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CHO'ZILISH - SIQILISHDA STATIK ANIQ MASALALAR USTIDA AMALLAR BAJARISH

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Annotatsiya: Mazkur maqolada cho'zilish va siqilishda statik aniq masalalarni hal qilishning asosiy tamoyillari va metodlari ko'rib chiqiladi. Mualliflar statik kuchlanish taqsimotini aniqlash va kuchlanish o'zgarishlarining hisoblash amallarini bajarish bo'yicha nazariy hamda amaliy yondashuvlarni taqdim etishadi. Ishda cho'zilish va siqilish jarayonlarini modellashtirish, matematik hisoblashlarning aniqligini oshirish usullari va ular texnik amaliyotda qo'llanilishi haqida batafsil ma'lumot berilgan.

Kalit so'zlar: cho'zilish, siqilish, statik masalalar, mexanik kuchlanish, matematik, modellashtirish, texnik hisoblash.

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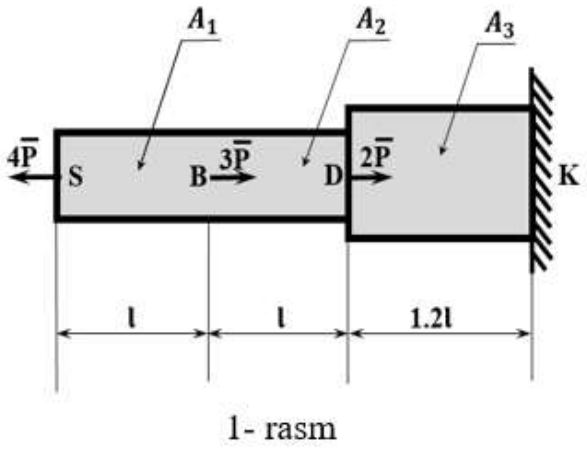
$P = 55kN$
$\ell = 0.3m$

$E = 2 \cdot 10^5 \frac{N}{mm^2}$

$[\sigma] = 72 \frac{N}{mm^2}$

$A = A_1 = A_2 = \frac{A_3}{2}$



1- rasm

Topish kerak ?

A =?

$\Delta\ell$ =?

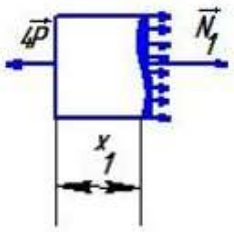
Π =?

Topilishi kerak

1. Kesish usulidan foydalanib N – bo'ylama kuchlarni hisoblash va epyurasini qurish,
2. Normal kuchlanishlarni hisoblash va epyurasini qurish,
3. Kesimda xosil bo'ladigan ko'chishlarni hisoblash va epyurasini qurish,
4. Cho'zilish – siqilish deformatsiyasining mustahkamlik shartidan foydalanib xavfli kesim ko'ndalang kesim yuzasini hisoblash,
5. Sterjenning bo'sh uchidagi ko'chishning son qiymatini hisoblash,
6. Sterjenning bo'sh uchidagi potensial energiyani xisoblanadi.

Yechish:

1. Sterjenni ixtiyoriy joyidan I-I vertikal tekislik bilan x_1 masofada fikran (xayolan) kesib olamiz va chap tomonini muvozanatda qaraymiz. (1.a – rasm)



1.a - rasm

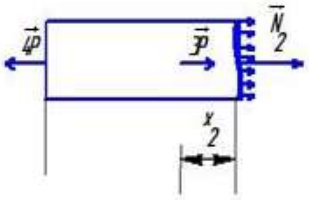
$0 \le x_1 \le \ell$,

Muvozanat tenglamasini tuzamiz.

