EFFECTS OF LIQUID ON CYLINDER SHELL VIBRATIONS

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Annotation: This paper presents the results of the study of the effect of fluid on the oscillations of the cylindrical shell. The cylindrical shell was dynamically analyzed by considering the inertial forces in the longitudinal and rotational directions as small.

Keywords: Inertial force, voltage, frequency, fluid, static solution, cylindrical shell

SILINDRIK QOBIQ TEBRANISHLARIGA SUYUQLIKNING TA'SIRI

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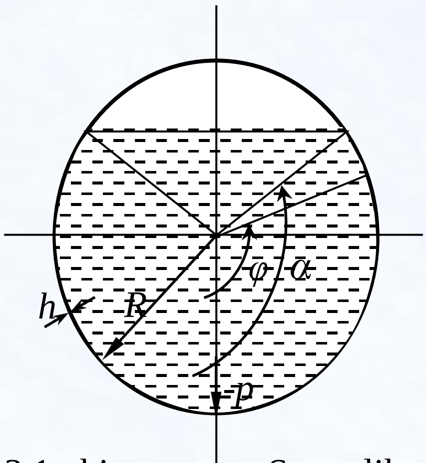
Annotatsiya : Ushbu maqolada silindrik qobiq tebranishlariga suyuqlikning ta'sir jarayonini o'rganishda olingan natijalar keltirilgan. Bo'ylama va aylanish yo'nalishidagi inertsiya kuchlarini kichik deb qarab silindrik qobiq dinamik jihatdan tahlil qilingan.

Kalit so'zlar : inertsiya kuchi, zo'riqish, chastota, suyuqlik, statik yechim, silindrik qobiq,

Gorizontal joylashgan uzunligi L va radiusi R bo'lgan , zichligi ρ_1 bo'lgan suyuqlik bilan qisman to'ldirilgan silindirik balkani qaraymiz .Bo'ylama va aylanish yo'nalishidagi inertsiya kuchlarini kichik deb qarab silindrik qobiqni dinamik tahlil qilamiz.(1) munosabatga ko'ra

X=0 , Y=0, $Z=-\rho h\dfrac{\partial^2 W}{\partial t}+Q_z$ ekanligini hisobga olib qobiq uchun statik yechim $Q_z=-P$ ni topamiz



3.1-chizma. Suyuqlik bilan qisman to'ldirilgan silindrik qobiqning

Agar gidrostatik bosimni P deb olsak $\varphi<\alpha$ shart bajarilgandagi bosimi quyidagicha bo'ladi.

$$P=\rho_1 gR(\cos\varphi-\cos\alpha)$$

Agar $\varphi\geq\alpha$ va p=0 deb olingan shartni hisobga olib quyidagi tenglamalar sistemasiga kelamiz.

$$\begin{gathered}\frac{\partial^2 u}{\partial x^2}+\frac{1}{2R}(1+\nu)\frac{\partial^2 v}{\partial x\partial\varphi}+\frac{1}{2R^2}(1-\nu)\frac{\partial^2 u}{\partial\varphi^2}-\frac{\nu}{R}\frac{\partial w}{\partial x}=0\\ \frac{1}{2R}(1+\nu)\frac{\partial^2 u}{\partial x\partial\varphi}+\frac{1}{2}(1-\nu)\frac{\partial^2 v}{\partial x^2}+\frac{1}{R^2}\frac{\partial^2 v}{\partial\varphi^2}-\frac{1}{R^2}\frac{\partial w}{\partial\varphi}=0 \qquad (1)\\ \frac{\nu}{R}\frac{\partial u}{\partial x}+\frac{1}{R^2}\frac{\partial v}{\partial x}-\frac{w}{R^2}=\frac{1-\nu^2}{Eh}\left[\rho h\frac{\partial^2 w}{\partial t^2}+\rho_1 gR(\cos\varphi-\cos\alpha)\right]\end{gathered}$$

