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BALKANING NOSIMMETRIK EGILISHI TAHLILI

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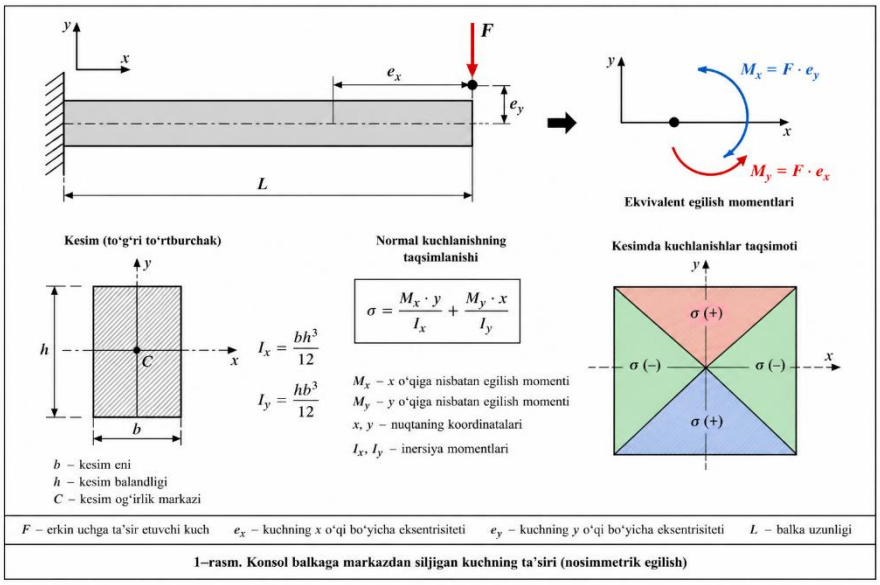
Annotatsiya: Tadqiqot ishida balkaning nosimmetrik egilishi jarayoni o'rganilgan. Nosimmetrik yuklanish natijasida yuzaga keladigan ikki o'q bo'yicha egilish holati analitik usulda tahlil qilindi. Egilish momentlari, inersiya momentlari va kuchlanishlarning taqsimlanishi ko'rib chiqildi. Olingan natijalar asosida balkalarda nosimmetrik yuklanishni hisobga olish konstruktsiya mustahkamligi uchun muhim ekanligi ko'rsatildi.

Kalit so'zlar: nosimmetrik egilish, balka, egilish momenti, inersiya momenti, neytral o'q, kuchlanish

Kirish. Balkalar qurilish va mashinasozlikda eng ko'p qo'llaniladigan elementlardan biridir. Ularning deformatsiyasi yuklanish turiga bog'liq holda o'zgaradi. Agar yuk balka kesimining markaziy o'qi bo'yicha ta'sir etsa, oddiy egilish yuzaga keladi. Ammo amaliyotda ko'pincha yuk markazdan chetda qo'yiladi yoki kesim nosimmetrik bo'ladi.

Bunday holatda **nosimmetrik egilish** yuzaga keladi va bu oddiy egilishdan farqli ravishda murakkab hisoblanadi. Ushbu maqolada aynan shu jarayon nazariy va amaliy jihatdan o'rganiladi.

Masalaning qo'yilishi. Uzunligi L bo'lgan, bir uchi mahkamlangan (konsol) to'g'ri balkani qaraymiz. Balkaga erkin uchida markazdan siljigan nuqtaviy kuch F ta'sir etadi. Kuch kesim og'irlik markazidan quyidagi masofalarga siljigan: e_x - x o'qi bo'yicha eksentrisitet , e_y — y o'qi bo'yicha eksentrisitet .Balka kesimi to'g'ri to'rtburchak shaklida bo'lib, uning o'lchamlari eni b ,balandligi h . Koordinata tizimi kesim markazidan o'tkazilgan bo'lib x o'qi gorizontal , y o'qi vertikal . Kuchning markazdan siljib qo'yilishi natijasida balkada ikki o'q bo'yicha egilish momentlari hosil bo'ladi M_x — x o'qiga nisbatan , M_y — y o'qiga nisbatan



1–rasm. Konsol balkaga markazdan siljigan kuchning ta'siri (nosimmetrik egilish)

$$M_x = Fe_y \quad , \quad M_x = Fe_y \quad (1)$$

Natijada balkada **nosimmetrik egilish** yuzaga keladi.