$\sum F_{xi} = 0 \rightarrow -4P + N_1 = 0$

$N_1 = 4P$ (cho'zilish)

Ikkinchi uchastkani ham II-II vertikal tekislik bilan x_2 - masofada fikran kesib olamiz va chap tomonini muvozanatda qaraymiz. (1.b – rasm)



1.b - rasm

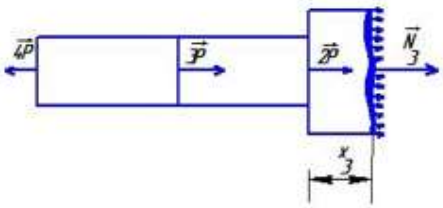
$0 \le x_2 \le \ell$,

$\sum F_{xi} = 0 \rightarrow$

$-4P + 3P + N_2 = 0$

$N_2 = P$ (cho'zilish)

Uchinchi uchastkani xam III-III vertikal tekislik bilan ixtiyoriy x_3 - masofada fikran kesib olamiz va chap tomonini muvozanatda qaraymiz.(1.d – rasm)



1.d - rasm

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$$0 \le x_3 \le 1.2\ell$$

$\sum F_{xi} = 0 \rightarrow -4P + 3P + 2P + N_3 = 0$

$N_3 = -P$ (siqilish).

Epyurani qurish uchun masshtab tanlaymiz, nollik chiziq o‘tkazamiz va ishorani qabul qilamiz.

Epyura $N -$ qurildi.

2. Normal kuchlanishlarni hisoblaymiz va epyurasini quramiz.

$$\sigma_1 = \frac{N_1}{A_1} = \frac{4P}{A} = 4\,\frac{P}{A}$$

$$\sigma_2 = \frac{N_2}{A_2} = \frac{P}{A}$$

$$\sigma_3 = \frac{N_3}{A_3} = -\frac{P}{2A} = -0{,}5\,\frac{P}{A}$$

Epyurani qurish uchun nollik chiziq o‘tkazamiz, masshtab tanlab olamiz va ishorani qabul qilamiz.

3. Ko‘chishlarni hisoblaganda K nuqtada ko‘chish nolga teng ekanligini inobatga olamiz, chunki K - qo‘zg‘almas nuqta, qolgan kesimlardagi ko‘chishlarni shu nuqtaga nisbatan hisoblaymiz, demak ko‘chishni o‘ng tomondan boshlab hisoblaymiz.

Guk qonuniga binoan.

$$\Delta\ell_3(x_3) = \frac{N_3 x_3}{EA_3}$$

$$(0 \le x_3 \le 1.2\ell)$$

$$x_3 = 0 \rightarrow \Delta\ell_3(0) = \frac{P \cdot 0}{E \cdot 2A} = 0 = \Delta\ell_K$$

$$x_3 = 1.2\ell \rightarrow \Delta\ell_3(1.2\ell) = \frac{-P1.2\ell}{E \cdot 2A} = -0.6\frac{P\ell}{EA} = \Delta\ell_D$$

$$\Delta\ell_2(x_2) = \Delta\ell_D + \frac{N_2 x_2}{E \cdot A_2}$$

$(0 \le x_2 \le \ell)$

$$x_2 = 0 \rightarrow \Delta\ell_2(0) = -0{,}6\frac{\mathrm{P}\ell}{EA} + \frac{\mathrm{P}\cdot 0}{E\cdot A} = -0{,}6\frac{\mathrm{P}\ell}{EA} = \Delta\ell_{\mathrm{D}}$$

$$x_2 = \ell \rightarrow \Delta\ell_2(\ell) = -0{,}6\frac{\mathrm{P}\ell}{EA} + \frac{\mathrm{P}\cdot \ell}{E\cdot A} = 0.4\frac{\mathrm{P}\ell}{EA} = \Delta\ell_{\boldsymbol{B}}$$

$$\Delta\ell_1(x_1) = \Delta\ell_{\mathrm{D}} + \frac{\mathrm{N}_1 x_1}{EA_1}$$

$(0 \le x_1 \le \ell)$

$$x_1 = 0 \rightarrow \Delta\ell_1(0) = \Delta\ell_{\mathrm{B}} + \frac{4\mathrm{P}\cdot 0}{E\cdot A} = \Delta\ell_{\mathrm{B}} = 0.4\frac{\mathrm{P}\ell}{EA}$$

