delta_C=-0,0025\text{ sm}$.

1.20. Diametri $d=4\text{ cm}$ bo'lgan silindrik po'lat sterjen zarurat yuzasidan o'rtasidan uzunligi $\ell_1=40\text{ sm}$ bo'lgan teshik olib zaiflashtirilgan. Zaiflashtirilgan va zaiflashmagan qismlarining to'la uzayishi va kuchlanishlari topilsin.

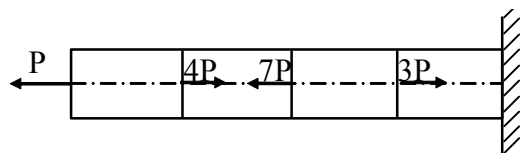
Javobi:

$$\sigma_{BB}=159,2\text{ kg/sm}^2; \delta_{DB}=0,0032\text{ sm}; \sigma_{A-A}=438,6\text{ kg/sm}^2;$$

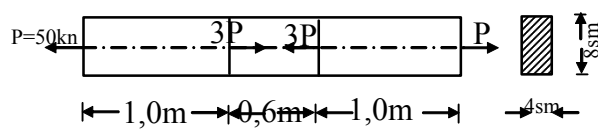
$$\delta_{A-A}=0,0088\text{ sm}; \delta=\delta_{A-A}+\delta_{B-B}=0,012\text{ sm}.$$

1.21. Shaklda ko'rsatilgan, ruxsat etilgan kuchlanishi $[\sigma_c]=1000\text{ kg/sm}^2$ bo'lgan cho'yan trubaning devor qalinligi topilsin.

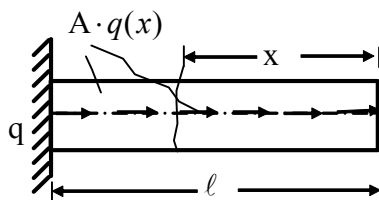
Javobi: $\delta=2,88\text{ sm}.$



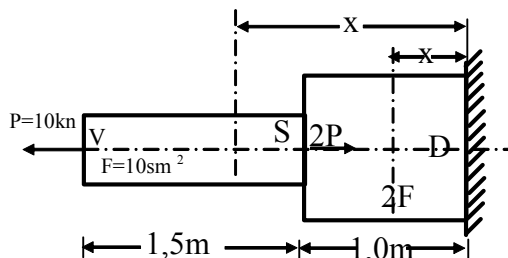
1.15-misol uchun



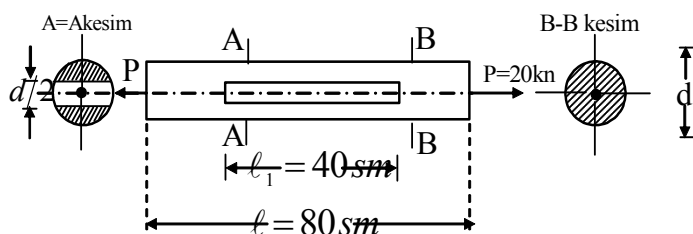
1.16-misol uchun



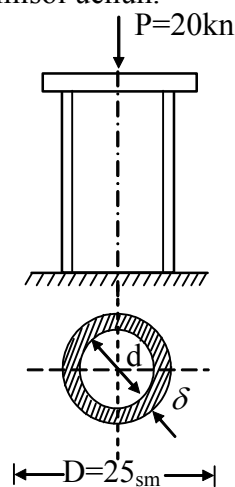
1.18-misol uchun.



1.19-misol uchun.



1.20-misol uchun



1.21-misol uchun

1.22. Diametri $d=2,5$ sm, uzunligi $\ell = 25$ sm bo'lgan po'lat sterjen $R=25$ kn kuch bilan cho'ziladi. Sterjendagi cho'zuvchi kuchlanish, absolyut va nisbiy cho'zilishlari topilsin.

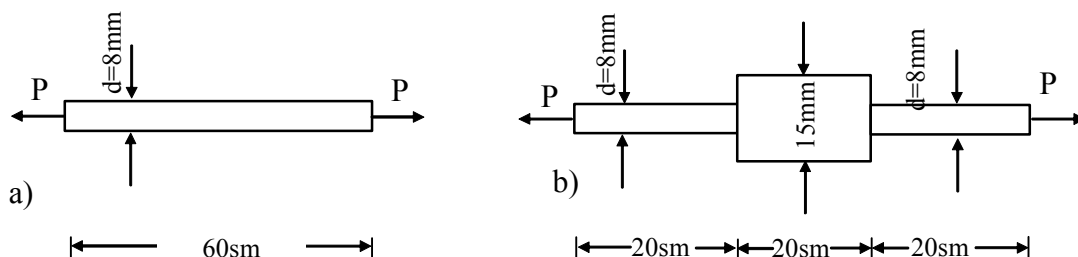
Javobi. $\sigma = 510 \text{ kg/sm}^2$; $\Delta\ell = 0,00638 \text{ sm}$; $\varepsilon = 0,000255$.

1.23. Mustahkamlik chegarasi $\sigma_g = 4200 \text{ kg/sm}^2$, mustahkamlik koeffitsiyenti $n=3$ va qalinligi $\delta=0,8$ sm bo'lgan po'lat polasa $R=98$ kn kuch bilan cho'ziladi. Polasaning eni v-topilsin.

Javobi. $v=8,75$ sm.

1.24. Ichki diametri $d=50$ sm bo'lgan silindrga, bug' silindrining qapqog'i 8 ta bolt bilan biriktirilgan va undagi bug'ning bosimi $r=6$ at. Boltlar uchun $[\sigma]=500 \text{ kg/sm}^2$ bo'lsa uning diametri qanday bo'lishi kerak?

Javobi: $d=1,94$ sm.



1.26-misol uchun

1.25. Elastiklik chegarasi $\sigma_y = 2500 \text{ kg/sm}^2$ bo'lgan po'lat sterjenning cho'zilishida hosil bo'ladigan solishtirma potensial energiya aniqlansin.

Javobi: $a = 1,56 \text{ kgsm/sm}^3$.

1.26. Ko'ndalang kesimi doiraviy bo'lgan po'lat sterjenlarning ikkala holida ham eng katta cho'zuvchi kuchlanish bir xil bo'lib, $\sigma = 1500 \text{ kg/sm}^2$ va $E = 2,2 \cdot 10^6 \text{ kg/sm}^2$ bo'lganda, ularda hosil bo'lgan solishtirma potensial energiyalari solishtirib ko'rilsin.

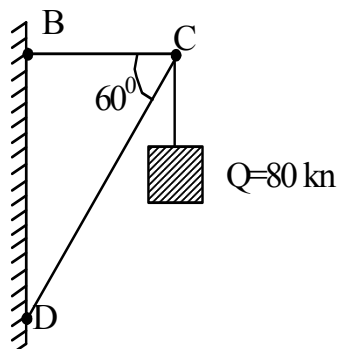
Javobi: $\frac{a_1}{a_2} \approx 1,4$.

1.27 Siqilishga ruxsat etilgan $[\sigma_c] = 1200 \text{ kg/sm}^2$, $E = 0,8 \cdot 10^6 \text{ kg/sm}^2$ va $\frac{d}{D} = \frac{4}{5}$ bo'lgan holda, uzunligi $\ell = 30 \text{ sm}$ li halqasimon ko'ndalang kesimli cho'yan silindrik taglik $F = 80 \text{ kn}$ kuch bilan siqilayapti. Shu taglikning ichki d va tashqi D diametrlari hamda to'la qisqarishi topilsin.

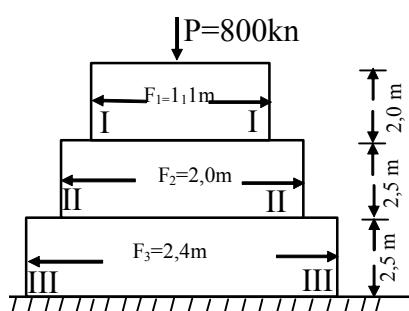
Javobi: $D = 5 \text{ sm}$, $d = 4 \text{ m}$, $\Delta \ell = 0,042 \text{ sm}$.

1.28. Cho'zilish uchun $[\sigma_u] = 300 \text{ kg/sm}^2$ va siqilish uchun $[\sigma_c] = 900 \text{ kg/sm}^2$ bo'lgan cho'yan kranshteynning tortqi va tirgagining ko'ndalang kesimi yuzalari qanday bo'lishi kerak.

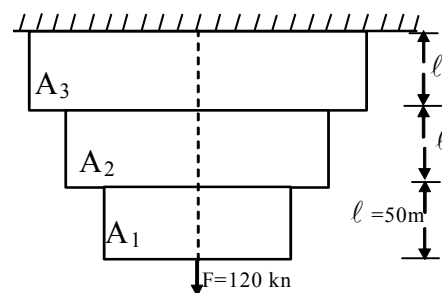
Javobi: $F_{mopm} = 15,4 \text{ sm}^2$; $F_{mupz} = 10,26 \text{ sm}^2$.



1.28-misol uchun



1.29-misol uchun



1.31-misol uchun

1.29. Shaklda ko'rsatilgan kesimi kvadrat bo'lgan pog'onali fundament materialining hajmiy og'irligi $\gamma = 0,024 \text{ kg/sm}^3$ bo'lsa, I-I, II-II, III-III kesimlarida hosil bo'ladigan kuchlanishlar topilsin.

Javobi: $\sigma_{I-I} = 7,29 \text{ kg/sm}^2$; $\sigma_{II-II} = 2,75 \text{ kg/sm}^2$; $\sigma_{III-III} = 2,51 \text{ kg/sm}^2$.

1.30. Ko'ndalang kesim yuzi $6 \times 6 \text{ sm}^2$; uzunligi $\ell = 10 \text{ m}$ bo'lgan po'lat sterjen $P = 200 \text{ kn}$ kuch bilan cho'ziladi. Sterjenning o'z og'irligini hisobga olgan holda undagi eng katta kuchlanish va uzayishi aniqlansin.

Javobi: $\sigma_{\max} = 563,4 \text{ kg/sm}^2$; $\Delta \ell = 0,27996 \text{ sm}$.

1.31. Ruksat etilgan kuchlanishi $[\sigma] = 500 \text{ kg/sm}^2$ bo'lgan pog'onali prizmatik po'lat shtanganing o'z og'irligini hisobga olgan holda, har bir pog'onasining ko'ndalang kesim yuzasi va to'la uzayishi aniqlansin.

Javobi: $F_1 = 26 \text{ sm}^2$; $F_2 = 28,2 \text{ sm}^2$; $F_3 = 30,6 \text{ sm}^2$; $\Delta \ell = 3,32 \text{ sm}$.

1.32. Shaklda ko'rsatilgandek sharnirlar yordamida birlashtirilgan ikkita sterjenning zaruriy yuzasi va C kesimining ko'chishi aniqlansin.

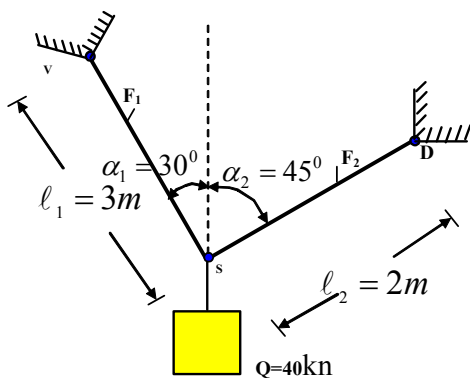
Javobi. $F_1 = F_{\text{po'lat}} = 1,82 \text{ sm}^2$; $F_2 = F_{\text{mis}} = 2,07 \text{ sm}^2$; $\delta_c = 0,3 \text{ sm}$.

1.33. Shaklda ko'rsatilgan po'lat sterjenning o'rtasiga qo'yilgan R kuchning qanday qiymatida uning pastki tayanchga erkin tegadi. Sterjenning VS va SD uchastkalarida hosil bo'ladigan kuchlanishlar ham topilsin.

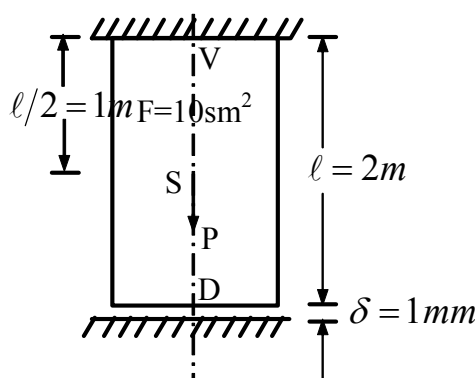
Javobi: $P = 20000 \text{ kg}$; $\sigma_{VS} = 2000 \text{ kg/sm}^2$; $\sigma_{SD} = 0$.

1.34. Shaklda ko'rsatilgan ustunning ko'ndalang kesim yuzasi $F_x = F_0 \frac{x}{h}$ qonunga muvofiq o'zgaradi. Agar E va γ ma'lum bo'lsa, ustunning o'z og'irligidan to'liq kattalashishini toping.

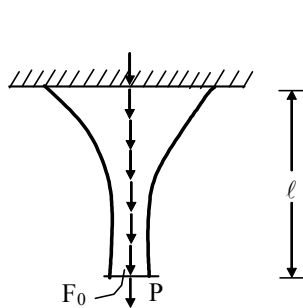
Javobi: $\Delta h = \frac{\gamma h^2}{4E}$.



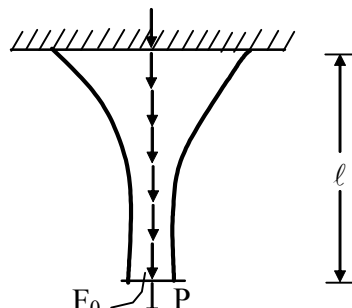
1.32-misol uchun



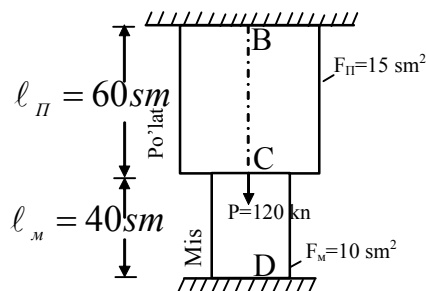
1.33-misol uchun



1.34-misol uchun



1.35-misol uchun



1.36- misol uchun

1.35. Teng qarshilikli sterjenning o'z og'irligini hisobga olgan holda ko'ndalang kesimining o'zgarish qonunini aniqlang va to'la cho'zilishini toping.

Javobi: $F_x = \frac{F_0}{[\sigma]} e^{\frac{\gamma}{[\sigma]} x}$; $\Delta l = \frac{[\sigma]}{E} l$

1.36. Shaklda ko'rsatilgan pog'onali sterjenning tayanch reaksiyalarining qiymati aniqlansin.

Javobi : $R_B = 80 \text{ kn}$; $R_D = 40 \text{ kn}$.

1.37. Shaklda ko'rsatilgan pog'onali po'lat sterjenning o'z og'irligidan tayanchlarida hosil bo'ladigan reaksiya kuchlarining qiymatlari topilsin.

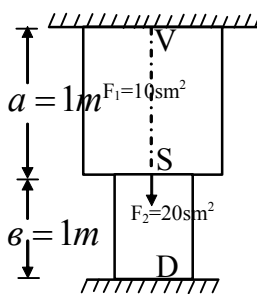
Javobi: $R_V = 7,85 \text{ kg}$; $R_D = 15,7 \text{ kg}$.

1.38. Shaklda ko'rsatilgandek absalyut qattiq brus uchta sterjen bilan osib qo'yilgan. Shu uchala sterjenlarda hosil bo'ladigan zo'riqish kuchlari aniqlansin.

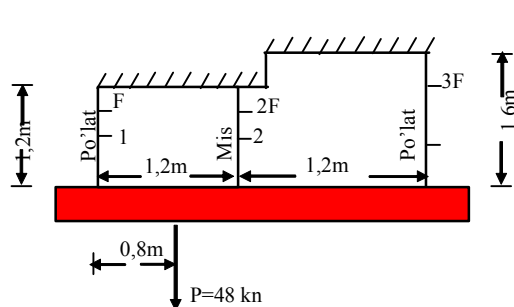
Javobi: $N_1 = 23,6 \text{ kn}$; $N_2 = 16,8 \text{ kn}$; $N_3 = 7,6 \text{ kn}$.

1.39. Materiali va ko'ndalang kesimi bir xil bo'lgan uchta po'lat sterjen tutashgan O sharnirga P kuch qo'yilgan. Shu sterjenlarda hosil bo'ladigan zo'riqish kuchlari va O sharnirning kuchishi aniqlansin.

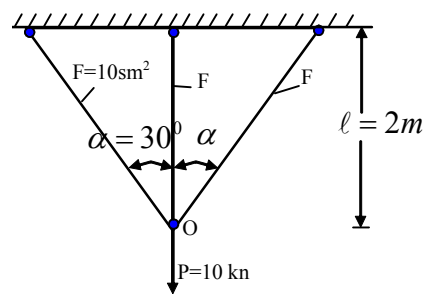
Javobi : $N_1 = N_3 = 326,09 \text{ kg}$; $N_2 = 434,78 \text{ kg}$; $\delta_0 = 0,0043 \text{ sm}$.



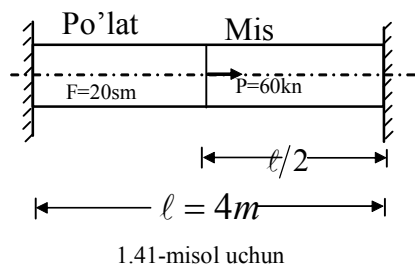
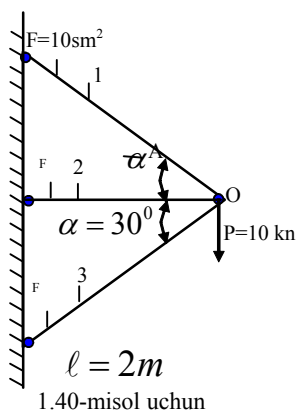
1.37- misol uchun



1.38-misol uchun



1.39-misol uchun



1.40. Uchta bir xil materialdan va ko'ndalang kesimi bir xil bo'lgan sterjenlardan tuzilgan kran shteynning O sharnirining ko'chishi va sterjenlardagi zo'riqish kuchlari topilsin

Javobi: $N_1 = 10_{\text{кН}}$; $N_3 = -10 \text{ кН}$; $N_2 = 0$; $\delta_0 = 0,023 \text{ см}$.

1.41. Shaklda ko'rsatilgandek yuklangan sterjenning temperaturasi $t=20^0$ ga ko'tarilganda ikkala qismda hosil bo'ladigan kuchlanishlar hisoblansin.

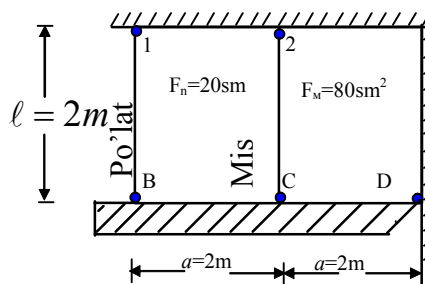
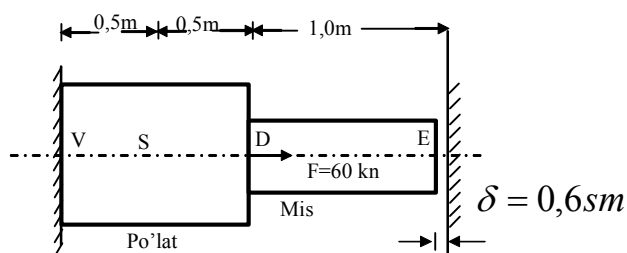
Javobi: $\sigma_n = 380 \frac{\text{кг}}{\text{см}^2}$; $\sigma_m = -680 \frac{\text{кг}}{\text{см}^2}$.

1.42. Shaklda ko'rsatilgan pog'onali sterjenni $t=20^0$ ga qizdirganda qismlarida hosil bo'lgan kuchlanishlar aniqlansin.

Javobi: $\sigma_{VS} = 82,5 \frac{\text{кг}}{\text{см}^2}$; $\sigma_{SD} = -157,5 \frac{\text{кг}}{\text{см}^2}$; $\sigma_{DE} = -315 \frac{\text{кг}}{\text{см}^2}$.

1.43. Shaklda ko'rsatilgan VD absolyut bikr brus yig'ilgandan co'ng $t=60^0$ ga qizdirilganda sterjenlarda hosil bo'ladigan kuchlanishlarni brusning xususiy og'irligini hisobga olmagan holda aniqlang.

Javobi: $\sigma_1 = 320 \text{ кг/см}^2$; $\sigma_2 = -160 \text{ кг/см}^2$.



1.44. Shaklda ko'rsatilgan ikki xil ko'ndalang kesimi sterjenlarga bir xil cho'zuvchi kuch qo'yilgan bo'lib, ularning qaysida bo'ylama kuch katta bo'ladi.

Javobi: Ikkalasida ham bir xil bo'ladi.

1.45. Shakl, *a* da ko'rsatilgan trosni qiya burchagini kamaytirsak, bo'ylama kuch qiymati o'zgaradimi.

Javobi: Ha o'zgartirilgan holda bo'ylama kuch kattta bo'ladi.

1.46. Shaklda ko'rsatilgan, 2000 kq yuk ko'taruvchi zanjirning diametri topilsin. $\sigma_n = 4000 \text{ kg/sm}^2$, mustahkamlik chegarasi bo'yicha normativ ehtiyot koeffitsiyenti $n = 8$.

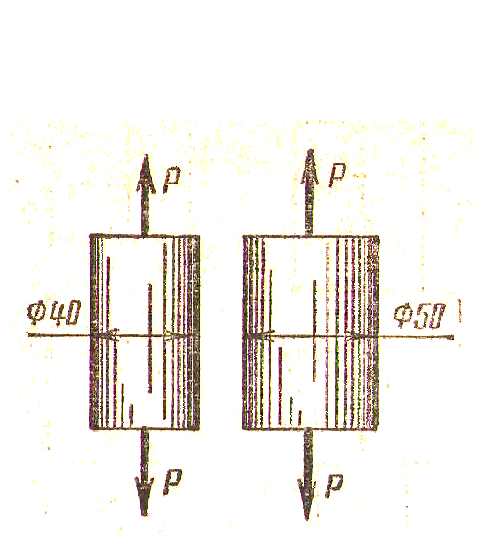
Javobi: $d = 1,6 \text{ sm}$.

1.47. Juda og'ir yuklarni ko'taruvchi skobaning AV va VS sterjenlarning diametri aniqlansin, agar unda 1000 kn yuk ko'tarilsa, $[\sigma] = 1000 \text{ kg/sm}^2$.

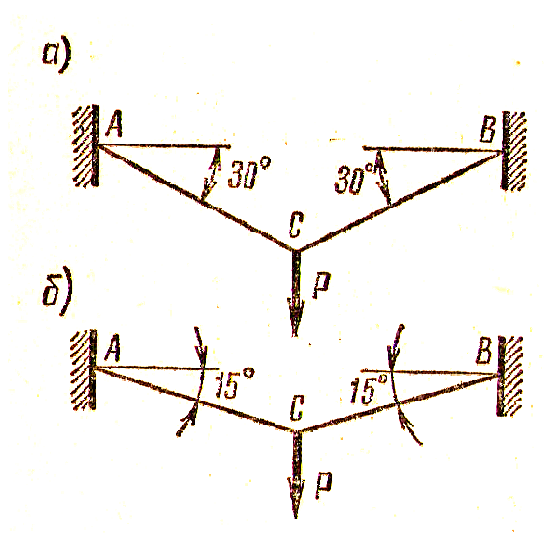
Javobi: $d = 8,2 \text{ sm}$.

1.48.. Shaklda ko'rsatilgandek yuklangan moslamaning sterjenlaridagi kuchlanish $\sigma = 1600 \text{ kg/sm}^2$ dan oshmasligi uchun V sharnirga qo'yiladigan xavfli bo'lmagan eng katta yuk qancha bo'ladi.

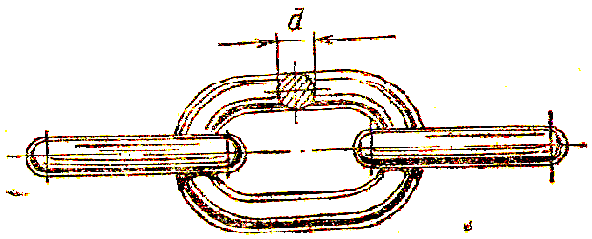
Javobi: $Q = 57,5 \text{ kn}$



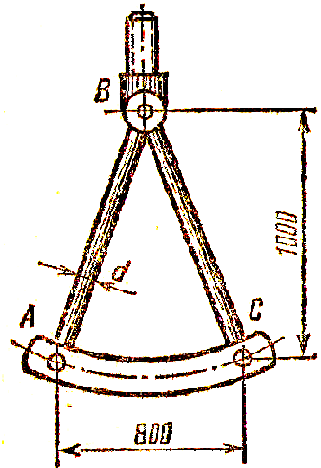
1.44-misol uchun.



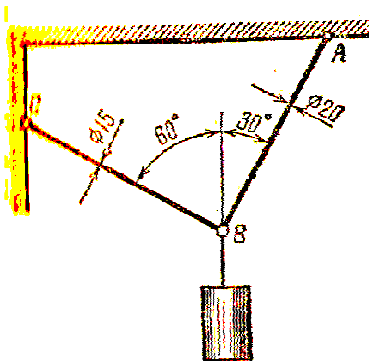
1.45-misol uchun



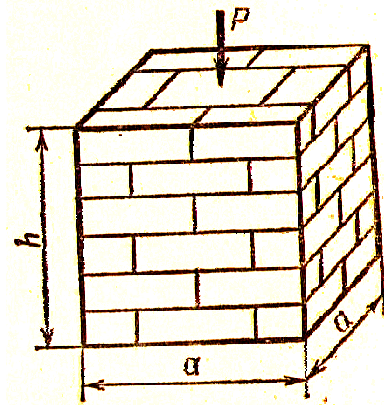
1.46-misol uchun



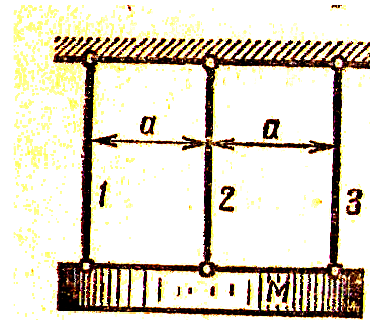
1.47-misol uchun



1.48-misol uchun



1.49-misol uchun.



1.50-misol uchun

1.49. Shaklda ko'rsatilgan, balandligi $h=5m$ bo'lgan g'ishtdan yasalgan ustun $P=200 kn$ kuch bilan siqilsa, ustunning zaruriy bo'lgan tomonining o'lchami topilsin. $[\sigma_c]=12 kg/sm^2, \gamma=1500 kg/m^3$.

Javobi: $a=42,3 sm$

1.50. Shaklda ko'rsatilgandek og'irligi $30 kn$ bo'lgan balka uchta po'lat sterjen bilan osib qo'yilgan. Agar sterjenlarning ko'ndalang kesim yuzalari $F_1=F_3=2 sm^2, F_2=1 sm^2$ bo'lsa, ularda hosil bo'ladigan zo'riqish kuchlari va kuchlanishlar aniqlansin.

Javobi: $N_1=N_3=1170 kg; N_2=589 kg; \sigma_1=\sigma_2=\sigma_3=589 kg/sm^2$

1.51 Ko'ndalang kesimi doira bo'lgan po'lat sterjen $P=100 kn$ kuch ta'sirida cho'ziladi. Uning ko'ndalang kesimida hosil bo'ladigan kuchlanish $1290 kg/sm^2$ dan, nisbiy uzayish esa $0,0005$ dan oshmasligini ta'minlovchi eng kichik diametri aniqlansin.

Javobi. $3.56 sm$.

MURAKKAB KUCHLANISH HOLATI.

