12 TH INTERNATIONAL BLACK SEA COASTLINE COUNTRIES SCIENTIFIC RESEARCH CONFERENCE

September 26-28, 2025
Trabzon, Türkiye

EDITOR

Prof. Dr. Osman Kubilay GÜL

ISBN: 979-8-89695-205-3

12th INTERNATIONAL BLACK SEA COASTLINE COUNTRIES SCIENTIFIC RESEARCH CONFERENCE

September 26-28, 2025 - Trabzon, Türkiye

20.10.2025

Liberty Publishing House

Water Street Corridor New York, NY 10038

www.libertyacademicbooks.com

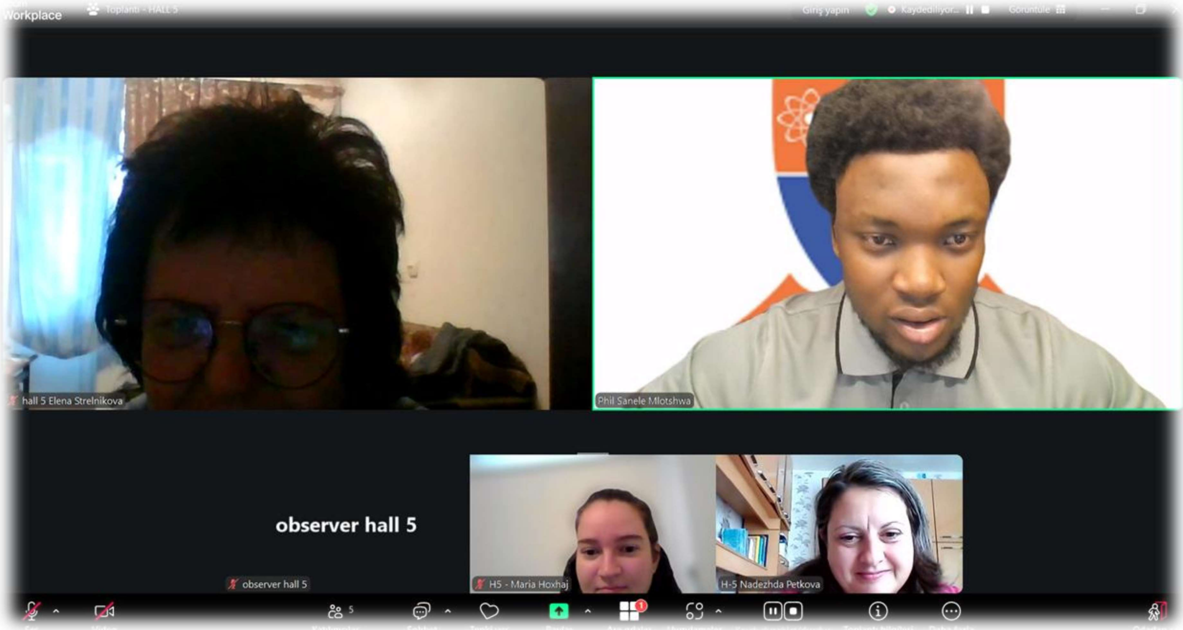
+1 (314) 597-0372

adopted by Mariam Rasulan

PROCEEDINGS BOOK

ISBN: 979-8-89695-205-3

PHOTO GALLERY



CONTENTS

COMPUTATIONAL MODELING OF LIQUID SLOSHING IN PARTITIONED TANKS

PhD Kirill Degtyarev

Institute of Energy Machines and Systems, NAS of Ukraine, Komunalnikiv 2/10, Kharkiv, 61046, Ukraine

PhD Denys Kriutchenko,

Institute of Energy Machines and Systems, NAS of Ukraine, Komunalnikiv 2/10, Kharkiv, 61046, Ukraine

Post graduate Maxim Mischenko

V.N. Karazin Kharkiv National University, Svobody Square 4, Kharkiv, 61022, Ukraine

PhD Olena Sierikova

National University of Civil Defence of Ukraine, Onopriyenka, 8, m. Cherkasy, 8034,

Hon. Prof. M.S. Bokarius Scientific Institute, Kharkiv, 61177, Ukraine

Prof. Dr. Ellena Strelnikova

Kharkiv National University of Radio Electronics, Nauky Ave. 14, Kharkiv, 61166, Ukraine

ABSTRACT

This study develops numerical approaches for analyzing the stability of fluid motion in tanks with partitions of various configurations. The stability of sloshing in horizontally and vertically partitioned tanks is of theoretical and practical importance for aerospace, marine, and terrestrial liquid storage systems. Partitions significantly alter sloshing dynamics by modifying the free-surface frequency spectrum, vortex structures, energy localization, and resonance onset. Neglecting these effects may compromise safety, increase dynamic loads, and reduce system reliability. Experimental investigation of such processes is costly, technically challenging, and often hazardous, requiring large facilities, expensive equipment, and strict safety protocols. In contrast, computational modeling offers a safe and cost-effective tool for exploring a broad range of operating regimes. In this work, potential theory and singular integral equations are combined with the boundary element method, the subdomain method, and the method of prescribed normal modes. The effects of horizontal and vertical excitations are studied for both unpartitioned and partitioned tanks. Parametric regions of stable and unstable motion are identified. The results show that horizontal and vertical partitions strongly affect fluid stability in tanks. These findings are directly applicable to improving the safety of tank systems in aerospace, marine, and energy engineering

