UCH QATLAMLI KOMPOZIT TO‘G‘RI TO‘RTBURCHAK PLASTINKANING ERKIN TEBRANISH JARAYONIDAGI BIRLAMCHI XOS CHASTOTASINI HISOBLASH

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Annotatsiya. *Bu ishda to‘rtburchakli uch qavatli plastinkani erkin tebranishini ko‘rib chiqiladi. Plastinkaning to‘rtta burchaklari qo‘zg‘almas sharnir bilan mahkamlangan bo‘lsin deb olingan. Plastinkaning tebranishlar tenglamasi variatsion prinsip asosida olingan. Olingan tebranishlar tenglamasi analitik yechilib sonli natijalar olingan. Ishlab chiqilgan metodika asosida olingan sonli natijalar dasturiy ta’minot asosida olingan natijalar bilan solishtirilgan.*

Kalit so‘zlar: *plastinka, erkin tebranish, sharnirli tayanch, variatsion prinsip, chastota*.

Plastinkani biror burchaklaridan birida biz OXY dekart koordinatalar sistemasini joylashtiramiz. O‘lchamlari OX va OY o‘qlari bo‘ylab plastinkani mos ravishda a va b deb belgilangan tomonlarda yotadi. To‘rtburchakli uch qavatli plastinkani erkin egilishdagi tebranishlarining variatsion tenglamasi ikkinchi bobdan kelib chiqsak quyidagicha bo‘ladi.Normalni buralishini ham hisobga olsak variatsion tenglama quyidagicha bo‘ladi [1, 2]

$$\int_0^a\int_0^b L\delta w dxdy - \int_0^b [Q_x\delta w]_0^a dy - \int_0^a [Q_y\delta w]_0^b dx = 0$$

$$\int_0^a\int_0^b L_x\delta\theta_x dxdy - \int_0^b [M_x\delta\theta_x]_0^a dy - \int_0^a [M_{xy}\delta\theta_x]_0^b dx = 0 \quad (1)$$

$$\int_0^a\int_0^b L_y\delta\theta_y dxdy - \int_0^b [M_{xy}\delta\theta_y]_0^a dy - \int_0^a [M_y\delta\theta_y]_0^b dx = 0$$

$$L = K_x\frac{\partial^2 w}{\partial x^2} + K_y\frac{\partial^2 w}{\partial y^2} + K_x\frac{\partial\theta_x}{\partial x} + K_x\frac{\partial\theta_y}{\partial y} + B_\rho\omega^2 w$$

bunda

$$L_x = -K_x \frac{\partial w}{\partial x} + D_{11}\frac{\partial^2 \theta_x}{\partial x^2} + D_{33}\frac{\partial^2 \theta_x}{\partial y^2} - K_x\theta_x + \left(D_{12} + D_{33}\right)\frac{\partial^2 \theta_y}{\partial x \partial y}$$

$$L_y = -K_y \frac{\partial w}{\partial y} + D_{22}\frac{\partial^2 \theta_y}{\partial y^2} + D_{33}\frac{\partial^2 \theta_y}{\partial x^2} - K_x\theta_x + \left(D_{12} + D_{33}\right)\frac{\partial^2 \theta_x}{\partial x \partial y}$$

$$Q_x = K_x\left(\theta_x + \frac{\partial w}{\partial x}\right),\ \ Q_y = K_y\left(\theta_y + \frac{\partial w}{\partial y}\right)$$

Uch qatlamli plastinkaning asosiy chastotasini aniqlashning samarali usuli Galyorkinning taqribiy usulini qo‘llashdan iborat. Buning uchun salqilik $w(x,y),\ \theta_x(x,y),\ \theta_y(x,y)$ - analitik ko‘rinishdagi ifodalar bilan almashtirib olinadi OX, OY o‘qlari bo‘ylab:

$$w = AU_x + BU_y + CU_xU_y,\ \ \theta_x = DV_x + PV_xU_y,\quad \theta_y = FV_y + TU_xV_y \qquad (2)$$

bu yerda A,B,C,D,F,P,T – noma’lum kattaliklar; $U_x,\ V_x,\ U_y,\ V_y$ - approksimatsiya qilingan funksiyalar bo‘lib , quyidagi ko‘rinishlarga ega

$$U_x(x) = \sin\lambda_1 x,\ V_x(x) = \cos\lambda_1 x,\ U_y(y) = \sin\lambda_2 x,\ V_y(y) = \cos\lambda_2 x,\ \lambda_1 = \pi/a,\ \lambda_2 = \pi/b$$

