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CHO‘ZILISH - SIQILISHDA STATIK ANIQ VA NOANIQ MASALALAR

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Annotatsiya: Ushbu maqolada cho‘zilish va siqilish holatlarida statik aniq va noaniq masalalarni tahlil qilishga alohida e’tibor qaratilgan. Masalalarni yechish jarayonida materiallar qarshiligi, deformatsion xususiyatlari va mexanik tenglamalar asosida nazariy va amaliy usullar qo‘llanilgan. Tadqiqot natijalari cho‘zilish va siqilish jarayonlaridagi deformatsiyalarni aniqlash uchun zarur bo‘lgan nazariy ma’lumotlar va amaliy dasturlarni taqdim etadi.

Kalit so‘zlar: Statik aniq masalalar,Statik noaniq masalalar, Cho‘zilish, Siqilish, Materiallar qarshiligi, Deformatsiya, Mexanik tenglamalar.

Bir xil materialdan yasalgan sterjenga quyidagi kattaliklar berilgan $P; \ell; E; [\sigma]$

P –Tashqi yig’ilgan kuch, $[N]$

ℓ – Qism uzunligi, $[m]$

A – Ko’ndalang kesim yuzasi, $[m^2]$

E – Elastiklik moduli materialning turiga bog’liq GOST bo’yicha qo’llanmalardan olinadi, $\left[\frac{N}{m^2}\right]$

$[\sigma]$ – normal kuchlanishning ruhsat etilgan qiymati materialning turiga bog'liq, GOST bo'yicha qo'llanmalardan olinadi, $\left[\frac{N}{m^2}\right]$

Topish kerak ?

A =?

$\Delta\ell$ =?

Π =?

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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:

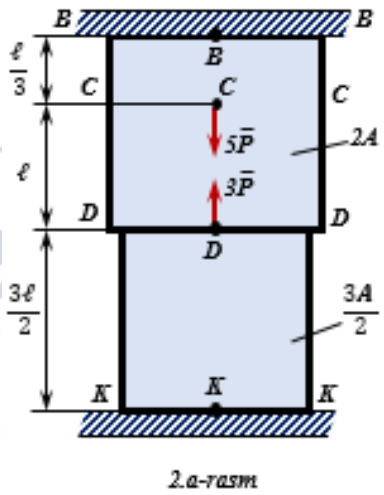
Asosiy shart B-B, K-K kesimlarda ko’chishlar

$$\Delta\ell_b = \ell_k = 0 \quad \text{(2.a - rasm)}$$

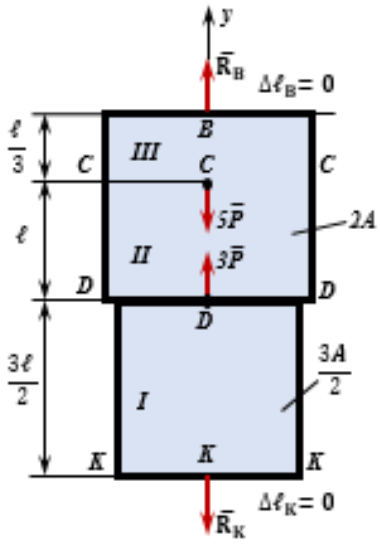
B-B, K-K kesimlarda sterjenni bog’lanishlardan ozod etib, ularni tayanch reaksiya kuchlari bilan almashtiramiz. (2.b - rasm). Masala boshida tayanch reaksiya kuchlari yo’nalishlari ixtiyoriy olinadi. Muvozanat tenglamasini tuzamiz,

$$\sum F_{iy} = 0 \rightarrow R_B - 5P + 3P - R_K = 0 \qquad (1)$$

Tekislikda ixtiyoriy joylashgan kuchlar sistemasining muvozanat shartiga ko'ra, tuziladigan qolgan ikki tenglama, tuzilish imkoni bo'lmaganligi, deformatsiya kattaligidan foydalanib qo'shimcha tenglama tuzamiz va masalani statik aniq holatga keltiramiz. Deformatsiyalardan foydalanishda B va K nuqtalarda ko'chish nolga tengligini e'tiborga olamiz.