Keywords: Liquid Sloshing, Partitioned Tanks, Subdomain Method, Singular Integral Equations, Boundary Element Method,

INTRODUCTION

The dynamics of liquid motion in tanks of various purposes, from fuel reservoirs of launch vehicles and aircraft to containers for transportation and storage of industrial liquids, remains a relevant scientific and engineering problem. One of the most significant factors affecting the reliability and safe operation of such engineering systems is the stability of fluid motion under external disturbances. Oscillations of the free surface (sloshing) can generate additional dynamic loads on the structure walls, reduce the controllability of vehicles, and increase the risk of emergency situations. A particular challenge arises in the analysis of tanks with internal baffles, as their arrangement and geometry substantially alter the flow patterns of the liquid. Experimental investigations in this area are often expensive and potentially hazardous, especially when dealing with large liquid volumes or with fuels and aggressive media. Therefore, the development of efficient mathematical and numerical models of sloshing mitigation is an urgent scientific and technical task. An important aspect of maintaining stability is the consideration of damping effects. A proper selection of damping coefficients allows a significant reduction in oscillation amplitudes and a shift in the system's stability boundaries. A practical tool in this context is the inclusion of the Rayleigh damping matrix, which enables an adequate description of the dissipative properties of the system. Furthermore, one of the promising approaches to enhancing such system reliability is the implementation of special damping devices, such as baffles, floating lids, and other structural elements capable of reducing vibration intensity and providing an additional level of safety. Thus, the study of the stability of fluid motion in tanks with horizontal and vertical baffles, taking into account the influence of damping, which constitutes the focus of the present work, possesses both scientific and practical significance.

Modern operating conditions of engineering systems and the emergence of new structural materials have a significant impact on the stress–strain state and vibration characteristics of structural elements. This necessitates in-depth studies of the strength and dynamic properties of equipment operating under intense mechanical and thermal loads, as well as in interaction with various liquids or gases. The problem of mitigating the liquid oscillation in tanks became particularly important in the 1960s with the advent of space exploration, when inadequate design of fuel tank systems led to loss of stability and structural failure of launch vehicles. Today, the development of advanced, high-performance rockets requires new approaches to the design of fuel tanks, which increasingly exhibit complex or nontraditional geometries (Karaev & Strelnikova 2020, Liu & Li,2022).

Thus, the investigation of fluid motion stability and the suppression of free-surface oscillations in tanks and fuel systems has remained a relevant research topic over the past decades (Balas et al.,2023, Gani et al. 2025, Strelnikova et al., 2020). To analyse the strength and vibration characteristics of structures, modern numerical methods are employed, including the *R*-functions method (Lamtiuhova, 2025), the methods of singular (Medvedovskaya et al.,2015) and hypersingular integral equations (Strelnikova et al., 2024), the boundary element method (BEM), (Gnitko et al., 2022), the finite element method (FEM), (Murawski, 2020). the finite difference method (Smetankina & Pavlikov, 2021), the finite volume method (Lampart et al., 2005), and the absorption method (Tong et al., 2021). During the design of fuel tanks, engineers employ various methods to reduce liquid oscillations, including the use of internal baffles (Poguluri & Cho 2023),vertical partions (Strelnikova et al., 2019), different inserts (Choudhary et al., 2021), complete (Sierikova et al., 2023) or partial (Choudhary et al., 2024) coverage of the free surface, the application of advanced materials (Sierikova et al., 2021, Degtyariov et al., 2022), and active control systems (Konopka et al., 2019).

All these solutions are aimed at ensuring a sufficient level of damping, which makes it possible to reduce vibration amplitudes and prevent the system from entering unstable operating modes. In this context, constraints related to the structural mass, available space, and manufacturing technologies are taken into account, along with the requirements for reliability, durability, and safe operation of the equipment under various working conditions. Therefore, the investigation of fluid motion stability, taking into account damping effects in rigid rotational shells with internal baffles, represents a relevant scientific and engineering problem. The results of such studies can be applied to enhance the reliability and efficiency of technical systems.