$$x_1 = \ell \rightarrow \Delta\ell_1(\ell) = \Delta\ell_{\mathrm{B}} + \frac{4\mathrm{P}\cdot \ell}{E\cdot A} = 0.4\frac{\mathrm{P}\ell}{EA} + \frac{4\mathrm{P}\cdot \ell}{E\cdot A} = 4.4\frac{\mathrm{P}\ell}{EA} = \Delta\ell_s$$

Ko‘chishning epyurasini qurish uchun masshtab tanlab olinadi, nollik (neytral) chiziq o‘tkaziladi va ishorasi qabul qilinadi.

4. Xavfli kesim 1- uchastka kesimida eng katta normal kuchlanish bo'lganligi uchun, kesim yuzasi doira bo'lgan sterjen ko'ndalang kesimining yuzasi geometrik harakteristikasi o'rnatiladi.

$$\sigma_{\max} = \sigma_1 = 4\frac{\mathrm{P}}{A} \le [\sigma]$$

Tengsizlikning o‘ng tomonidan.

$$A \ge \frac{4\mathrm{P}}{[\sigma]} \ge \frac{4\cdot 55\cdot 10^3\, N}{72\frac{N}{mm^2}} \ge \frac{220\cdot 10^3}{72} \ge 3050\ mm^2$$

Ko‘ndalang kesim yuzasi doiradan iborat deb qarab.

$$A = \frac{\pi d^2}{4} \ge 3050\ mm^2$$

$$d \ge \sqrt{\frac{4\cdot 3050}{\pi}} \ge \sqrt{3885}\ \mathrm{mm} \ge 62.3mm$$

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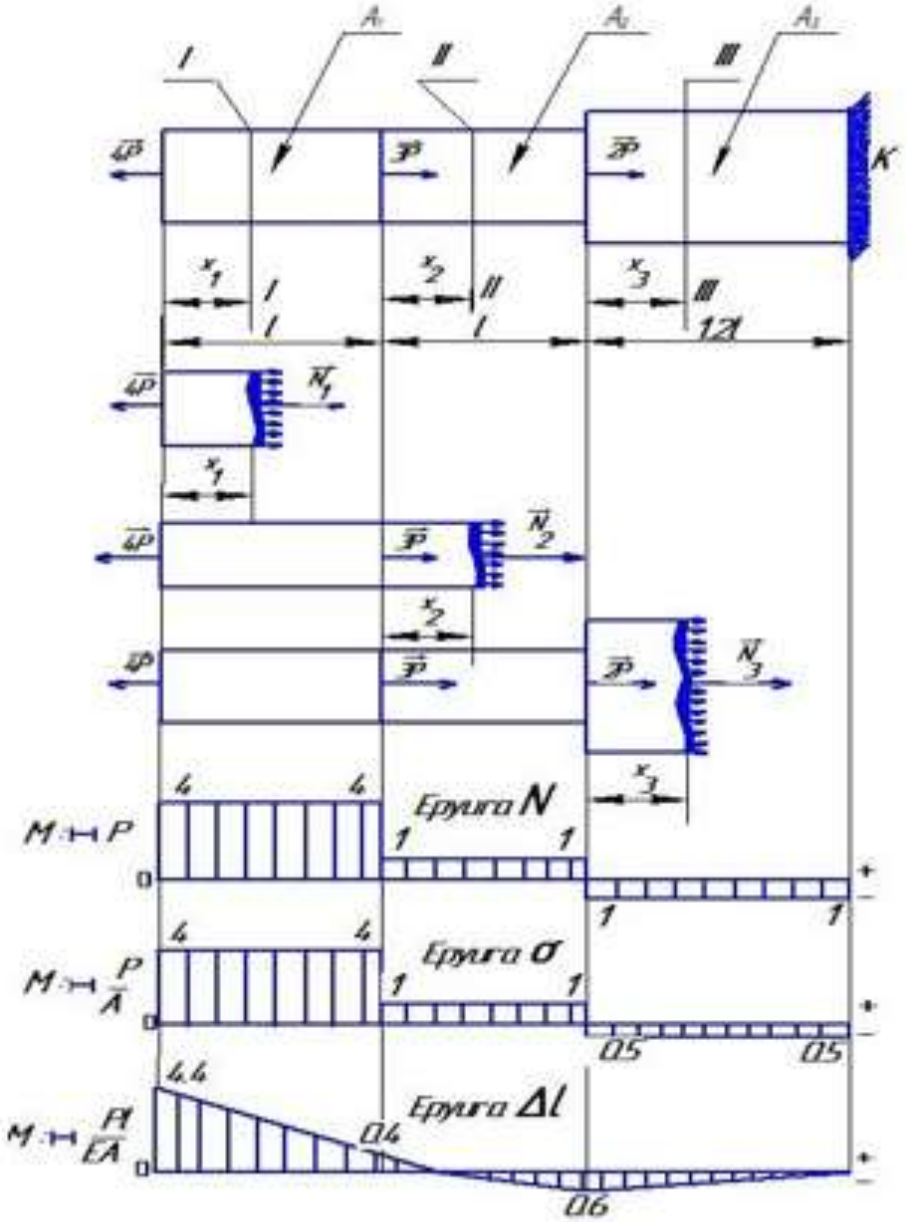

