5. INTERNATIONAL FOOD, AGRICULTURE AND VETERINARY SCIENCES CONGRESS

17 - 19 March 2023
Kafkas University, Kars, Turkiye

PROCEEDINGS BOOK (VOLUME-2)









EDITORS:
Prof. Dr. Tarkan ŞAHİN
Ass. Prof. Mükremin ÖLMEZ

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LIQUID VIBRATIONS IN CYLINDRICAL AND CIONICAL SHELLS WITH AND WITHOUT BAFFLES

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During operation the shell and shell structures containing various liquid fillers can be exposed to intense dynamic effects. In order to analyze the strength of structures in these conditions, it is necessary to take into account nonlinear phenomena in fluid motion, since the application of linear equations does not provide an adequate assessment for estimating the pressure and sloshing amplitude. In this research a study of fluid vibrations in rigid cylindrical and conical reservoirs with and without baffles under lateral and longitudinal excitations has been carried out. The systems of differential equations that correspond to the linear and nonlinear formulation of the problem are obtained as in [1,2]. It is assumed that a fluid is an ideal and incompressible one, and its motion caused by external influences, is non-vortex. In these suppositions, there exists a velocity potential that satisfies the Laplace equation. For slosh reducing, a lot of devices, such as baffles [3] and cover membranes [4] were proposed as well as new constructive materials for tank manufacture [5].

The problem is formulated as following. At boundaries of the liquid domain, no-penetration conditions on the wetted reservoir surfaces are chosen. On the free surface, the kinematic and static conditions are specified. The static condition consists in the equality of pressure on the liquid free surface to atmospheric one. The pressure is received from the Cauchy-Lagrange integral. In this case, the linearization of the Cauchy-Lagrange integral leads to the linear formulation of the problem, whereas in the nonlinear formulation, quadratic terms are taken into account. To formulate the kinematic condition, an additional unknown function is introduced, that describes the free surface motion. The kinematic condition is in equality of the liquid velocity described by the velocity potential, and the velocity of the free surface itself. The problem of the fluid-structure interaction is solved using single-domain and multi-domain reduced boundary element methods. If longitudinal excitations agitation is considered, then it leads to an additional acceleration. In this case, in the linear formulation we obtain the system of uncoupled differential equations, each of them represenrs the Mathieu equation. This allows us to investigate the phenomena of parametric resonance. In analyzing differential equations, arises in a nonlinear problem, it was found that the solutions of such equations depend drastically on the initial data. The phase portraits of the considered dynamic systems with indication of resonances are obtained. The numerical analysis of the differential equation corresponding to nonlinear formulation has been carried out. The proposed approach allows us to carry out the numerical simulation of frequencies and the level of the free surface elevation for baffled liquid storage tanks with baffles of different sizes and with different position in the tank considering liquid sloshing and elasticity effects. This gives the possibility of governing the baffle' sizes and their positions within the tank at design stage. That will be useful in designs of seismic protection of reservoirs [6].

Keywords: liquid vibrations, hazardous liquid, seismic loads, storage tanks, petroleum products, sloshing.

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