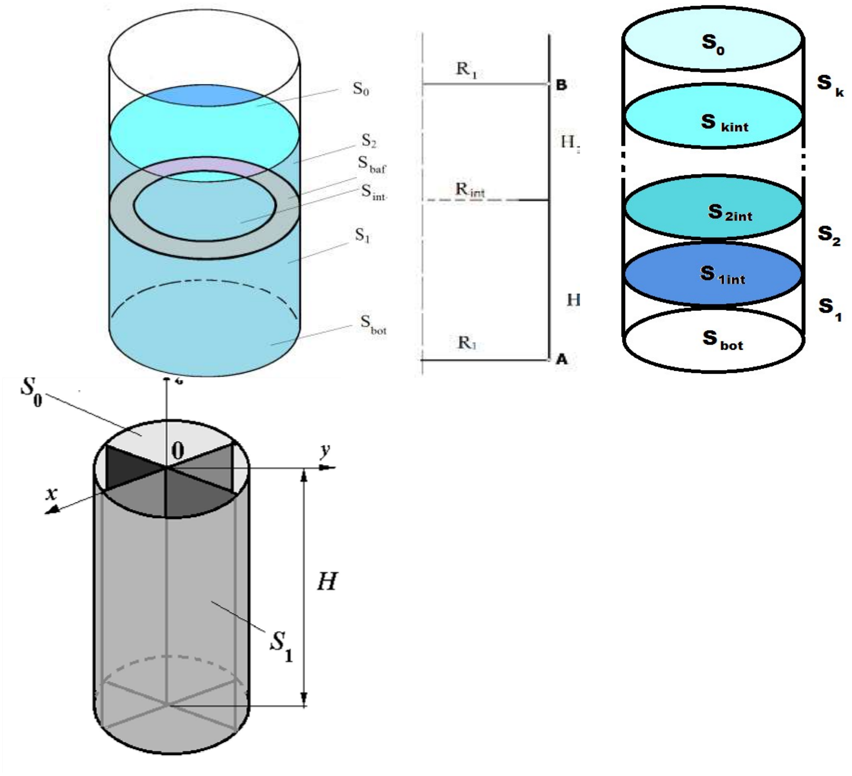
CONCEPTUAL FRAMEWORK

Basic Relations

A rigid shell of revolution partially filled with an ideal incompressible fluid is considered. The fluid motion induced by the shell oscillations under external loading is assumed to be irrotational. Under these conditions, there exists a scalar velocity potential Φ such that **V** = grad Φ. The incompressibility condition in this case takes the form

$$\frac{\partial^2\Phi}{\partial x^2}+\frac{\partial^2\Phi}{\partial y^2}+\frac{\partial^2\Phi}{\partial z^2}=0. \tag{1}$$

Let S_1denote the wetted surface of the shell and S_0 the free surface of the fluid. The domain occupied by the fluid is denoted by Ω, which is bounded by the surface $S=S_0\cup S_1$. It is assumed that the shell structure may contain several internal baffles of arbitrary geometry, which are installed to suppress liquid oscillations. The surfaces of these baffles are denoted by S_{baf}. The geometric configuration of the system is shown schematically in Fig. 1a)-1c).



a b c d

Figure 1. Shells of revolution with baffles.

It is assumed that the tank containing the fluid is subjected to dynamic excitation. The pressure p is calculated according to the Bernoulli integral and is given by (Gavrilyuk et al., 2008) as follows

$$p-p_0=-\rho_l\left(\frac{\partial\Phi}{\partial t}+gz+a_x(t)x+a_z(t)z\right), \tag{2}$$

where ρ_l is the fluid density, z is the vertical coordinate of the point under consideration, p_0 is the atmospheric pressure, g is the acceleration due to gravity, and $a_x(t)$, $a_z(t)$ are the components of the excitation acceleration.

The liquid volume is divided by the baffles into several subdomains, as shown in Fig. 1c). The internal subdomains have interface surfaces as part of their boundaries. On each interface surface, the continuity (coupling) conditions must be satisfied. On the lateral surfaces and at the bottom of the tank, the no-penetration conditions are imposed. On the free surface, both kinematic and dynamic boundary conditions are applied. The kinematic condition states that the fluid particles located on the free surface at the initial moment of time remain on that surface throughout the subsequent motion. Let the function $\zeta = \zeta(x, y, z)$ describe the shape and position of the free surface as a function of time. The mathematical expression of the kinematic condition in the linear formulation has the form

$$\left.\frac{\partial \Phi}{\partial \mathbf{n}}\right|_{S_0} = \frac{\partial \zeta}{\partial t}, \tag{3}$$

where $\mathbf{n}$ is the unit outward normal to the surface, the unknown function $\zeta = \zeta(t, x, y)$ describes the position of the free surface and its variation over time The dynamic condition requires that the pressure of the liquid on the free surface S_0 be equal to the atmospheric pressure. According to equation (2),

$$\frac{\partial \Phi}{\partial t} + gz + a_x(t)x + a_z(t)z = 0. \tag{4}$$

In addition, the conjugation conditions on the interface surfaces (Gnitko et al., 2016) are added to conditions (3)–(4). For the i-th interface surface, these conditions take the following form:

$$\Phi_{i+1} = \Phi_i, \quad q_{i+1} = -q_i, \quad q = \frac{\partial \Phi}{\partial \mathbf{n}}. \tag{5}$$