(1) sistema yechimini ko'shishlarga nisbatan quyidagicha tanlab olamiz

$$u=\sum_m\sum_n U_{mn}(x,\varphi)T_{mn}(t),$$

$$v=\sum_m\sum_n V_{mn}(x,\varphi)T_{mn}(t),\quad w=\sum_m\sum_n W_{mn}(x,\varphi)T_{mn}(t) \quad (2)$$

Yechimni (2) ko'rinishda tanlasak tenglamalar sistemasining differentsial ko'rinishi quyidagicha bo'ladi.

$$\begin{gathered}\left[U''_{mn}+\frac{1}{2R}(1+\nu)\dot{V}'_{mn}+\frac{1}{2R^2}(1-\nu)\ddot{U}_{mn}-\frac{\nu}{R}W'_{mn}\right]T_{mn}(t)=0\\ \left[\frac{1}{2R}(1+\nu)\dot{U}'_{mn}+\frac{1}{2}(1-\nu)V''_{mn}+\frac{1}{R^2}\ddot{V}_{mn}-\frac{1}{R^2}\dot{W}_{mn}\right]T_{mn}=0 \qquad (3)\\ \sum_m\sum_n\left[\frac{\nu}{R}U'_{mn}+\frac{1}{R^2}\dot{V}_{mn}-\frac{1}{R^2}W_{mn}\right]T_{mn}=\frac{1-\nu}{Eh}\sum_m\sum_n\rho hW_{mn}\frac{d^2T_{mn}}{dt^2}+\\ +\rho_1 gR\frac{1-\nu^2}{Eh}(\cos\varphi-\cos\alpha)\end{gathered}$$

Endi U_{mn},V_{mn},W_{mn} ko'chishlarga nisbatan quyidagicha tanlaymiz

$$\begin{gathered}U_{mn}=\alpha_{mn}\cos\lambda_m{}^* x\cos n\varphi\\ V_{mn}=\beta_{mn}\sin\lambda^*{}_m x\sin\varphi \qquad (4)\\ W_{mn}=\gamma_{mn}\sin\lambda^*{}_m x\cos n\varphi\end{gathered}$$

bu yerda $\lambda^*{}_m=\frac{m\pi}{L}$ ga teng , $\alpha_{mn},\beta_{mn},\gamma_{mn}$ lar o'zgarmas sonlar

(4) hosil bo'lgan yechimni (3) ifodaga qo'ysak ,o'zgarmas $\overline{\alpha}_{mn}=\frac{\alpha_{mn}}{\gamma_{mn}}$ va $\overline{\beta}_{mn}=\frac{\beta_{mn}}{\gamma_{mn}}$ larga ko'ra ikkita algebraik tenglamalar sistemasi hosil bo'ladi.

$$\begin{gathered}-\overline{\alpha}_{mn}\left[\lambda^2{}_m+\frac{n^2}{2}(1-\nu)\right]+\overline{\beta}_{mn}\frac{n\lambda_m}{2}(1-\nu)=\nu\lambda_m\\ \overline{\alpha}_{mn}n\lambda_m\frac{1}{2}(1+\nu)-\overline{\beta}_{mn}\left[n^2+\frac{\lambda^2{}_m}{2}(1-\nu)\right]=-n\end{gathered} \qquad (5)$$

Bu berilgan (5) tenglamalardan $\lambda_m=R\lambda^*{}_m$ belgilashni olsak ,bu berilgan algebraik sistemaning $\overline{\alpha}_{mn}$ va $\overline{\beta}_{mn}$ yechimlarni topamiz

$$\bar{\alpha}_{mn}=\frac{-\nu\lambda_m\left[n^2+\frac{\lambda_m^2}{2}(1-\nu)\right]+\frac{n^2\lambda_m}{2}(1+\nu)}{\left[\lambda^2{}_m+\frac{n^2}{2}(1-\nu)\right]\left[n^2+\frac{\lambda_m}{2}(1-\nu)\right]-\frac{n^2\lambda^2{}_m}{4}(1+\nu)^2};$$

$$\bar{\beta}_{mn}=\frac{n\left[\lambda^2{}_m+\frac{n^2}{2}(1-\nu)\right]-\nu\frac{n\lambda^2{}_m}{2}(1+\nu)}{\left[\lambda^2{}_m+\frac{n^2}{2}(1-\nu)\right]\left[n^2+\frac{\lambda^2{}_m}{2}(1-\nu)\right]-\frac{n^2\lambda^2{}_m}{4}(1+\nu)^2}.$$