2.1. Ko'ndalang kesim yuzasi $F=20 \text{ sm}^2$ bo'lgan sterjen $P=20 \text{ kn}$ kuch bilan cho'zilayapti. Normali sterjen o'qi bilan $\alpha=30^\circ$ burchak hosil qiluvchi qiya kesimdagi normal, urinma va to'la kuchlanishlar aniqlansin.

$$\text{Javobi: } \sigma_\alpha = 75 \text{ kg/sm}^2; \tau_\alpha = 43,3 \text{ kg/sm}^2; P_\alpha = 86,6 \text{ kg/sm}^2$$

2.2. Doiraviy kesimli ($d=10\text{cm}$) sterjen o'q bo'ylab $P=50 \text{ kn}$ kuch bilan cho'zilayapti. Normali sterjen o'qi bilan $\alpha=30^\circ$ burchak hosil qiluvchi qiya kesim bo'yicha normal va urinma kuchlanishlar qiymatini hamda urinma kuchlanish qanday kesimda o'zining eng katta qiymatiga erishishini toping.

$$\text{Javobi: } \sigma_\alpha = 47,77 \text{ kg/sm}^2; \tau_\alpha = 27,58 \text{ kg/sm}^2; \tau_{\max} = 31,85 \text{ kg/sm}^2$$

2.3. Ko'ndalang kesimi $15 \times 15 \text{ sm}^2$ dan iborat bo'lgan kvadrat sterjen $P=60 \text{ kn}$ kuch bilan siqilayapti. Sterjenning ko'ndalang kesimidagi va normali sterjen o'qi bilan $\alpha=30^\circ$ burchak hosil qiluvchi kesimdagi to'la kuchlanishlar aniqlansin.

$$\text{Javobi: } P_0 = \sigma_0 = 26,67 \text{ kg/sm}^2; P_\alpha = 5,62 \text{ kg/sm}^2$$

2.4. Qiya kesimdagi normal kuchlanish 600 kg/sm^2 , urinma kuchlanish 300 kg/sm^2 bo'lsa, bu kesim normali sterjen o'qi bilan qanday burchak hosil qiladi va ko'ndalang kesimdagi normal kuchlanish (σ_0) qiymati qancha bo'ladi.

$$\text{Javobi: } \alpha = 45^\circ, \sigma_0 = 1200 \text{ kg/sm}^2.$$

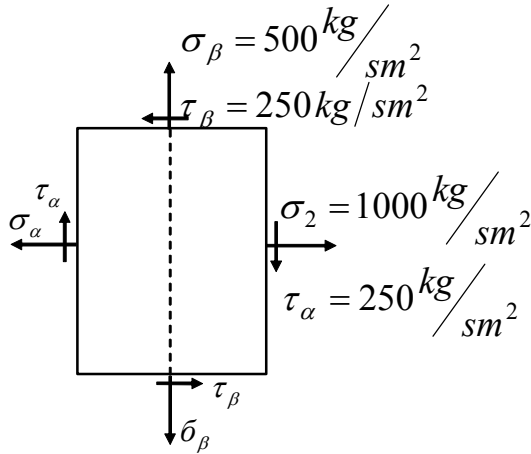
2.5. Kvadrat ko'ndalang kesimli $a=16 \text{ sm}$ bo'lgan kalta sterjen P kuch bilan siqiladi. Normali sterjen o'qi bilan $\alpha=45^\circ$ burchak hosil qiluvchi kesimdagi siquvchi kuchlanish $\sigma_\alpha = 20 \text{ kg/sm}^2$ ga teng bo'lsa, siquvchi kuch P ning qiymati topilsin.

$$\text{Javobi: } P = 102,40 \text{ kn}.$$

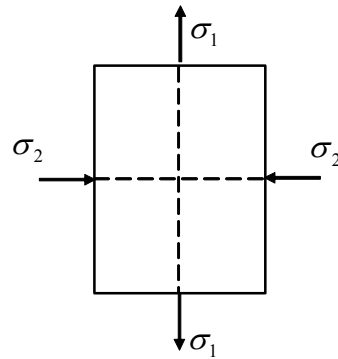
2.6. Shaklda ko'rsatilgandek kuchlanishlar ta'siridagi elementdagi bosh kuchlanishlar qiymati va bosh yuzalar yo'nalishi aniqlansin.

Javobi:

$$\begin{aligned} \sigma_{\max} = \sigma_1 &= 1103,5 \text{ kg/sm}^2; & \sigma_{\min} &= 396,5 \text{ kg/sm}^2 \\ \alpha_1 &= -22,5^\circ; & \alpha_2 &= 67,5^\circ \end{aligned}$$



2.6-misol ushun



2.7-misol uchun

2.7. σ_1 va σ_2 kuchlanishlar yo'nalishi bo'yicha nisbiy deformasiyalar $\varepsilon_1 = 0,00565$ bo'lsa, shu kuchlanishlar qiymati aniqlansin, $E = 2 \cdot 10^6 \text{ kg/sm}^2$ va $\mu = 0,3$ deb olinsin.

Javobi: $\sigma_1 = 1373,6 \text{ kg/sm}^2$; $\sigma_2 = -1087,9 \text{ kg/sm}^2$

2.8. Po'latdan yasalgan kubning tomonlariga σ_1, σ_2 kuchlanishlar ta'sir etadi. Nisbiy deformasiya $\varepsilon_1, \varepsilon_2$ larni toping.

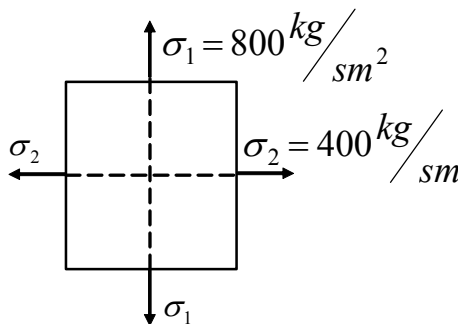
Javobi: $\varepsilon_1 = 0,00034$; $\varepsilon_2 = 0,00008$

2.9. σ_1, σ_2 cho'zuvchi kuchlanishlarning qanday nisbatida, nisbiy deformasiya $\varepsilon_1 = 0$ bo'ladi.

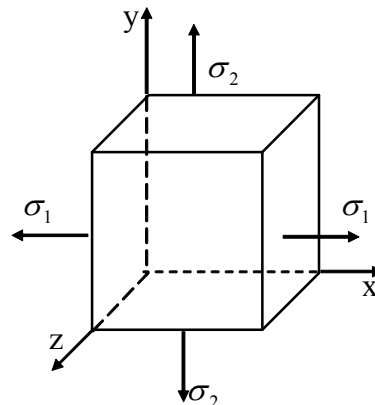
Javobi: $\frac{\sigma_1}{\sigma_2} = \mu$.

2.10. Bosh σ_1 va σ_3 kuchlanishlar ta'sirida bo'lgan elementning normali σ_1 bosh kuchlanish yo'nalishi bilan $\alpha = 60^\circ$ burchak hosil qilgan qiya yuzidagi normal, urinma va to'la kuchlanishlar topilsin.

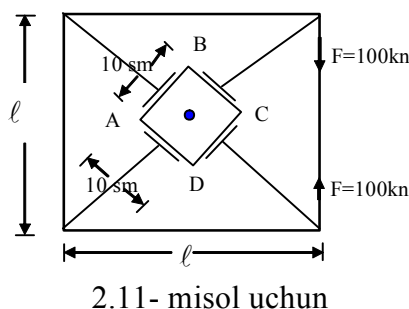
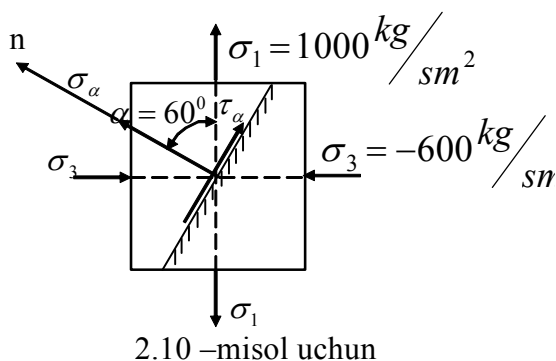
Javobi: $\sigma_\alpha = -200 \text{ kg/sm}^2$; $\tau_\alpha = 692,8 \text{ kg/sm}^2$; $P_\alpha = 721,1 \text{ kg/sm}^2$



2.8-misol uchun



2.9- misol uchun



2.11. Shaklda ko'rsatilgandek ABcD kub ($10 \times 10 \times 10 \text{ sm}^3$) tekis yoyilgan kuch bilan siqilayapti. Agar $E = 0,4 \cdot 10^6 \frac{\text{kg}}{\text{sm}^2}$; $\mu = 0,3$ bo'lsa, kub hajmining o'zgarishi aniqlansin.

Javobi: $Q = -0,00028$

2.12. Hajmiy kuchlanish holatidagi po'lat kubning hajmning nisbiy o'zgarishini, to'la solishtirma potensial energiyasi (to'la hajmiy va shakl)

$$\Theta = 0,00024; u = 0,3275 \frac{\text{kgsm}}{\text{sm}^3}; u_x = 0,048 \frac{\text{kgsm}}{\text{sm}^3}; u_u = 0,2795 \frac{\text{kgsm}}{\text{sm}^3}$$

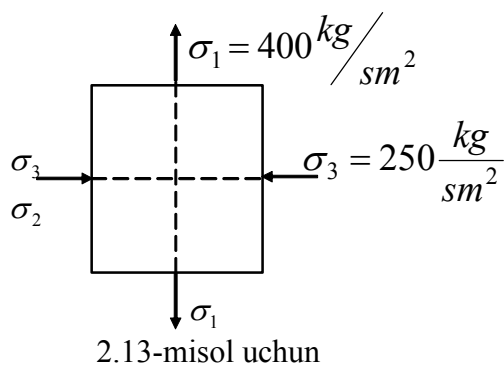
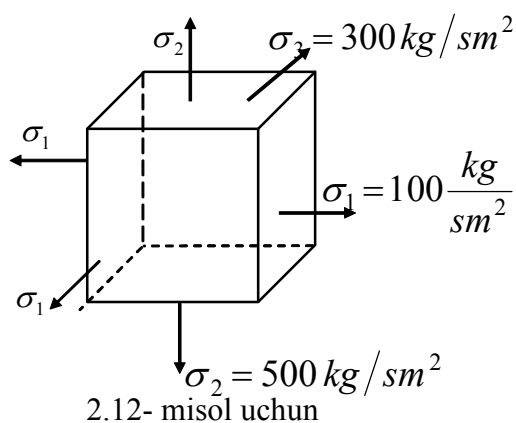
topilsin. $E = 2 \cdot 10^6 \frac{\text{kg}}{\text{sm}^2}$; $\mu = 0,3$ deb olinsin.

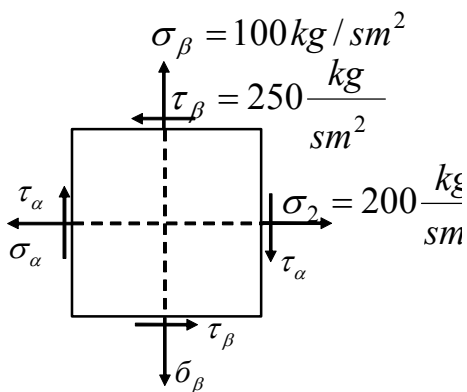
Javobi:

2.13. Tekis kuchlanish holatidagi kub uchun hajmning nisbiy o'zgarishi va deformasiyaning solishtirma potensial energiyasi (to'la hajmning va shaklning o'zgarishi) topilsin.

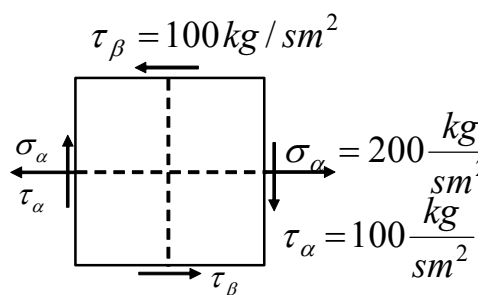
Javobi: $\Theta = 0,00003$; $u = 0,07062 \frac{\text{kgsm}}{\text{sm}^3}$

$$u_x = 0,00075 \frac{\text{kgsm}}{\text{sm}^3}; u_u = 0,06987 \frac{\text{kgsm}}{\text{sm}^3}$$





2.14 –misol uchun



2.15-misol uchun

2.14. Shaklda ko'rsatilgan kuchlanish holatidagi kub uchun hajmning nisbiy o'zgarishi va deformatsiyaning solishtirma potensial energiyasi (to'la, hajm va shakl o'zgarishi) hisoblansin.

Javobi: $\Theta = 0,00006$; $u = 0,0111 \text{ kgsm}/\text{sm}^3$;

$$u_x = 0,003 \text{ kgsm}/\text{sm}^3; u_{uu} = 0,0081 \text{ kgsm}/\text{sm}^3$$

2.15. Shakldagi kuchlanish holati uchun Θ, u, u_x, u_{uu} lar hisoblansin.

Javobi: $\Theta = -0,00004$; $u = 0,0165 \text{ kgsm}/\text{sm}^3$

$$u_x = 0,0013 \text{ kgsm}/\text{sm}^3; u_{uu} = 0,0152 \text{ kgsm}/\text{sm}^3$$

2.16. Qiya yuzadagi normal kuchlanish $\sigma = 840 \text{ kg}/\text{sm}^2$, urinma kuchlanish $\tau = 280 \text{ kg}/\text{sm}^2$ bo'lsa, bu yuza normali cho'zuvchi kuch yo'nalishi bilan qanday α burchak hosil qiladi va ko'ndalang kesimdagi σ_0 kuchlanish nimaga teng bo'ladi.

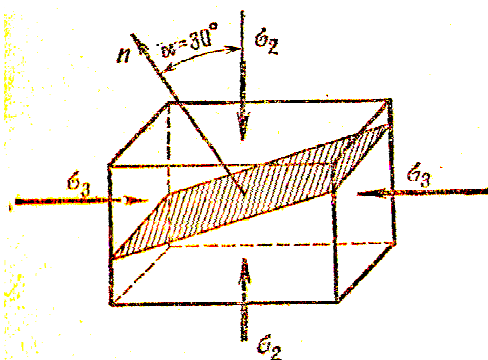
Javobi: $\alpha = \arctg \frac{1}{3}$; $\sigma_0 = \frac{\sigma}{\cos^2 \alpha} = 911 \text{ kg}/\text{sm}^2$.

2.17. Shaklda ko'rsatilgan elementar parallelopipedning tomonlariga $\sigma_2 = -500 \text{ kg}/\text{sm}^2$, $\sigma_3 = -800 \text{ kg}/\text{sm}^2$; $\tau_\alpha = -130 \text{ kg}/\text{sm}^2$ bosh kuchlanishlar ta'sir etadi. Berilgan qiya yuzada hosil bo'ladigan normal va urinma kuchlanishlar aniqlansin..

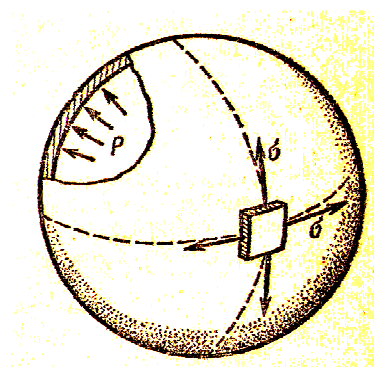
Javobi: $\sigma_\alpha = -575 \text{ kg}/\text{sm}^2$; $\tau_\alpha = -130 \text{ kg}/\text{sm}^2$.

2.18. Shaklda ko'rsatilgandek, bosim ostidagi sferik idish devoridan ajratilgan to'g'ri burchakli element o'zaro tik yo'nalgan va teng σ kuchlanishlar bilan cho'zilayapdi. Bu kuchlanishlarning biri bilan normali α burchak hosil qiluvchi yuzadagi normal va urinma kuchlanishlar topilsin.

Javobi: $\sigma_\alpha = \sigma$; $\tau_\alpha = 0$



2.17-misol uchun.



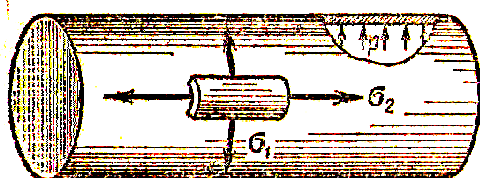
2.18-misol uchun.

2.19. Shaklda ko'rsatilgandek, silindrik qozonning devoridan ajratilgan to'g'ri burchakli elementning tomonlariga $\sigma_1 = 1000 \text{ kg/sm}^2$, $\sigma_2 = 500 \text{ kg/sm}^2$ bosh kuchlanishlar ta'sir etadi. Normali σ_1 kuchlanish yo'nalishi bilan $\alpha = 20^\circ$ burchak tashkil qiluvchi yuzada hosil bo'ladigan normal va urinma kuchlanishlar topilsin.

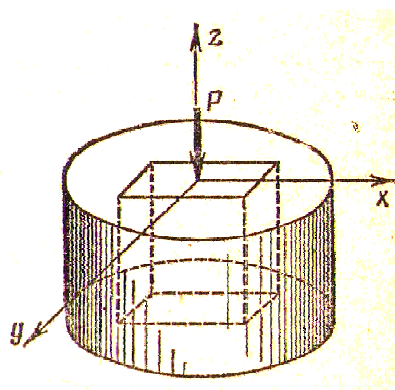
Javobi: $\sigma_\alpha = 942 \text{ kg/sm}^2$; $\tau_\alpha = -161 \text{ kg/sm}^2$.

2.20. O'lchamlari $5 \times 5 \times 5 \text{ sm}$ bo'lgan viniplast kubik shaklda ko'rsatilgandek po'lat massivga jips qilib qo'yilgan va $P = 12 \text{ kn}$ kuch bilan siqiladi. Massivni absolyut qattiq va $\mu = 0,35$ deb hisoblab kubdagi bosh kuchlanish topilsin.

Javobi: $\sigma_x = \sigma_y = -26 \text{ kg/sm}^2$; $\sigma_z = -48 \text{ kg/sm}^2$.



2.19-misol uchun.



2.20-misol uchun.

S I L J I Sh.

3.1 Shaklda ko'rsatilgan parallelipipedning yonboshdagi qirralarining nisbiy siljish burchagi va deformatsiyaning solishtirma potensial energiyasi aniqlansin.

Javobi $\gamma = 0,000625 \text{ sm}$; $u = 0,31 \text{ kg/sm}^3$

3.2 Shakllarda ko'rsatilgan sof siljish holatidagi parallelipiped uchun $\sigma_{\max}, \sigma_{\min}, \tau_{\max}, \tau_{\min}$ kuchlanishlarning qiymatlari hisoblansin.

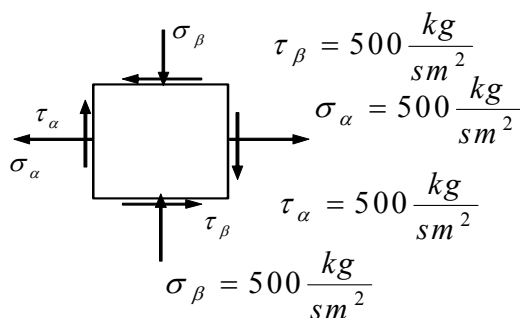
Javobi: a) $\sigma_{\max} = -\sigma_{\min} = \tau_{\max} = -\tau_{\min} = 150 \text{ kg/sm}^2$

b) $\sigma_{\max} = -\sigma_{\min} = \tau_{\max} = -\tau_{\min} = 418 \text{ kg/sm}^2$

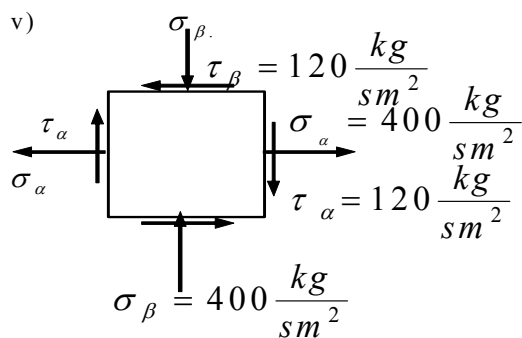
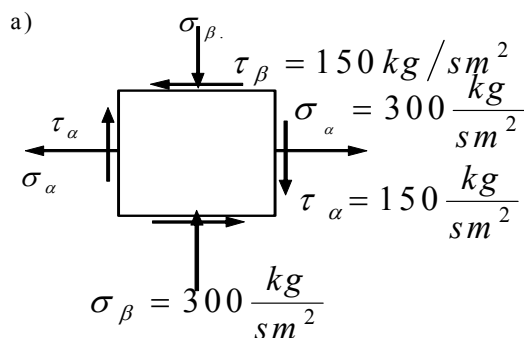
3.3. Shaklda ko'rsatilgandek ikki list ustma-ust qo'yib 6ta $d=2 \text{ sm}$ li parchin mix bilan biriktirilgan. Ruxsat etilgan cho'zuvchi R kuchlar va listning zaruriy kengligi v -aniqlansin.

Ruxsat etilgan kuchlanishlar: cho'zilishga $[\sigma] = 1600 \text{ kg/sm}^2$, qirqishga $[\tau] = 1200 \text{ kg/sm}^2$ va ezilishga $[\sigma_s] = 3200 \text{ kg/sm}^2$, deb olinsin.

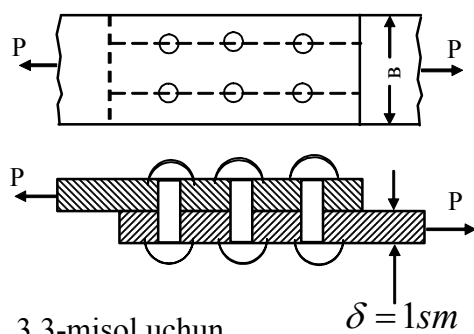
Javobi: $R = 226 \text{ kn}$; $v = 18 \text{ sm}$.



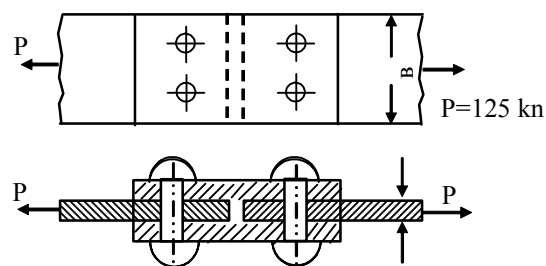
3.1-misol uchun



3.2-misol uchun



3.3-misol uchun



3.4-misol uchun

3.4. Kesimi o'lchamlari $1,0 \times 15$ sm va qalinligi $\delta = 0,6$ sm bo'lgan ikki list shaklda ko'rsatilgan ikki ust qo'yma bilan biriktirilgan. Parchin mixlarning diametri $d = 2$ sm. Ruxsat etilgan kuchlanishlar $[\sigma] = 1600 \text{ kg/sm}^2$, $[\tau] = 1000 \text{ kg/sm}^2$ va $[\sigma_s] = 3200 \text{ kg/sm}^2$, bo'lsa birikmaning mustahkamligi tekshirilsin.

Javobi: list uchun $\delta_{\max} = 1140 < 1600 \text{ kg/sm}^2$

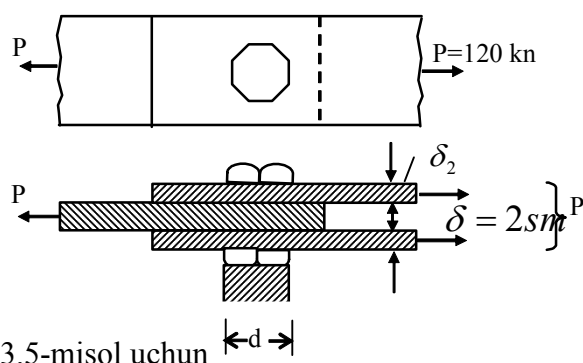
parchin mix uchun $\sigma_s = 3120 < 3200 \text{ kg/sm}^2$; $\tau = 996 < 1000 \text{ kg/sm}^2$

3.5. Shaklda ko'rsatilgan bog'lanish uchun ruxsat etilgan kuchlanishlarni $[\sigma] = 2000 \frac{\text{kg}}{\text{sm}^2}$; $[\tau] = 800 \frac{\text{kg}}{\text{sm}^2}$ deb qabul qilib, boltning diametrini aniqlang.

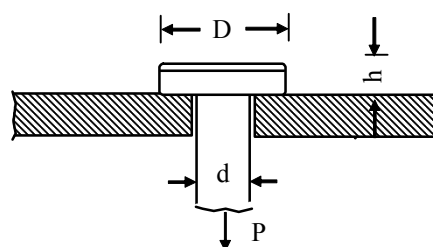
Javobi: $d = 31 \text{ mm}$

3.6 Cho'zilishga ishlaydigan $d = 10$ cm li bolt qalpoqchasi bilan listga tayanib turibdi. Agar bolt kesimidagi cho'zuvchi kuchlanish $\sigma = 1000 \frac{\text{kg}}{\text{sm}^2}$, qalpoqcha tayangan yuzadagi ezish kuchlanishi $\sigma_{\text{oz}} = 400 \text{ kg/sm}^2$ va qalpoqchani qirqish kuchlanishi $\tau = 500 \text{ kg/sm}^2$ bo'lsa, qalpoqcha diametri D va balandligi h aniqlansin.

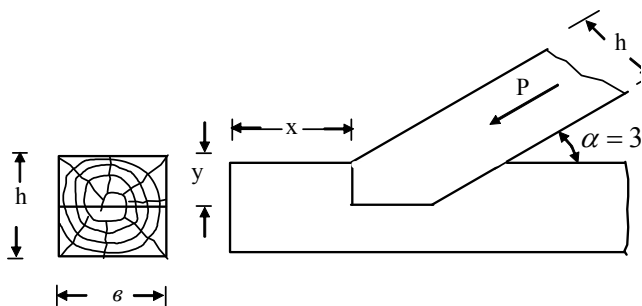
Javobi: $D = 18,7$ sm, $h = 5$ cm.



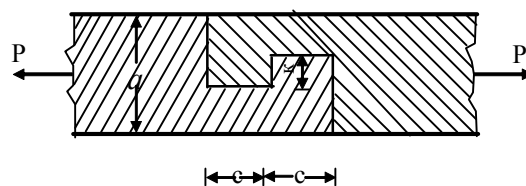
3.5-misol uchun



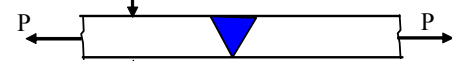
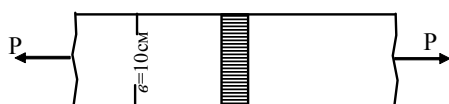
3.6-misol uchun



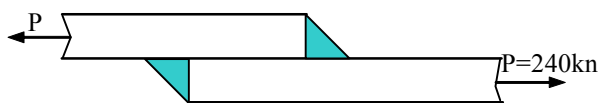
3.7-misol uchun



3.8-misol uchun



$\delta = 0,1 sm$ 3.9-misol uchun.



3.10-misol uchun

3.7 Strapilo oyog'i bilan uning tortqisining payvandi hisoblansin. Konstruksiya elementlarining yo'nalishlari orasidagi burchak $\alpha = 30^\circ$. Strapilo oyog'i bo'ylab ta'sir qiladigan kuch $F = 4000 \text{ kg}$, qarag'ay uchun yorilishga ruxsat etilgan kuchlanish $[\tau] = 12 \text{ kg/sm}^2$, ezilishga ruxsat etilgan kuchlanish $[\sigma_{\text{uz}}] = 60 \text{ kg/sm}^2$, stropilo oyog'i o'lchamlari $h = b = 15 \text{ sm}$

Javobi: $u = 4 \text{ cm}$; $x = 20 \text{ sm}$

3.8. Ikkita qarag'ay brusning uchlari tirnoq yordamida bir-biriga ulangan. Cho'zuvchi kuch $R = 40 \text{ kn}$, bruslarning ko'ndalang kesim yuzlari kvadrat shaklida bo'lib tomonlari a ga teng. Tirnoqli birikmaning o'lchamlari aniqlansin. Cho'zilish uchun ruxsat etilgan kuchlanish $[\sigma] = 100 \text{ kg/sm}^2$, yorilish uchun ruxsat etilgan kuchlanish, esa $[\tau] = 10 \text{ kg/sm}^2$

Javobi: $a = 11,4 \text{ sm}$, $\kappa = 4,4 \text{ sm}$, $c = 35,1 \text{ sm}$

3.9. Eni $b = 10 \text{ sm}$, qalinligi $\delta = 1.0 \text{ sm}$ bo'lgan ikkita list uchma-uch payvandlangan. List materiali uchun ruxsat etilgan kuchlanish $[\sigma] = 1400 \text{ kg/sm}^2$, chok uchun ruxsat etilgan kuchlanish $[\sigma_{\text{y}}] = 1000 \text{ kg/sm}^2$. List materiali va chok uchun ruxsat etilgan kuch topilsin.

Javobi: List uchun $P = 14000 \text{ kg}$ Chok uchun $P = 9000 \text{ kg}$

3.10. Qalinligi $\delta = 1,6 \text{ sm}$ va eni $b = 14 \text{ sm}$ bo'lgan ikki list ustma-ust payvandlangan. Choklar ko'ndalang bo'lib, ruxsat etilgan kuchlanishlar $[\sigma] = 1600 \text{ kg/sm}^2$, $[\tau_s] = 900 \text{ kg/sm}^2$. Payvandning mustahkamligi tekshirilsin.

Javobi: Chokning mustahkamligi: $\tau_s = 824,2 \text{ kg/sm}^2 < [\tau_s]$,

Listning mustahkamligi: $\sigma = 1071,4 \text{ kg/sm}^2 < [\sigma]$.

3.11. Har xil kenglikdagi ikki list ustma-ust qo'yilib, bo'ylama choklar bilan payvandlangan. Ruxsat etilgan kuchlanish $[\tau_s] = 800 \text{ kg/sm}^2$. Bo'ylama chokning uzunligi ℓ_σ aniqlansin.

Javobi: $\ell_\sigma = 13,5 \text{ sm}$.

3.12. Ikkita list ikkita ust qo'yma bilan tutashtirilgan. Agar listlarning qalinligi $\delta = 1,0 \text{ sm}$, ust qo'ymalarning qalinligi $\delta = 0,8 \text{ sm}$, choklarni qirqishga ruxsat etilgan kuchlanishi $[\tau_s] = 1000 \text{ kg/sm}^2$ bo'lsa, ust qo'ymalarning biriktirish uchun zaruriy bo'ylama choklarning uzunligi topilsin.

Javobi: $\ell_\sigma = 11,2 \text{ sm}$.

3.13. Shaklda ko'rsatilgan birikma $P = 48 \text{ kn}$ kuch bilan cho'ziladi. Tyaga va boltning zaruriy diametri hamda eng kichik ruxsat etilgan plastina kesimning o'lchami topilsin. Plastinkaning qalinligi $\delta = 8 \text{ mm}$, $[\sigma] = 1200 \frac{\text{kg}}{\text{sm}^2}$, $[\tau_{kes}] = 800 \text{ kg/sm}^2$

Javobi: $d = 2,26 \text{ sm}$, $d_0 = 1,95 \text{ sm}$; $a = 2,5 \text{ sm}$

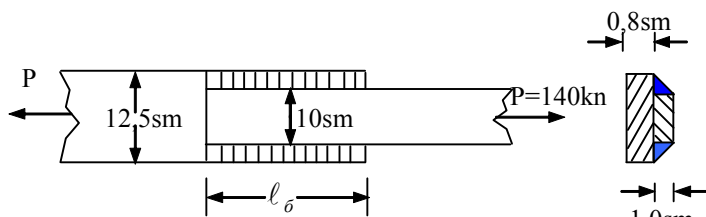
3.14. Agar $[\sigma] = 1400 \text{ kg/sm}^2$, $[\tau_{kes}] = 1000 \text{ kg/sm}^2$, $[\sigma_{93}] = 2400 \text{ kg/sm}^2$ bo'lsa shaklda ko'rastilgan parchin mixli birikmaning mustahkamligi tekshirilsin.