Let $\mathbf{P}$ denote the points within the domain Ω. For equation (1), the following boundary value problem is formulated:

$$\nabla^2 \Phi = 0, \mathbf{P} \in \Omega, \frac{\partial \Phi}{\partial \mathbf{n}} = 0, \mathbf{P} \in S_1, \ \frac{\partial \Phi}{\partial \mathbf{n}} = \frac{\partial \zeta}{\partial t}, p - p_0 = 0, \ \mathbf{P} \in S_0. \tag{6}$$

Thus, it is necessary to determine the unknown functions Φ and ζ, while the following relation holds on the free surface:

$$\frac{\partial^2 \Phi}{\partial t^2} + g\frac{\partial \Phi}{\partial \mathbf{n}} = 0. \tag{7}$$

So, a boundary-value problem is formulated to determine the velocity potential and the function describing the elevation of the free surface, using the subdomain method.

METHODOLOGY

The method of prescribed modes and the reduction of the boundary-value problem to a system of singular integral equations.

The unknown functions ζ and Φ in cylindrical coordinates (r, θ, z) are represented in the form of series

$$\zeta(r, \theta, t) = \sum_{l=0}^{m} \cos(l\theta) \sum_{k=1}^{n} d_{kl}(t)\zeta_{kl}(r), \tag{8}$$

$$\Phi(r, \theta, z, t) = \sum_{l=0}^{m} \cos(l\theta) \sum_{k=1}^{n_2} \dot{d}_{kl}(t)\varphi_{kl}(r, z) \tag{9}$$

Next, according to (Strelnikova et al., 2020), we obtain a solvable system of singular integral equations for determining $\varphi_{kl}(r, z)$. Here, for simplicity, the indices kl are omitted.

$$2\pi\varphi(z_0,R)+\int_\Gamma\varphi(z,R)\Theta\,(z,z_0)r(z)d\Gamma-\frac{\chi^2}{g}\int_0^R\varphi(\rho,H)\Xi(P,P_0)\rho d\rho=0,P_0\in S_1, \quad (10)$$

$$2\pi\varphi\big(\rho_0,H\big)+\int_\Gamma\varphi(z,R)\Theta\,(z,z_0)r(z)d\Gamma-\frac{\chi^2}{g}\int_0^R\varphi(\rho,H)\;\Xi(P,P_0)\rho d\rho=0,P_0\in S_0.$$

The kernels in integral operators in (10) are determined as follows

$$\Theta(z,z_0)=4/\sqrt{a+b}\left\{\frac{1}{2r}\left[\frac{r^2-r_0^2+(z_0-z)^2}{a-b}E_l(k)-F_l(k)\right]n_r+\frac{z_0-z}{a-b}E_l(k)n_z\right\}, \quad (11)$$

$$\Xi(P,P_0)=4/\sqrt{a+b}\;F_l(k),\,a=r^2+r_0^2+(z-z_0)^2,\,b=2rr_0,$$

where the generalized integrals are introduced by the next formulas

$$E_l(k)=(-1)^l(1-4l^2)\int_0^{\pi/2}\cos(2l\beta\,\psi)\sqrt{1-k^2\sin^2\psi}d\psi\,,. \quad (12)$$

$$F_l(k)=(-1)^l\int_0^{\pi/2}\frac{\cos(2l\beta\psi)d\psi}{\sqrt{1-k^2\sin^2\psi}}.$$

As shown in (Strelnikova et al., 2020), in relations (12), we set $\beta = 1$ when studying the motion of fluid in shells without partitions, and $\beta = 2$ for shells with vertical partitions, see Fig. 1d). After solving the spectral problem (6), we obtain the basis functions $\varphi_{kl}(r, z)$ and $\zeta_k(r)$, as well as the eigenfrequencies ω_{kl}.

Free vibrations of fluid in cylindrical shells

Let us investigate the free vibrations of a fluid in rigid cylindrical shells without partitions, with horizontal partitions, and with vertical partitions. First, we consider a rigid cylindrical shell with a flat bottom characterized by the following parameters: radius $R = 1$ m and length $L = 2$ m. Let H denote the fluid filling height. The horizontal partition is a circular plate with a central opening (an annular baffle) (see Fig. 1). The vertical coordinate of the partition (its height position) is denoted as $H_1(H_1 < H)$. The radius of the interface surface is denoted as R_{int}. Thus, $H = H_1 + H_2$ and $R_{\text{baf}} = R - R_{\text{int}}$.

The numerical results were obtained using the boundary element method. A total of 150 boundary elements were used along the bottom radius (N_b), 120 elements along the wetted cylindrical parts (N_w), and 150 elements along the radius of the free surface (N_0). Further refinement of the mesh did not lead to significant changes in the results. Different numbers of elements were used on the interface and partition surfaces depending on the baffle radius. In the numerical simulations, various values of R_{int} and H_1were considered. The analytical solution (Gavrilyuk et al., 2008) was employed for comparison and validation of the numerical results. The results are presented in the Table 1 below.