Keltirilgan (4) funksiyalarni o'zaro ortogonal deb olaylik va o'zaro normallik shartini quyidagicha tanlaylik

$$\int_0^L\int_0^{2\pi}W_{mn}W_{kl}\,dxd\varphi=\begin{cases}0, agar, m\neq k; n\neq l\\ \frac{\pi L}{2}, agar, m=k, n=l\end{cases}$$

bundan, $$\gamma_{mn}=1 \qquad (6)$$

Bu (6) natijani (4) ifodaning mos qiymatiga qo'yib , (2) munosabatni W_{kl} funksiyaga ko'paytirib integrallasak quyidagi ifodani keltirib chiqaramiz

$$\int_0^L\int_0^{2\pi}\sum_m\sum_n[(-\nu\alpha_{mn}\lambda_m+\beta_{mn}-1)W_{mn}T_{mn}]W_{kl}\,dxd\varphi=$$
$$=\int_0^L\int_0^{2\pi}\frac{1-\nu^2}{Eh}R^2\left[\rho h\sum_m\sum_n\left(W_{mn}\frac{d^2T_{mn}}{dt^2}\right)W_{kl}+\rho_1 gR(\cos\varphi-\cos\alpha)W_{kl}\right]dxd\varphi \qquad (7)$$

Doiraviy silindirik qobiq uhun bosimni $p=\rho_1 gR(\cos\varphi-\cos\alpha)$ ekanligini hisobga olib quyidagi munosabatni yoza olamiz

$$\rho_1 gR(\cos\varphi-\cos\alpha)=\sum_m\sum_n\delta_{mn}W_{mn}=\sum_m\sum_n\delta_{mn}\sin\lambda^*{}_m\cos n\varphi \qquad (8)$$

bundan,

$$(\cos\varphi-\cos\alpha)=\sum_m\sum_n\left[a_{mn}\cos\frac{m\pi}{L}x\cos n\varphi+b_{mn}\sin\frac{m\pi}{L}x\cos n\varphi+\right.$$
$$\left.+c_{mn}\cos\frac{m\pi}{L}x\sin n\varphi+d_{mn}\sin\frac{m\pi}{L}x\sin n\varphi\right]$$

Qobiq uchun koeffisiyentlarni topish uchun ifodani $-\alpha$ dan $+\alpha$ oraliqda integrallaymiz.

$$a_{mn}=\frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi-\cos\alpha)\cos\frac{m\pi x}{L}\cos n\varphi\,dxd\varphi,$$

$$b_{mn}=\frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi-\cos\alpha)\sin\frac{m\pi x}{L}\cos n\varphi\,dxd\varphi,$$

$$c_{mn}=\frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi-\cos\alpha)\cos\frac{m\pi x}{L}\sin n\varphi\,dxd\varphi,\ d_{mn}=\frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi-\cos\alpha)\sin\frac{m\pi x}{L}\sin n\varphi\,dxd\varphi.$$

Bu integral ifodadan quyidagilar topiladi $a_{mn}=0$, $b_{mn}=0, c_{mn}=0$, $d_{mn}=0$ va

$$b_{mn}=-\frac{2}{L\alpha}\left[\cos\frac{m\pi x}{L}\right]_0^L\frac{L}{m\pi}\int_{-\alpha}^{+\alpha}(\cos\varphi-\cos\alpha)\cos n\varphi$$

Agar m=1,3,5,7,... va $n\neq 1$ shart bajarilsa,

$$\delta_{mn} = \rho_1 gRb_{mn} = \frac{8\rho_1 gR}{m\beta\pi\alpha(1-n^2)}(n\sin\alpha\cos n\alpha - \cos\alpha\sin n\alpha). \qquad (9)$$

Qobiq uchun koeffisiyentlarni topish uchun ifodani $-\alpha$ dan $+\alpha$ oraliqda integrallaymiz.