Javobi:

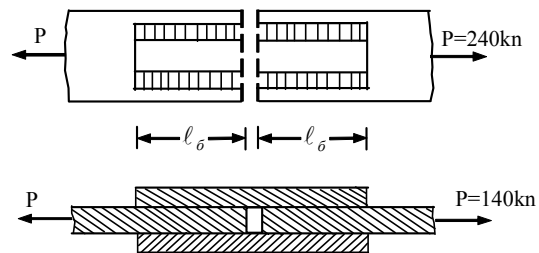
$$\sigma_{max}^{list} = 1040 \text{ kg/sm}^2, \sigma_{max}^u = 1430 \text{ kg/sm}^2, \sigma_{93} = 1660 \text{ kg/sm}^2, \tau_{kes} = 638 \text{ kg/sm}^2.$$

3.15. Agar $[\sigma] = 1600 \text{ kg/sm}^2$, $[\tau_{kes}] = 1400 \text{ kg/sm}^2$ va $[\sigma_{ez}] = 2800 \text{ kg/sm}^2$ bo'lsa, shaklda ko'rsatilgan parchin mixli birikmaning mustahkamligi tekshirilsin.

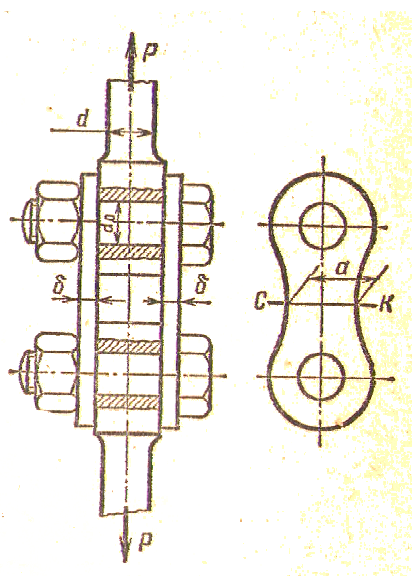
Javobi: $[\sigma] = 1530 \text{ kg/sm}^2$, $[\tau_{kes}] = 1460 \text{ kg/sm}^2$, $[\sigma_{ez}] = 2300 \text{ kg/sm}^2$.



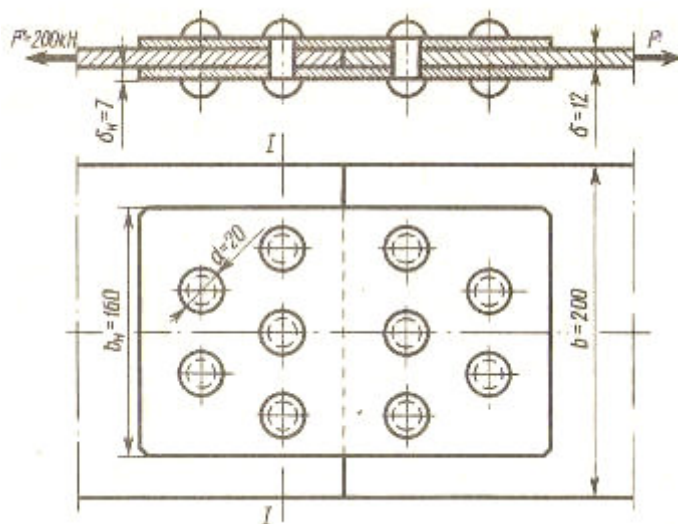
3.11-misol uchun



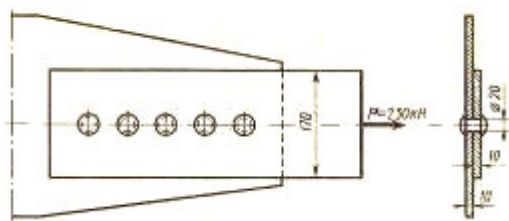
3.12-misol uchun



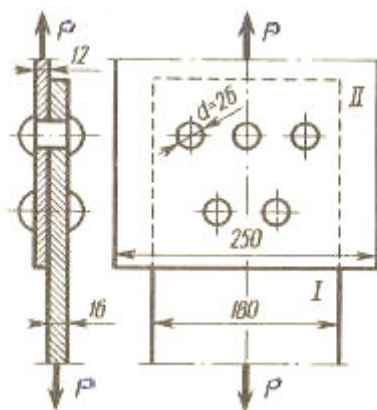
3.13-misol uchun.



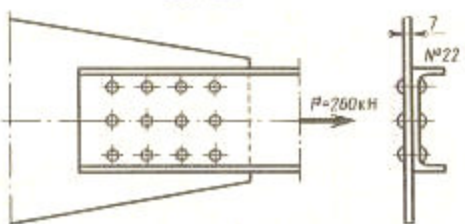
3.14-misol uchun.



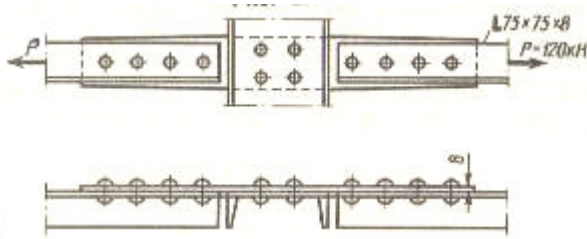
3.15-misol uchun.



3.18-misol uchun.



3.16—misol uchun.



3.17-misol uchun.

3.16. Agar parchin mixning diametri $d = 1,4 \text{ sm}$, $[\tau_{kes}] = 1400 \text{ kg/sm}^2$, $[\sigma_{ez}] = 3200 \text{ kg/sm}^2$ bo'lsa parchin mix sonini aniklang. τ_{kes} , σ_{ez} lar xisoblansin. Shveller uchun bo'ylama kuch eyuprasi qurilsin va uning mustahkamligi tekshirilsin $[\sigma] = 1600 \text{ kg/sm}^2$ deb olinsin.

Javobi: 12 ta parchin mix, $[\tau_{kes}] = 1410 \text{ kg/sm}^2$, $[\sigma_{ez}] = 2870 \text{ kg/sm}^2$ va shveller uchun $\sigma_{max} = 1060 \text{ kg/sm}^2$.

3.17. Agar parchin mixning diametri $d = 1,7 \text{ sm}$, materiali St.2 markali po'lat, $[\tau_{kes}] = 1400 \text{ kg/sm}^2$, $[\sigma_{ez}] = 2800 \text{ kg/sm}^2$ bo'lsa shaklda ko'rsatilgan parchin mixli birikmadagi parchin mixlar soni aniqlansin. Topilgan parchin mixlar soni bilan τ_{kes} , σ_{ez} lar hisoblansin.

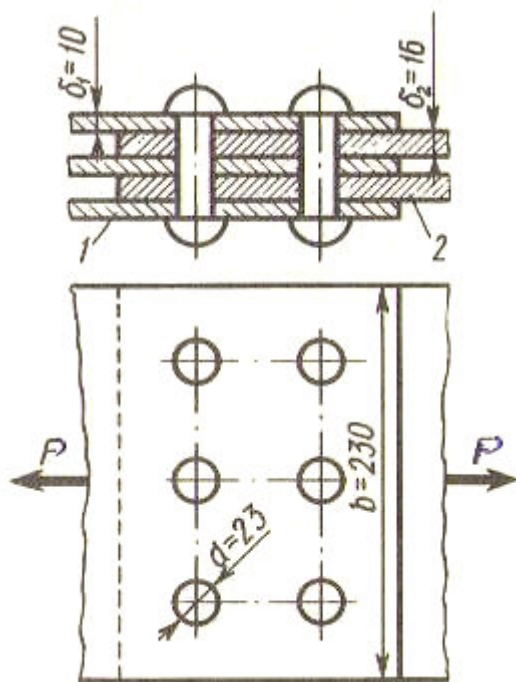
Javobi: 4 ta parchin mix, $[\tau_{kes}] = 1300 \text{ kg/sm}^2$, $[\sigma_{ez}] = 21600 \text{ kg/sm}^2$.

3.18. Agar polosa 1 uchun $[\sigma_u] = 1600 \text{ kg/sm}^2$, 2 polosa uchun $[\sigma_u] = 1400 \text{ kg/sm}^2$, $[\tau_{kes}] = 1400 \text{ kg/sm}^2$, $[\sigma_{ez}] = 2800 \text{ kg/sm}^2$ bo'lsa, shakldagi parchin mixli birikmaning $[P]$ ruxsat etilgan kuchi aniqlansin.

Javobi: $[P] = 289 \text{ kn}$.

3.19. Agar $[\sigma] = 1600 \text{ kg/sm}^2$, $[\tau_{kes}] = 1100 \text{ kg/sm}^2$, $[\sigma_{ez}] = 2800 \text{ kg/sm}^2$ bo'lsa, shaklda ko'rsatilgan birikmaga ta'sir etayotgan ruxsat etilgan kuchni qiymati topilsin.

Javobi: $[P] = 730 \text{ kn}$.



3.19-misol uchun. .

TEKIS SHAKLLARNING GEOMETRIK XARAKTERISTIKASI

4.1. Shaklda ko'rsatilgan to'g'ri to'rtburchak yuzasining y , z o'qlariga nisbatan ekvatorial va markazdan qochirma inersiya momentlari hisoblansin.

Javobi: $J_y = 126666,67 \text{ sm}^4$, $J_z = 106666,67 \text{ sm}^4$, $J_{yz} = 160000 \text{ sm}^4$.

4.2. Shaklda ko'rsatilgan kuchsizlantirilgan to'g'ri to'rtburchakli brus kesimining bosh markaziy inersiya momentlarining qiymati aniqlansin.

Javobi: $J_y \cong 20310 \text{ sm}^4$; $J_z \cong 5461 \text{ sm}^4$.

4.3. Shaklda ko'rsatilgan kvadrat shaklning o'qlarini o'zgartirmasdan qoldirib, shaklni 45° burganimizda shaklning y va z o'qlariga nisbatan inersiya momenti qanday o'zgaradi.

Javobi: o'zgarmaydi.

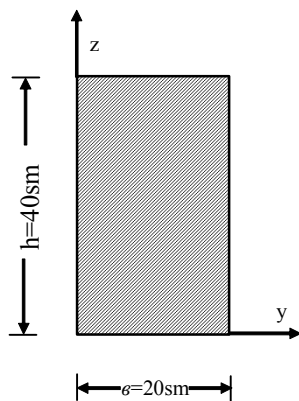
4.4. Shaklda ko'rsatilgan uchburchak yuzasining u va z o'qlariga nisbatan ekvatorial, markazdan qochirma inersiya momentlari va z_1 o'qiga nisbatan ekvatorial inersiya momenti hisoblansin hamda bosh o'qlari vaziyati aniqlansin.

Javobi.

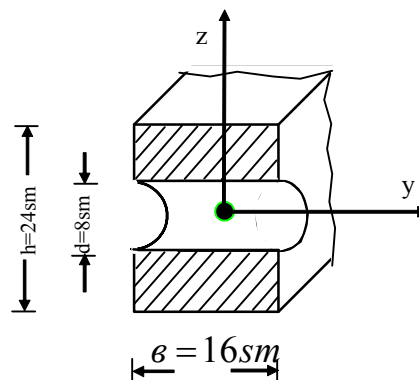
$$J_y = \frac{\epsilon h^3}{36}; J_z = \frac{h \epsilon^3}{36}; J_{yz} = -\frac{\epsilon^2 h^2}{72}; J_{z_1} = \frac{\ell c^3}{36} = \frac{\epsilon^3 h^3}{36 \ell^2}; \quad \text{tg} 2\alpha = -\frac{\epsilon h}{\epsilon^2 - h^2}.$$

4.5. Uchburchakning katetlaridan o'tuvchi y va z o'qlariga nisbatan ekvatorial va markazdan qochirma inersiya momentlari aniqlansin.

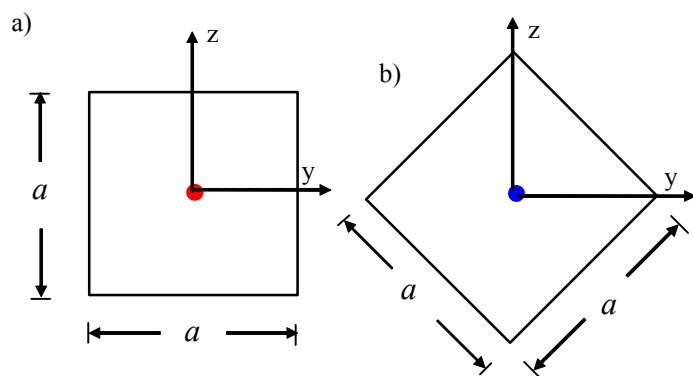
Javobi: $J_y = \frac{\epsilon h^3}{12}$; $J_z = \frac{h \epsilon^3}{12}$; $J_{yz} = \frac{\epsilon^2 h^2}{24}$.



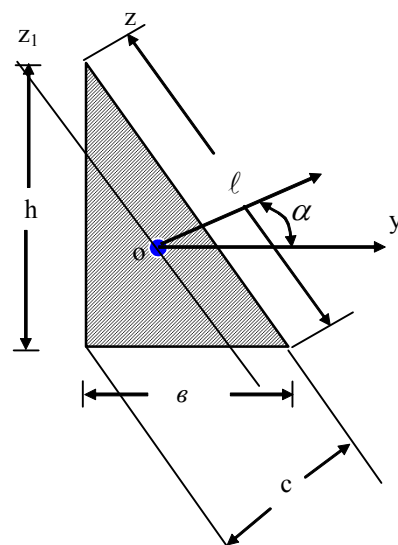
4.1-misol uchun



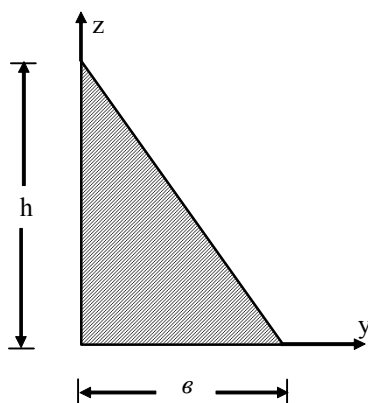
4.2 –misol uchun



4.3-misol uchun



4.4.- misol uchun



4.5.- misol uchun

4.6. Agar shaklda ko'rsatilgan doira, kvadrat va to'g'ri to'rtburchakning kesim yuzasi A bir xil bo'lsa markaziy y o'qiga nisbatan olingan inersiya momentlarining qiymatlari taqqoslansin.

Ko'rsatma: kesimlarning inersiya momentlarini kesim yuzasi orqali ifodalang.

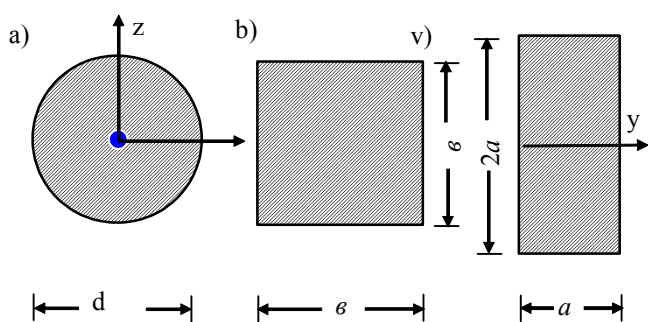
Javobi: a) $J_y = 0,0747A^2$; b) $J_y = 0,0833A^2$; c) $J_y = 0,167A^2$.

4.7. Ikki kanalli trubaning bosh markaziy inersiya momentlarini quyidagi ikki variantda hisoblansin: a) diametri

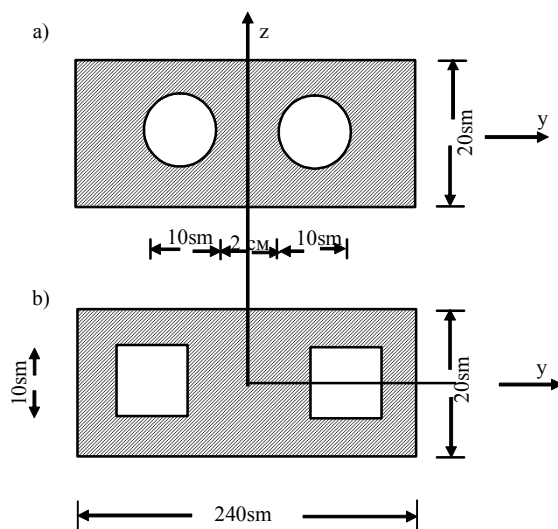
$d=10$ sm bo'lgan ikki doira. b) 10×10 sm bo'lgan ikki kvadrat teshikli.

Javobi: a) $J_y = 15018,75 \text{ sm}^4$, $J_z = 16406,75 \text{ sm}^4$

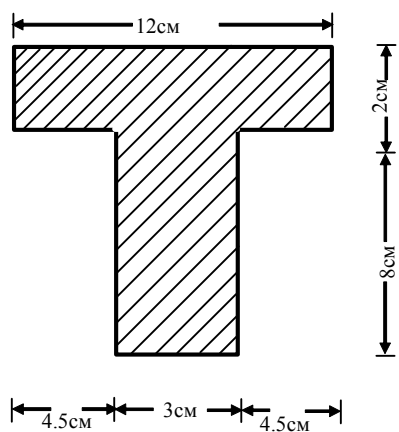
b) $J_y = 14333,33 \text{ sm}^4$, $J_z = 14173,33 \text{ sm}^4$.



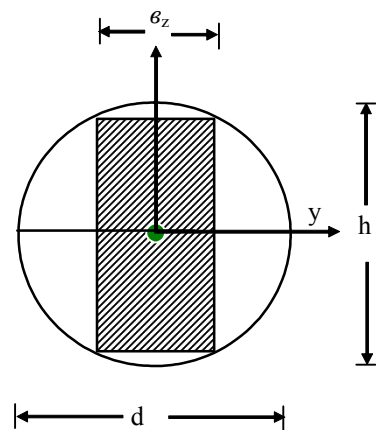
4.6. – misol uchun



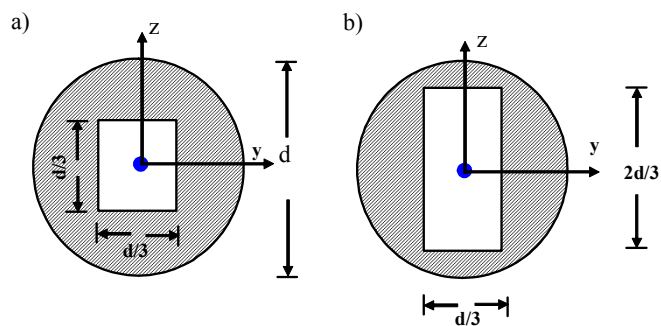
4.7. – misol uchun



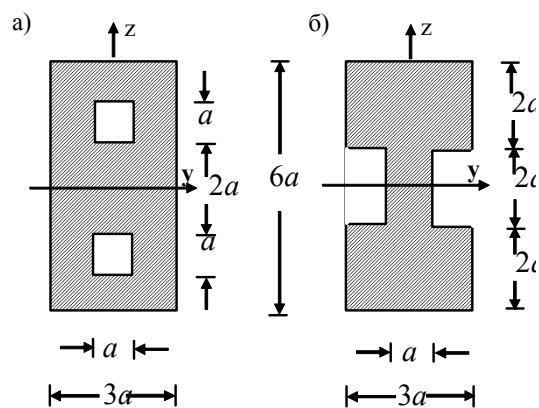
4.8 – мисол учун



4.9. – misol uchun



4.10. – misol uchun



4.11. – misol uchun

4.8. Shaklda ko'rsatilgan tavr shaklidagi kesimning markaziy o'qlariga nisbatan bosh inersiya momentlari topilsin.

Javobi: $J_y = 436 \text{ sm}^4$, $J_z = 306 \text{ sm}^4$.

4.9. $\frac{e}{d}$ va $\frac{h}{e}$ larni shunday tanlash kerakki, diametri d bo'lgan aylana ichiga chizgan to'g'ri to'rt burchakning u o'qiga nisbatan olingan inersiya J_u momenti eng katta bo'lsin.

Javobi: $\frac{e}{d} = 0.5$, $\frac{h}{e} = \sqrt{3}$.

4.10. Shaklda ko'rsatilgan kesimlar uchun bosh markaziy inersiya momentlari hisoblansin.

Javobi:

a) $J_{max} = 0,048d^4$; $J_{min} = 0,048d^4$

b) $J_{max} = 0,047d^4$; $J_{min} = 0,41d^4$

4.11. Shaklda ko'rsatilgan kesimlar uchun bosh markaziy inersiya momentlari hisoblansin

Javobi:

a) $J_{max} = 49,3a^4$; $J_{min} = 13,a^4$;

b) $J_{max} = 51,3d^4$; $J_{min} = 9,2d^4$

4.12. Shaklda ko'rsatilgan kesim uchun bosh markaziy inersiya momentlari hisoblansin.

Javobi: a) $J_{max} = 857\delta^4$; $J_{min} = 82,5\delta^4$;

b) $J_{max} = 1232 \delta^4$, $J_{min} = 514\delta^4$;

4.13. Ikkita teng yonlimas burchaklikdan yasalgan kesim uchun c masofani shunday shart bilan tanlash kerakki unda $J_y = J_z$ bo'lsin.

Javobi: $c=1,14 \text{ sm}$.

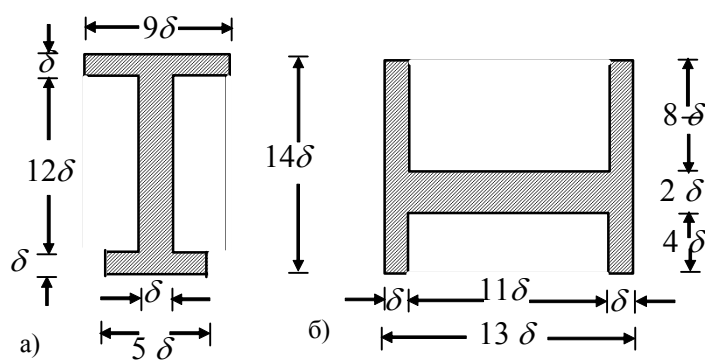
4.14. Shaklda ko'rsatilgan kesim uchun c masofani shunday shart bo'yicha topingki, kesimning hamma markaziy o'qlari bosh o'qlar bo'lsin va o'nga mos kelgan inersiya momentini hisoblang.

Javobi: a) $c=5,76 \text{ sm}$; $J_y=J_z=1010\text{sm}^4$;

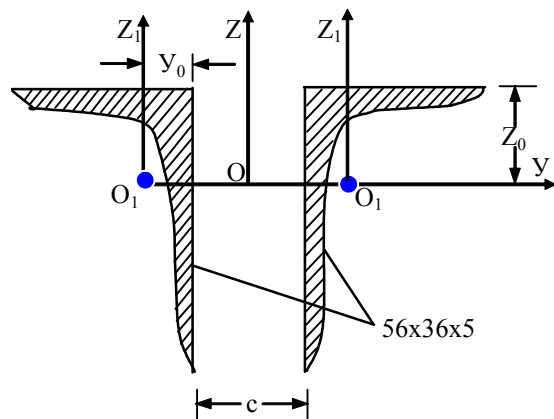
b) $c=11,5 \text{ sm}$; $J_y=J_z=1010\text{sm}^4$;

4.15. Shakldagi shtrixlangan kesimning $u-u$ o'qiga nisbatan inersiya momentini hisoblang.

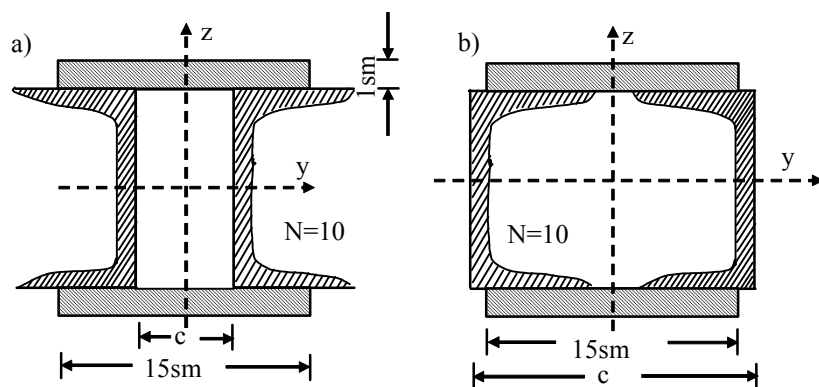
Javobi: $J_y = \frac{r^4}{2}(\varphi - \sin 4\varphi / 4)$.



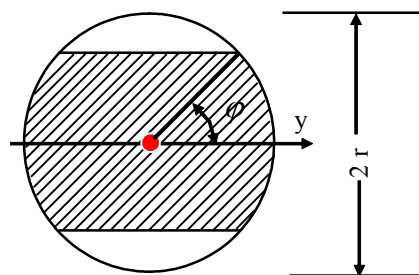
4.12. – misol uchun



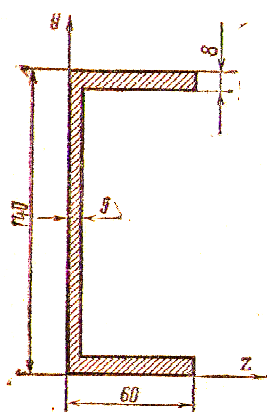
4.13.-misol uchun



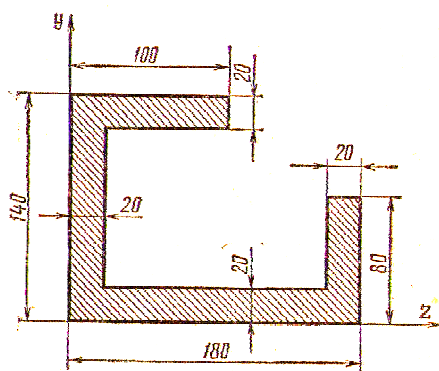
4.14 – misol uchun



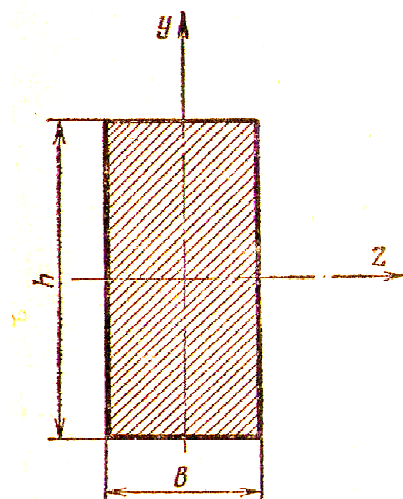
4.15-misol uchun



4.16-misol uchun.



4.17-misol uchun.



4.18-misol uchun.

4.16.. Shaklda ko'rsatilgan kesimlarning og'irlik markazining koordinatalari topilsin.

Javobi: $z_c = 1,92 \text{ sm}$; $y_c = 7,0 \text{ sm}$;

4.17.. Shaklda ko'rsatilgan kesimlarning og'irlik markazining koordinatalari topilsin.

Javobi: $z_c = 7,36 sm$; $y_c = 5,64 sm$;

4.18. Shaklda ko'rsatilgan to'g'ri to'rtburchaklarning markaziy o'qiga nisbatan inersiya momenti, qarshilik momenti va inersiya radiuslari hisoblansin, o'lchamlari jadvalda keltirilgan.

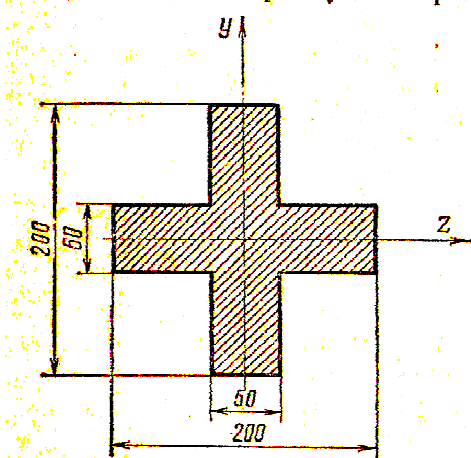
Berilgan	$b \times h \text{ sm}$	5×15	8×15	10×16	10×20	12×20	15×22
javoblari	$J_z (sm^4)$	416	2250	3400	6670	8000	13300
	$J_y (sm^4)$	104	640	1330	1670	2880	6200
	$W_z (sm^3)$	83,2	300	425	667	800	1210
	$W_y (sm^3)$	41,6	160	267	334	480	825
	$r_z (sm)$	2,9	4,3	4,6	5,8	5,8	6,4
	$r_y (sm)$	1,4	2,3	2,9	2,9	3,5	4,3

4.19. Shaklda ko'rsatilgan kesim uchun bosh inersiya momenti, qarshilik momenti va inersiya radiusi hisoblansin.

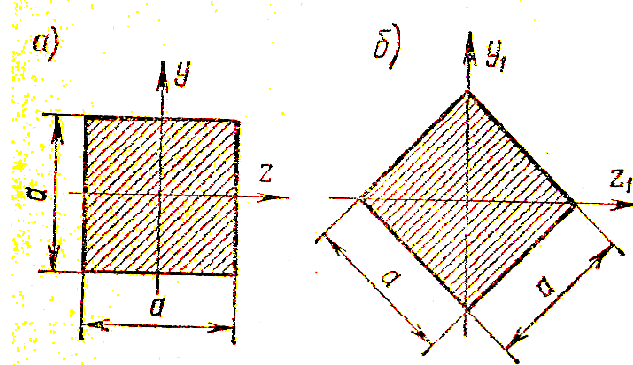
Javobi: $J_z = J_y = 3490 sm^4$; $W_z = W_y = 349 sm^3$; $r_z = r_y = 4,5 sm$.