Table 1. Vibration frequencies at $l = 1$ for cylindrical shells.

Reservoir type	ω_{11}	ω_{12}	ω_{13}	ω_{14}	ω_{15}
Unbaffled, BEM	4.1424	7.2286	9.1473	10.7123	11.9624
Analitical solution	4.1424	7.2284	9.1472	10.7112	11.9616
Vertical baffle	5.4582	8.1067	9.8791	11.2574	12.657
Horizontal baffle, BEM	2.6350	6.6446	8.9667	10.6468	11.9876
Analitical solution	2.6350	6.6444	8.9661	10.6467	11.9874

The results for horizontal baffles were obtained for $H_1 = 0.9m$ and $R_{\text{int}} = 0.5m$. The comparison of the results demonstrates the convergence and efficiency of the proposed method, confirming its reliability for analyzing fluid vibrations in cylindrical shells.

Forced vibrations of fluid in cylindrical shells

Let the basis functions $\varphi_k(r, z)$ be already defined. We substitute them into formulas (8) for the free-surface elevation ζ and (9) for velocity potential Φ. The obtained expressions are then applied in the dynamic condition on S_0. As a result, on the free surface we obtain the following relation:

$$\sum_{l=0}^{m} \cos(l\theta) \sum_{k=1}^{n} \left[\ddot{d}_{kl}(t) + \omega_{kl}^2 \left(1 + \frac{a_v(t)}{g}\right) d_{kl}(t)\right] \varphi_{kl}(r, z) + a_h(t) r\cos\theta = 0, z = \zeta\,. \quad (13)$$

By performing the scalar multiplication of equation (13) by the functions $\varphi_{lk} (k = \overline{1, n};\ l = \overline{0, m})$ and applying the orthogonality condition of the eigenmodes (Raynovskyy & Timokha, 2020) we obtain the following system of second-order ordinary differential equations:

$$\ddot{d}_{k0}(t) + \omega_{k0}^2 \left(1 + \frac{a_v(t)}{g}\right) d_{k0}(t) = 0, \quad (14)$$

$$\ddot{d}_{k1}(t) + \omega_{k1}^2 \left(1 + \frac{a_v(t)}{g}\right) d_{k1}(t) + a_h(t) F_{k1} = 0,\ F_{k1} = \frac{(r, \varphi_{k1})}{(\varphi_{k1}, \varphi_{k1})},$$

$$\ddot{d}_{kl}(t) + \omega_{kl}^2 \left(1 + \frac{a_v(t)}{g}\right) d_{kl}(t) = 0, k = \overline{1, n}; l = \overline{2, m}.$$

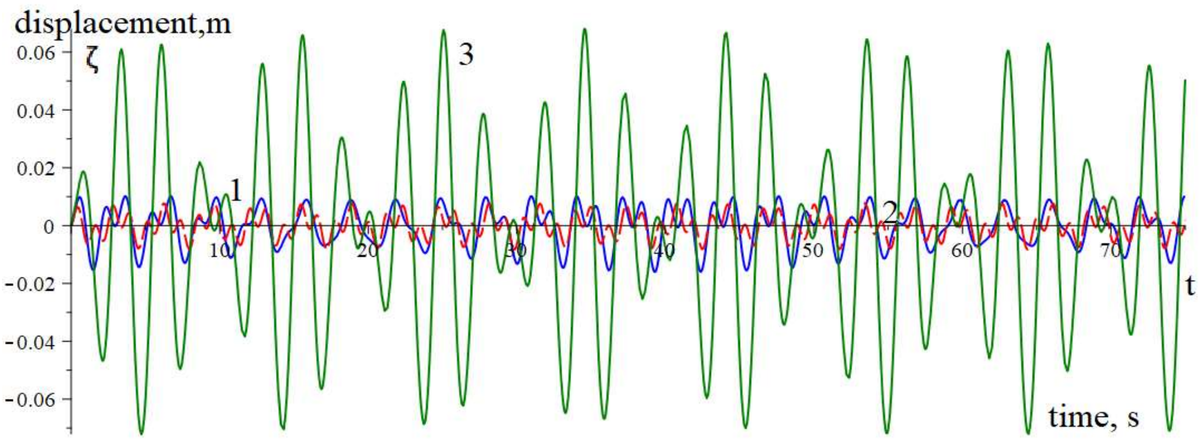
For a unique solution of system (14), it is necessary to specify the initial conditions, that is

$$d_{kl}(t) = d_{kl}^0,\ \dot{d}_{kl}(t) = d_{kl}^1,\ k = \overline{1, n},\ l = \overline{0, m}. \quad (15)$$

