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SUMMARIES

Anosov V.N., Lukashevich A.B., Pustoshniy A.V. **Particulars of scaling up the resistance of hydrofoil towed model to full scale.** Pp. 5–16.

The authors consider special features of the method for scaling up the towing resistance of hydrofoil craft to full scale. Lifting system of hydrofoil craft significantly differs from similar systems of conventional vessels and at different speeds it has different geometric parameters (either of hull & hydrofoils or only hydrofoils). These differences when using conventional calculations can lead to significant errors. The paper offers analysis of existing methods of scaling up the resistance of hydrofoil craft to full scale and come to conclusion that main drawback of these methods is not fully correct account of friction resistance of hydrofoils in mixed laminar-turbulent flow conditions. The data suitable for this kind of calculation are formed on the basis of existing experimental data from wind-tunnel tests of models of symmetrical profiles with different relative thickness in the UK National Physics Laboratory and Aerodynamics Institute of Gottingen under mixed laminar-turbulent flow conditions. These data are used for deriving two transcendent equations, which define Reynolds number Rn, corresponding to transition from laminar to turbulent flow conditions for hydrofoil profiles of different relative thickness. Change of friction force coefficient between these two values of Rn (Blasius function and value corresponding to Prandtl-Shlichting equation) is assumed to be linearly dependent on decimal logarithm of Reynolds number. The equations are solved by Newton's method of successive iteration. The results are presented in tables. The paper also presents an example of scaling up the resistance of hydrofoil vessel from model to full scale using the recommended method and two existing methods.
Key words: *hydrofoil craft, mixed laminar-turbulent flow, resistance of hydrofoil vessel.*

Rodionov V.A., Semionicheva E.Ya. **Analysis of results of self-propelled tests of vessel model with water jets carried out according to recommendations of ITTC 24th session.** Pp. 17–32.

The paper presents results of tests of a benchmark self-propelled model of Anthena-type patrol boat with two water jets carried out in test tank. The tests were carried out under the international ITTC program using the ITTC method.

On the basis of results obtained during the tests the researchers analysed hydrodynamic characteristics of basic elements of water jet and its interaction with the vessel hull in operation and bollard-pull modes.

The paper presents results of computations for determination of optimum parameters of water jet for the given vessel and compares them with design values. The paper validates the feasibility of achieving the basic design parameters of water jet for patrol boat of "Anthena" project.

The researchers also compare test results with data from other countries test basins-participants of the international program and specify most probable sources of errors.

Summary includes list of tests performed at the Krylov Institute for the purpose of more accurate prediction of propulsion of fast and high speed naval and commercial ships equipped with water jets.
Key words: *high speed ship, experimental model basin, water jet, prediction of propulsion.*

Afremov A.Sh., Gitnyuk A.P., Levchenko V.I., Mitrofanov E.F., Smolina N.A. **Investigation into hydrodynamics and dynamics of caisson gate of C-1 navigation pass of Saint Petersburg flood protecting system using the experimental facility of rotating arm basin. Development of structure for its safe operation.** Pp. 33–52.

Caisson gates of navigation pass are one of the critical elements of Saint Petersburg flood protecting system. These gates are to close navigation pass just before the start of water level rise in Neva Harbour as a part of the city flood protecting system thus creating barrier to surge coming from Gulf of Finland.

The initial option of caisson gate developed by 2000 according to results of model tests doesn't close safely the navigation pass. When flooding starts there is water level difference between the boards and grounding caisson gate begins to swing with spans up to 3 meters and even more. As a consequence of it structures of C-1 navigation pass system crash against the ground and get damaged.

The paper presents basic results of hydrodynamic investigations using the new experimental facility of rotating arm basin aimed at elimination of these oscillations. The performed works in short time enabled development of improved form of caisson gates of C-1 navigation pass system.

The investigations included following works:

Development of experimental facilities enabling simulation the flow conditions for caisson gate section at Krylov Institute's rotating arm tank.

Identification of causes of self-excited oscillations based on tests and calculations, experimental check and development of recommendations on modification of caisson gate structure and use of flexible mounted and damping elements enabling elimination of self-excited oscillations on sill and provision of safety in extreme conditions.
Key words: *caisson, hydrodynamics, navigation pass system.*

Afremov A.Sh., Smolina N.A. **Development of mathematical model of dynamics and investigation into motion of caisson gate when grounding on sill of C-1 navigation pass system in waves.** Pp. 53–68.