4.20. Shaklda keltirilgan kvadratlarning a) sidami yoki b) sida inersiya momenti, qarshilik moment va inersiya radiusi katta bo'ladi.

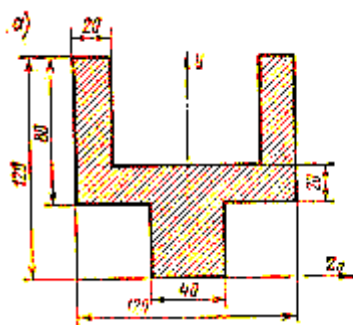
Javobi: Inersiya momenti va inersiya radiusi ikkalasida ham bir-biriga teng, qarshilik momenti a) katta bo'ladi.



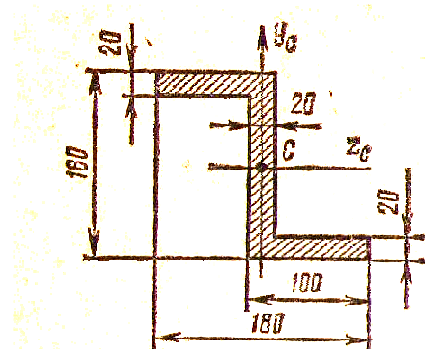
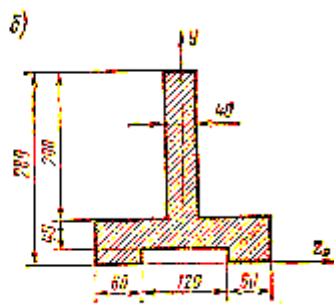
4.19-misol uchun.



4.20-misol uchun.



4.21-misol uchun.



4.22-misol uchun.

4.21. Shaklda ko'rsatilgan kesimlarning bosh markaziy o'qlarning holati aniqlansin va bosh inersiya momentlari hisoblansin.

Javobi: a) $y_c = 5,75 \text{ sm}$; $J_{\max} = 917 \text{ sm}^4$; $J_{\min} = 590 \text{ sm}^4$;

b) $y_c = 8,44 \text{ sm}$; $J_{\max} = 10580 \text{ sm}^4$; $J_{\min} = 6730 \text{ sm}^4$;

4.22 Shaklda ko'rsatilgan zit kesim uchun bosh markaziy o'qlarning holati aniqlansin va bosh inersiya momentlari hisoblansin.

Javobi: $\alpha = 31^{\circ}08'$; $J_{\max} = 2840 \text{ sm}^4$; $J_{\min} = 310 \text{ sm}^4$

BURALISH.

5.1. Val sirtidagi kuchlanish $\tau_{\max} = 800 \text{ kg/sm}^2$, val sirtidan radiusining chorak masofasidagi ko'ndalang kesimda urinma kuchlanish nimaga teng?

Javobi $\tau = 600 \text{ kg/sm}^2$.

5.2. Agar ruxsat etilgan kuchlanish $[\tau] = 1000 \text{ kg/sm}^2$ bo'lsa, diametri 2sm bo'lgan doiraviy kesimli po'lat sterjenning yuk ko'taruvchanligi $[M_b]$ ni aniqlang. Sterjenning 100sm uzunlikdagi uchastkasining buralish burchagi qiymati nimaga teng?

Javobi $[M_{\delta}] = 15,7 \text{ kgsm}$; $\varphi = 0,125 \text{ rad}$.

5.3. Diametri 10sm va uzunligi 6 m bo'lgan yaxlit po'lat val 4° burchakka burilgan. Eng katta kuchlanish nimaga teng?

Javobi $\tau_{\max} = 465 \text{ kg/sm}^2$.

5.4. Ko'ndalang kesim yuzlari teng bo'lgan uchta I,II,III, vallar M_1 , M_2 va M_3 momentlar bilan buraladi. Agar har bir valning ko'ndalang kesimida hosil bo'ladigan eng katta urinma kuchlanishlar bir xilda bo'lsa u vaqtda M_1, M_2 va M_3 mikdorlar aniqlansin. Barcha kesimlar uchun urinma kuchlanishlar epyuralari qurilsin. Halka kesim ichki konturi nuqtalaridagi urinma kuchlanishlar aniqlansin.

Javobi: $K_I = 1,12$; $K_{II} = 1,41$;

$$W_{\rho I} = 0,2d^3, \quad W_{\rho II} = 0,17d^3; \quad W_{\rho III} = 0,43d^3.$$

$$M_I = \tau \cdot 0,2d^3; \quad M_{II} = \tau \cdot 0,27d^3; \quad M_{III} = \tau \cdot 0,43d^3;$$

5.5. O'zgarmas kesimli valning mustahkamligi va bikrligi tekshirilsin. $[\tau] = 200 \text{ kg/sm}^2$; $[\varphi_0] = 0,4 \text{ grad/m}$; $G = 8 \cdot 10^5 \text{ kg/sm}^2$ deb olinsin. $n = 150 \text{ ayl/min}$.

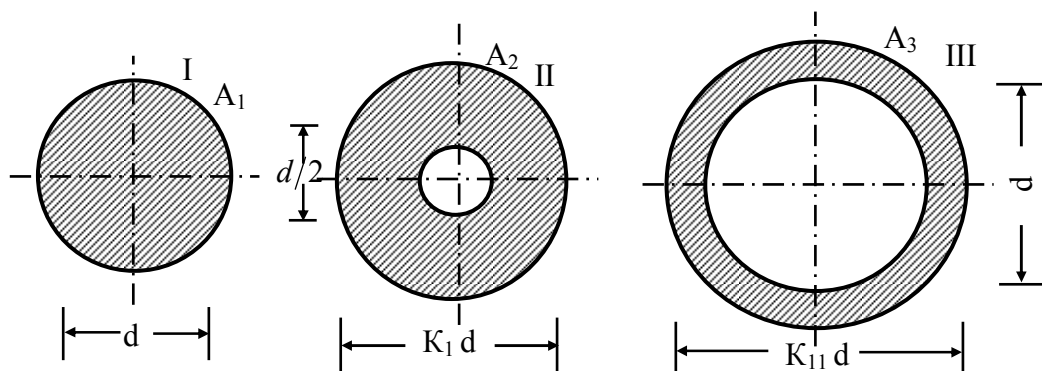
Javobi: $\tau_{\max} = 153 \text{ kg/sm}^2$; $\varphi_0 = 0,35 \text{ grad/m}$.

5.6. Val $M_b = 200 \text{ kgm}$ moment bilan buraladi. Agar ruxsat etilgan kuchlanish $[\tau] = 500 \text{ kg/sm}^2$ bo'lsa valning diametri aniqlansin.

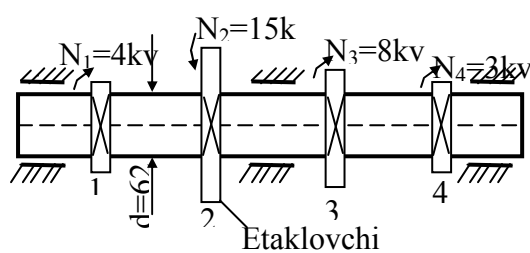
Javobi: $d = 6,0 \text{ sm}$.

5.7. Kavak val $M_b = 500 \text{ kgm}$ moment bilan buraladi. Ichki diametrning tashqisiga nisbati $\alpha = \frac{d}{D} = 0,7$, ruxsat etilgan kuchlanish $[\tau] = 600 \text{ kg/sm}^2$ bo'lsa, kesimning o'lchamlari va yaxlit val bilan taqqoslab og'irligini tejashni aniqlang.

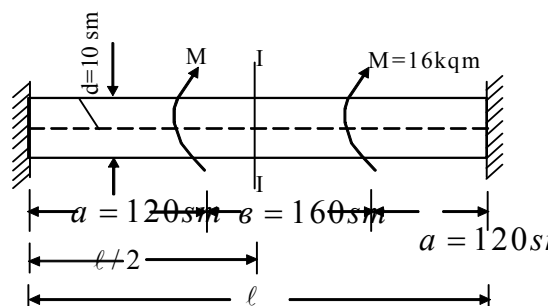
Javobi: $F_{\text{ковак}} = 26,9 \text{ sm}^2$; $F_{\text{яхлит}} = 44,2 \text{ sm}^2$; $\frac{F_k}{F_{\text{я}}} = 0,61$; 39% tejash mumkin



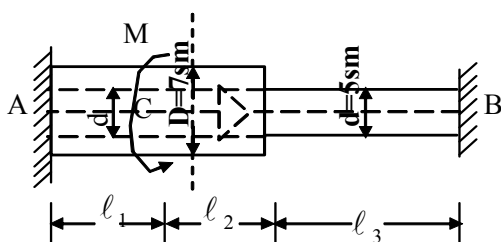
5.4- misol uchun



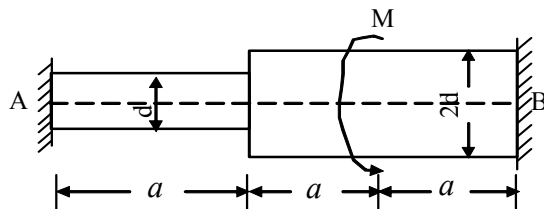
5.5-misol uchun



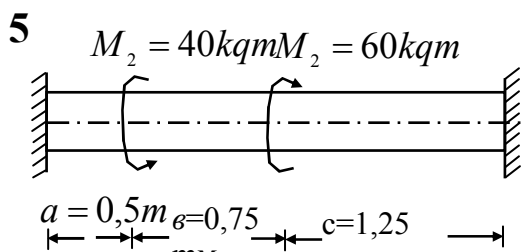
5.9-misol uchun



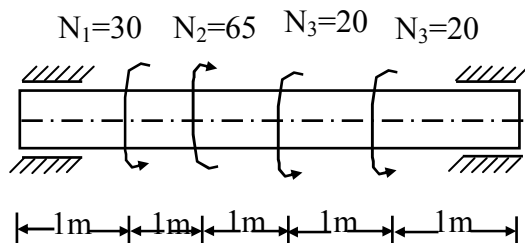
5.10-misol uchun



5.11-misol uchun



5.12-misol uchun



5.13- misol uchun

5.8. Agar 1,5 m uzunlikda o'lchangan buralish burchagi $0,5^0$ bo'lsa, valning dvigatelda uzatadigan quvvati aniqlansin. Valning diametri $d=12$ sm, $n=600$ ayl/min. $G = 8 \cdot 10^5 \text{ kg/sm}^2$.

Javobi: $N=951,5$ ot kuchi

5.9. Po'lat brus I-I kesimining buralish burchagi aniqlansin $G = 8 \cdot 10^5 \text{ kg/sm}^2$.

Javobi: $\varphi_{I-I} \approx 36 \cdot 10^{-7} \text{ rad}$.

5.10. Brusning C kesimiga qo'yilgan M momentning maksimal ruxsat etilgan mikdori topilsin. $[\tau] = 900 \text{ kg/sm}^2$, $\ell_1 = 40 \text{ sm}$, $\ell_2 = 40 \text{ sm}$, $\ell_3 = 80 \text{ sm}$.

Javobi: $M \approx 52 \cdot 10^3 \text{ kgsm}$.

5.11. Ikkala uchi bilan qattiq mahkamlangan va M burovchi moment bilan yuklangan brus deformasiyasining potensial energiyasi aniqlansin.

Javobi: $U = 0,32 \frac{M^2}{Gd^4}$.

5.12. Shaklda ko'rsatilgan, sterjenning diametri mustahkamlik va bikrlilik shartidan topilsin. Ruxsat etilgan kuchlanish $[\tau] = 400 \text{ kg/sm}^2$, har bir metr uchun ruxsat etilgan buralish burchagi $[\tau] = \frac{1^\circ}{4}$; $G = 8 \cdot 10^5 \text{ kg/sm}^2$.

Javobi: $d = 5,75 \text{ sm}$.

5.13. Kovak valning diametrlari mustahkamlik va bikrlilik shartlaridan topilsin. Val ko'ndalang kesim d-ichki diametrining D-tashqi diametriga nisbati $\alpha = 0,7$, ruxsat etilgan urinma kuchlanish $[\tau] = 250 \text{ kg/sm}^2$ va $[\varphi] = 0,3 \text{ grad/m}$; $n = 220 \text{ ayl/min}$.

Javobi: $D = 78 \text{ mm}$, $d = 55 \text{ mm}$.

5.14. Uzunligi 1,8 m bo'lgan kovak val uchlariga $M = 6 \text{ knm}$ momentli ikki juft kuchlar qo'yilgan. Agar buralish burchagi 2° dan oshishi mumkin bo'lmasa, urinma kuchlanish $\tau = 700 \text{ kg/sm}^2$ bo'lsa, valning tashqi va ichki diametrini aniqlang.

Javobi: $D = 20,4 \text{ mm}$, $d = 72,4 \text{ mm}$.

5.15. Kovak valning diametrlari $D = 2d$ bo'lsa, burovchi momentlar bir xil bo'lganda kovak valdagi eng katta urinma kuchlanish topilsin. Bu val siljishga ruxsat etiladigan kuchlanish 600 kg/sm^2 bo'lganda loyihadagi yaxlit valdan 20% yengil.

Javobi: $\tau_{\max} = 58 \text{ kg/sm}^2$.

5.16. Burovchi moment va ruxsat etiladigan kuchlanishlar bir xil bo'lganda o'lchamlari shunga moslab tanlangan ikki valning og'irliklarini taqqoslang. Birinchi val yaxlit, ikkinchisi turbasimon, ichki diametrining tashqi diametriga nisbati 0,6 ga teng.

Javobi: $Q_T:Q_{ya} = 0,702$.

5.17. Kesimi 10×10 mm bo'lgan va po'latdan yasalgan silindrik vintli prujinada 12 o'ram bor. O'ramlarning o'rtacha radiusi 5 sm. Agar sinishga ruxsat etiladigan kuchlanish 2800 kg/sm^2 bo'lsa, prujinaga qo'yilishi mumkin bo'lgan eng katta kuchni aniqlang. Shu kuch ta'sir etganda prujina qanchaga cho'kadi.

Javobi: 112 kg, 9,42 sm.

TEKIS EGILISH.

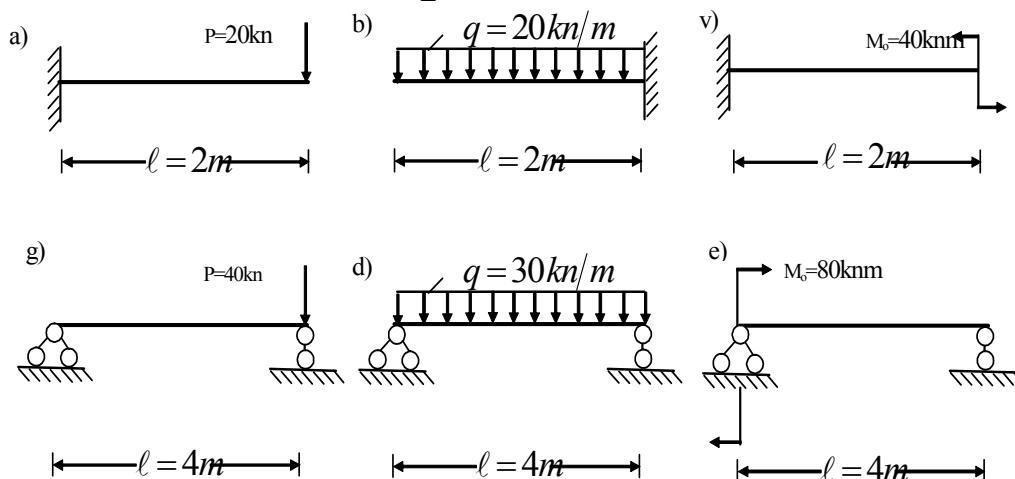
6.1. Shakllarda ko'rsatilgan balkalar uchun kesuvchi $Q(x)$ kuch va eguvchi $M(x)$ moment epyuralari qurilsin.

6.2. Shaklda ko'rsatilgandek yuklangan konsollar uchun R kuchning qanday qiymatida, qistirib maxkamlangan tayanchda eguvchi moment nolga teng bo'lishi topilsin. R -kuchning shu topilgan qiymati bo'yicha $Q(x)$ va $M(x)$ epyuralari qurilsin.

6.3. Shaklda ko'rsatilgandek yuklangan konsollar uchun M juft kuchning qanday qiymatida, qistirib maxkamlangan tayanchda eguvchi moment nolga teng bo'lishi topilsin. Topilgan M juft kuchning qiymati bo'yicha $Q(x)$ va $M(x)$ epyuralari qurilsin

Javobi:

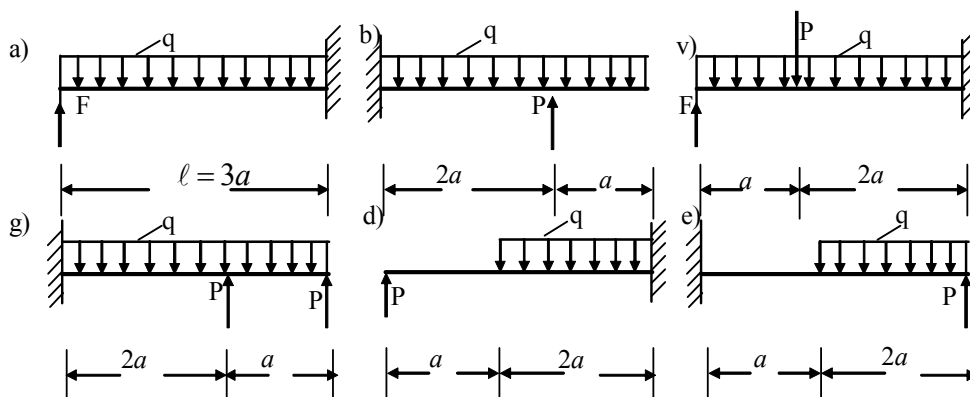
a) $M = qa^2$; $M_{\max} = \frac{qa^2}{2}$; $Q_{\max} = qa$; b) $M = 6\text{knm}$; $M_{\max} = 6\text{knm}$; $Q_{\max} = 5\text{kn}$.



6.1-misol uchun

Javobi:

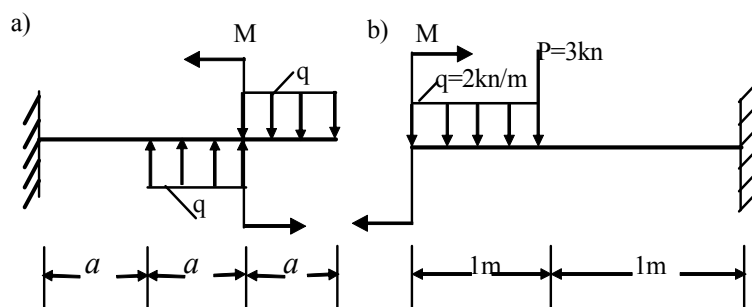
sxema	$Q(x)$ (kn)	$M(x)$ (knm)
a	20	-40
b	-40	-40
v	00	40
g	60	40
d	20	60
e	-20	80



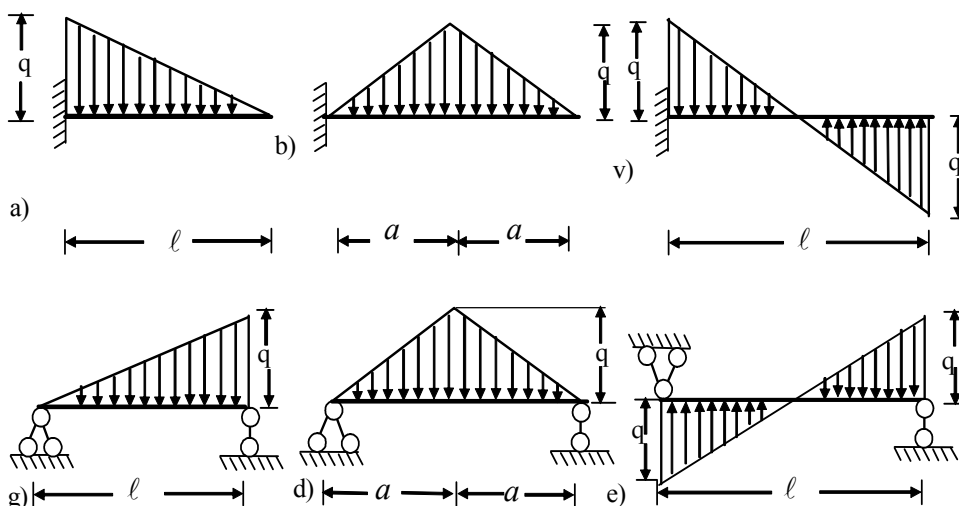
6.2-misol uchun

Javobi:

sxema	P kuch	$M_{\max}$ (knm)
a	$\frac{9\ell}{2}$	$\frac{9\ell^2}{8}$
b	$\frac{3}{4}q\ell$	$\frac{4}{9}q\ell^2$
v	$\frac{3}{2}q\ell$	$\frac{4}{9}q\ell^2$
g	$0,3q\ell$	$0,08q\ell^2$
d	$\frac{2}{9}q\ell$	$\frac{8}{81}q\ell^2$
e	$\frac{4}{9}q\ell$	$\frac{8}{81}q\ell^2$



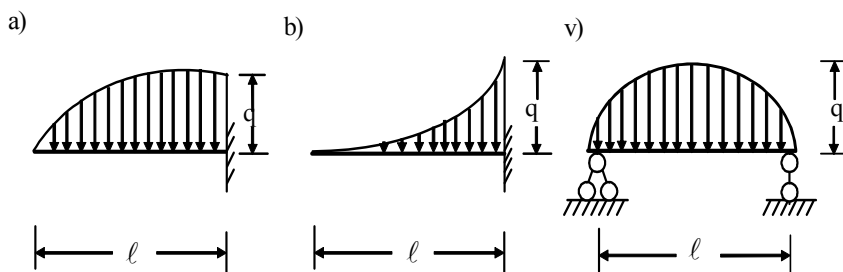
6.3-misol uchun



6.4-misol uchun

Javobi:

sxema	Q(x)	M(x)
a	$\frac{ql}{2}$	$-\frac{ql^2}{2}$
b	qa	$-\frac{qa^2}{2}$
b	$\frac{ql}{4}$	$-\frac{ql^2}{4}$
g	$-\frac{ql}{3}$	$-\frac{ql^2}{3}$
d	$-\frac{qa}{2}$	$-\frac{9\sqrt{3}}{2}qa^2$
e	$\frac{ql}{\sigma}$	$-\frac{ql^2}{36\sqrt{3}}$



6.5-misol uchun

Javobi:

sxema	Q(x)	M(x)
a	$-\frac{2ql}{3}$	$-\frac{ql^2}{4}$
b	$\frac{ql}{3}$	$-\frac{ql^2}{12}$
v	ql/π	ql^2/π^2

6.4. Shaklda ko'rsatilgandek yuklangan konsol va balkalar uchun $Q(x)$ va $M(x)$ epyuralari qurilsin va ularning absolyut qiymati bo'yicha eng katta qiymatlarini aniqlang.

6.5. Shaklda ko'rsatilgandek yuklangan konsol va balka uchun $Q(x)$ va $M(x)$ epyurasi qurilsin, hamda agar a) $q(x) = \frac{q \cdot x}{\ell^2}(2\ell - x)$;

b) $q(x) = \frac{qx^2}{\ell}$; v) $q(x) = q \sin \frac{\pi x}{\ell}$ bo'lsa, $Q(x)$ va $M(x)$ ning eng katta qiymatlari topilsin.

6.6. $Q(x)$ va $M(x)$ larning berilgan epyuralari bo'yicha balkalarning mahkamlanish sxemasi va ularning yuklanishini ko'rsating hamda kuchlarning qiymatini aniqlang.

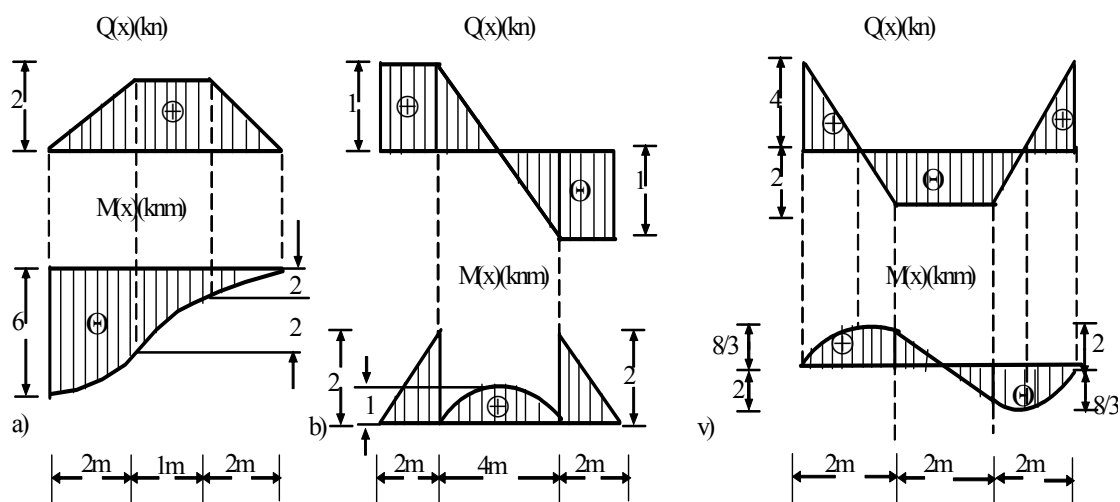
Javobi: a) $q = \pm 1 \text{ kn/m}$; b) $q = 0,5 \text{ kn/m}$; $M = 2 \text{ kn}$; v) $q = \pm 3 \text{ kn/m}$.

6.7. Shaklda ko'rsatilgan kesuvchi ($Q(x)$) kuch epyurasi bo'yicha konsol yuklansin va eguvchi moment epyurasi qurilsin. Juft kuch konsolga qo'yilmagan.

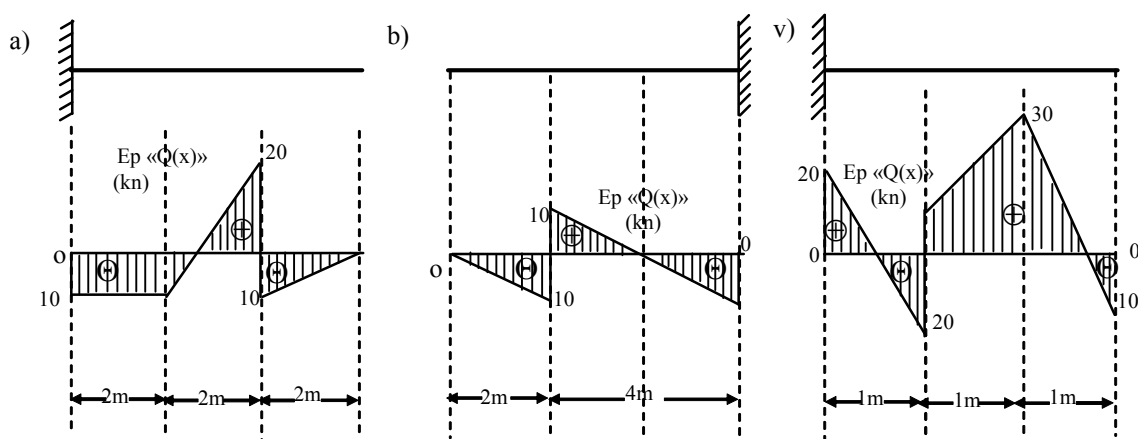
Javoblar: a) $M_{\max} = 20 \text{ knm}$; b) $M_{\max} = -10 \text{ knm}$; v) $M_{\max} = -30 \text{ knm}$.

6.8. Shaklda ko'rsatilgan kesuvchi ($Q(x)$) kuch epyurasi bo'yicha balka yuklansin va eguvchi moment epyurasi qurilsin. Juft kuch balkaga qo'yilmagan.