Oxirgi olingan funksiyalar variatsiyasi quyidagicha bo‘ladi:

$$\delta w = U_x\delta A + U_y\delta B_y + U_xU_y\delta C,\ \ \delta\theta_x = V_x\delta D + V_xU_y\delta P,\ \ \delta\theta_y = V_y\delta F + U_xV_y\delta T \qquad (3)$$

Ular bir jinsli algebraik tenglamalar sistemasini tashkil etadi. Bir jinsli algebraik tenglamalar sistemasi trivial bo‘lmagan yechimga ega bo‘lishi uchun asosiy aniqlovchisi nolga teng bo‘lishi kerak. Bundan quyidagicha kubik tenglamani olamiz [3]:

$$\gamma_3\Omega^3 + \gamma_2\Omega^2 + \gamma_1\Omega + \gamma_0 = 0$$

Agar qovushoq elastik mexanik sistema o‘rganilsa, u holda kubik tenglama hadlari oldidagi koeffitsiyentlar $\gamma_0(\omega_R),\ \gamma_1(\omega_R),\ \gamma_2(\omega_R),\ \gamma_3(\omega_R)$ chastotani haqiqiy qismiga bog‘liq bo‘ladi. Bu yerda $\Omega = \omega^2$, $\omega = 2\pi f$ f - chastota. Bu ishlab chiqqan metodika bo‘yicha birinchi asosiy chastota topiladi:

$$f = \frac{1}{2\pi}\sqrt{\frac{\sqrt[3]{12\gamma_3\left(3\gamma_1\gamma_2 - 9\gamma_0\gamma_3 + \sqrt{\left(12\gamma_1^3\gamma_3 - 3\gamma_1^2\gamma_2^2 - 54\gamma_3\gamma_2\gamma_1\gamma_0 = 81\gamma_0^2\gamma_3^2 + 12\gamma_2^3\gamma_0\right)}\right)} - 8\gamma_2^2}{16\gamma_3\left(12\gamma_1\gamma_3 + 4\gamma_2^2 - 2\gamma_2\right)} - \frac{1}{2\gamma_3}}$$

Uch qatlamli qovushoq – elastik to‘rtburchakli turli xil o‘lchamdagi va qalinlikdagi plastinkalarni asosiy chastotasini topish bilan shug‘ullanamiz. Tashqi qatlamli plastinkalarni parametrlari quyidagicha:

$$E_x = 50GPA,\ E_y = 50GPA,\ G_{xy} = 21GPA,\ G_{xz} = G_{yz} = 4GPA,\ \nu_{xy} = \nu_{yx} = 0.30,\ \rho = 1500kg/m^3$$

To‘ldiruvchini fiziko–mexanik xususiyati quyidagicha:

$$G_{xy} = 400GPA,\ G_{yz} = G_{yz} = 220GPA,\ \rho = 83kg/m^3$$

Plastinkaning o‘lchamlari quyidagicha $b = 1m,\ a = 0.5;\ 1;2m$.

1 –jadval.

Asosiy chastotani qalinligiga bog'liq o'zgarishi

h_0,м	h_z(a=1, b=2)	h_z(a=1, b=2)	h_z(a=1, b=2)	h_z(a=1, b=2)	h_z(a=1, b=2)	h_z(a=1, b=2)
	0.01м	0.05м	0.1м	0.01м	0.05м	0.1м
0.002	35,40323	115,8264	176,7201	29,7564	87,9423	146,0646
0.004	41,46511	150,1305	251,4235	32,8465	114,3162	178,0835

Tashqi qatlam qalinligi h quyidagicha 0.001 va 0.002, to'ldiruvchini qalinligi 0.01,0.05,0.1m. Relaksatsiya yadrosi: $R_k\left(t\right)=A_k e^{-\beta_k t}/t^{1-\alpha_k}$. Bu yadroning parametrlari $A=0,048$, $\beta=0,05$ va $\alpha=0,1$ ga teng. Olingan sonli natijalar 1 jadvallarda keltirilgan [3]. Ko'rinib turibdiki ikki dasturiy ta'minot asosida olingan chastotalarni xaqiqiy qisimlari orasidagi farq 15% farq bilan ustma ust tushar ekan. Bu ABACUS dasturiy ta'minotini sonli yechish usuliga asoslanganligi bilan izohlanadi.

Foydalanilgan adabiyotlar

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