$$a_{mn} = \frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi - \cos\alpha)\cos\frac{m\pi x}{L}\cos n\varphi dx d\varphi,$$

$$b_{mn} = \frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi - \cos\alpha)\sin\frac{m\pi x}{L}\cos n\varphi dx d\varphi,$$

$$c_{mn} = \frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi - \cos\alpha)\cos\frac{m\pi x}{L}\sin n\varphi dx d\varphi,\ d_{mn} = \frac{2}{L\alpha}\int_0^L\int_{-\alpha}^{+\alpha}(\cos\varphi - \cos\alpha)\sin\frac{m\pi x}{L}\sin n\varphi dx d\varphi.$$

Bu integral ifodadan quyidagilar topiladi $a_{mn} = 0$, $b_{mn} = 0, c_{mn} = 0$, $d_{mn} = 0$ va

$$b_{mn} = -\frac{2}{L\alpha}\left[\cos\frac{m\pi x}{L}\right]_0^L \frac{L}{m\pi}\int_{-\alpha}^{+\alpha}(\cos\varphi - \cos\alpha)\cos n\varphi$$

Agar m=1,3,5,7,... va $n \neq 1$ shart bajarilsa,

$$\delta_{mn} = \rho_1 gRb_{mn} = \frac{8\rho_1 gR}{m\beta\pi\alpha(1-n^2)}(n\sin\alpha\cos n\alpha - \cos\alpha\sin n\alpha). \qquad (10)$$

Agar m=1,3,5,7,... va n=0 shart bajarilsa ,

$$\delta_{m0} = \frac{8\rho_1 gR}{\alpha\pi m}(\sin\alpha - \alpha\cos\alpha),$$

agar m=1,3,5,7,... bo'lib n=1 hol uchun esa

$\delta_{m1} = \frac{4\rho_1 gR}{\alpha\pi m}(\alpha - 2\cos\alpha\sin\alpha)$. ko'rinishda bo'ladi. (8) munosabatdan va (10) ifodaga nisbatan ortoganallik shartidan foydalanib T_{mn} ga nisbatan quyidagi ifodaga kelamiz.

$$\frac{1-\nu^2}{Eh}R^2\rho h\frac{d^2T_{mn}}{dt^2} + (1+\nu\alpha_{mn}\lambda_{mn} - \beta_{mn})T_{mn} = -\frac{1-\nu^2}{Eh}R^2\delta_{mn} \qquad (11)$$

Bu munosabatni differensiallab quyidagi ko'rinishga kelamiz

$$T_{mn} = A_{mn}e^{i\omega_{mn}t} - \frac{\frac{1-\nu^2}{Eh}}{1+\nu\alpha_{mn}\lambda_m - \beta_{mn}} \qquad (12)$$

(11) va (12) munosabatlardan quyidagiga kelamiz

$$-A_{mn}\left[\frac{1-\nu^2}{E}R^2\rho\omega^2{}_{mn} - (1+\nu\alpha_{mn}\lambda_m - \beta_{mn}\right] = 0$$

Tebranish chastotasini topish formulasi quyidagicha bo'ladi

$$\omega_{mn} = \frac{1}{R}\sqrt{\frac{E}{\rho(1-\nu^2)}(1+\nu\alpha_{mn}\lambda_m - \beta_{mn})} \qquad (13)$$

O'qqa nisbatan radial ko'chishi esa quyidagi ifoda bilan hisoblanadi

$$w = \mathrm{Re}\sum_m\sum_n\left\{A_{mn}e^{i\omega_{mn}t} - \frac{\delta_{mn}}{\rho h\omega^2_{mn}}\right\}\sin\frac{m\pi x}{L}\cos n\varphi \qquad (14)$$

Yuqorida topilgan ifodalardan $\alpha_{mo} = -\frac{\nu}{\lambda_m}, \beta_{mn} = 0$ va $\omega_{mo} = \frac{1}{R}\sqrt{\frac{E}{\rho}}$ ekanligi kelib chiqadi.

