MURAKKAB KONSTRUKTIV SHAKLDAGI YUPQA MAGNITELASTIK PLASTINALARNING GEOMETRIK NOCHIZIQLI DEFORMATSIYALANISH JARAYONLARINI MATEMATIK MODELLASHTIRISH

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Annotatsiya. *Maqola Gamilton-Ostrogradskiy variatsion tamoyili asosida haroratni hisobga olgan holda yupqa magnitelastik plastinalarning geometrik nochiziqli deformatsiyalanish jarayonlarining umulashgan matematik modelini qurish, hisoblash algoritmlarini ishlab chiqish, hamda hisoblash tajribalari o'tkazishga bag'ishlanadi. Bunda harorat ta'siridagi Potensial energiya, Kinetik energiya, hamda tashqi kuchlar bajargan ishning variasion ko'rinishi aniqlandi. Koshi munosabatlari, Kirxgof-Lyav gipotezasi, Guk qonuni va Lorens kuchi hamda Maksvell elektromagnit tenzor ko'rinishidan foydalanib, murakkab shakldagi yupqa termo magnitelastik plastinning deformatsion kuchlanish holatiga elektromagnit maydon ta'siri ko'rildi. Ishlab chiqilgan matematik modelni yechish uchun R-funksiya, Bubnov Galerkin, Gauss kvadratlar, Gauss, Nyumark va Iteratsiya usullaridan foydalanib hisoblash algoritmi ishlab chiqildi. Yaratilgan dasturiy majmua yordamida olingan natijalar grafik diagrammalar orqali tahlil qilindi.*

Kalit so'zlar: *Gamilton-Ostrogradskiy tamoyili, Koshi munosabatlari, Guk qonuni, Kirxgof-Lyav gipotezasi, Maksvell elektromagnit tenzori, R-funksiyasi.*

Bugungi kunda elektromagnit maydonlarning elektro'tkazuvchanlik va magnitelastiklikning nochiziqli nazariyalari, xususan ikki yoki undan ortiq fizik maydonlarning o'zaro bog'liqlik nazariyasiga asoslangan ilmiy tadqiqot ishlari izchil suratlarda rivojlanmoqda. Yupqa magnitelastik plastinalar, texnikaning turli sohalarida jumladan mashinasozlik, samolyotsozlik, kemasozlik va inshoot qurish obektlarining muhim tarkibiy elementlarini tashkil etadi.

Jahonda va yuztimizda yupqa elektroʻtkazuvchan jismlarning magnitelastikligini tadqiq qilish masalalari boʻyicha bir qator olimlar: D.I.Bardzokas, S.A.Ambarsumyan, G.Ye.Bagdasaryan, M.V.Belubekyan X.A.Raxmatulin, V.K.Kobulov, B.Kurmanbaev, Sh.A.Nazirov, T.Yuldashev, A.A.Xoljigitov, R.Sh.Indiaminov, F.M.Nuraliev kabi mamlakatimiz olimlari ilmiy-tadqiqot ishlarini olib borishgan[4].

Adabiyotlar tahlili shuni koʻrsatadiki, elektromagnit maydon ta’siridagi elektr oʻtkazuvchan murakkab konstruktiv shakldagi magnitelastik yupqa plastinalarning geometrik nochiziqli deformatsiyalanish jarayonlarini matematik modellashtirish muammolari hozirgi kunda yetarli darajada oʻrganilmagan.

Magnitelastik plastinanig gometrik nochiziqli deformatsiyalanish jarayonining umumlashgan matematik modelini ishlab chiqish Gamilton-Ostrogradskiy variatsion tamoyili, Kirxgof-Lyav gipotezasi, Koshi munosabatlari, Guk qonuni Lorens kuchi hamda Maksvell elektromagnit tenzor koʻrinishidan foydalanib qurildi [5].

$$\begin{cases} \rho h\dfrac{\partial^2 u}{\partial t^2}+\dfrac{\partial N_{xx}}{\partial x}+\dfrac{\partial N_{xy}}{\partial y}+N_x+R_x+q_x+T_{zx}=0 \\ \rho h\dfrac{\partial^2 v}{\partial t^2}+\dfrac{\partial N_{yy}}{\partial y}+\dfrac{\partial N_{xy}}{\partial x}+N_y+R_y+q_y+T_{zy}=0 \\ \rho h\dfrac{\partial^2 w}{\partial t^2}+\dfrac{\partial^2 M_{xx}}{\partial x^2}+2\dfrac{\partial^2 M_{xy}}{\partial x\partial y}+\dfrac{\partial^2 M_{yy}}{\partial y^2}+N_{xx}\dfrac{\partial^2 w}{\partial x^2}+N_{yy}\dfrac{\partial^2 w}{\partial y^2}+ \\ +N_{xy}\dfrac{\partial^2 w}{\partial x\partial y}+\left(\dfrac{\partial N_{xx}}{\partial x}+\dfrac{\partial N_{xy}}{\partial y}\right)\dfrac{\partial w}{\partial x}+\left(\dfrac{\partial N_{yy}}{\partial y}+\dfrac{\partial N_{xy}}{\partial x}\right)\dfrac{\partial w}{\partial y}+N_z+R_z+q_z+T_{zz}=0, \end{cases}$$