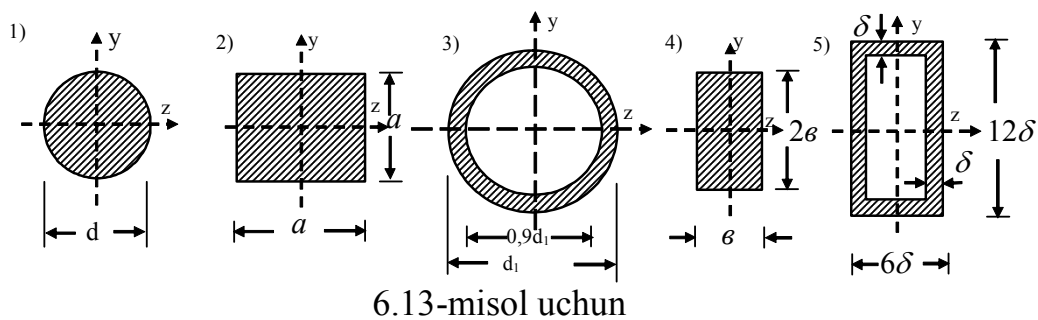
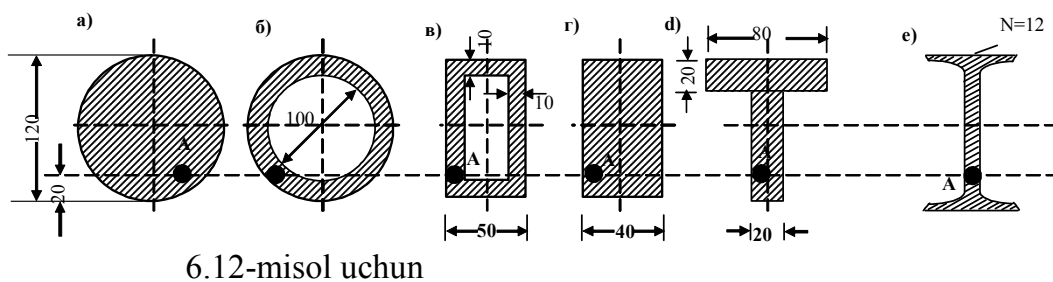
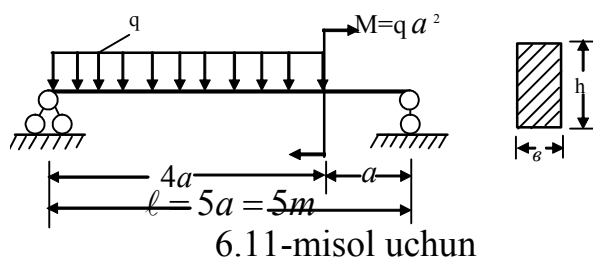
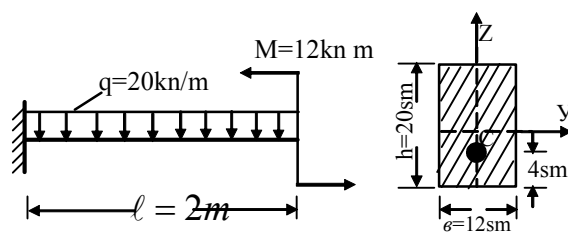
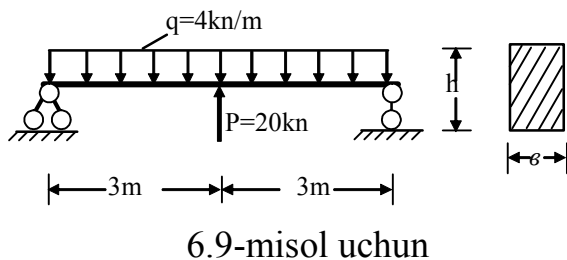
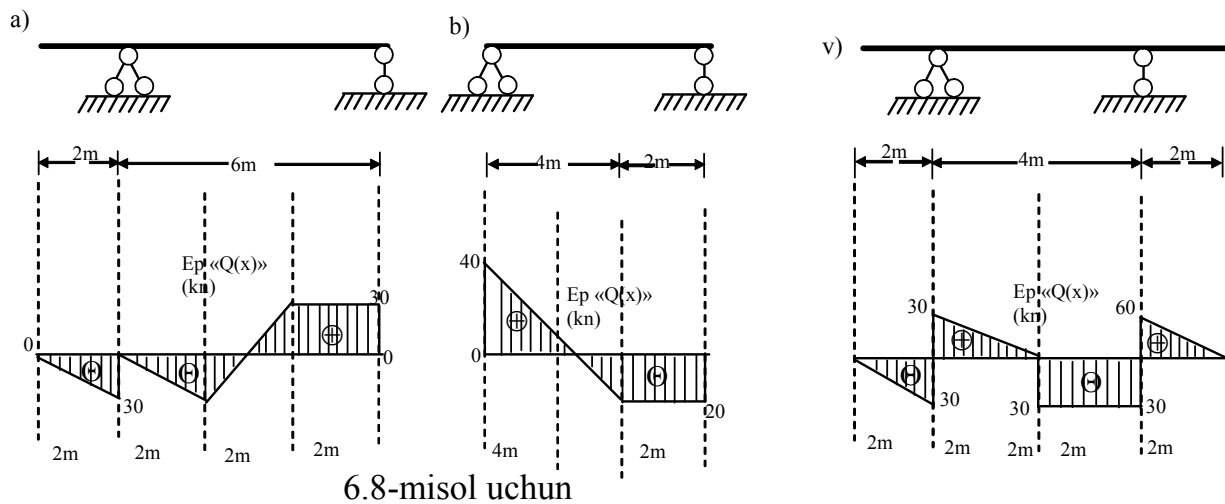
Javoblar: a) $M_{\max} = -75 \text{ knm}$; b) $M_{\max} = 160/3 \text{ knm}$; v) $M_{\max} = -60 \text{ knm}$.

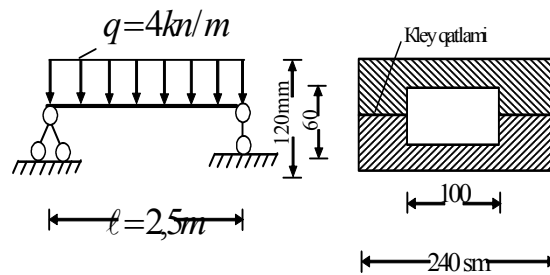


6.6-nisol uchun



6.7 – misol uchun





6.14-misol uchun

6.9. Ko'ndalang kesimi $12 \times 20 \text{ sm}^2$ bo'lgan yog'och balka xavfli kesimdagi eng katta normal kuchlanishni hisoblang.

Javobi: $\sigma_{\max} = 150 \text{ kg/sm}^2$.

6.10. Ko'ndalang kesimi $12 \times 20 \text{ sm}^2$ bo'lgan balkaning xavfli ko'ndalang kesimidagi eng katta normal kuchlanish hisoblansin. Ko'ndalang kesimning S nuqtasidagi kuchlanish ham aniqlansin.

Javobi: $\sigma_{\max} = 93 \text{ kg/sm}^2$; $\sigma_c = -68 \text{ kg/sm}^2$;

6.11. Ko'ndalang kesimi $12 \times 20 \text{ sm}^2$ bo'lgan balkaning xavfli kesimida hosil bo'ladigan eng katta normal kuchlanish $\sigma_{\max} = 121 \text{ kg/sm}^2$ bo'lsa, q-kuchning intensivligini aniqlang.

Javobi: $M_{\max} = 2,42qa^2$; $q = 4 \text{ kn/m}$.

6.12. Agar $M(x) = 12 \text{ knm}$ bo'lsa, shaklda ko'rsatilgan ko'ndalang kesimlarning A nuqtasidagi normal kuchlanishlar va ko'ndalang kesimlarda hosil bo'ladigan eng katta normal kuchlanishlar aniqlansin. Kesim o'lchamlari mm.da berilgan.

Javoblari:

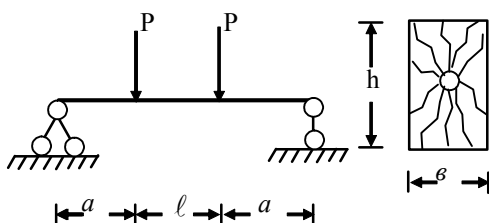
Sxema	a)	b)	v)	g)	d)	ye)
σ_A (n/mm ²)	47	89,5	102	83,3	139	137
$\sigma_{\max}$ (n/mm ²)	70,5	134	153	125	208	206

6.13. Shaklda ko'rsatilgan ko'ndalang kesimlar o'lchamlarining qanday nisbatida, egilishda balkalarning mustahkamligi teng bo'ladi.

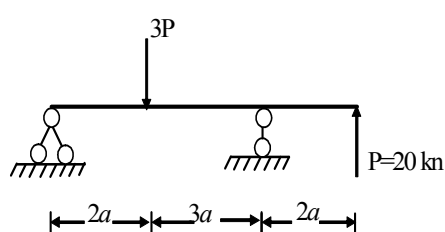
Javoblari: $a = 0,838d$; $d_1 = 1.43d$; $e = 0,528d$; $\delta = 0.1035d$.

6.14. Agar $[\sigma] = 12 \text{ n/mm}^2$; $[\tau]_{kl} = 0,6 \text{ n/mm}^2$ bo'lsa shaklda ko'rsatilgan balkalarning mustahkamligi tekshirilsin.

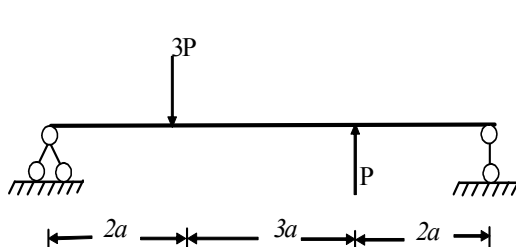
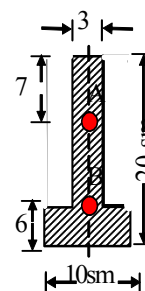
Javobi: $\sigma_{\max} = 5,73 \text{ n/mm}^2$; $\tau_{\max} = 0,42 \text{ n/mm}^2$.



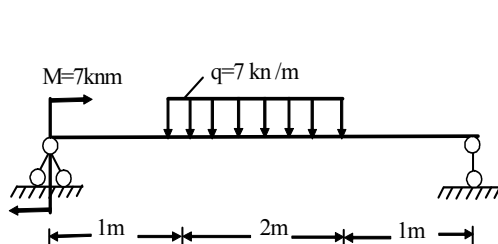
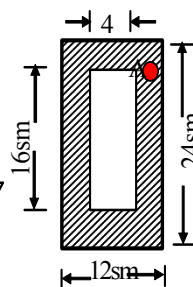
6.15-misol uchun



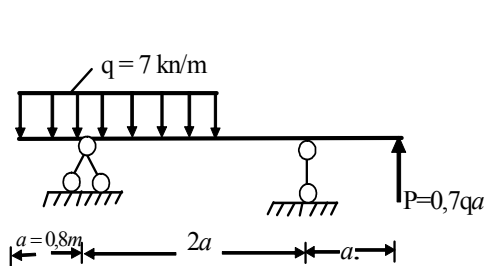
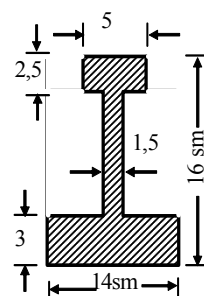
6.16-misol uchun



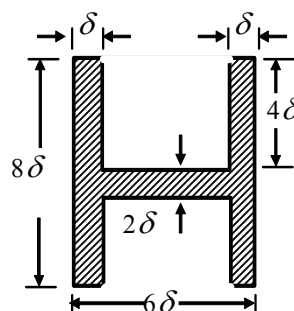
6.17-misol uchun



6.18-misol uchun



6.19-misol uchun



6.15. $a:h$ - ning qanday qiymatida, yog'och balkani eng katta urinma kuchlanish bo'yicha mustahkamlikka hisoblaydi.

Javobi: $\frac{a}{h} \leq 2,5$.

6.16. Shaklda ko'rsatilgan balka uchun kesuvchi kuch eng katta qiymatga ega bo'lgan kesimda A va B nuqtasidagi urinma kuchlanishlar, hamda eng katta urinma kuchlanish topilsin.

Javobi: $\tau_A = 8,66 \text{ n/mm}^2$; $\tau_B = 10,8 \text{ n/mm}^2$; $\tau_{max} = 11,0 \text{ n/mm}^2$.

6.17. Agar ko'ndalang kesimning A nuqtasidagi urinma kuchlanish $\tau_A = 2 \text{ n/mm}^2$ bo'lsa, balka uchun P kuchning qiymati aniqlansin.

Javobi: $P = 36,3 \text{ kn}$.

6.18. Agar $[\sigma]_q = 40 \text{ n/mm}^2$ va $[\sigma]_c = 120 \text{ n/mm}^2$ bo'lsa shaklda ko'rsatilgan cho'yan balkaning mustahkamligi tekshirilsin.

Javobi: $\sigma_{max}^q = 37,3 \text{ n/mm}^2$.

6.19. $[\sigma]_q = 30 \text{ n/mm}^2$ va $[\sigma]_c = 90 \text{ n/mm}^2$ deb olib, shaklda ko'rsatilgan cho'yan balka ko'ndalang kesimning zaruriy o'lchamlari topilsin.

Javobi: $\delta = 29 \text{ mm}$.

EGILISHDA BALKALARNING DEFORMASIYALARINI ANIQLASH

7.1. Shaklda ko'rsatilgan konsollarning erkin uchining aylanish burchagi va salqiligi egilgan ukning differensial tenglamasini integrallash yo'li bilan aniqlansin.

Javobi: a) $\theta = 0$; b) $\theta = -0,0054 \text{ rad}$;

$$f = -0,516 \text{ sm} \qquad f = 0.$$

7.2. Shaklda ko'rsatilgan balkalarning tayanchlaridagi θ_A va θ_B aylanish burchaklari va prolyotlarining o'rtasidagi salqilik aniqlansin

Javobi:

$$\text{a) } \theta_A = -\theta_B = -0,0094 \text{ rad} \quad \text{b) } \theta_A = 0,0097 \text{ rad} \quad \theta_B = -0,0127 \text{ rad}$$

$$f = -1,04 \text{ sm} \qquad f = -1,94 \text{ sm}$$

$$\text{v) } \theta_A = -\theta_B = -0,001 \text{ rad}; \quad f = -0,062 \text{ sm}.$$

7.3. Ko'ndalang kesimi qo'shtavrdan iborat bo'lgan ikki tayanchda yotuvchi po'lat balka uchun $[f] = \ell/400$ bo'lganda sortament jadvalidan qo'shtavr tanlansin va mustahkamligi tekshirilsin.

Javobi: Qo'shtavr №55; $\sigma_{\max} = 1600 \cdot \text{kg} / \text{sm}^2 < [\sigma]$

7.4. Boshlang'ich parametr usulidan foydalanib, shaklda ko'rsatilgan balka uchun eng katta ($f_{\max}$) salqilik va prolyot o'rtasidagi ($f_{\ell/2}$) salqiligi topilsin.

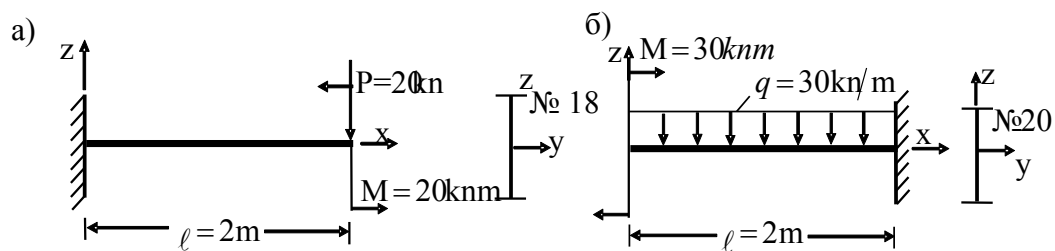
Javobi:

$$x = 0,52 \ell \text{ da } f_{\max} = -0,00652 \frac{q\ell^4}{EJ}; \quad x = 0,5 \ell \text{ da } f_{\max} = -0,00651 \frac{q\ell^4}{EJ};$$

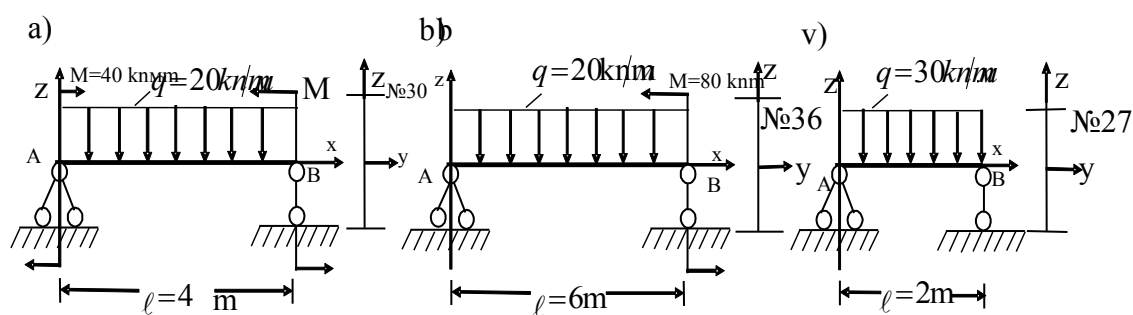
7.5. Shaklda ko'rsatilgan konsolning erkin uchidagi balkaning tayanchlaridagi aylanish burchagi, prolyot o'rtasining salqiligi boshlang'ich parametr usulidan foydalanib aniqlansin.

Javobi:

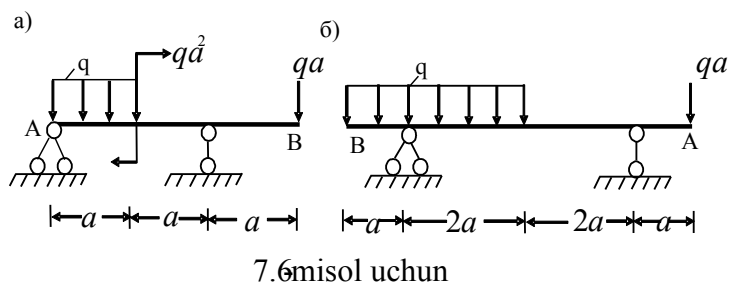
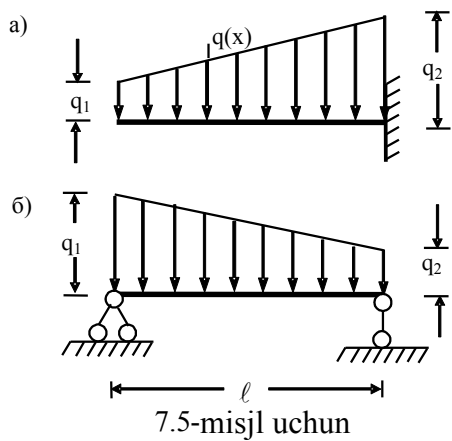
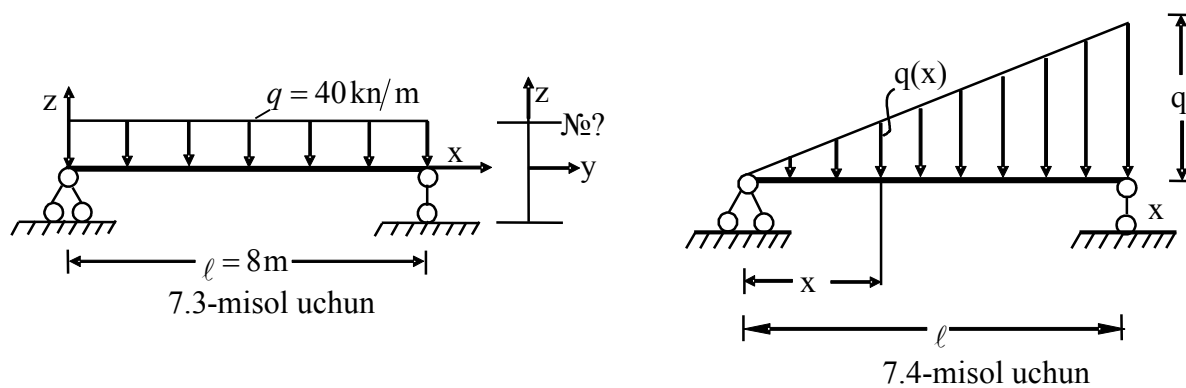
$$\begin{aligned} \text{a) } \theta &= \frac{(3q_1 + q_2)\ell^3}{24EJ}; \\ f &= -\frac{5(q_1 + q_2)\ell^4}{120EJ} \end{aligned} \qquad \begin{aligned} \text{b) } \theta_A &= -\frac{(8q_1 + 7q_2)\ell^3}{360EJ}; \quad \theta_B = \frac{(7q_1 + 8q_2)\ell^3}{360EJ}; \\ f &= -\frac{5(q_1 + q_2)\ell^4}{768EJ}. \end{aligned}$$

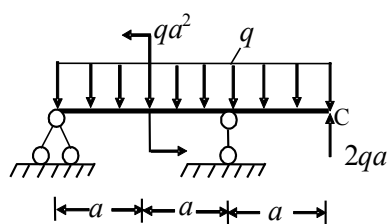


7.1-Misol uchun

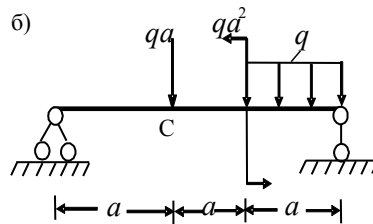
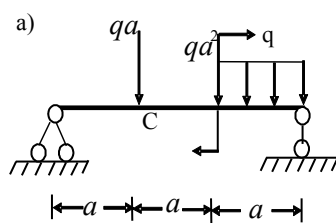


7.2misol uchun





7.7-misol uchun



7.8-misol uchun

7.6. Shaklda ko'rsatilgan balkalar B kesimining salqiligi va A kesimning aylanish burchaklari aniqlansin.

Javobi:

$$\text{a) } f_B = \frac{37qa^4}{48EJ}; \quad \theta_A = -\frac{11qa^3}{48EJ}. \quad \text{b) } f_B = -\frac{qa^4}{24EJ}; \quad \theta_A = \frac{qa^3}{EJ}.$$

7.7. Shaklda ko'rsatilgan balka S kesimining salqiligi va aylanish burchagi aniqlansin.

$$\text{Javobi: } f_c = -\frac{43qa^4}{24EJ}; \quad \theta_c = -\frac{25qa^3}{12EJ}$$

7.8. Shaklda ko'rsatilgan balkalar C kesimlarining salqiligi aniqlansin.

$$\text{Javobi: a) } f_c = \frac{47qa^4}{72EJ}; \quad \text{b) } f_c = \frac{67qa^4}{72EJ}$$

7.9. Agar shaklda ko'rsatilgan po'lat balkalarning salqiligi $\frac{\ell}{800}$ dan oshmasa, ularning bikrligi tekshirilsin.

Javobi:

$$\text{a) bikrligi yetarli: } f = 0,9[f]$$

$$\text{b) bikrligi yetarli emas: } f = 1,15[f]$$

7.10. Shaklda ko'rsatilgan balkalarning S kesimining salqiligi va D kesimning aylanish burchagini Kastilyano teoremasidan foydalanib toping.

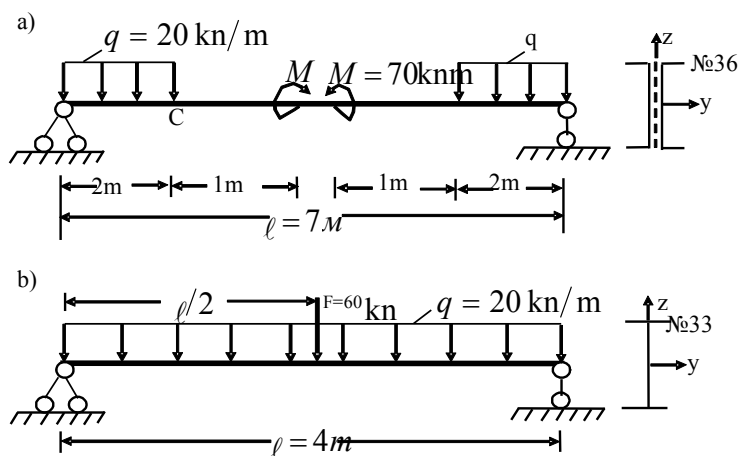
Javobi: a) $f_c = -2,5 \text{ sm}$; b) $f_c = -3,5 \text{ sm}$; v) $f_c = -0,916 \text{ sm}$;
 $\theta_D = 0,015 \text{ rad}$, $\theta_D = 0,0025 \text{ rad}$, $\theta_D = 0,0025 \text{ rad}$.

7.11. Shaklda ko'rsatilgan ikki balkaning ko'chishini xisoblash yo'li bilan ikki xususiy misolda o'zaro ko'chish teoremasining to'g'riligini tekshiring.

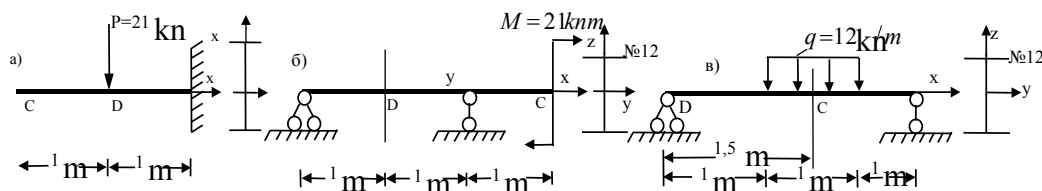
Javobi: $z_1 = z_2 = \frac{P\ell^2 a}{16EJ}$, $\theta_1 = \theta_2 = \frac{M \cdot \ell}{24EJ}$.

7.12. Shaklda ko'rsatilgan konsolli balkaning konsoli chidagi D kesimning salqiligi P kuchning qanday qiymatida nolga teng bo'lishini aniqlang.

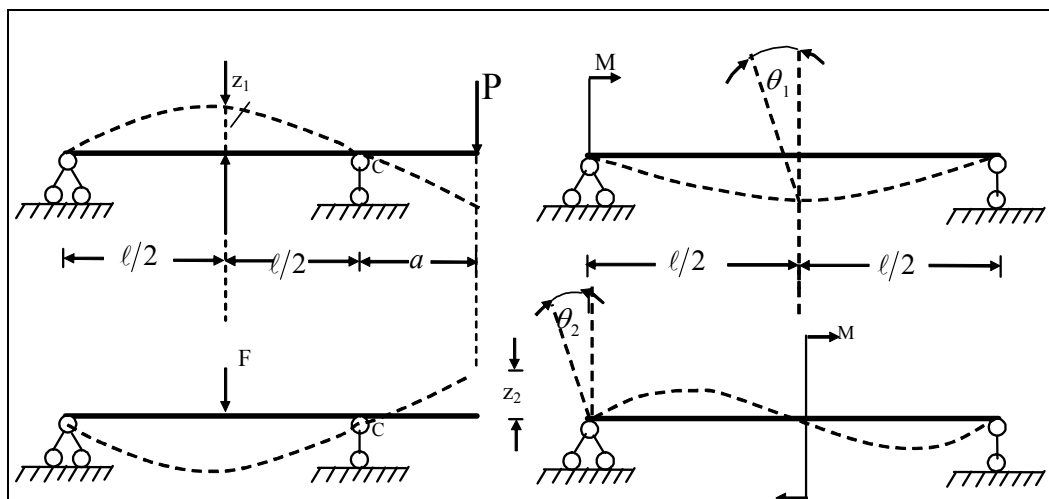
Javobi: $P = 100 \text{ kn}$.



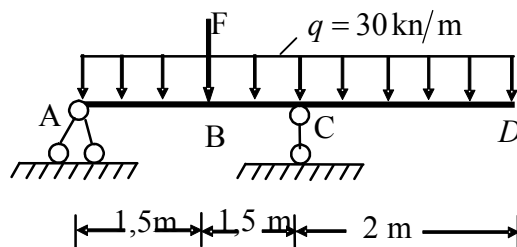
7.9-misol uchun



7.10 -misol uchun



7.11-misol uchun



7.12-misol uchun

sxemalar	javoblar		sxemalar	javoblar	
	$\frac{F}{EJz}$	$\frac{EI\theta}{EJ}$		$\frac{F}{EJz}$	$\frac{EI\theta}{EJ}$
	$-\frac{7}{8}qa^4$	$\frac{1}{2}qa^3$		$\frac{19}{8}qa^4$	$-\frac{4}{3}qa^3$
	$-\frac{5}{24}qa^4$	o		$\frac{41}{24}qa^4$	$-\frac{5}{6}qa^3$
	$-\frac{1}{2}qa^4$	$-\frac{1}{6}qa^3$		$-\frac{7}{6}qa^4$	$-\frac{2}{3}qa^3$
	$\frac{23}{24}qa^4$	$-\frac{1}{2}qa^3$		$\frac{13}{24}qa^4$	$-\frac{1}{3}qa^3$
	$\frac{7}{24}qa^4$	o		$\frac{29}{24}qa^4$	$-\frac{5}{6}qa^3$
	o	$-\frac{1}{6}qa^3$		$\frac{2}{3}qa^4$	$\frac{1}{3}qa^3$

7.13-misol uchun

7.13. Shakllarda berilgan konsollarning prolyoti o'rtasining aylanish burchagi va erkin uchining salqiligi topilsin.

7.14. Jadvalda keltirilgan balkalar uchun C kesimning salqiligi (z_c) va B tayanchning aylanish burchagi aniqlansin. Ko'ndalang kesimi qo'shtavrdan iborat bo'lib uning nomeri har bir variant uchun berilgan. Balkalarga ta'sir etuvchi kuchlar ikki variantda bo'ladi:

1. $q = 20 \text{ kn/m}; \quad F = 40 \text{ kn}; \quad M = 60 \text{ knm};$

1.

2. $q = 40 \text{ kn/m}; \quad F = 60 \text{ kn}; \quad M = 30 \text{ knm};$

2.

Agar har kaysi balkaning xususiy og'irligi hisobga olinsa, ularning salqiligi kanchaga (Δz_c) o'zgaradi?

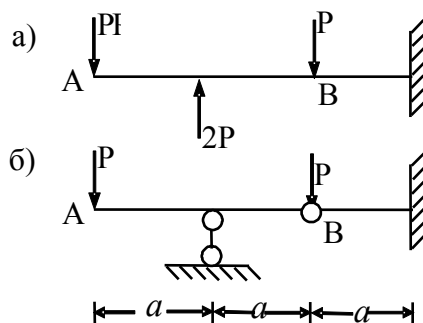
variant		javoblar			
sxemalar	Qo'shtavr nomeri	Zc, (sm)			
		$\theta_B, (rad)$	$\Delta z_C, (sm)$		
a)	1	33	-1,355	0,00926	-0,031
	2	40	-1,197	0,00806	-0,022
b)	1	27 ^a	-1,212	0,00707	-0,045
	2	30	-1,319	0,00675	-0,038
v)	1	36	-1,295	0,00822	-0,027
	2	45	-1,117	0,00692	-0,017
g)	1	27	-0,355	-0,00488	-0,046
	2	30	-1,130	0,00832	-0,038
d)	1	27	-0,444	0,00866	-0,046
	2	20	0	0,00785	-0,084
e)	1	27 ^a	-1,858	0,001192	-0,045
	2	36	-1,046	0,00775	-0,027

7.14-misol uchun

7.15. Shaklda ko'rsatilgan, maxkamlanish shartlari bo'yicha har xil bo'lgan ikki balkaning A va B kesimlaridagi salqilik va aylanish burchaklari topilsin.