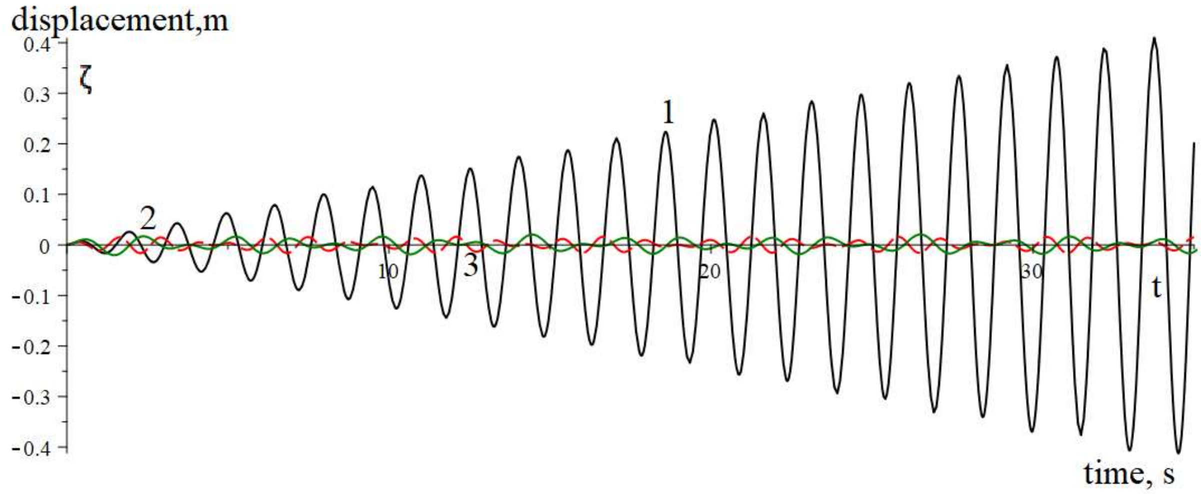
The external loads were selected with the following accelerations

$$a_x(t) = a_h \cos(\omega_h t), a_z(t) = a_v \cos(\omega_v t) \quad (16)$$

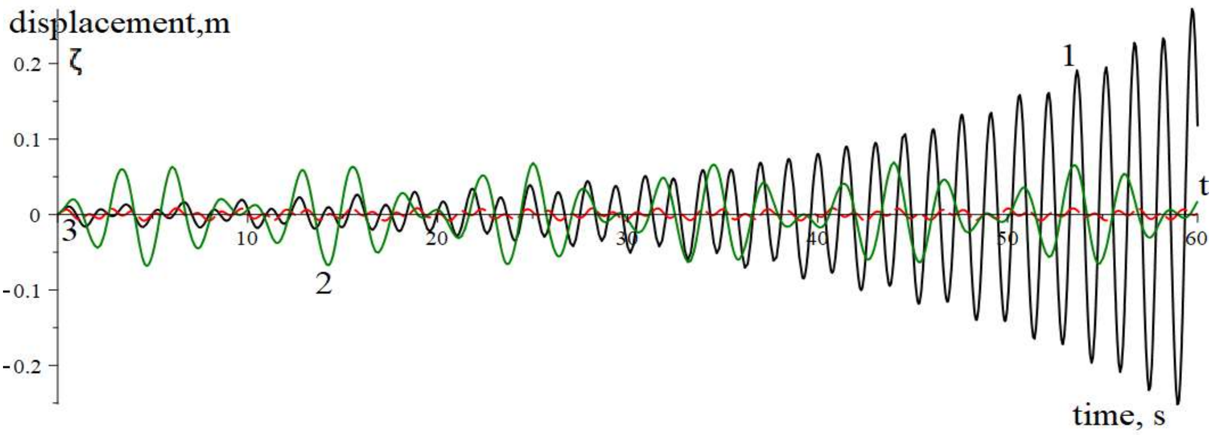
under different values of $a_v, \omega_v, a_h, \omega_h$. Further, the stability of the fluid motion in the tanks under combined loads, both with and without baffles, will be investigated, and the parameters of the baffles that lead to vibration damping will be determined.



(a) $a_v = 1m, \omega_v = 2Hz, a_h = 0.1m, \omega_h = 2Hz.$



(b) $a_v = 1m, \omega_v = 2Hz, a_h = 0.1m, \omega_h = 4.1424Hz$



(c) $a_v = 1m, \omega_v = 8.2848Hz, a_h = 0.1m, \omega_h = 2Hz$

Figure 2. Time-history of free surface level in different cylindrical tanks

Figure 2 illustrates the time histories of free-surface oscillations in tanks with and without internal baffles. Curve 1 corresponds to the unbaffled tank, curve 2 represents the tank with vertical partitions, and curve 3 corresponds to the configuration with a horizontal partition. The obtained results demonstrate that the introduction of partitions leads to a pronounced reduction in the free-surface elevation, confirming their damping effect on sloshing motion. Only in case

(a) was a slight increase in the free-surface level observed after partition installation; however, the motion in this case remained stable.

