INTERACTION OF SPATIAL THIN-WALLED STRUCTURES WITH FLUID-SATURATED SOIL

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Thin-walled spatial structures are broadly used in the modern technician and building. In fuel industry for long-term keeping of oil and gas are used reservoirs of various capacity, which on technological reasons can be shipped under the soil. Shells of reservoirs combine in itself high toughness and low specific consumption of materials. At the same time, being under the soil, they feel steady-state and dynamic loads from ambiance, which particularly in the event, when reservoir is empty, can bring about the loss of stability of its form. On the other hand contact interactions of shell and soil greatly depend on features of ambiance and its saturating of liquid. For building generalized porous springy ambiance models, saturated by the liquid, it is possible to use Bio equations of motion for displacement of hard and fluid phases. Elaboration of mathematical specified interaction models and theirs realization by means of modern computing software allows to study behaviour of spatial thin-walled designs on base of geometric nonlinear theory of shells.

Differential equations of shell movement, proceeding from condition of equality to zero of a main vector and main moment of all forces, including inertia forces, applied on an element of a middle-surface of an shell, we shall present in a kind

$$\frac{\partial \sqrt{a}\,\vec{T}^{\alpha}}{\partial x^{\alpha}} + \sqrt{a}\,\vec{q}(t) - \sqrt{a}\,\gamma h\,\vec{w} = 0;$$

$$\frac{\partial \sqrt{a}\,\vec{M}^{\alpha}}{\partial x^{\alpha}} + [\vec{e}_{\alpha} \times \vec{T}^{\alpha}]\sqrt{a} = 0, \qquad \alpha = 1,2.$$

Here a - fundamental determinant of metric tensor of a shell surface, h - thickness, γ - density of a material, $T\alpha, M\alpha$- contravariant tensor components of internal forces and moments, $\vec{w}$ - absolute acceleration vector.

For building generalized porous springy ambiance models, saturated by the liquid, it is possible to use Bio equations of motion for displacement of hard and fluid phases. Accepting features of porous hard phase as linear and isotrophic, a Guk law it is possible to write as

$$\sigma_{ij}^{s} = A\varepsilon\delta_{ij} + 2Ne_{ij} + Q\varepsilon\delta_{ij}$$

$$\sigma^{f} = -mp_0 = Qe + R\varepsilon$$

where A, N hang from the constant Lame.

For description of interaction between deepened shells-capacity and the soil is used as first drawing near a Vinkler model with acerbity factor Cz , characterizing of soil in dry condition and in saturated by water condition. For this case equations of moving of shell's element of reservoir we shall write in type:

$$\frac{\partial \sqrt{a}\,\vec{T}^{\alpha}}{\partial x^{\alpha}} + \sqrt{a}\,\vec{q}(t) - \sqrt{a}\,\gamma h\,\vec{w} = C_z\,\vec{w};$$

$$\frac{\partial \sqrt{a}\,\vec{M}^{\alpha}}{\partial x^{\alpha}} + [\vec{e}_{\alpha} \times \vec{T}^{\alpha}]\sqrt{a} = 0, \qquad \alpha = 1,2.$$

Dynamic influences can vastly change characteristics of soils, i.e. cause "dilution" of sandy soils or "ticsotroption " of clayey soils. Passing of waves of different frequency can also influence upon the redistribution of stresses under the shell, deepened in soil, saturated by the liquid, or change a behaviour of elevated designs. That is why at formulation of problems of specified direction it is necessary to distinguish nature of dynamic influences, which on first stage it possible to divide into :

- vibrating, greatly influencing upon changing the characteristics of soils;
- striking (explosive);
- oscillatory (seismic) influences.

In particular, for the shell of reservoir (fig.1), load vector q(t) includes in itself steady-state component q_1 and dynamic component $q_2\cos\omega t$ evenly distributed on surface of shell.

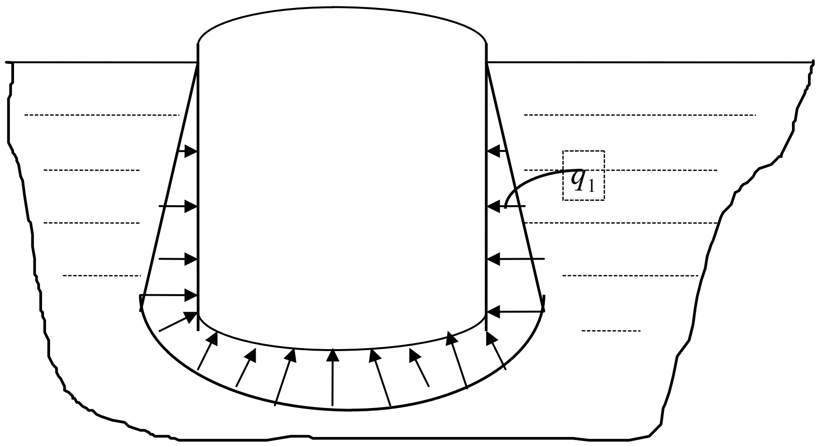

Fig.1

At the evaluation of behaviour of porous ambiance depending on quantity of kept in her water are considered three its conditions: dry soil, soil of natural moisture and completely fluid-saturated ambiance. Accordingly this conditions a factor of acerbity of basis Cz takes for natural moisture traditional values, decreases for dry condition or increases double for full fluid-saturated ambiance.

For solution of specified class of problems numerically-analytical method of building and stability analysis of periodic solutions the nonlinear differential equations in partial derived, describing compelled formed shell fluctuations under power and kinematic excitements is elaborated [1]. Discriminating particularity of method is a possibility in axi-symmetric formulation with the analysis of broad spectrum of district harmonicas to research a nature of evolution and realignments of the forms of shell-type structures fluctuations. Method allows to build dynamic loading paths, find on them limiting and bifurcating spots and define in their vicinities branching solutions.

On the base developed strategies is created automatic problem-oriented computing complex, realizing on PC numerical algorithms of solution the problems of stability of compelling shell fluctuations in geometric nonlinear formulation under free boundary conditions.

Number of problems about stability of compelled nonlinear steady-state shell fluctuations under power harmonic excitement is investigated [2]. Thus explored stability of fluctuations of closed cylindrical shells with ellipsoidal and torah-spherical bilges and lids. Results of obtained solutions will be used in the process of study of interaction of shells of reservoirs with soils, saturated by the liquid, under various types of dynamic influences.

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