GRAVITY FLUID FLOW PAST A BOAD WITH APPEARANCE OF A VORTEX

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A flow of ideal inviscid incompressible gravity fluid along a semi-infinite board with a vortex is under consideration. Aperiodic solutions (solitary waves) are investigated.

The vector of fluid velocity V in modulo on the free surface is related to the height of the ordinate y by the Bernoulli's equation. Imz=0 on the board, where $z=x+iy$ are the complex coordinates of points.

The ideal fluid flow is solenoidal and potential according to assumptions. The problem solution can be found as the analytic functions of a complex variable $z(\zeta)$, $w(\zeta)$, where ζ is a parametric variable. The range of this variable is a semicircle. The function w is a complex potential. The bounds of flow are impenetrable and the area of flow in the plane of the complex potential is a belt with the half-belt connected with it. This half-belt is an image of the closed flow domain around the vortex.

The problem is solved by the collocation method [1]. The Bernoulli's equation is fulfilled at the discrete points $\sigma_m=\pi m/N$, $m=\overline{1,N}$. Solving the problem by conformal mapping we seek the function $z(\zeta)$ as the sum

$$z(\zeta)=h[z_0(\zeta)+z_1(\zeta)],$$

where $z_0(\zeta)$ is solution of a similar problem for weightless fluid, $z_1(\zeta)$ is a function, which are chosen to fulfill the Bernoulli's equation. Variety of the boundary element method is applied to seek this function. The imaginary part of $z_1(\zeta)$ on the circle $\zeta=e^{i\sigma}$ is presented in the form of a cubic spline $y_1(\sigma)$. The real part $x_1(\sigma)$ is reconstructed by the Schwartz integral. The values $y_1(\sigma)$ at the points σ_m are defined from nonlinear equations system solved by the Newton's method with step variation. The condition that the lift acted to the vortex is equal to zero is used in order to find the point of the vortex location. The second method applied to seek the function $z_1(\zeta)$ is the modified Levi-Chivita method [1]. The error estimates is carried out by the improved Runge's rule.

Coincidence of the two methods results allows to conclude of certainty of obtained estimates.

The detailed results of numerical investigations demonstrate efficiency of the developed algorithms of the problem solution.

References

[1] V. Zhitnikov, N. Sherykhalina, O. Sherykhalin, "Postcritical regimes in the nonlinear problem of vortex motion under the free surface of a weightable fluid", *Trans. from Journal of Applied Mechanics and Technical Physics*, v. 41, No. 1, 2000, Kluwer Academic/ Plenum Publishers, 0021-8944/00/4101-0062, p. 62-68, 2000.