The excitation frequency of 2 Hz is far from the system's resonance region and therefore produces small, regular oscillations without noticeable amplitude growth. In contrast, the frequency of 4.1424 Hz coincides with the first fundamental natural frequency of the liquid in the tank, resulting in a significant linear amplification of surface motion. When the excitation frequency reaches 8.2848 Hz, which is approximately double the first fundamental frequency, a condition of parametric resonance arises. Under such excitation, the oscillations become strongly amplified (exponential growth), and the system exhibits transitions toward instability. These results highlight the sensitivity of sloshing dynamics to excitation frequency and confirm that the inclusion of partitions can effectively shift resonance boundaries and suppress instability even near parametric excitation conditions.

CONCLUSION AND DISCUSSION

This study presents a comprehensive numerical framework for analyzing the stability of fluid motion in tanks equipped with horizontal and vertical partitions. By integrating potential theory, singular integral equations, and the boundary element method with the subdomain approach and prescribed-mode techniques, the developed method enables a detailed examination of sloshing dynamics under combined horizontal and vertical excitations. The results reveal that partitions substantially modify the frequency spectrum, alter vortex structures, and shift the boundaries of stable and unstable motion.

It was shown that an excitation frequency of 2 Hz lies far from resonance, resulting in stable, low-amplitude oscillations; the frequency of 4.1424 Hz corresponds to the first fundamental mode, where the amplitude of the free surface increases markedly; and 8.2848 Hz, being double the fundamental frequency, leads to parametric resonance and pronounced instability. These observations confirm that the introduction of partitions significantly reduces free-surface elevations and suppresses resonance effects, even near parametric excitation conditions.

The findings indicate that properly designed partitions can effectively suppress sloshing, mitigate dynamic loads, and enhance the overall stability and safety of liquid-filled structures. These insights are directly applicable to the design and optimization of tanks in aerospace, marine, and energy systems where dynamic reliability is critical. Nevertheless, the present analysis is limited by the assumption of an ideal, inviscid, and incompressible liquid. In practical applications, viscous effects, turbulence, and fluid–structure interaction may substantially influence the sloshing response and energy dissipation mechanisms. Future research should therefore extend the current framework to include viscous and nonlinear effects, flexible tank walls, and multiphase or stratified fluids. Experimental validation and high-fidelity CFD simulations would further strengthen the predictive capability of the proposed model and support its integration into engineering design practice.

REFERENCES

Balas O.-M., Doicin C. V. and Cipu E. C. (2023). Analytical and Numerical Model of Sloshing in a Rectangular Tank Subjected to a Braking, *Mathematics*, vol. 11, pp. 949-955, DOI:10.3390/math11040949

Choudhary N., Bora S.N. and Strelnikova E. (2021). Study on liquid sloshing in an annular rigid circular cylindrical tank with damping device placed in liquid domain, *J. Vib. Eng. Tech.*, vol. 9, pp. 1–18, DOI:10.1007/s42417-021-00314-w.

Choudhary N., Rana S., Degtyarev K., Kriutchenko D., and Strelnikova E. (2024), Numerical study on sloshing in coaxial shells, *Vibroengineering Procedia*, Vol. 55, pp. 86–90, Sep. https://doi.org/10.21595/vp.2024.24091.

Degtyariov K., Gnitko, V., Kononenko Y., Kriutchenko D., Sierikova O., Strelnikova E. (2022). Fuzzy methods for modelling earthquake induced sloshing in rigid reservoirs. *2022 IEEE 3rd KhPI Week on Advanced Technology (KhPIWeek).* pp. 1-6, DOI: 10.1109/KhPIWeek57572.2022.9916466.

Gani E., Öztürk S., Sari A. (2025). Effects of Liquid Sloshing in Storage Tanks: An Overview of Analytical, Numerical, and Experimental Studies. *Int J Steel Struct* , vol. 25, pp. 544–556, https://doi.org/10.1007/s13296-025-00946-8.

Gavrilyuk I., Hermann M., Lukovsky I., Solodun O., Timokha A. (2008). Natural Sloshing frequencies in Truncated Conical Tanks, *Engineering Computations*, 25(6),.518 – 540, DOI: 10.1108/02644400810891535.

Gnitko V., Naumenko V., Rozova L. & Strelnikova E. (2016). Multi-Domain Boundary Element Method for Liquid Sloshing Analysis of Tanks with Baffles. *J. of Basic and Appl. Research Int.*, 17(1), pp. 75–87. ISSN: 2395-3438 (P), ISSN: 2395-3446 (O).

Gnitko V.I., Karaiev A.O., Degtyariov K.G., Vierushkin I.A., Strelnikova E.A. (2022). Singular and hypersingular integral equations in fluid–structure interaction analysis. *WIT Transactions on Engineering Sciences,* vol.134, pp.67 – 79, DOI:10.2495/BE450061.