2.a-rasm



2.b-rasm

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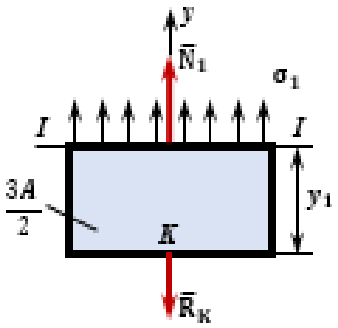
Tenglamada ikkita noma'lum R_K va R_B reaksiya kuchlari, tenglama bitta, demak masala bir marta statik noaniq. Masalani yechish uchun qo'shimcha tenglama tuzish kerak. Buning uchun kesish usulidan foydalanib, deformatsiyalar xisoblanadi, xisoblashni quyi tomondan boshlaymiz, (2.d - rasm).

Sterjenning uchastkalarga I; II; III – ajratamiz va I uchastkani I-I gorizontal tekislik bilan fikran kesib olamiz, past tomonini muvozanatda qaraymiz $N_1 -$ bo'ylama kuchga ega bo'lamiz va muvozanat tenglamasidan $N_1 -$ topamiz.



2.d-rasm

$N_1 - R_K = 0$ ifodadan

$N_1 = R_K$ oldik

Endi normal kuchlanish: $\sigma_1 = \frac{N_1}{A_1} = \frac{R_K}{\frac{3A}{2}} = \frac{2R_K}{3A}$

Guk qonuniga binoan: $\Delta\ell_1(y_1) = \frac{N_1 \cdot y_1}{EA_1}$;

$(0 \le y_1 \le \frac{3\ell}{2})$ oraliqda o'zgaradi.

$$y_1 = 0 \to \Delta\ell_1(0) = \frac{R_K \cdot 0}{\frac{E \cdot 3A}{2}} = 0 = \Delta\ell_K$$

$$y_1 = \frac{3\ell}{2} \to \Delta\ell_1\left(\frac{3\ell}{2}\right) = \frac{R_K \cdot \frac{3\ell}{2}}{\frac{E \cdot 3A}{2}} = \frac{R_K \cdot \ell}{EA} = \Delta\ell_D$$

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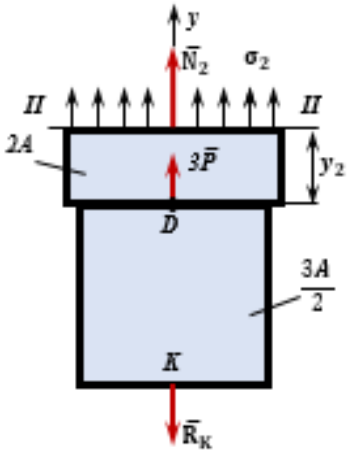
Ikkinchi uchastkani II-II gorizontal tekislik bilan fikran kesib olib pastki tomonini muvozanatda qaraymiz va N_2 – bo’ylama kuchni olamiz, (2.e - rasm)



2.e-rasm

$$\sum F_{iy} = 0 \rightarrow N_2 = R_K - 3P = 0$$

Normal kuchlanish: $\sigma_2 = \frac{N_2}{A_2} = \frac{R_K - 3P}{2A}$

Ikkinchi uchastkadagi ko’chish: $\Delta\ell_2(y_2) = \Delta\ell_D + \frac{N_2 \cdot y_2}{EA_2}$;