Masalaning yechilishi. Asosiy farazlar (model qurish) . Elastik balka uchun quyidagi klassik farazlar qabul qilinadi material Hook qonuniga bo'ysunadi , deformatsiyalar kichik , kesim tekisligi deformatsiyadan keyin ham tekis qoladi , siljishlar uzluksiz . Shuning uchun: $\sigma \propto \varepsilon$

Balkaning egilishi natijasida**:**

$$\varepsilon_x = -y\frac{\partial^2\omega}{\partial x^2} \quad \varepsilon_y = -x\frac{\partial^2\omega}{\partial y^2}$$

Hook qonuni (3D ko'rinishi)

$$\sigma_x = E\varepsilon_x, \sigma_y = E\varepsilon_y$$

Shundan:

$$\sigma_x = -Ey\frac{\partial^2\omega}{\partial x^2}, \sigma_x = -Ex\frac{\partial^2\omega}{\partial y^2}$$

Normal kuchlanishdan moment:

$$M_x = \int_A \sigma_x y \mathrm{d}A$$

$$M_x = \int_A (-Ey\frac{\partial^2\omega}{\partial x^2})y\mathrm{d}A$$

$$M_x = -E\frac{\partial^2\omega}{\partial x^2}\int_A y^2\mathrm{d}A$$

Inertsiya momentini kelib chiqishi

$$I_x = \int_A y^2\mathrm{d}A$$

$$M_y = -EI_y\frac{\partial^2\omega}{\partial y^2}$$

Umumiy moment yig'indisi

$$M = M_x + M_y$$

$$M = -EI_x\frac{\partial^2\omega}{\partial x^2} - EI_y\frac{\partial^2\omega}{\partial y^2}$$

$$EI_x\frac{\partial^2\omega}{\partial x^2} + EI_y\frac{\partial^2\omega}{\partial y^2} + M = 0$$

Agar yuk taqsimlangan bo'lsa

$$M \to q(x,y)$$

$$EI_x\frac{\partial^2\omega}{\partial x^2} + EI_y\frac{\partial^2\omega}{\partial y^2} = q(x,y)$$

Yechimni shunday faraz qilamiz:

$$\omega(x,y) = X(x)Y(y)$$

$$\frac{\partial^4\omega}{\partial x^4} = Y\frac{d^4X}{dx^4}$$

$$\frac{\partial^4\omega}{\partial y^4} = X\frac{d^4Y}{dy^4}$$

$$EI_xY\frac{d^4X}{dx^4} + EI_yX\frac{d^4Y}{dy^4} = q(x,y)$$

$$\frac{1}{X}\frac{d^4X}{dx^4} + \frac{1}{Y}\frac{d^4Y}{dy^4} = \lambda$$

$$r^4 - \lambda = 0$$

$$X(x) = Asin(kx) + Bcos(kx) + Csinh(kx) + Dcosh(kx)$$

Konsol balka uchun:

$$\omega(0,y) = 0, \frac{\partial\omega}{\partial x}(0,y) = 0$$

$$\int_0^L X_m(x)X_n(x)\,dx = 0, \quad m \neq n$$

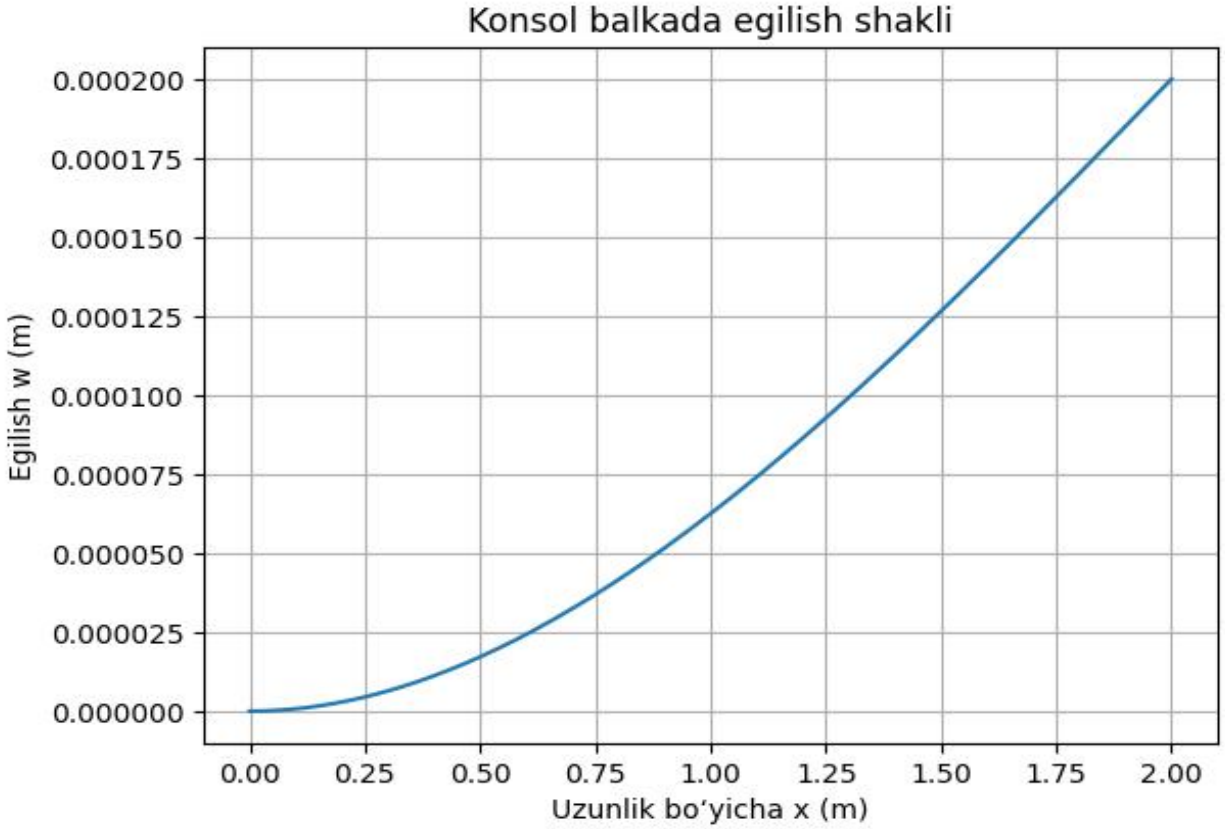
$$\int_0^L X_n^2(x)\,dx = 1$$

$$\omega(x,y,t) = \sum_{m=1}^{\infty}\sum_{n=1}^{\infty} A_{mn} sin\left(\frac{m\pi x}{L}\right) \sin\left(\frac{n\pi x}{h}\right) e^{i\omega_{mn}t}$$

$$\sigma(x,y) = \frac{M_x y}{I_x} + \frac{M_y x}{I_y}$$

Olingan natijalar . Yuqorida keltirib chiqarilgan formulalar asosida hisob dasturi tuzildi, olingan sonli natijalar grafik shaklida tasvirlandi, shular asosida suyuqlik bilan qisman to'ldirilgan qobiqning tebranishlari tahlil qilindi.

2-chizmada $F = 1000N$, $e_x = 0.02m$, $I_y = 0.03m$, $b = 0.1\,m$, $h = 0.2\,m$, $x = 0.05\,m$, $y = 0.1\,m$ koordinatadan bog'liq o'zgarish grafigi tasvirlangan



2-rasm

Xulosalar. Mazkur tadqiqot ishida balkaning nosimmetrik egilishi jarayoni nazariy jihatdan tahlil qilindi. Ko'rsatildiki, yukning kesim og'irlik markazidan siljib qo'yilishi natijasida balkada ikki o'q bo'yicha egilish momentlari hosil bo'ladi va bu esa kuchlanishlarning murakkab taqsimlanishiga olib keladi . Tahlil natijalari shuni ko'rsatadiki, nosimmetrik egilish holatini hisobga olmaslik konstruktsiyaning mustahkamligi va ishonchliligiga salbiy ta'sir ko'rsatishi mumkin. Shuning uchun muhandislik hisoblarida eksentrisitet va kesim geometriyasini inobatga olish muhim ahamiyatga ega.

Foydalanilgan adabiyotlar ro'yxati

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