$$\frac{\partial w(x,\varphi,0)}{\partial t} = 0 \qquad w(x,\varphi,0) = W_0(x,\varphi).$$

Boshlang'ich va chegaraviy shartdan foydalansak (14) ifodaning ko'rinishi quyidagi ko'rinishga keladi.

$$\operatorname{Re}\{A_{mn}\} = A^{*}{}_{mn} + \frac{\delta_{mn}}{\rho h\omega^{2}{}_{mn}}$$ Bunda

$$A^{*}{}_{mn} = \frac{2}{\pi L}\int_0^L\int_0^{2\pi} W_0(x,\varphi)\sin\frac{m\pi x}{L}\cos n\varphi dx d\varphi$$ ga teng.

Bundan x o'qida joylashgan N_x zo'riqish kuchini dinamik tahlilini qaraymiz .

$$N_x = \frac{Eh}{1-\nu^2}\frac{1}{R}\operatorname{Re}\sum_m\sum_n[\nu(\beta_{mn}n-1)-\alpha_{mn}\lambda_m]*\left[\left(A^{*}{}_{mn} + \frac{\delta_{mn}}{\rho h\omega^2{}_{mn}}\right)e^{i\omega_{mn}t}\right]\sin\frac{m\pi x}{L}\cos n\varphi$$

y uqida joylashgan zo'riqish kuchlari quyidagicha bo'ladi.

$$N_\varphi = \frac{Eh}{1-\nu^2}\frac{1}{R}\operatorname{Re}\sum_m\sum_n[(\beta_{mn}n-1)-\nu\alpha_{mn}\lambda_m]\times\left[(A_{mn}{}^{*} + \frac{\delta_{mn}}{\rho h\omega^2{}_{mn}})e^{i\omega_{mn}t} - \frac{\delta_{mn}}{\rho h\omega^2{}_{mn}}\right]\sin\frac{m\pi x}{L}\cos n\varphi \quad (15)$$

$$N_{x\varphi} = \frac{Eh}{2(1+\nu)}\frac{1}{R}\operatorname{Re}\sum_m\sum_n[-\alpha_{mn}n+\beta_{mn}\lambda_m]\times$$
$$\times\left[(A_{mn}{}^{*} + \frac{\delta_{mn}}{\rho h\omega^2{}_{mn}})e^{i\omega_{mn}t} - \frac{\delta_{mn}}{\rho h\omega^2{}_{mn}}\right]\sin\frac{m\pi x}{L}\cos n\varphi \quad (16)$$

Endi n va m dan bog'liq xususiy hollarni qaraymiz. m=1, n=0 bo'lsin. Bu hol uchun ko'chish funksiyasini quyidagicha tanlab olamiz

$$W_0(x,\varphi) = \frac{a}{L}(L-x)x\cos\varphi$$

$$\operatorname{Re}\{A_{10}\} = 4a\frac{L^3}{\pi^2} + \frac{8\rho_1 gR}{\frac{\pi R}{L}}(\sin\alpha - \alpha\cos\alpha)\cdot\frac{1}{\rho h\omega^2{}_{10}} = 4a\frac{L^3}{\pi^2} + \frac{8\rho_1 gL}{\pi}(\sin\alpha-\alpha\cos\alpha)\frac{1}{\rho h\omega^2{}_{10}} \quad A^{*} = \frac{8aL}{\pi^3},$$

$$\operatorname{Re}\{A_{10}\} = \frac{8aL}{\pi^3} + \frac{8\rho_1 gL}{\pi h\omega^2{}_{10}},$$

bu yerda $\omega_{10} = \frac{1}{R}\sqrt{\frac{E}{\rho}}$ ga teng. Bu topilgan natijalardan ko'chish funksiyasining ifodasini topib olamiz.

$$W = \left\{\left(\frac{8aL}{\pi^3} + \frac{8\rho_1 gL}{\pi h\rho\omega_{10}}(\sin\alpha - \cos\alpha)\right)\cos\omega_1^0 t - \frac{8\rho_1 gL}{\pi h\rho\omega_{10}}(\sin\alpha-\cos\alpha)\right\}\sin\frac{\pi x}{L}$$