Javobi: a) $z_A = -\frac{Fa^3}{EJ}$; $z_B = 0$; $\theta_A = \frac{Fa^2}{EJ}$ $\theta_B = 0$.

b) $z_A = -\frac{2Fa^3}{3EJ}$; $z_B = 0$; $\theta_A = \frac{5Fa^2}{6EJ}$; $\theta_B = \frac{5Fa^2}{6EJ}$;



7.15-misol uchun

sxemalar	variant		javoblar		
	Qo'shimatv nomenin	Qo'shimatv Z _C , (sm)	Z _D , (sm)	θ_A , (rad)	
	1	27	-0,866	0,266	-0,01067
	2	27	-0,931	0,196	-0,00931
	1	33	0,169	-0,474	0,00068
	2	30 ^a	-0,343	-0,129	-0,00343
	1	27	-0,067	-0,566	-0,00133
	2	30	-0,799	0,494	-0,00659
	1	27	-0,498	0,241	-0,00732
	2	18	0	-0,711	-0,00518
	1	24 ^a	-0,658	0,844	-0,00438
	2	18	0	-0,194	0
	1	27	-0,965	1,042	-0,00432
	2	33	-0,881	0,89	-0,00678

7.16-misol uchun

7.16. Jadvalda ko'rsatilgan konsolli balkaning prolyotini o'rtasini va konsol erkin uchining salqiligi va chap (A) tayanchning aylanish burchagi topilsin.

Ko'ndalang kesimi qo'shtavrdan iborat bo'lib, balkaning yuklanishi ikki variantda bo'ladi:

1. $q = 20 \text{ kn/m}; \quad P = 40 \text{ kn}; \quad M = 60 \text{ knm}$

2. $q = 40 \text{ kn/m}; \quad P = 60 \text{ kn}; \quad M = 20 \text{ knm};$

7.17. Prolyoti ℓ bo'lgan va ikki sharnirli tayanchga qo'yilgan bikrligi o'zgarmas ($EJ = \text{const}$) bo'lgan balkaning o'rtasiga F va M kuchlar ta'sir qiladi. Balka deformasiyasining potentsial energiyasining qiymatini xisoblang.

Javobi: $\frac{P^2 \ell^3}{96EJ} + \frac{M^2 \ell}{24EJ}.$

7.18. Prolyoti ℓ , bikrligi EJ va balandligi h , bo'lgan o'zgarmas kesimli balka sof egilish ta'sirida turibdi. Balkadagi eng katta normal kuchlanishlar ruxsat etilgan kuchlanish $[\sigma]$ ga teng deb xisoblab, balkada to'plangan potentsial energiyaning qiymatini xisoblang.

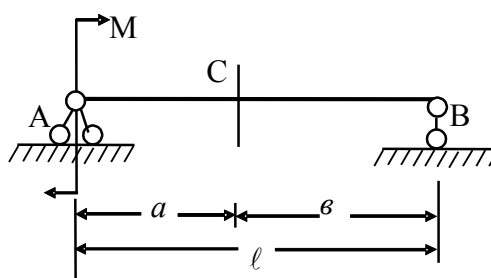
Javobi: $\frac{2[\sigma]^2 J \ell}{Eh^2}.$

7.19. Jadvalda ko'rsatilgan ikki konsolli simmetrik balkalar simmetrik yuk bilan yuklangan. Konsol uchidagi salqilik (Z_y) ni, prolyot o'rtasi (Z_{yp}) ni va chap tayanchdagi kesimning aylanish burchagini harflar tarzida aniqlang.

7.20. Shaklda ko'rsatilgan balkaning A va B tayanchlarining aylanish burchagini va S kesimining salqiligini Kastilyano teoremasidan foydalanib aniqlang.

Javobi: $\theta_A = \frac{M_0 \ell}{3EJ};$

$\theta_B = \frac{M_0 \ell}{6EJ};$



7.20- misol uchun

S x e m a l a r	J a v o b l a r		
	EJz_y	EJz_y	$EJ\theta$
a)	$-\frac{61}{48} Pa^3$	$\frac{9}{16} Pa^3$	$\frac{15}{16} Pa^2$
b)	$-\frac{5}{6} Pa^3$	$\frac{1}{6} Pa^3$	$\frac{1}{2} Pa^2$
v)	$-\frac{17}{6} Pa^3$	$\frac{25}{12} Pa^3$	$\frac{5}{2} Pa^2$
g)	$\frac{9}{8} qa^4$	$-\frac{135}{128} qa^4$	$-\frac{9}{8} qa^3$
d)	$-\frac{7}{8} qa^4$	$\frac{9}{16} qa^4$	$\frac{3}{4} qa^3$
e)	$\frac{1}{4} qa^4$	$-\frac{63}{128} qa^4$	$-\frac{3}{8} qa^3$
j)	$-2 Ma^2$	$\frac{9}{8} Ma^2$	$\frac{3}{2} Ma$
z)	$\frac{1}{2} Ma^2$	$-\frac{5}{8} Ma^2$	$-\frac{1}{2} Ma$

7.19-misol uchun

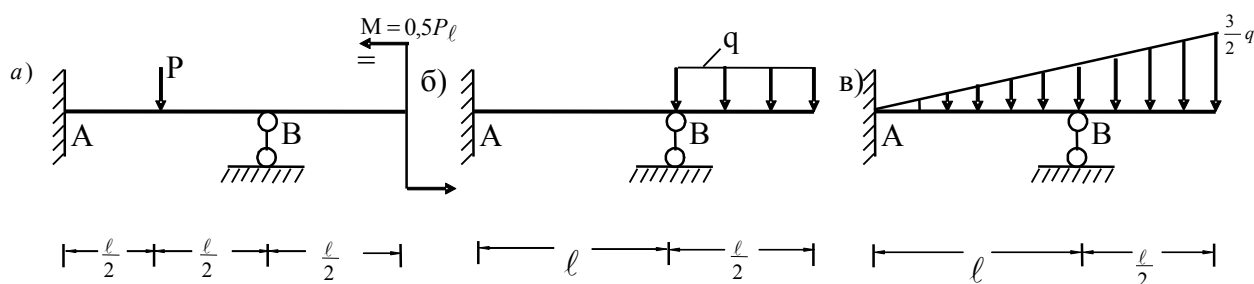
STATIK ANIQMAS SISTEMALARNI HISOBLASH

8.1. Shaklda ko'rsatilgan balkalarning tayanch reaksiya kuchlari topilsin .

Javoblar: a) $R_A = \frac{23}{16}P$; $R_B = -\frac{7}{16}P$; $M_A = -\frac{7}{16}P\ell$;

b) $R_A = -\frac{3}{16}q\ell$; $R_B = \frac{11}{16}q\ell$; $M_A = \frac{q\ell^2}{16}$;

c) $R_A = -\frac{q\ell}{40}$; $R_B = \frac{23}{20}q\ell$; $M_A = \frac{q\ell^2}{40}$.



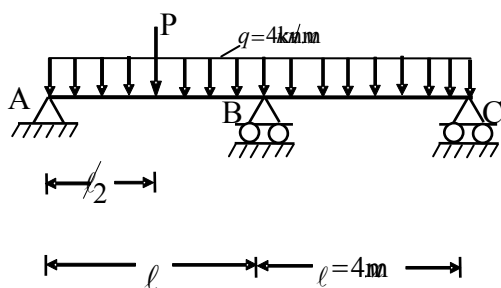
8. 1-misol uchun

8.2. Shaklda ko'rsatilgan balkaning S tayanchiga qo'yilgan uchi ko'tarilib ketmasligi uchun R kuchning qiymati nimaga teng bo'lishi kerak.

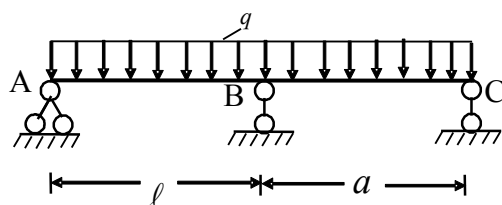
Javobi: $R = 16 \text{ kn}$

8.3. Shaklda ko'rsatilgan balkaning S tayanchidagi reaksiya kuchining qiymati nolga teng bo'lishi uchun $\frac{a}{\ell}$ nisbat kanday bo'lishi kerak.

Javobi: $\frac{a}{\ell} = 0,433$.



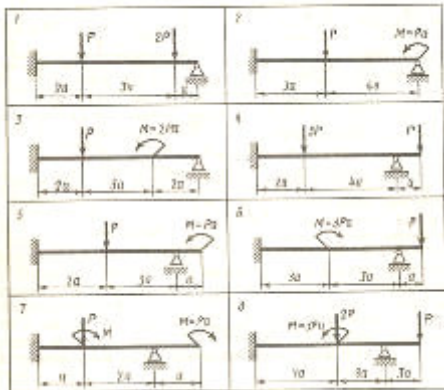
8.2 -misol uchun



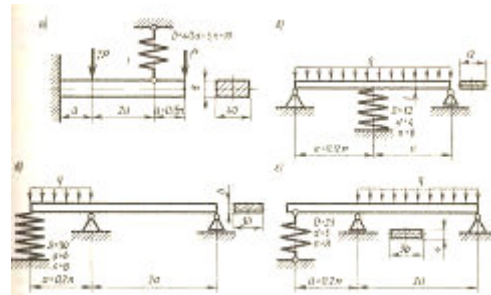
8.3 -misol uchun

8.5. Agar $P = 1 \text{ kn}$, $a = 20 \text{ sm}$, $[\sigma] = 1200 \text{ kg/sm}^2$ bo'lsa, shaklda ko'rsatilgan po'lat balkalar uchun xalqasimon ko'ndalang kesimli $\alpha = \frac{d_0}{d} = 0,8$ bo'lganda mustahkamlik shartidan ko'ndalang kesimning o'lchamlari aniqlansin.

8.6. Agar balka uchun $E = 2 \cdot 10^6 \text{ kg/sm}^2$, $[\sigma] = 2500 \text{ kg/sm}^2$; prujina uchun $G = 8 \cdot 10^5 \text{ kg/sm}^2$, $[\tau] = 4000 \text{ kg/sm}^2$ bo'lsa shaklda ko'rsatilgan sistemalar uchun ruxsat etilgan yuk qiymatini aniqlang.



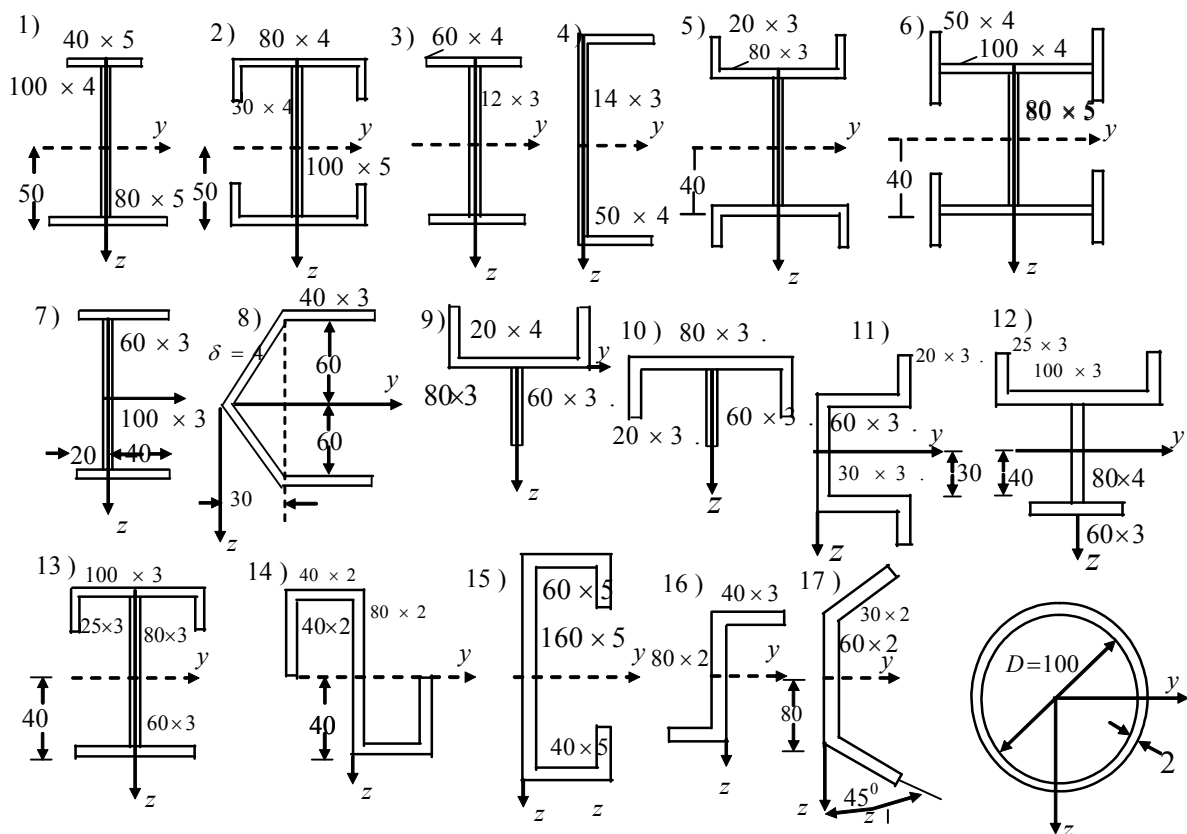
8.5-misol uchun.



8.6-misol uchun.

OCHIQ PROFILLI YUPQA DEVORLI STERJENLAR

9.1. Shaklda ko'rsatilgan profillar uchun egilish markazi (A nuqta) vaziyati aniqlansin, asosiy sektorial yuzalar epyurasi qurilsin, shu epyuraning eng katta ordinatasi ω_{max} aniqlansin va sektorial inersiya momenti qiymati hisoblansin.



9.1-misol uchun

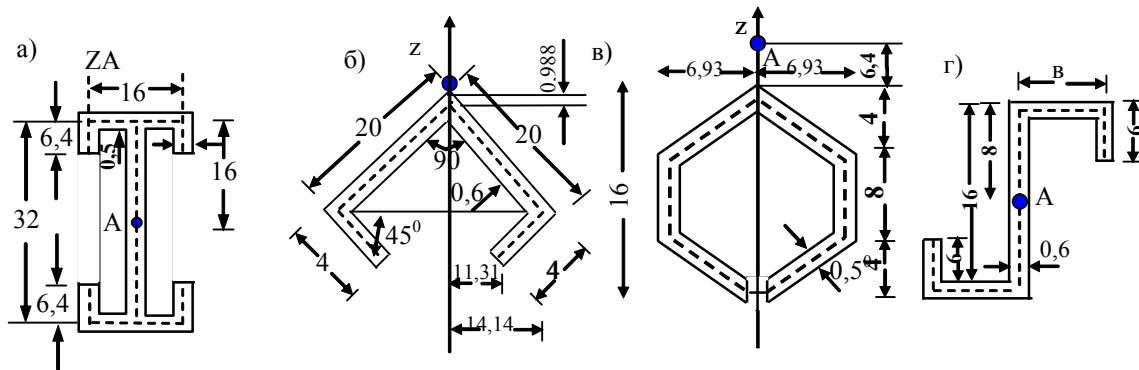
javoblari:

Sxema nomeri	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
y_A	0	0	0	-1,85	0	0	-0,78	-1,33	0	0	1,259	0	0	0	-3,64	0	-3,64	0
z_A	+3,88	0	0	0	0	0	0	0	+0,6	-0,6	0	-2,67	-4,051	0	0	0	0	+10
$ \omega_{max} $	117,76	32	18	22,05	16	32,5	16,1	16	5,6	5,6	5,22	20	24,15	21,3	57,45	11,2	2,74	78,5
J_ω	237	4156	518,5	726	768	4683	289,5	319,5	14,1	14,1	30,0	304	423,5	547	9890	112,5	4,28	5065

9.2. Shaklda ko'rsatilgan kesimlar uchun egilish markazi A berilgan, har bir kesim uchun absolyut qiymati bo'yicha $\omega_{0,max}$ ning eng katta koordinatalari aniqlansin va sektorial inersiya momenti J_{ω} hisoblansin.

Javobi:

kesimlar	a	b	v	g
$\omega_{0,max}$	179,2	68,8	166,3	76,4
J_{ω}	575039	7915	88580	26159



9.2-misol uchun

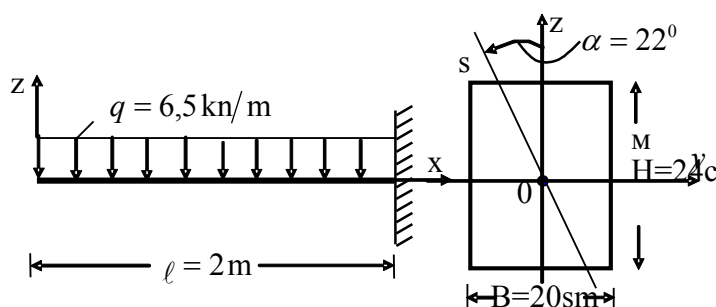
MURAKKAB QARSHILIK

10.1. Shaklda ko'rsatilgan to'rtburchak ko'ndalang kesimli konsolga xos tekislik bo'yicha tekis yoyilgan kuch ta'sir etadi. Kesimning neytral o'qining holatini, erkin uchining to'la salqiligini va xavfli kesimdagi eng katta cho'zuvchi kuchlanishlarni aniqlang.

Javobi:

$$\varphi = 30^{\circ}13' ; f = 0.03 \text{ sm},$$

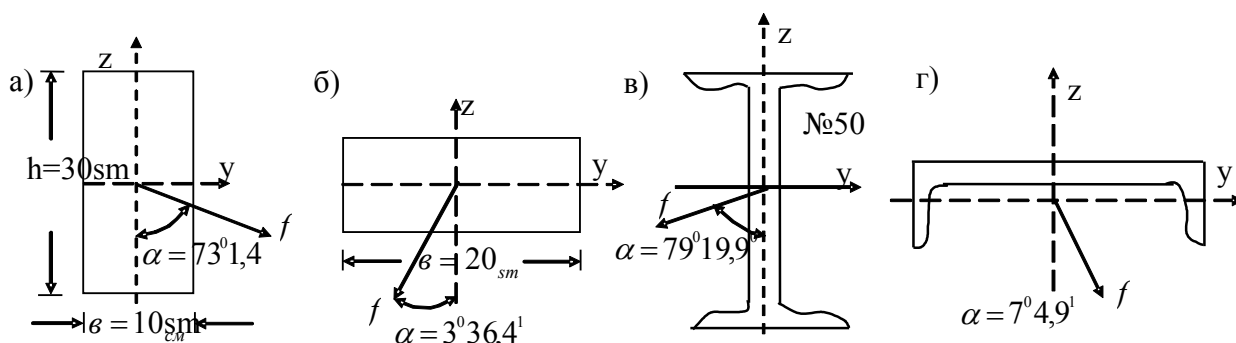
$$\sigma_{\max/\min} = \pm 93.2 \text{ kg/sm}^2.$$



10.1-misol uchun

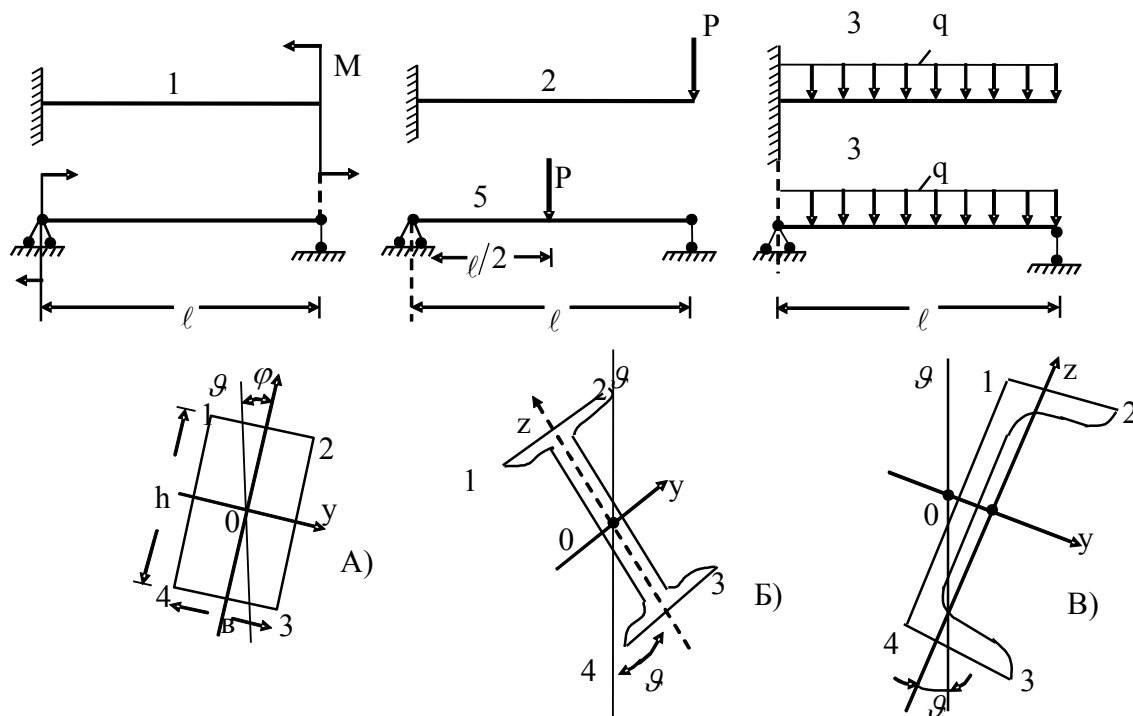
10.2. Ko'ndalang kesimlari shaklda ko'rsatilgan balkalarning egilishi natijasida kesimlarning og'irlik markazlari ko'rsatilgan yo'nalishda surilgan. Balkalarning har qaysisi uchun tashqi kuchlarning ta'sir tekisliklari vaziyatini aniqlang (φ burchakning z o'qi bilan).

Javoblari: a) $\varphi = 20^{\circ}$, b) $\varphi = 35^{\circ}$, v) $\varphi = 8^{\circ}$, g) $\varphi = 60^{\circ}$.



10.2-misol uchun

10.3. Shaklda ko'rsatilgan balkalar uchun neytral chiziqning vaziyatini toping (o'q y bilan burchak α), xavfli kesimda eng katta normal kuchlanishlarni aniqlang, kesim tomonlari bo'yicha bu kuchlanishlarning epyuralarini quring va balkaning eng katta salqiligini aniqlang. Hamma holda ham yuklanishning ta'sir tekisligi kesimning egilish markazi – nuqta O orqali o'tadigan vertikal tekislik ν ga to'g'ri keladi. Balkalarning ko'ndalang kesimi A) bo'lganda materiali yog'och, B) va V) – po'lat.



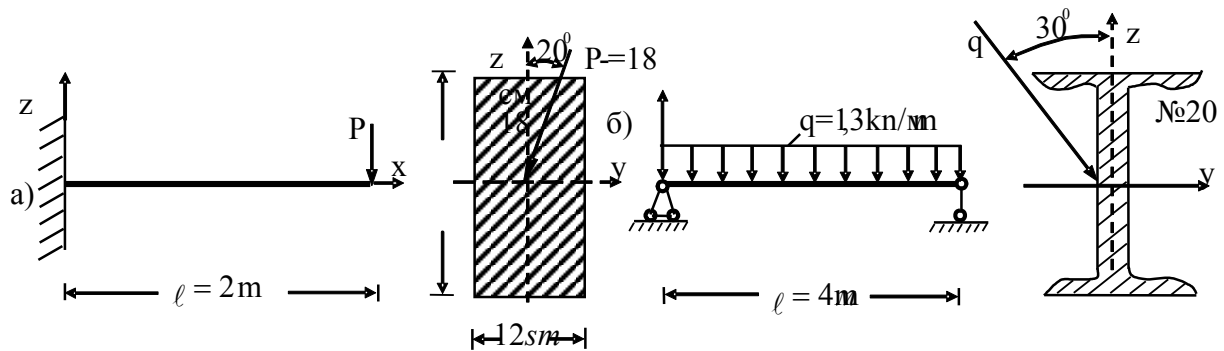
10.3-misol uchun

N/N	Balka sxema-si va kesimi	Pro- lyot ℓ (m)	Yuklar	Kesim o'lcham-lari	Bur- chak φ	javoblar		
						Burchak α	σ max (kg/cm^2)	f max (cm)
1	1-A	1,5	$M=4 \text{ knm}$	12x20sm	60°	$78^\circ 16^1$	97,2	1,38
2	1-B	1,4	$M=2 \text{ knm}$	Ko'shtavr №12	30°	$82^\circ 8^1$	1443	1,77
3	1-V	2,0	$M=6 \text{ knm}$	Shveller №6 knm	60°	$87^\circ 55^1$	1492	1,98
4	2-A	2,0	$F=0,8 \text{ kn}$	10x15sm	45°	$66^\circ 12^1$	75,2	1,32
5	2-B	1,5	$F=2 \text{ kn}$	Ko'sht. №16	30°	$83^\circ 22^1$	1273	0,97
6	2-V	1,4	$F=3 \text{ kn}$	Shvel. №22	60°	$87^\circ 38^1$	1552	0,79
7	3-A	2,0	$q=2 \text{ kn/m}$	10x25 cm	45°	$80^\circ 55^1$	95,0	0,47
8	3-B	1,2	$q=3 \text{ kn/m}$	Ko'sht. №14	30°	$82^\circ 46^1$	1168	0,47
9	3-V	2,4	$q=2 \text{ kn/m}$	Shvel. №24	45°	$85^\circ 54^1$	1481	1,41
10	4-A	2,5	$M=6 \text{ kn/m}$	12x30 sm	60°	$84^\circ 43^1$	88,8	0,48
11	4-B	3,0	$M=8 \text{ kn/m}$	Ko'sht. №27	45°	$87^\circ 2^1$	1516	0,63
12	4-V	2,2	$M=3 \text{ knm}$	Shvel №14 ^a	30°	$79^\circ 39^1$	1463	0,41
13	5-A	2,5	$F=2.5 \text{ kn}$	9x51sm	45°	$70^\circ 12^1$	87,3	0,67
14	5-B	4,0	$F=12 \text{ kn}$	Ko'sht. №36	60°	$88^\circ 44^1$	1542	1,34
15	5-V	2,4	$F=4 \text{ kn}$	Shvel. №14	30°	$80^\circ 54^1$	1388	0,64
16	6-A	3,2	$q=6 \text{ kn/m}$	16x24cm	60°	$75^\circ 37^1$	90,0	0,89
17	6-B	5,0	$q=4 \text{ kn/m}$	Ko'sht. №40	60°	$88^\circ 50^1$	1326	2,12
18	6-V	4,0	$q=1.2 \text{ kn/m}$	Shvel. №16	45°	$85^\circ 9^1$	1415	2,24

10.4. Agar $[\sigma] = 1400 \text{ kg/sm}^2$ va $[f] = \ell/400$ bo'lsa, shaklda ko'rsatilgan po'lat balkaning mustahkamligi va bikrligi tekshirilsin.

Javobi: a) $\delta_{\max} = 807 \text{ kg/sm}^2$, $f = 0,5 \text{ sm}$

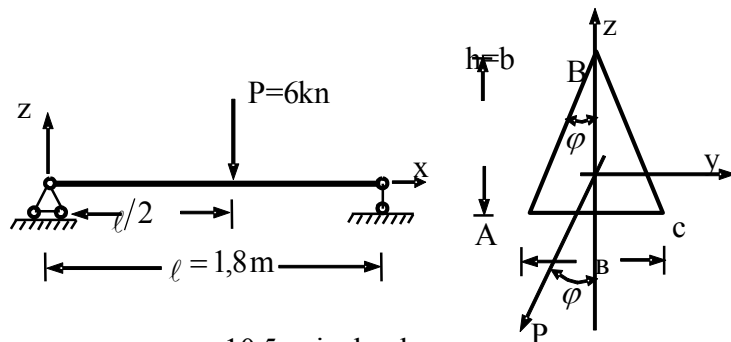
b) $\delta_{\max} = 686 \text{ kg/sm}^2$, $f = 0,95 \text{ sm}$



10.4-misol uchun

10.5. Agar shaklda ko'rsatilgan uchburchak ko'ndalang kesimli cho'yan balka uchun $[\sigma]_{ch} = 400 \text{ kg/sm}^2$, $[\sigma]_s = 1200 \text{ kg/sm}^2$ bo'lsa, ko'ndalang kesimning zaruriy o'lchamlari aniqlansin.

Javobi: $h=12 \text{ cm}$.



10.5-misol uchun

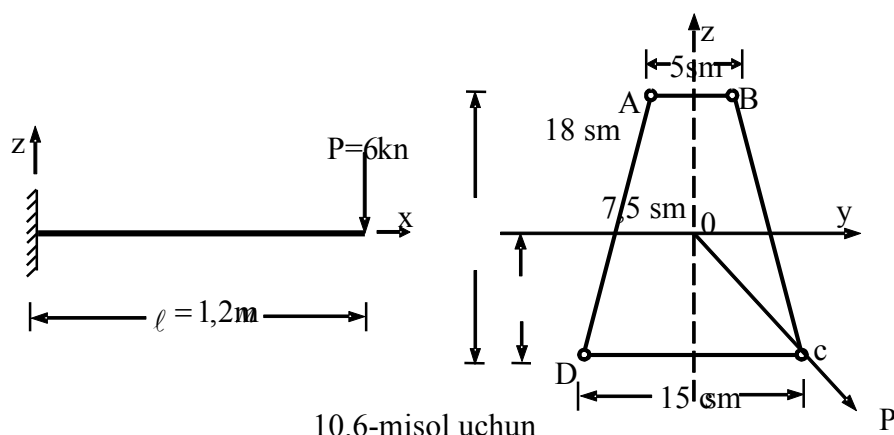
10.6. Ko'ndalang kesimi trapesiyasimon bo'lgan cho'yan konsol kesimining burchagidagi nuqtalaridagi normal kuchlanishlar va eng katta salqilik aniqlansin.