1.e - rasm

Sterjenning diametrini tanlashda jadvaldan GOST bo'yicha 5 ga karrali son olamiz, amalda keyingi kursda, "Mashina detallari" fanidan kurs loyihasini amalga oshirganda, valning aniq hisobida diametri 5 ga karrali son olinadi, chunki val o'rnatiladigan podshipnikning markasida qo'yilgan yukning qiymatiga qarab, zo'ldorli yoki rolikli bo'lishiga qaramasdan ichki diametri 5 ga karrali son bo'ladi.

Demak,

$d = 65mm$

Sterjenning haqiqiy ko'ndalang kesim yuzasi

$$A = \frac{\pi d^2}{4} = \frac{3.14 \cdot 65^2}{4} = 3316\ mm^2$$

Keyingi hisoblashlarda ushbu yuzani valning kesim yuzasi deb aytilganda, val uchun epyuralar qurilganda, uning xavfsizlik koefitsiyentini tanlaganda tushunmovchilik kelib chiqmaslik uchun yuqoridagi so'zlar takrorlandi.

5. Sterjenning bo'sh uchidagi bajariladigan ko'chish sonini hisoblaymiz.

(1.e - rasm)

$$\Delta\ell_1(\ell) = 4.4\frac{P\ell}{EA} = 4.4 \cdot \frac{55 \cdot 10^3 N \cdot 0.3 \cdot 10^3 mm}{2 \cdot 10^5 \frac{N}{mm^2} \cdot 3316 mm^2} = 0{,}1mm$$

6. Sterjenning bo'sh uchidagi bajariladigan ish yoki potensial energiyani hisoblaymiz.(1.e - rasm)

$$\Pi = \frac{{N_1}^2 \cdot \ell}{2EA} = \frac{(4 \cdot 55 \cdot 10^3 N)^2 \cdot 0{,}3 \cdot 10^3 mm}{2 \cdot 2 \cdot 10^5 \frac{N}{mm^2} \cdot 3316 mm^2} = \frac{(22)^2 \cdot 10^8 \cdot 0{,}3 \cdot 10^3}{13264 \cdot 10^5} =$$

$= 0{,}1090 \cdot 10^5 Nmm = 10{,}9\ Nm = 11$J ish bajarildi.

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