Chegaraviy shartlar:

$$\left(N_{xx}+N_{Px}+N_{Tx}\right)\delta u\Big|_x=0,\ \left(N_{xy}+N_{Py}+N_{Txy}\right)\delta v\Big|_x=0,\ M_{xx}\delta\frac{\partial w}{\partial x}\Big|_x=0,\ M_{xy}\delta\frac{\partial w}{\partial y}\Big|_x=0,$$

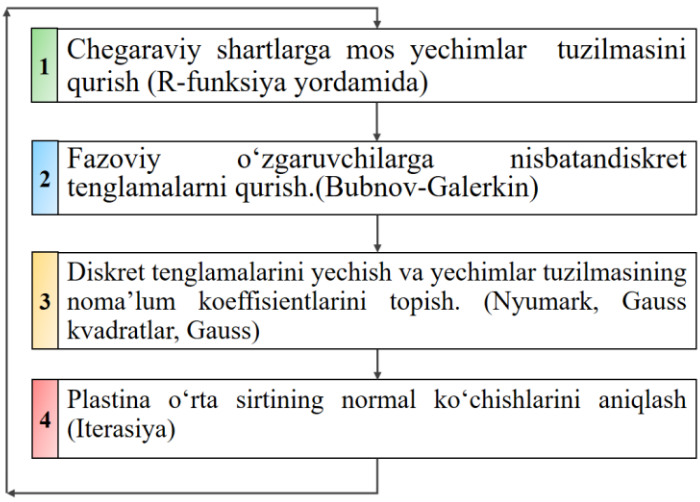
$$M_{yy}\delta\frac{\partial w}{\partial y}\Big|_y=0,\ M_{xy}\delta\frac{\partial w}{\partial x}\Big|_y=0,\left(N_{yy}+N_{Fy}+N_{Tyy}\right)\delta v\Big|_y=0,\ \left(N_{xy}+N_{Fx}+N_{Tyx}\right)\delta u\Big|_y=0,$$

$$\left[N_{xx}\frac{\partial w}{\partial x}+N_{xy}\frac{\partial w}{\partial y}-\frac{\partial M_{xx}}{\partial x}-\frac{\partial M_{xy}}{\partial y}+N_{Pz}+N_{Txz}\right]\delta w\Big|_x=0,$$

$$\left[N_{yy}\frac{\partial w}{\partial y}+N_{xy}\frac{\partial w}{\partial x}-\frac{\partial M_{yy}}{\partial y}-\frac{\partial M_{xy}}{\partial x}+N_{Fz}+N_{Tyz}\right]\delta w\Big|_y=0.$$

bu yerda N_{xx}, N_{yy} ва N_{xy} – plastinaning qalinligi bo‘yicha normal va urunma kuchlari. M_{xx}, M_{yy} ва M_{xy} – plastinaning egilish va buralish momentlari, $R_x, R_y, R_z, N_x, N_y, N_z$ – hosil bo‘luvchi hajm kuchlari, $q_x, q_y, q_z, T_{zx}, T_{zy}, T_{zz}$ – sirt kuchlari, $T_{xx}, T_{xy}, T_{xz}, T_{yy}, T_{yz}, T_{zx}$, – hosil bo‘luvchi kontur kuchlari.

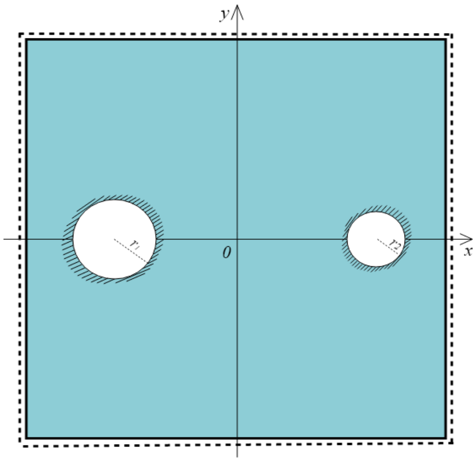
Masalani sonli yechishning hisoblash algoritmi