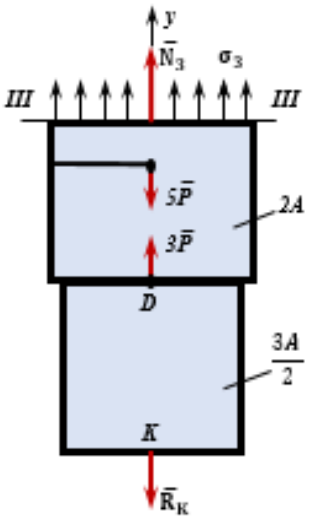
$(0 \le y_2 \le \ell)$ o’zgaradi

$$y_2 = 0 \rightarrow \Delta\ell_2(0) = \Delta\ell_D + \frac{(R_K - 3P)\cdot 0}{EA_2} = \Delta\ell_D = \frac{R_K \cdot \ell}{EA}$$

$$y_2 = \ell \rightarrow \Delta\ell_2(\ell) = \Delta\ell_D + \frac{(R_K - 3P)\cdot \ell}{EA_2}$$

$$\Delta\ell_c = \frac{R_K \cdot (2-\ell) - 3\ell P}{2EA}$$

Uchinchi uchastkani xam III-III gorizantal tekslik bilan fikran kesib olamiz va past tomonini muvozanatda qaraymiz va N_3 – ga ega bo’lamiz. (2.f - rasm)



2.f-rasm

$$\sum F_{iy} = 0 \rightarrow N_3 - 5P + 3P - R_K = 0;$$

$$N_3 = R_K + 2P$$

Normal kuchlanish: $\sigma_3 = \frac{N_3}{A_3} = \frac{R_K+2P}{2A}$

Guk qonuniga asosan ko'chish

$$\Delta\ell_3(y_3) = \Delta\ell_c + \frac{N_3 \cdot y_3}{EA_3} = \frac{(R_K + 2P) \cdot y_3}{2EA} + \Delta\ell_c$$

$(0 \le y_3 \le \frac{\ell}{3})$ o'zgaradi

$$y_3 = 0 \rightarrow \Delta\ell_3(0) = \Delta\ell_c + \frac{(R_K + 2P) \cdot 0}{2EA} = \Delta\ell_c = \frac{R_K(2-\ell) - 3\ell P}{2EA}$$

$$y_3 = \frac{\ell}{3} \rightarrow \Delta\ell_3\left(\frac{\ell}{3}\right) = \Delta\ell_c + \frac{(R_K + 2P) \cdot \frac{\ell}{3}}{2EA} =$$

$$= \frac{R_K(2-\ell) - 3\ell P}{2EA} + \frac{(R_K + 2P) \cdot \frac{\ell}{3}}{2EA} = \frac{2R_K(3-\ell) - 7\ell P}{6EA} = \Delta\ell_B$$

$$\Delta\ell_B = 0$$

Boshlang'ich asosiy shartdan foydalanib $R_K -$ ni topamiz.

$\frac{2R_K(3-\ell)-7\ell P}{6EA} = 0$;

Demak $R_K = P \cdot \frac{7\ell}{2(3-\ell)}$

Musbat ishora tayanch reaksiya yo'nalishi to'g'ri tanlanganini bildiradi. (1) Tenglamaga murojat qilib $R_B -$ ni topamiz.

$$R_B = P \cdot \frac{6 + 2\ell}{3 - \ell}$$

Cho'zilish siqilish deformatsiyasining mustahkamlik shartidan foydalanib, kesim yuzasi doira bo'lgan sterjenning A – ko'ndalang kesim yuzasini topamiz:

$\sigma_{max} \leq [\sigma]$ bo'lishi kerak, bizning misolimizda epyuradan.

$$\sigma_{max} = \sigma_3 = \frac{R_k + 2P}{2A} \leq [\sigma]$$

olinadi.

$A \geq \frac{3P(\ell+4)}{4(3-\ell)\cdot[\sigma]}$ kelib chiqadi.

Shart saqlangan holda kesim yuzasi masalaning qo'yilishiga qarab qo'shtavr, shveller shakllaridan biri, GOST 8239 – 72* qo'shtavr, GOST 8240 – 72* shveller kesim yuzalari profil raqami IV, V-ilovalar bo'yicha tanlanadi. Masalaning keyingi bosqichlari va epyuralar qurishlar, statik aniq pog'onali sterjenlarini hisoblash kabi davom ettiriladi.

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