Caisson gates are one of the critical elements of Saint Petersburg flood protecting system. At the threat of flooding caisson gate is transferred from dry dock and set on the sill of navigation pass.

To estimate safety of procedure of setting the caisson gate on the sill the researchers have developed mathematical model of its motion in waves and at surge coming from Gulf of Finland. Mathematical model is built on the grounds of theoretic investigations into unsteady flow and results of model tests. The paper accounts for forces and moments related to filling in of different types of tanks and acting on supports and hull at contact with bottom of navigation pass. The paper considers damping force and moment caused by gates approaching the bottom.

The developed motion model enables predicting motions parameters and caisson gates dynamics when sitting on sill, development of recommendations on dampers and vibration absorbers parameters, rational algorithms of tank filling control.

The paper also gives the results of computations to determine parameters of dampers and vibration absorbers to avoid contact of gates with sill. The paper shows that the use of stabilizing tanks on caisson gates is not justified. Damping forces due to operation of these tanks are small as compared to other types of forces and tanks and only make the structure more complicated, reduce its reliability, increase the cost of maintenance and make it more difficult.

Key words: *caisson, hydrodynamics, waves, navigation pass system, mathematical model, dampers, vibration absorbers.*

Klichko V.V. **Lateral stability of air cushion vehicles.** Pp. 69–118.

The paper presents analysis into forces and moments acting on ACV under variation of its heel and trim, it describes the main features of physical processes in lifting system of such vessels at their heeling over solid ground and water. It also contains estimations of lifting system parameters influence on ACV lateral stability, recommendations on lifting system parameters for provision of required ACV lateral stability. The estimations and analysis of physical processes at ACV heeling are supported by significant number of model and full-scale tests of these ships obtained in recent years.

Key words: *air cushion vehicle, lifting system, lateral stability.*

Klichko V.V., Semionicheva E. Ya., Kolosova E.A. **Development of computerised system for design of ACV lifting system.** Pp. 119–136.

The paper is devoted to issues of ACV lifting system design. The paper describes existing approach to solution of design problems, presents the flowchart of the whole design process, classifies the tasks. The paper also describes components of computerised system for design of ACV flexible skirt. The paper presents detail description of module for computation of geometric parameters of basic board section. The paper shows possibility of automatic generation of plane sections of bow section of flexible skirt by AutoCAD system and the process of developing the surface of flexible skirt bow section by Unigraphics system. The researchers give their assessment of obtained results.

Ключевые слова: *амфибийное судно на воздушной подушке, несущий комплекс, гибкое ограждение, параметры, проектирование, алгоритм расчета, автоматизированная система проектирования.*

Key words: *air cushion vehicle, lifting system, flexible skirt, design.*

Anosov V.N., Dyakova T.A., Kalitin A.I., Lukashevich A.B. **Experimental investigation into parameters of vessel with fully submerged hydrofoils with automatic control in emergency conditions.** Pp. 137–146.

Stable motion of vessel with fully submerged hydrofoils is possible only with automatic control system providing required change of lifting force of hydrofoils for changing vessel motion parameters. Hydrofoil lifting force can be controlled through turning of flaps responding to signals of automatic control system.

When operating a vessel with fully submerged hydrofoils one may face emergency when one or several flaps get out of control and do not provide required functioning of a hydrofoil. Taking account that speed of modern hydrofoil craft with fully submerged hydrofoils is 45-50 knots, such cases can lead to major troubles.

The paper presents results of experimental investigation in test basin of hydrodynamic parameters of hydrofoil craft towed model with fully submerged hydrofoils for different flap failures.

The paper considers three kinds of emergencies:

- failure of flaps of bow underwater hydrofoil which provide vertical stabilization of vessel;
- failure of central flap of stern hydrofoil which provides trim stabilization;
- failure of side flap or stern underwater hydrofoil which provides trim and heel vessel stabilization.

The obtained results were used for dynamics computation of full-scale hydrofoil craft in cases of emergency due to damage of different flaps of hydrofoils.