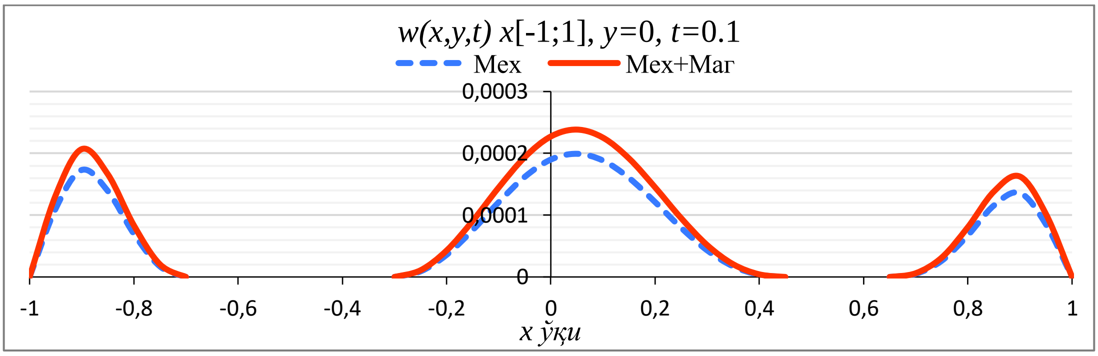
1-rasm. Hisoblash algoritmi

Hisoblash tajribalari tahlili

Murakkab konfiguratsiyali nosimmetrik magnitelastik plastinaning chegaralari sharnir mahkamlangan va markazi qattiq mahkamlangan (1-rasm) holatida tadqiqodlar o‘tkazildi va quyidagi sonli natijalar asosida grafik tasvir (2-rasm) olindi [5].

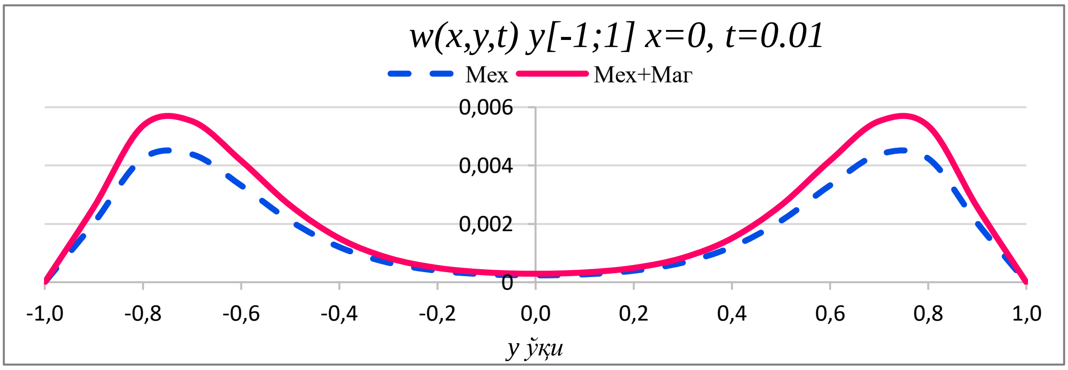


2-rasm. Nosimmetrik magnitelastik plastina.



3-rasm. Murakkab shakllimagnitelastik yupqa plastinaning egilishi.

Mazkur 1-rasmdagi murakkab shakldagi magnitelastik plastinaning olingan conli qiymatlar asosida (*Oy*) o‘qi bo‘ylab egilishi 4-rasmda keltirilgan.



4-rasm. magnitelastik yupqa plastinaning *Oy* o‘qi bo‘ylab egilishi.

Tajriba natijalariga ko‘ra elektro‘tkazuvchan yupqa plastinaga mexanik kuchlar ta’siri hamda mexanik kuchlarga magnit maydon kuchlar ta’siri ham qo‘shib hisoblash ishlari olib borildi (3-4-rasm) va hisoblash tajribalar xulosasi shuni ko‘rsatadiki ularning o‘zaro farqi 15.8% ni tashkil qildi [6].

Xulosa

Murakkab konfiguratsiyali magnitelastik yupqa plastinaning geometrik nochiziqli deformatsiyalanish jarayonlarining matematik modeli qurildi. Uni yechish uchun hisoblash algoritmi ishlab chiqildi. Tajribalar o‘tkazish uchun dasturiy majmua yaratildi. Murakkab konstruktiv shakldagi magnitelastik yupqa plastinalarning elektromagnit kuchlar ta’sirida geometrik nochiziqli deformatsiyalanish jarayonlari turli chegaraviy sharlar asosida o‘rganildi va sonli natijalar olindi hamda qiyosiy tahlillar keltirildi. O‘tkazilgan tajriba natijalari shuni ko‘rsatadiki magnit maydon kuchlarning yupqa magnitelastik plastinalarga ta’siri kichik bo‘lsada mavjudligi aniqlandi va bu plastinaning deformatsiyalanish jarayoniga bevosita ta’sirini isbotlaydi.

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