Karaiev A., Strelnikova E. (2020). Liquid Sloshing in Circular Toroidal and Coaxial Cylindrical Shells. In: Ivanov, V., Pavlenko, I., Liaposhchenko, O., Machado, J., Edl, M. (eds) Advances in Design, Simulation and Manufacturing III. DSMIE 2020. Lecture Notes in Mechanical Engineering. Springer, Cham.. https://doi.org/10.1007/978-3-030-50491-5_1

Konopka M., De Rose F., Strauch H., Jetzschmann C., Darkow N., Gerstmann J. (2019). Active slosh control and damping - Simulation and experiment, *Acta Astronautica*, vol. 158, pp. 89-102, , https://doi.org/10.1016/j.actaastro.2018.06.055

Lampart P., Rusanov A., Yershov S., Marcinkowski S., Gardzilewicz A. (2005). Validation of a 3D BANS solver with a state equation of thermally perfect and calorically imperfect gas on a multi-stage low-pressure steam turbine flow, *Journal of Fluids Engineering, Transactions of the ASME*, vol. 127(1), pp. 83–93, DOI: 10.1115/1.185249.

Lamtiuhova S.M. (2025) Mathematical Modeling of Steady Flow Past Circular Cylinder with Splitter Plates by R-Functions Method, *International Journal of Mathematics and Physics*, DOI: 10.26577/ijmph.202516110.

Liu L., Li J., (2022). Dynamic Deformation and Perforation of Ellipsoidal Thin Shell Impacted by Flat-Nose Projectile, *Materials*, vol. 15(12), 4124, OI:10.3390/ma15124124.

Medvedovskaya T., Strelnikova E., Medvedyeva K. (2015). Free Hydroelastic Vibrations of Hydroturbine Head Covers . Intern. J. *Eng. and Advanced Research Technology (IJEART).* vol.1(1), pp. 45 - 50. DOI 10.13140/RG.2.1.3527.4961.

Murawski K. (2020). Technical Stability of Very Slender Rectangular Columns Compressed by Ball-And-Socket Joints without Friction, Int. *Journal of Structural Glass and Advanced Materials Research*, vol. 4(1), pp. 186-208,. DOI: 10.3844/sgamrsp.2020.186.208/

Poguluri S. K., Cho Il H., (2023). Effect of vertical porous baffle on sloshing mitigation of two-layered liquid in a swaying tank, *Ocean Engineering*, vol. 289, Part 1, ,115952, https://www.sciencedirect.com/science/article/pii/S0029801823023363

Raynovskyy I. A. and Timokha A. N., Sloshing in Upright Circular Containers: Theory, Analytical Solutions, and Applications, *CRC Press/Taylor and Francis Group*, 2020, DOI: 0.1201/9780429356711

Sierikova E., Strelnikova E., Koloskov V., Degtyarev K. (2021). The effective elastic parameters determining of threedimensional matrix composites with nanoinclusions. Problems of Emergency Situations. *Proc. of International Scientific-practical Conference. Kharkiv: NUCDU*, pp. 327–328, http://repositsc.nuczu.edu.ua/handle/123456789/13026

Sierikova O., Strelnikova E., Kriutchenko D. (2023) Membrane installation in storage tanks for seismic loads impact protection, Acta Periodica Technologica, Vol. 54, pp. 209-222. https://doi.org/10.2298/APT2354209.

Smetankina N. and Pavlikov V. (2021). Mathematical Model of the Stress State of the Antenna Radome Joint with the Load-Bearing Edging of the Skin Cutout, *ICoRSE 2021. Lecture Notes in Networks and Systems,* vol. 305, pp. 287–295, https://doi.org/10.1007/978-3-030-83368-8_28.

Strelnikova E., Kriutchenko D., Gnitko V. (2019). Liquid Vibrations in Cylindrical Quarter Tank Subjected to Harmonic, Impulse and Seismic Lateral Excitations, *Journal of Mathematics and Statistical Science*, vol.5, pp. 31-41,. Science Signpost Publishing, ISSN 2411-2518.

Strelnikova E., Kriutchenko D., Gnitko V., Tonkonozhenko A. (2020). Liquid Vibrations in Cylindrical Tanks with and Without Baffles Under Lateral and Longitudinal Excitations *International Journal of Applied Mechanics and Engineering*, vol. 25(3), pp.117-132, DOI: https://doi.org/10.2478/ijame-2020-0038.

Strelnikova E., Choudhary N., Degtyariov K., Kriutchenko D., Vierushkin I. (2024). Boundary element method for hypersingular integral equations: Implementation and applications in potential theory. *Engineering Analysis with Boundary Elements*, vol. 169, 105910.

Tong C., Shao Y., Bingham H.B. & Hanssen, FC. W. (2021). An Adaptive Harmonic Polynomial Cell Method with Immersed Boundaries: Accuracy, Stability and Applications. *International Journal for Numerical Methods in Engineering*, vol. 122, pp. 2945–2980, https://doi.org/10.1002/nme.66489, https://doi.org/10.1016/j.enganabound.2024.105999.