Key words: *air cushion vehicle, hydrofoil, submerged hydrofoils, emergency.*

Afremov A.Sh., SmolinaN.A. **Investigation into hydrofoil craft motion in cases of emergency caused by flap failures.** Pp. 147–164.

The paper presents the structure of mathematical model of controlled spatial motion of hydrofoil craft in conditions of calm water and sea waves in emergency conditions related to failures of different flaps.

Mathematical model is built up basing on analysis of available experimental data accounting for the theory of unsteady gliding. The researchers obtain structural ratios for hydrodynamic forces and moments both for foil-born type of motion and at hull contacts with water.

The developed motion model enables prediction of spatial motion parameters, probability of loss of foil-borne mode, high accelerations, danger of capsizing. Computation results show basic laws of vessel behaviour in considered emergencies and well correspond to the data obtained through vessel model tests in high-speed towing tank.

The paper shows that in order to decrease dangerous consequences of accidents one should apply special-purpose anti-accident control whose algorithm and signal coefficients depend on the type of failure.

Key words: *hydrofoil craft, mathematical model, gliding, anti-accident control.*

Zaitsev O.A. **Investigation of air cushion vessel take off and landing on test bench.** Pp. 165–172.

When craft takes off and lands on water / ground, there is a danger of losing stability and hull impacts against ground surfaces. A methodology of model tests is developed for take off and landing modes using variation of the air pumps revolution rates and blocking of their air intakes. Unlike static tests, such tests allow determining characteristics of craft landing and stability considering non-stationary nature of the lifting force variations. The paper results could be applied to development of the mathematical model for controlled craft movement during rise take off and landing and in determining safe control algorithms for craft air fans.

Key words: *air cushion vehicle, losing stability, craft landing, safe control algorithms.*

Sizova A.A. **Development of non-linear system for stabilisation in presence of external disturbing effects basing on principle of guaranteed result.** Pp. 173–184.

The synthesis of stabilisation circuit for aircraft normal overload under effect of excitations with unknown statistical properties is addressed. The problem is examined as antagonistic differential game between two players. One player through selection of aircraft controls strives to maximally move the aircraft overload closer to the specified value. Excitation affecting the aircraft is considered as another player whose interests are opposite to that of the first player. A method similar to the method of extreme targeting developed by N.N. Krasovskiy is proposed to solve this differential game. The method is based on calculation of the achievable areas that are common for both players. An iteration algorithm is developed to generate points of the achievable area borders accounting reaction of the second player. Software is developed that implements the proposed algorithm of achievable area generation and demonstrates its efficiency. A differential-game algorithm is developed to select first player controls using method similar to that of extreme targeting. Software for control synthesis in the overload stabilisation circuit under effect of excitations with unknown statistical properties is developed basing on this algorithm.

Ключевые слова: *летательный аппарат, система стабилизации, область достижимости, синтез управления, дифференциально-игровой алгоритм.*

Key words: *aircraft, system for stabilization, differential-game algorithm, stabilization circuit.*

Stanchits I.A. **Theoretical study of planing hydrodynamics.** Pp. 185–198.

The solution of a linear task of a planing plate having a finite width by means of the pressure potential method has been presented, taking into account the weightness of a fluid. The integral equation on the subject of density of circulation on a plate has been solved by the author using collocation technique, applied in the wing theory. The circulation density expands into trigonometric series and the integral equation is solved out in the points of collocation and is reduced to the system of linear algebraical equations relative to the coefficients of terms of series. Calculations of pressure distribution on a plate, coordinates of the centre of pressure and the coefficient of lift force have been made at various aspect ratios of a plate and a numbers of Froude. Comparison of these calculations with experiments shows acceptable agreement of the results.

Key words: *planing plate, pressure, lift force, calculations, experiments, Froude number.*

Gladilin A.V. **Active resonators as mufflers of acoustic noise and signals.** Pp. 199–210.

The physical base for active resonators compensation acoustic fields (noise and signals) is considered, as well as the research results their efficiency and work stability. The method of the adaptive change of the operational regime of the units with the additional sensors for the ventilation system is proposed.

Key words: *acoustic fields, active resonators compensation, ventilation system, adaptive control.*

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