Endi esa zo'riqish kuchlarini topamiz ;

$$N_x = 0;$$

$$N_\varphi = \frac{Eh}{R}\left[\left(\frac{8aL}{\pi^3} + \frac{8\rho_1 gR^3}{h\alpha\pi E}(\sin\alpha-\cos\alpha)\right)\cos\omega_1^0 t - \frac{8\rho_1 gR^3}{\pi hE\alpha}(\sin\alpha-\cos\alpha)\right]\sin\frac{\pi x}{L};$$

$$N_{x\varphi} = 0;$$

Endi n=1 *va* m=1 hol uchun ham qarab chiqaylik.

Bu hol uchun $\delta_{11} = \frac{4\rho_1 gR}{\alpha\pi}(\alpha - \sin 2\alpha)$ ga ω_{11} esa quyidagiga teng

$$\omega_{11}=\frac{1}{R}\sqrt{\frac{E}{\rho(1-\nu^2)}\left[1+\nu\left(\frac{-\nu\frac{\pi R}{L}\left[1+\frac{\pi R}{2L}(1-\nu)\right]+\frac{\pi R}{2L}(1+\nu)}{\left[\frac{\pi^2R^2}{L^2}+\frac{1}{2}(1-\nu)\right]\cdot\left[1+\frac{\pi^2R^2}{2L^2}+(1-\nu)\right]-\frac{R^2}{4L^2}(1+\nu)^2}\frac{\pi R}{L}\right)-\frac{\left(\frac{\pi^2R^2}{L^2}+\frac{1}{2}(1-\nu)\right)-\nu\frac{\pi^2R^2}{2L^2}(1+\nu)}{\left(\frac{\pi^2R^2}{L^2}+\frac{1}{2}(1-\nu)\right)\left(1+\frac{\pi^2R^2}{2L^2}+(1-\nu)\right)-\frac{\pi^2R^2}{4L^2}(1+\nu)^2}\right]};$$

$$A_{11}^{*}=\frac{2}{\pi L}\int_0^{\pi}\frac{a(L-x)}{L}\sin\frac{\pi x}{L}\cos\varphi\sin\varphi dx d\varphi=-\frac{4aL}{\pi^3}\ ;$$

$$\mathrm{Re}\{A_{11}\}=-\frac{4aL}{\pi^3}+\frac{4\rho_1 gR}{\rho h\omega_{11}^2\alpha\pi}(\alpha-\sin 2\alpha)$$

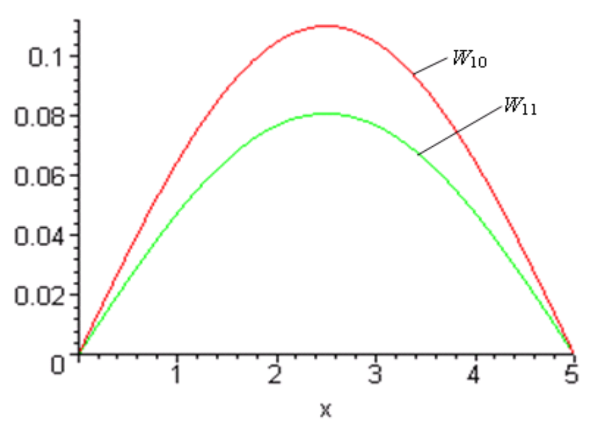
Bu munosabatlardan ko'chish funksiyasini topa olamiz .

$$W=\left\{\left(\frac{8aL}{\pi^3}+\frac{8\rho_1 gL}{\pi h\rho\omega_{10}}(\sin\alpha-\cos\alpha)\right)\cos\omega_1^0 t-\frac{8\rho_1 gL}{\pi h\rho\omega_{10}}(\sin\alpha-\cos\alpha)\right\}\sin\frac{\pi x}{L}+$$