Quyidagilar berilgan: kg/sm^2

$$E = 1,2 \cdot 10^6 \text{ kg/sm}^2 \quad J_y = 4455 \text{ sm}^4 \quad J_z = 1875 \text{ sm}^4$$

Javobi: $\sigma_A = 391 \text{ kg/sm}^2$ $\sigma_e = 109 \text{ kg/sm}^2$ $\sigma_c = 603 \text{ kg/sm}^2$

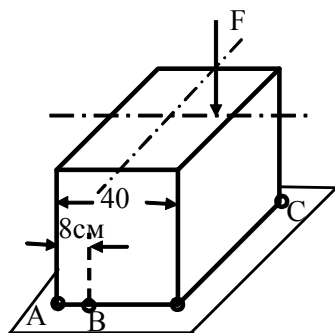
$$\sigma_D = 246 \text{ kg/sm}^2 \quad f = 0,58 \text{ sm}$$



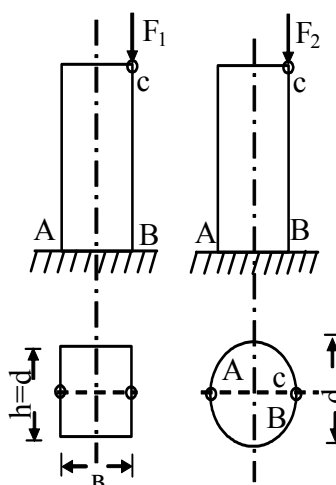
10.6-misol uchun

10.7. Siqilgan brusning A nuqtasidagi normal kuchlanish $\sigma_A = 12 \text{ kg/sm}^2$ ga teng (cho'zilish), V nuqtada $\sigma_B = 0$ ga teng S nuqtada kuchlanish nimaga teng?

Javobi: $\sigma_c = 48 \text{ kg/sm}^2$ (siqilish).



10.7-misol uchun



10.8-misol uchun

10.8. Shaklda ko'rsatilgan ikki ustunning V nuqtasidagi siquvchi kuchlanishlar bir-biriga tengligi ma'lum bo'ldi. Ustunlarning A nuqtasidagi kuchlanishlarni taqqoslang.

Javobi: Doiraviy kesimli ustunda kuchlanish 20% katta bo'ladi.

EGRI STERJENLAR

11.1. Po'latdan yasalgan sterjenning B kesimining vertikal, gorizonta va to'la ko'chishlari aniklansin.

$$\text{Javobi: } \delta_B^{vert} = \frac{\pi}{4} \frac{P\rho^3}{EJ} \approx 0,4 \text{ sm}, \quad \delta_B^{gor} = \frac{P\rho^3}{2EJ} = 0,25 \text{ sm}, \quad \delta_B^{to'la} = 0,472 \text{ sm}.$$

11.2. Shaklda ko'rsatilgan egri sterjen uchun eguvchi moment, bo'ylama va kesuvchi kuchlar epyuralari qurilsin.

$$\text{Javobi: } |M_{max}| = 0,125 q\rho^2; \quad |N_{max}| = |N_A| = 0,5 q\rho; \quad |Q_{max}| = |Q_B| = 0,5 q\rho.$$

11.3. Eni 6 sm, qalinligi 4 sm bo'lgan to'g'ri to'rtburchak kesimli stejenni egib, u o'rtacha radiusi 7 sm li taqasimon shaklga keltirilgan. Sterjenning o'rtasidagi kesimning markazidan 12 sm masofaga bir-biriga qarama-qarshi yo'nalgan 10 kn ga teng ikkita kuch qo'yilgan; bu kuchlar qayrilgan stejenni to'grilashga intiladilar. O'rtadagi kesimning eng katta cho'zuvchi va siquvchi kuchlanishlarni topib, shu kesim uchun normal kuchlanishning epyurasi qurilsin.

$$\text{Javobi: } 750 \frac{\text{kg}}{\text{sm}^2}; -340 \frac{\text{kg}}{\text{sm}^2} (r = 6,55 \text{ sm}).$$

11.4. To'g'ri to'rtburchak kesimli ilmoq ko'tara oladigan yuk miqdori topilsin. Ilmoqning qalinligi 7,5 sm, ichkari tomondagi tolalar radiusi 15 sm, tashqari tolalar radiusi 25 sm. Ichkaridagi tolalar qavatidan 7,5 sm uzoqlikda kuchning ta'sir chizig'i o'tadi. Ruxsat etilgan kuchlanish $700 \frac{\text{kg}}{\text{sm}}$ ga teng.

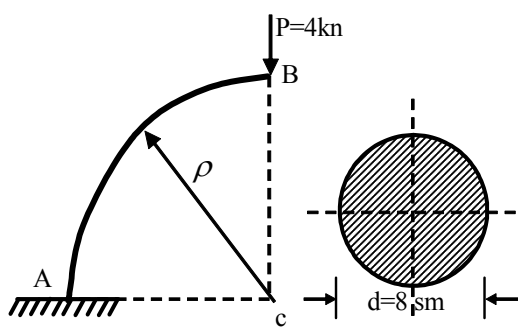
$$\text{Javobi: } 52 \text{ kn} (r = 19,577 \text{ sm}).$$

11.5. Diametri 8 sm bo'lgan doiraviy kesimli sterjendan yasalgan xalqaning ichki diametri 12 sm. Xalqa $P = 20 \text{ kn}$ kuch bilan siqiladi, A va B nuqtalardagi kuchlanishlar topilsin.

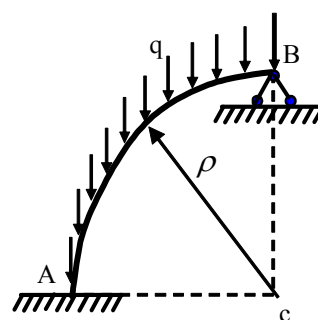
$$\text{Javobi: } 260 \frac{\text{kg}}{\text{sm}^2}; -607 \frac{\text{kg}}{\text{sm}^2} (r = 9,81 \text{ sm}).$$

11.6. Shaklda ko'rsatilgan egri sterjenning A nuqtasi P kuch ta'siridan gorizonta yo'nalishda ko'chadimi, agar ko'chsa qanchaga ko'chadi?

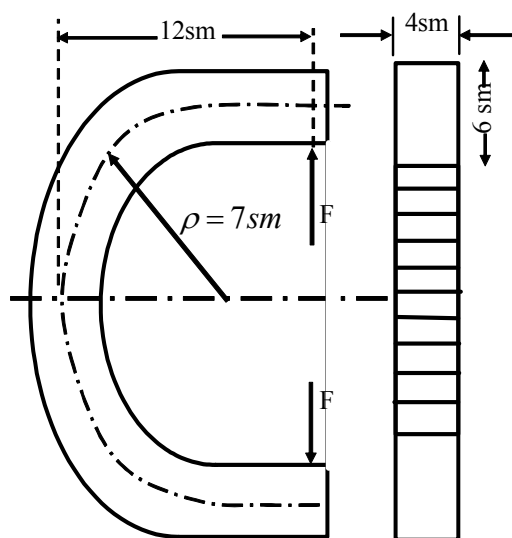
$$\text{Javobi: } \Delta_{cap} = \frac{P\rho^3}{2EJ} - \frac{P\rho}{2EA} \text{ chapga qarab ko'chadi.}$$



11.1-misol uchun



11.2-misol uchun



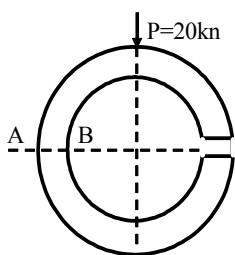
11.3-misol uchun

11.7. Shaklda ko'rsatilgan egri sterjenning B tayanch reaksiyasi aniqlansin. B nuqtaning gorizontal ko'chishi topilsin (bo'ylama kuch ta'siri hisobga olinmasin).

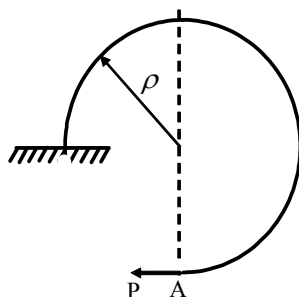
Javobi: $\chi_B = 0,9 \frac{M}{\rho}$; $\Delta_{qor} = 0,042 \frac{M \cdot \rho^2}{EJ}$.

11.8. Shaklda ko'rsatilgan ABC sterjenning xavfli ko'ndalang kesimidagi eng katta va eng kichik normal kuchlanishlarning qiymati aniqlansin.

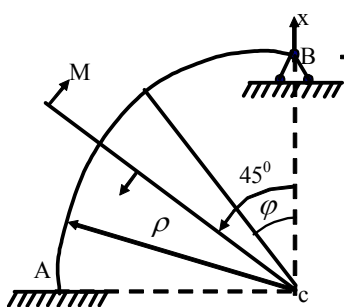
Javobi: $\sigma_{\max} = 1246 \frac{kg}{sm^2}$; $\sigma_{\min} = -1284 \frac{kg}{sm^2}$.



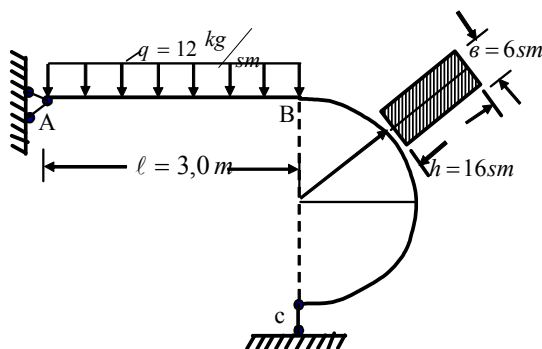
11.5-misol uchun



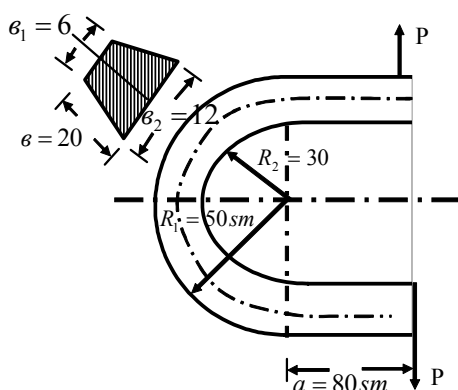
11.6-misol uchun



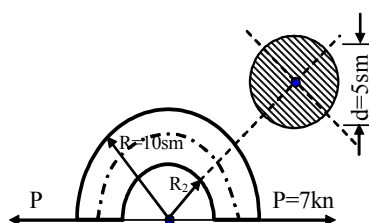
11.7-misol uchun



11.8-misjl uchun



11.9-misol uchun



11.10-misol uchun

11.9. Ruxsat etilgan kuchlanish $[\sigma] = 12 \frac{kg}{sm^2}$ bo'lganda, shaklda ko'rsatilgan zirak shaklidagi detal uchun P kuchning ruxsat etilgan qiymati topilsin.

Javobi: $[P] = 82 kn$.

11.10. Ruxsat etilgan kuchlanishlar $[\sigma_u] = 600 \frac{kg}{sm^2}$, $[\sigma_c] = 1800 \frac{kg}{sm^2}$ bo'lganda, yarim xalka shakliga ega bo'lgan cho'yandan yasalgan sterjenning mustaxkamligi tekshirilsin.

Javobi: $\sigma_{max} = 564 \frac{kg}{sm^2}$; $\sigma_{min} = -285 \frac{kg}{sm^2}$.

BO'YLAMA VA BO'YLAMA-KO'NDALANG EGILISH

12.1. Shaklda ko'rsatilgan ko'ndalang kesimlarning yuzasi teng bo'lgan va bir xil sharoitda ishlaydigan ustunlarning kritik kuchlari qiymatlari nisbatini Eyler formulasidan foydalanib toping.

Javobi : $P_{K1} : P_{K2} : P_{K3} : P_{K4} : P_{K5} : P_{K6} = 1,0 : 0,955 : 0,333 : 4,56 : 4,35 : 2,38$.

12.2. Shaklda ko'rsatilgan sterjenni siquvchi F_{kp} kuch qiymati qanday o'zgaradi;

agar: a) diametrini ikki marta oshirsak,

b) ko'ndalang kesim yuzini ikki marta oshirsak.

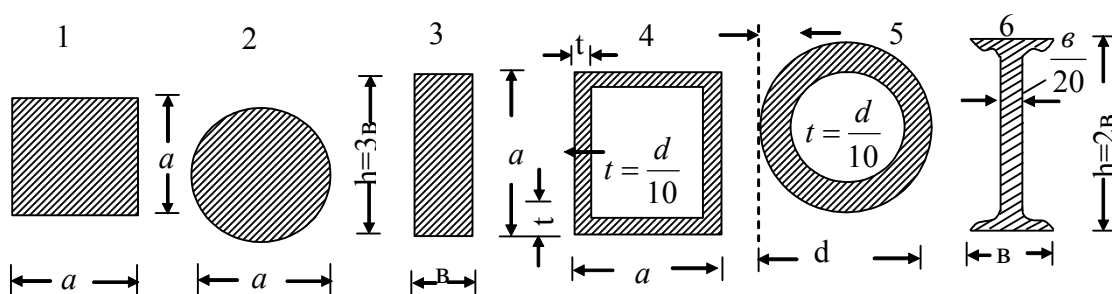
Sterjen $\sigma_{kp} < \sigma_n$ da ustivorligini yo'qotadi.

Javobi : Ortadi : a) 16 marta; b) 4 marta.

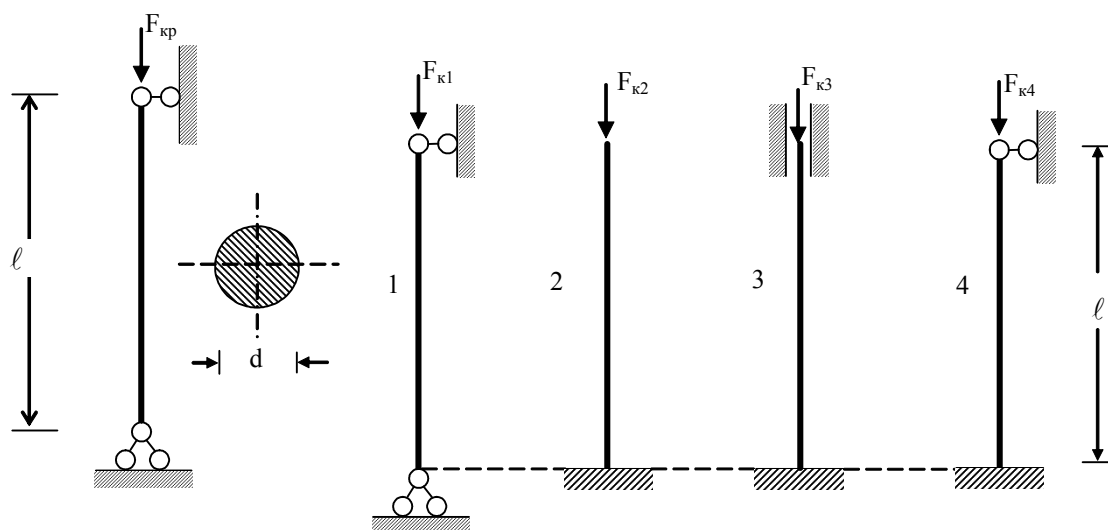
12.3. Materiallari va diametrlari bir xil bo'lgan doiraviy ko'ndalang kesimli ster-jenlar uchun siquvchi F_{kp} kuchning qiymatlarini taqqoslang.

Sterjenning ustivor-ligi $\lambda > \lambda_{cek}$ da yo'qoladi.

Javobi: $F_{k2} = \frac{1}{4} F_{k1}$; $F_{k3} = 4 F_{k1}$; $F_{k4} = 2,04 F_{k1}$.



12.1-misol uchun.



12.2-misol uchun.

12.3-misol uchun

12.4. Agar ko'ndalang kesimi d diametrli doirani teng yuzali: a) kvadrat, b) xalqa ($\alpha = \frac{d}{D} = 0,8$). v) to'g'ri to'rtburchak ($b \times 2b$) bilan almashtirsak, siquvchi F_{kp} kuchning qiymati qanday o'zgaradi.

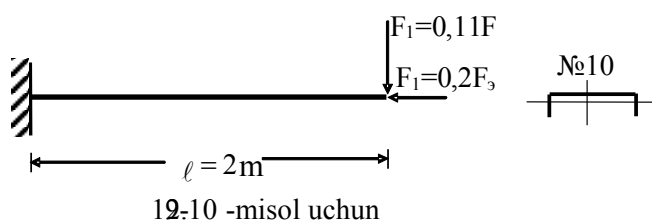
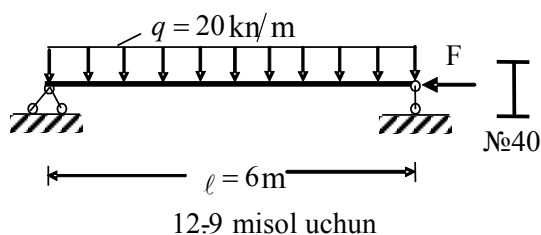
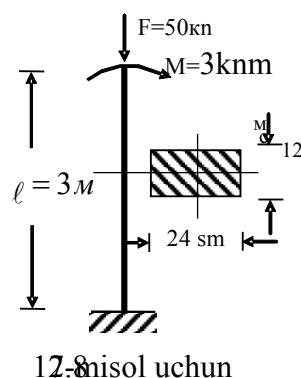
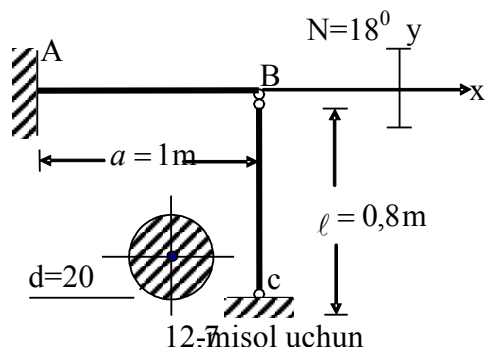
Javobi : Ortadi : a) 4,9 marta, b) 4,55 marta, v) 1,9 marta.

12.5. St.3 markali po'latdan yasalgan, balandligi $h = 2,5m$ bo'lgan, pastki qismi qistirib mahkamlangan va yuqori qismi erkin bo'lgan, ustun uchun qo'shtavrli ko'ndalang kesimning nomeri 12.2-jadvaldan foydalanib aniqlansin. Hisobiy yuk 250 kN , hisobiy kuchlanish 2000 kg/sm^2 .

Javobi : Qo'shtavr nomeri 30^a .

12.6. Ikki uchi bilan sharnirlar yordamida mahkamlangan, $(8 \times 12 \text{ sm})$ to'g'ri to'rtburchak ko'ndalang kesimli yog'och uchun $R = 30 \text{ kN}$ kuch bilan siqiladi. Ustivorlikning zapas ko'effitsiyentini ikki hol uchun toping : 1) $\ell = 2 \text{ m}$; 2) $\ell = 1 \text{ m}$ $\sigma_n = 2000 \text{ kg/sm}^2$ deb olinsin.

Javobi : 1) $n_y = 4$; 2) $n_y = 6,7$



12.7. Agar ustun BC ning materiali st.3 markali po'latdan va $[n_y] = 3$ bo'lsa, ustivorlik shartidan ustunning temperaturasining ruxsat etilgan oshirilishi $[\Delta t]$ ni aniqlang.

Agar balkani absalyut qattiq deb olsak, yechish natijasi necha marta o'zgaradi.

Javobi : 104^0 ; $[\Delta t^0]$ - 10,1 marta kamayadi.

12.8. Shaklda ko'rsatilgan yog'och ustunning ko'ndalang kesimidagi eng katta normal kuchlanish aniqlansin.

Javobi : 48 kg/sm^2

12.9. Shaklda ko'rsatilgan balkaga ta'sir etayotgan R kuchning qiymati normal kuchlanish 1600 kg/sm^2 dan oshmaslik shartidan aniqlansin.

Javobi : $R = 436 \text{ kn}$.

12.10. Shaklda ko'rsatilgan po'lat konsolning ko'ndalang kesimidagi eng katta salqilik aniqlansin.

Javobi : $\sigma_{\max} = 1400 \text{ kg/sm}^2$; $f_{\max} = 1,6 \text{ sm}$

12.11. Agar yaxlit kesimli ustunning diametrini 2,3 va 5 marta kattalashtirsak kritik kuch qanday o'zgaradi.

Javobi: 16, 81 va 625 marta ortadi.

12.12. Agar ustun uzunligini 3,4 va 5 marta kamaytirsak kritik kuch qanday o'zgaradi.

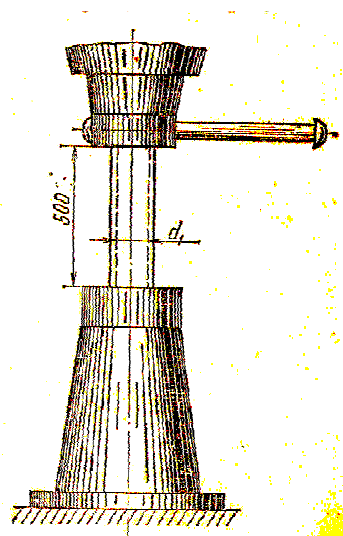
Javobi: 9,16 va 25 marta ortadi.

12.13 Shaklda ko'rsatilgan domkrat vintning ehtiyot koeffitsiyenti aniqlansin. Materiali st.5, $d_1 = 5,1 \text{ sm}$, eng katta ko'tarish balandligi 50 sm.

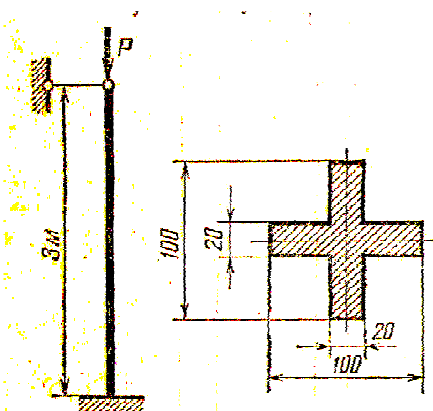
Javobi: $n_y = 3,43$.

12.14. Shaklda ko'rsatilgan cho'yan ustun $P = 87 \text{ kn}$ kuch bilan siqiladi. $[n_y] = 5$; $E = 1,2 \cdot 10^6 \text{ kg/sm}^2$. Ustunning ustivorligi tekshirilsin.

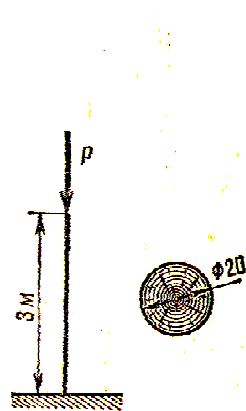
Javobi: $n_y = 5,3 > [n_y] = 5$.



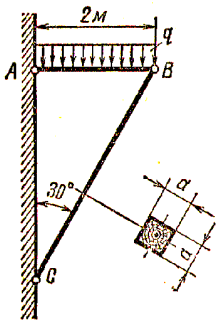
12.13-misol uchun



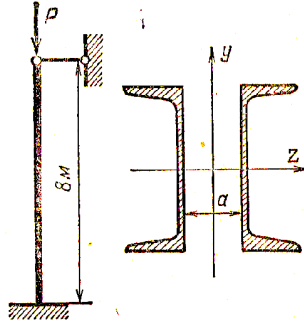
12.14-misol uchun



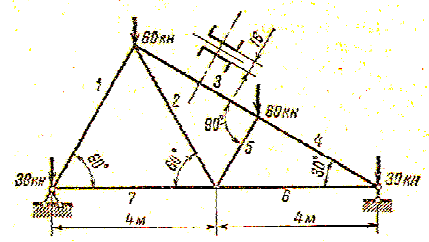
12.15-misol uchun



12.16-misol uchun



12.17-misol uchun



12.18-misol uch

12.15. Shaklda ko'rsatilgan yog'och ustun uchun ruxsat etilgan siquvchi kuch ustivorlik shartidan foydalanib topilsin. $[n_y]=3,2$.

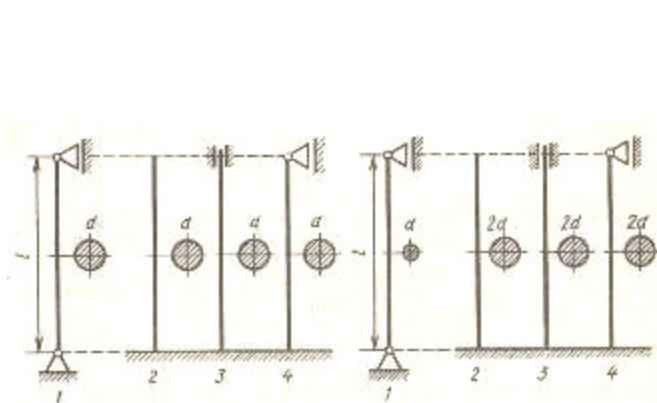
Javobi: $[P]=67 kn$.

12.16 Shaklda ko'rsatilgan ABC kranshteyn $q=10kg/m$ kuch bilan yuklangan. BC yog'och tirgak kvadrat kesimining o'lchamlari ustivorlik shartidan aniqlansin. $[\sigma_c]=50kg/sm^2$

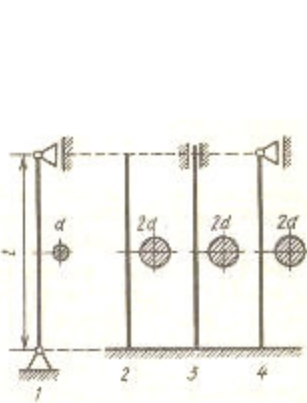
Javobi: $a=11sm$

12.17. Shaklda ko'rsatilgan ikkita shvellardan tuzilgan ustunning ko'ndalang kesim yuzasi o'lchamlari tanlansin. $P=600kn$, materiali st.3 markali po'latdan yasalgan bior ustun uchun biror variant bo'yicha ruxsat etilgan siquvchi kuch qymatini toping $[\sigma]=1600kg/sm^2$. Shvellarning orasida zaruriy masofa a topilsin.

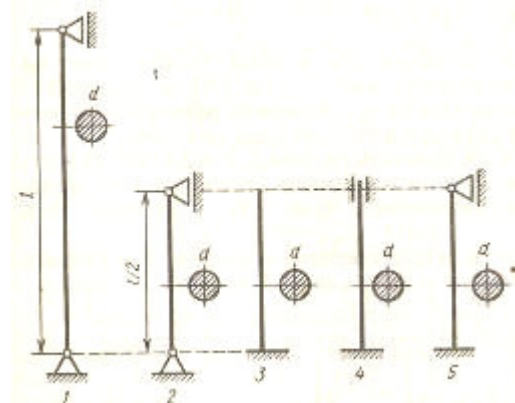
Javobi: Ikkita shvellar №20; $a=11,4sm$.



12.19-misol uchun



12.20-misol uchun



12.21-misol uchun

12.18. Shaklda ko'rsatilgan ikkita shvellardan tuzilgan ferma 3 sterjenning kesimi tanlansin. Materiali st.3 markali po'lat, $[\sigma]=1600kg/sm^2$. Sterjenlarning oxiri sharnir bilan biriktirilgan deb hisoblansin.

Javobi: Ikkita shvellar №6,5.

12.19. Shaklda ko'rsatilgan bir xil materialdan yasalgan sterjenlar uchun P_{np} qiymati taqqoslab qurilsin. Ustivorligi $\lambda > \lambda_{qez}$ bo'lganda yo'qoladi.

Javobi: $(P_{kp})_2 = 1,4(P_{kp})_1$; $(P_{np})_3 = 4(P_{np})_1$; $(P_{kp})_4 = 2,04(P_{kp})_1$.

12.20. Shaklda ko'rsatilgan bir xil materialli sterjenlar uchun P_{kp} qiymati taqqoslansin Ustivorligi $\sigma_{kp} < \sigma_n$ bo'lganda yo'qoladi.

Javobi: $(P_{kp})_2 = 4(P_{kp})_1$; $(P_{np})_3 = 64(P_{np})_1$; $(P_{kp})_4 = 32,6(P_{kp})_1$.

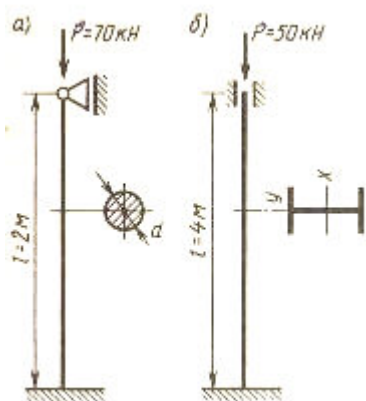
12.21. Shaklda ko'rsatilgan materiali bir xil bo'lgan sterjenlar uchun P_{kp} qiymati taqqoslangan. Ustivorligi $\lambda > \lambda$ da yo'qoladi.