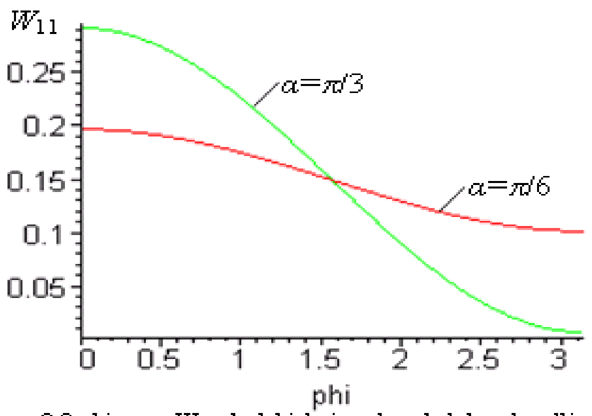
$$+\left\{-\frac{4aL}{\pi^3}+\frac{4\rho_1 gR}{\rho h\omega_{11}^2}(\alpha-\sin 2\alpha)\cos\omega_{11}^2-\frac{4\rho_1 gR}{\rho h\omega_{11}^2}(\alpha-\sin 2\alpha)\right\}\sin\frac{\pi x}{L}\cos\varphi$$

Yuqorida keltirib chiqarilgan formulalar asosida hisob dasturi Maple-7 da tuzildi, olingan sonli natijalar grafik shaklida tasvirlandi, shular asosida suyuqlik bilan qisman to'ldirilgan qobiqning tebranishlari tahlil qilindi.

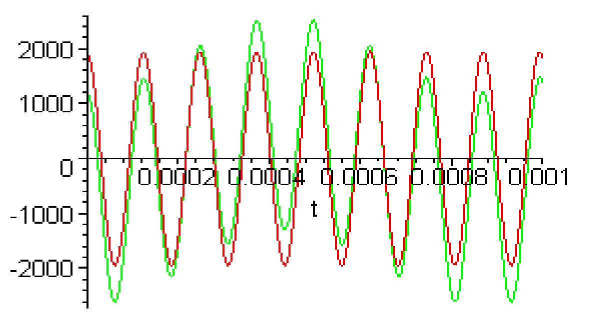
3.2-chizmada m=1, n=0 va m=1, n=1 bo'lgan hollar uchun ko'chishning koordinatadan bog'liq o'zgarish grafigi tasvirlangan. 3.3-chizmada W_{11} ko'chishning burchakdan bog'liq o'zgarishi keltirilgan. 3.4-chizmada esa N_φ zo'riqishning m=1, n=0 va m=1, n=1 bo'lgan hollarda vaqtdan bog'liq o'zgarishi keltirilgan



3.2-chizma. Ko'chishlarning koordinatadan bog'liq o'zgarishi (t=0.1; R=0.1; L=5; h=0.001; ρ=7800; E:=2.10[11]; ν=0.3; α=pi/3; ρ1:=1000; g=10; a=0.1; φ=pi/4;).



3.3-chizma. W_{11} ko'chishning burchakdan bog'liq o'zgarish grafigi (t=0.1; R=0.1; L=10; h=0.001; x=5; ρ=7800; E:=2.10[11]; ν=0.3; ρ1:=1000; g=10; a=0.1).



3.2-chizma. $N_{\varphi 0}$ va $N_{\varphi 1}$ zo'riqishning vaqtdan bog'liq o'zgarish grafigi (t=0.1; R=0.1; L=10; h=0.001; x=5; ρ=7800; E:=2.10[11]; ν=0.3; ρ1:=1000; g=10; a=0.1).

Natijalar shuni ko'rsatadiki:

- qobiqning markaziy nuqtasida maksimal egilishlar kuzatiladi;
- n parametrning oshishi tebranish amplitudasining oshishiga olib keladi;
- Suyuqlik sathi o'q bo'yicha maksimal kesim yuzasiga yaqinlashgan sayin tebranish amplitudasi oshib boradi;
- Qobiqning gorizontal o'q kesimidagi nuqtalari ko'chishlariga suyuqlik sathi o'zgarishining ta'siri sezilmaydi;
- n parametrning oshishi zo'riqishlarning tebranish chastotasini deyarli o'zgartirmaydi, lekin amplitudasini oshiradi.

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