Javobi: $(P_{kp})_2 = 4(P_{kp})_1$; $(P_{np})_3 = (P_{np})_1$; $(P_{kp})_4 = 16(P_{kp})_1$; $(P_{kp})_5 = 8,17(P_{kp})_1$

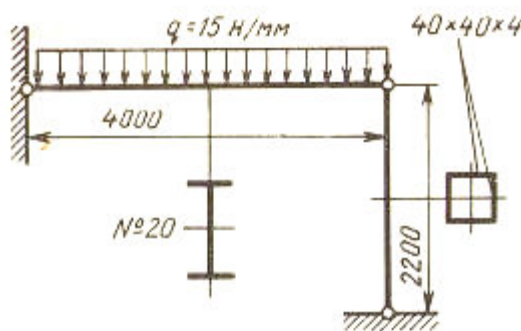
12.22. Shaklda ko'rsatilgan ustunlarni ustivorlikka tekshirishdan foydalanib ko'ndalang kesim diametri aniqlansin. Materiali 6,3 po'lat $[n_y] = 4,5$; $E = 2 \cdot 10^6 \text{ kg/sm}^2$ deb olinsin.

Javobi: a) 5,0 sm;

b) qo'shtavr №16



12.22-misol uchun



12.23-misol uchun

12.23. Shaklda ko'rsatilgan sistemadagi balkaning mustahkamligi va ustunning ustivorligi tekshirilsin.

$[n] = 1,5$; $[n_y] = 2,5$; $\sigma_{0.k.} = 2400 \text{ kg/sm}^2$; balkaning va ustunning materiali st.3 markali po'lat.

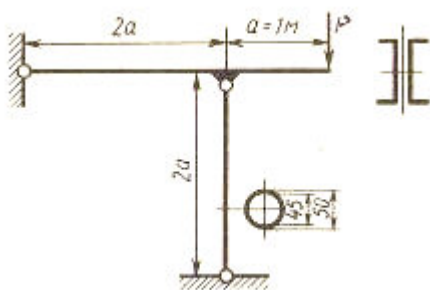
Javobi: 2% ga $n < [n]$; 24,8% ga $n_y < [n_y]$.

12.24. Agar $[n_y] = 2,5$ bo'lsa, shaklda ko'rsatilgan sistemaning ustivorlik shartidan ustun uchun R kuchning ruxsat etilgan qiymati aniqlansin.

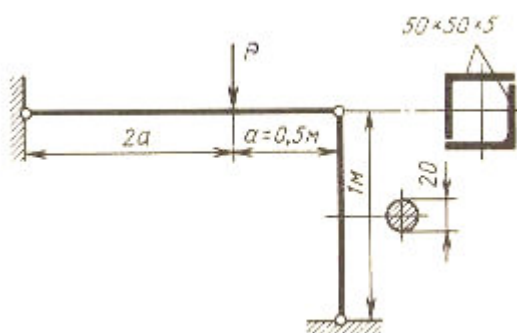
Javobi: $[P] = 14 \text{ kn}$.

12.25. Shaklda ko'rsatilgan sistema balkasi uchun mustahkamlik shartidan R kuchning ruxsat etilgan qiymati aniqlansin. Aniqlangan qiymatdan foydalanib ustunning ustivorligi tekshirilsin. Balka va ustunning materiali st.3 markali po'lat; $\sigma_{ok} = 2400 \text{ kg/sm}^2$; $[n] = 1,5$; $[n_y] = 3,5$ deb olinsin.

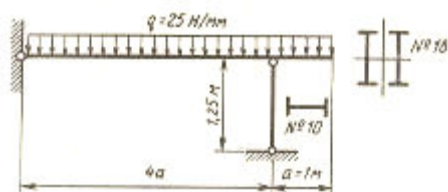
Javobi: $[P] = 6,86 \text{ kn}$; $n_y = 3,38$.



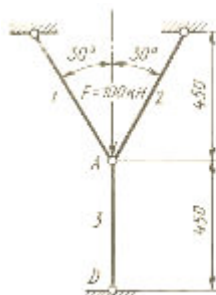
12.24-misol uchun



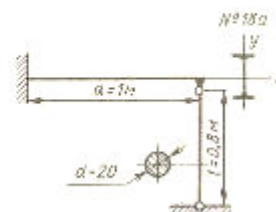
12.25-misol uchun



12.26-misol uchun



12.27-misol uchun



12.28-misol uchun.

12.26. Agar $[n] = 1,5$, $[n_y] = 3$, balka va ustun materiali st.3 markali po'lat, $\sigma_{ok} = 2400 \text{ kg/sm}^2$ bo'lsa shaklda ko'rsatilagn sistema balkaning mustahkamligi va ustunning ustivorligi tekshirilsin.

Javobi: $n = 1,56$; $n_y = 2,9$.

12.27. Materiali st.5 markali po'latdan tayyorlangan $d_1 = d_2 = 2 \text{ sm}$, $d_3 = 2,8 \text{ sm}$ bo'lgan sterjenlardan tuzilgan sistemaning 3 sterjenning ustivorligi tekshirilsin. $[n_y] = 2,5$ deb oling.

Javobi: $n_3 = 2,74$

12.28. Shaklda ko'rsatilgan sistema ustuni uchun $[\Delta t]$ aniqlansin. Ustun materiali st.3 markali po'lat, va $[n_y]=3$ deb olinsin. Agar balkani absolyut qattiq deb olsak, yechim natijasi necha marta o'zgaradi.

Javobi: $104; [\Delta t] - 20,1$ marta kamayadi.

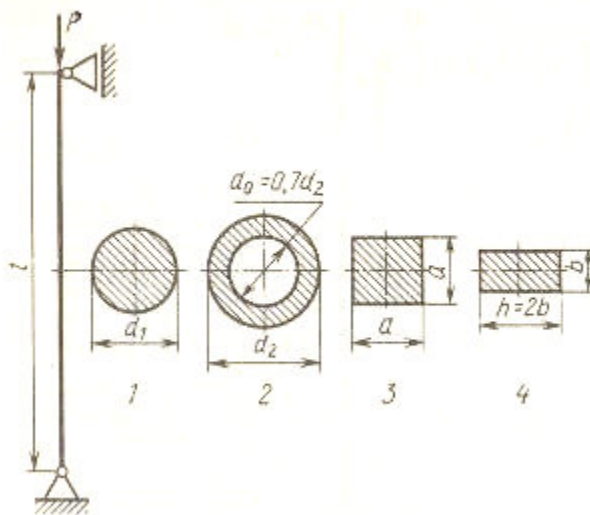
12.29. Ko'ndalang kesim yuzalari o'zaro teng bo'lgan kesimlar uchun: a) ustunning egiluvchivnligi chegarasida o'tgan; b) $d=5\text{ sm}, \ell=100\text{ sm}$ materiali st.3 markali po'lat bo'lganda ruxsat etilgan yukning nisbati aniqlansin.

Javobi: a) $[P_2]:[P_1]=2,92; [P_3]:[P_1]=1,05; [P_4]:[P_1]=0,515$

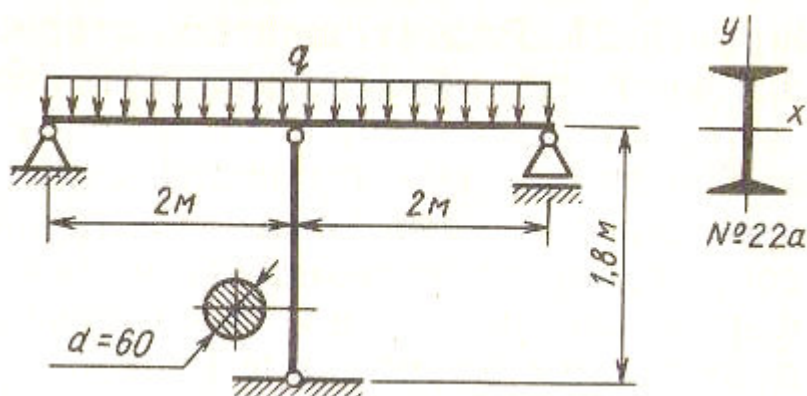
b) $[P_2]:[P_1]=1,09; [P_3]:[P_1]=1,01; [P_4]:[P_1]=0,745$

12.30. Agar $[n_y]=2$, materiali st.3 markali po'lat bo'lsa shaklda ko'rsatilgan sistemaning ustuni uchun $[q]$ ustivorlik shartidan aniqlansin. Topilgan $[q]$ ning qiymatidan foydalanib balkaning mustahkamligi tekshirilsin. $[\sigma]=1000\text{ kg/sm}^2$ deb olinsin.

Javobi: $[q]=77,4\text{ kn/m}; \sigma_{\max}=1220\text{ kg/sm}^2$



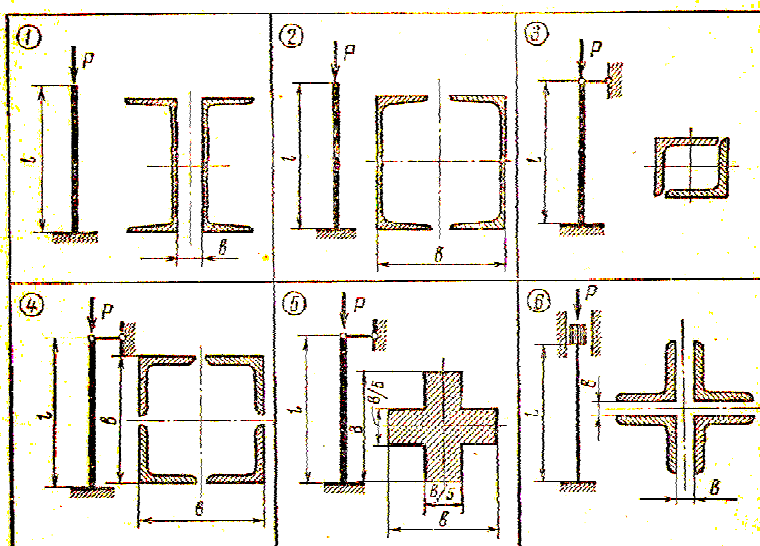
12.29-misol uchun



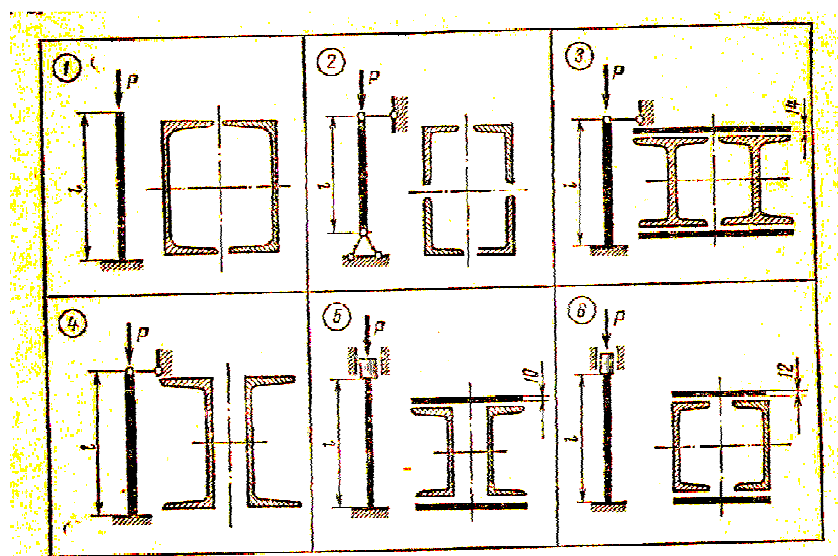
12.30-misol uchun

12.31. Shaklda ko'rsatilgan st.3 markali po'latdan yasalgan biror ustun uchun biror variant bo'yicha ruxsat etilgan siquvchi kuch qiymatini toping $[\sigma]=1600 \text{ kg/sm}^2$

12.32. Shaklda ko'rsatilgan st 3 markali po'latdan yasalgan biror ustun uchun biror varint bo'yicha ko'ndalang kesimning o'lchamlari topilsin $[\sigma]=1600 \text{ kg/sm}^2$.



12.31-misol uchun



12.32-misol uchun

DINAMIK VA ZARB KUCHLAR TA'SIRI

13.1. Uzunligi 60 m, materialining solishtirma og'irligi $\gamma = 7 \text{ kg/sm}^3$ ruxsat etilgan kuchlanishi $[\sigma] = 600 \text{ kg/sm}^2$ bo'lgan arqon 50 kn yukni dastlab 3 sekundda 9 m balandlikka ko'taradi Arqonning diametri, uning o'z og'irligini hisobga olgan va olmagan hollarda aniqlansin.

Javobi : 3,74 sm ; 3,58 sm .

13.2. Nomeri 22^a bo'lgan ikkita qo'shtavr balkaga o'rnatilgan lebetka yordamida $R_1 = 45 \text{ kn}$ yuk o'zgarmas tezlanish bilan ko'tariladi. Dastlabki 3 sekundda yuk 12 m balandlikka ko'tariladi. $[\sigma] = 1600 \text{ kg/sm}^2$ bo'lganda balkaning mustahkamligi, lebetkaning og'irligi $R_2 = 7 \text{ kn}$ ni hisobga olgan holda tekshirilsin.

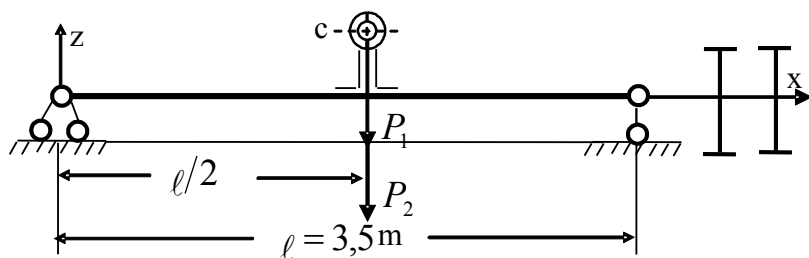
Javobi : $\sigma_{\delta}^{\max} = 1100 \text{ kg/sm}^2$.

13.3. Ko'ndalang kesim yuzasi 5 sm^2 , uzunligi 90 m, materialining hajmiy og'irligi $7,2 \text{ g/sm}^3$ bo'lgan po'lat arqon yordamida tekis tezlanish bilan 30 kN yuk ko'tariladi. Birinchi 2 sekunda yuk 4 m balandlikka ko'tariladi. Arqondagi eng katta normal kuchlanishni uning o'z og'irligini hisobga olgan va olmagan hollarda aniqlansin.

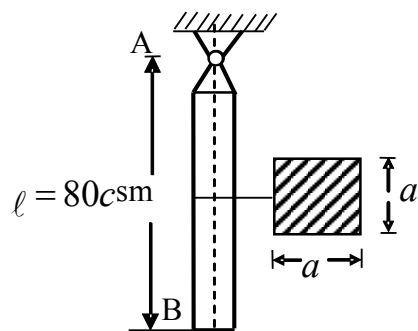
Javobi : 800 kg/sm^2 ; 722 kg/sm^2 .

13.4. Materialining solishtirma og'irligi $7,5 \text{ g/sm}^3$, $E = 2 \cdot 10^6 \text{ kg/sm}^2$ va tuginning o'rtacha radiusi $g = 1,5 \text{ m}$, bo'lgan maxovik minutiga 100 marta aylanadi. Shu maxovikning kuchlanishi bilan radiusining deformasiyasi aniqlansin.

Javobi : $\sigma_{\delta} = 1980 \text{ kg/sm}^2$; $\Delta r = 0,142 \text{ sm}$



13.2 -misol uchun



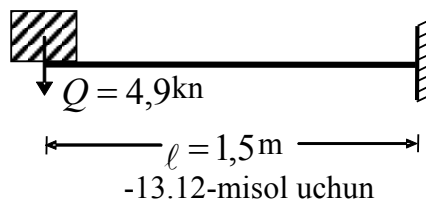
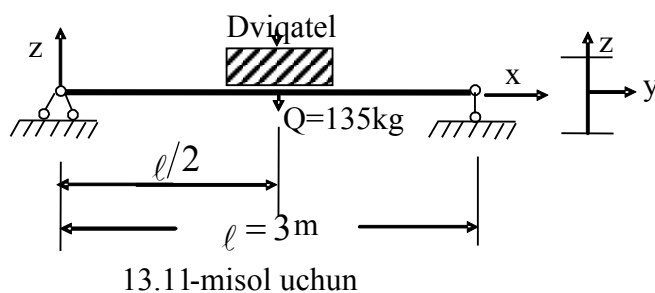
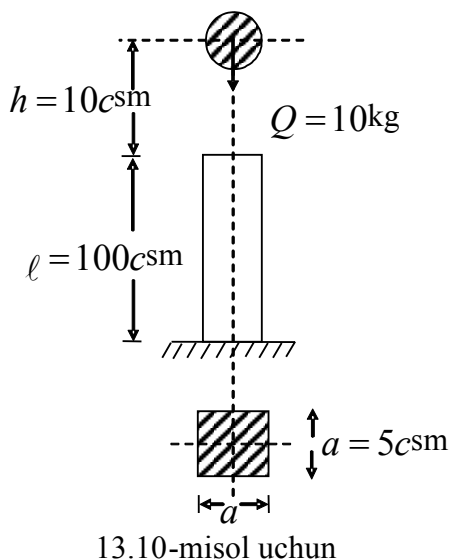
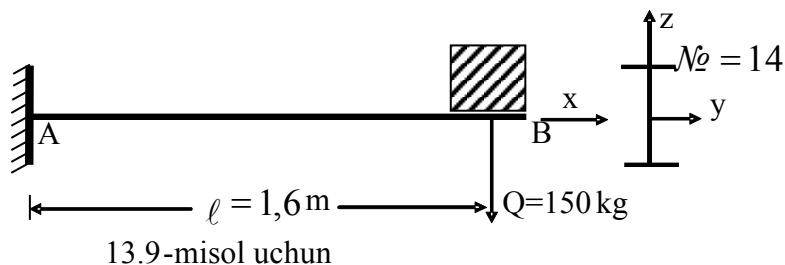
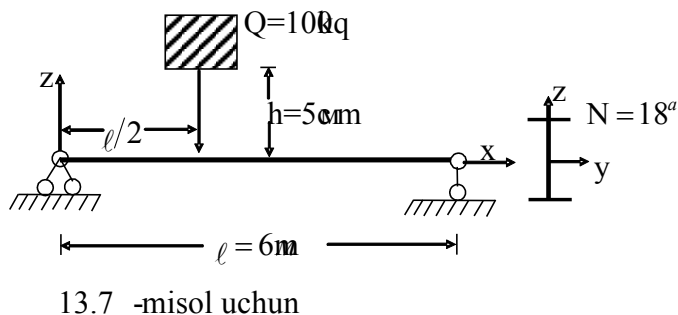
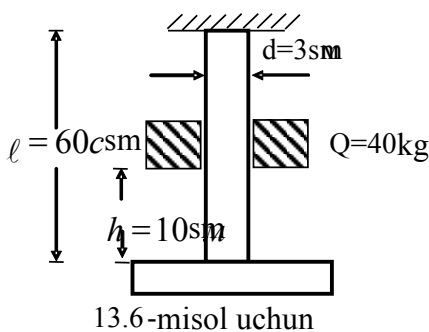
13.5 -misol uchun

13.5. Shaklda ko'rsatilgan po'lat stejen shakl tekisligiga tik A o'q atrofida tekis aylanadi. Undagi normal kuchlanish σ_n ga yetganda ω burchak tezlik aniqlansin. Kuchlanishning bu qiymatida sterjenning absalyut cho'zilishi aniqlansin. $\gamma = 7,85 \text{ g/sm}^3$, $E = 2 \cdot 10^6 \text{ kg/sm}^2$

Javobi : $\omega = 281 \text{ rad/sek.}$; $\Delta \ell = 0,053 \text{ sm}$

13.6. Shaklda ko'rsatilgan po'lat sterjen ko'ndalang kesimida Q yukning ta'siridan, Q yuk to'satdan ta'sir qilganda va u h balandlikdan diskaga tushganda hosil bo'ladigan bo'ylama cho'zuvchi zarbdan hosil bo'ladigan kuchlanishlar, sterjenning massasi hisobga olinmagan holda topilsin.

Javobi : $\sigma_{st1} = 5,65 \text{ kg/sm}^2$; $\sigma_{\theta} = 11,3 \text{ kg/sm}^2$; $\sigma'_{\theta} = 1944 \text{ kg/sm}^2$



13.7. Shaklda ko'rsatilgan balkaning xavfli ko'ndalang kesimidagi eng katta normal kuchlanish va salqilik balka massasini hisobga olmasdan va hisobga olib hisoblansin.

Javobi : $\sigma_{\delta} = 350 \text{ kg/sm}^2$; $\delta_{\delta} = f_{\delta} = 0,58 c$
 $\sigma_{\delta} = 304 \text{ kg/sm}^2$; $\delta_{\delta} = f_{\delta} = 0,506 c$

13.8. St.3 markali po'latdan yasalgan, ko'ndalang kesim yuzi $1 \times 1 \text{ sm}$ va uzunligi 1 m bo'lgan sterjenning kesimidagi cho'zuvchi zarbdan hosil bo'ladigan kuchlanish $\sigma_n = 2000 \text{ kg/sm}^2$ ga yetishi uchun $F = 100 \text{ kg}$ yuk qancha balandlikdan tushishi kerak ?

Javobi : $h = 0,9 \text{ sm}$.

13.9. Shaklda ko'rsatilgan konsolning erkin uchiga boshlang'ich tezligi nolga teng Q yuk to'satdan qo'yilgan. Balka erkin uchining salqiligi va qistirib mahkamlangan kesimining eng katta normal kuchlanishi hisoblansin.

Javobi: $f_b = 0,358 \text{ sm}$; $\sigma_a = 587 \text{ kg/sm}^2$

13.10. Shaklda ko'rsatilgan po'lat sterjenga h balandlikdan Q yuk tushadi. Sterjendagi eng katta siquvchi kuchlanish aniqlansin va bu kuchlanish $\sigma_n = 2000 \text{ kg/sm}^2$ dan oshmasligi uchun Q yuk qanday balandlikdan tushishi kerak. Masala sterjenning og'irligi hisobga olinmasdan yechilsin.

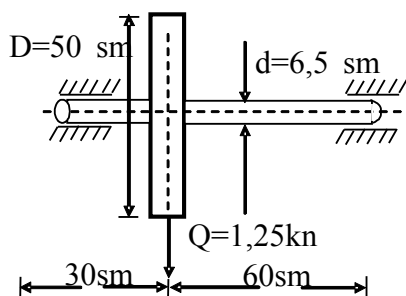
Javobi : $\sigma_{\delta} = 400 \text{ kg/sm}^2$; $h_1 = 250 \text{ sm}$

13.11. Shaklda ko'rsatilgan balkaning o'rtasiga minutiga 1200 marta aylanuvchi dvigatel o'rnatilgan. Agar balkaning erkin majburiy tebranish takrorligi 20% ortiq bo'lsa, uning uchun qo'shtavr kesim nomeri topilsin.

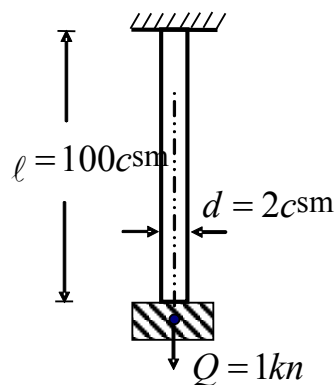
Javobi : qo'shtavr № 16.

13.12. Shaklda ko'rsatilgan konsolning bikrligi $E \cdot J = 22 \cdot 10^8 \text{ kg/sm}^2$ bo'lsa, uning o'z tebranish takrorligi topilsin.

Javobi : $\omega = 62,5 \text{ 1/sek}$.



13.14-misol uchun



13.15-misol uchun

13.13. Prujinaga bir-biriga teng ikkita yuk ilmoq yordamida osilgan va bu yuklarning birgalikdagi ta'sirida prujina 25 mm ga cho'ziladi. Agar yuklardan biri to'satdan olib tashlansa, qolgan yukning bo'ylama tebranish davri, eng katta tezligi va tebranishi topilsin.

Javobi : 0,224 sek ; 35 sm/sek; 981 sm / sek² .

13.14. Shaklda ko'rsatilgan valning xususiy ko'ndalang va aylangan tebranishlarining chastotasi topilsin.

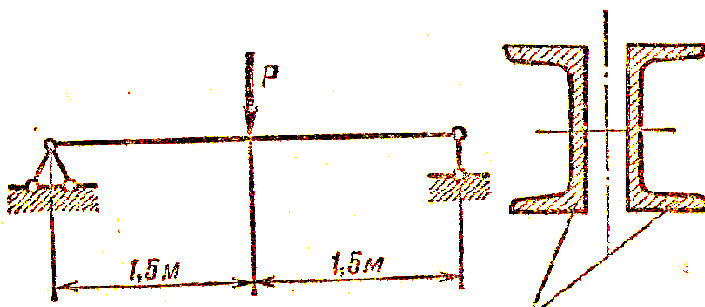
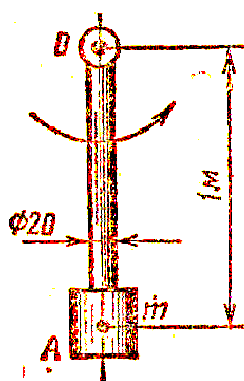
Javobi : $\omega_{0,ko'nd} = 125$ 1/sek ; $\omega_{0,ayl} = 200$ 1/sek

13.15. Shaklda ko'rsatilgan po'lat sterjenning o'z og'irligini hisobga olmasdan, uning tebranish takrorligi va davri aniqlansin.

Javobi : 785 1/sek ; 0,008 sek.

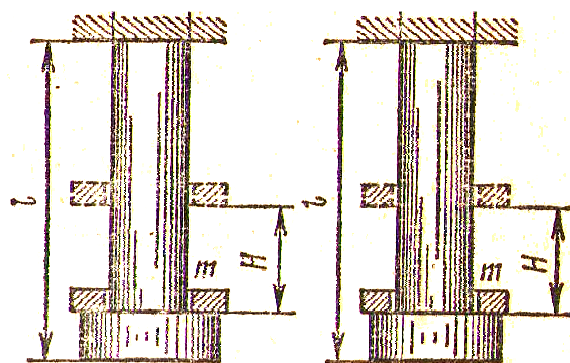
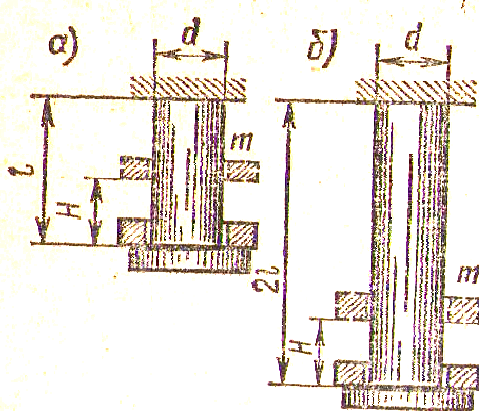
13.16. Shaklda ko'rsatilgan OA duralyumin sterjen vertikal tekislik bo'yicha O nuqta atrofida tekis harakatlanadi. Agar $\sigma_n = 4400 \text{ kg/sm}^2$ va $[\sigma] = 1200 \text{ kg/sm}^2$ bo'lsa, mumkin bo'lgan burchak tezligi va urilish vaqtdagi burchak tezligi topilsin. Sterjen massa hisobga olinmasin.

Javobi: 43,3 rad/sek (414 ayl/min); 83 rad/sek (794 ayl/man).



13.16-misol uchun.

13.17-misol uchun



13.18-misol uchun.

13.19-misol uchun

13.17. Shaklda ko'rsatilgan po'lat balkaning o'rtasiga tasodifan $P = 30 \text{ kn}$ qo'yilgan, agar $[\sigma] = 1400 \text{ kg/sm}^2$ bo'lsa, dinamik kuchlanish va balkaning salqiligi topilsin.

Javobi: $\sigma_d = 930 \text{ kg/sm}^2$; $f_d = 0,29 \text{ sm}$.

13.18. Shaklda ko'rsatilgan sterjenning qaysi birida yuk tushganda ko'proq kuchlanish hosil bo'ladi.

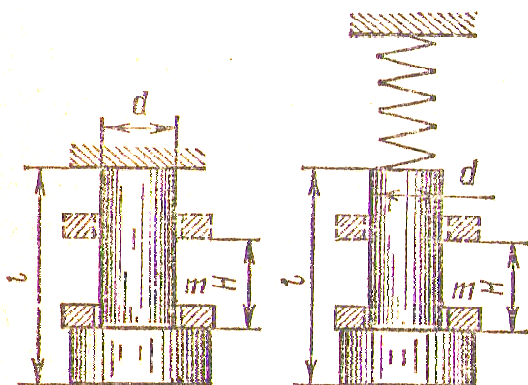
Javobi: a) variantda.

13.19. Shaklda ko'rsatilgan sterjenlarning qaysi birida yuk tushganda kamroq kuchlanish hosil bo'ladi.

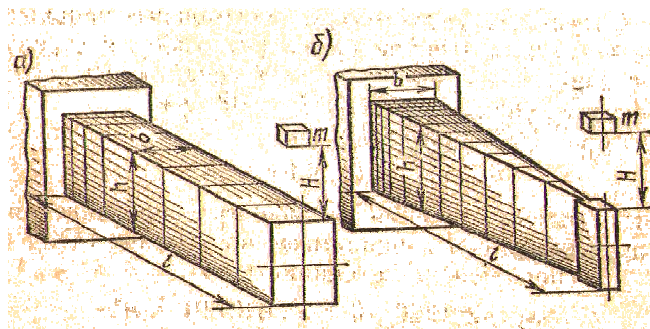
Javobi: Dyuralyumin sterjenda ya'ni ikkinchisida.

13.20. Shaklda ko'rsatilgan sterjenlarning qaysi birida kamroq dinamik kuchlanish hosil bo'ladi.

Javobi: Ikkinchi sterjenda.



13.20-misol uchun.



13.21-misol uchun

13.21. Shaklda ko'rsatilgan balkalarning qaysi birining qistirib mahkamlangan kesimida dinamik kuchlanish kamroq bo'ladi.

Javobi: b) variantda (1,8 ga kam bo'ladi).

