MATHEMATICAL MODEL FOR DETERMINING THE DEVELOPMENT OF CAVITATION IN THE WATER DISCHARGE SYSTEM OF HYDRAULIC FACILITIES

Uktam Ibragimovich Begimov
Alfraganus University, Associate Professor of the Department of Digital Technologies
Sadoqat Shermaxmatovna Sarmonova
Alfraganus University, digital technology department teacher

ANNOTATION: *In solving the problem of cavitation flows, two methods are mainly used: the method of integral equations and the method of finite differences. Theoretical Ryabushinsky or Zhukovsky-Roshko schemes of cavitation flow are used. The growth of cavitation voids in a dispersed mixture occurs near the surface of the liquid interface or in interaction with the inclusion voids. These conditions have a general effect on the nature of the movement of cavitation cavities and, accordingly, on the characteristics of the noise radiated by them and on the production of erosion of the areas. Karkidonsky Reservoir.*

Key words: *method of finite differences, problem, semi-rotational angle of the cone, radius, intensity.*

It is well known that in the finite difference method, the flow field is covered by the nodes, and the velocity potential of the function at the node points -Φ or current function - values are set. In this case, we switch from a continuous function and argument to a discrete function and argument. At each node, the values of the function and the values of the first and second derivatives of the function around the nodes are found. Given at this time -Φ or vine ψ - we construct the analog of the differential equation obtained for the function in finite differences. In finite differences Φ or vine - to find the values of the function, we bring the finite difference analog of the equation to the system of algebraic equations. The solution of the system of algebraic equations is worked out together with finite analogues of boundary conditions.

The method of finite differences requires deep access to the physical meaning of the problem, that is, how the function changes at specific points in the field under consideration, and it requires increasing the accuracy of the calculation level.

We solve the problem of cavitation flow in the Ryabushinsky scheme, for this we construct the odd function on a surface consisting of continuous vortices or in a vortex layer in the following form:

$$\psi = \frac{r}{4\pi}\int_{S_T}\frac{\varsigma_T\cos(\theta-\vartheta)}{\Delta}ds + \frac{r\varsigma_\kappa}{4\pi}\int_{S_\kappa}\frac{cos(\theta-\vartheta)}{\Delta}ds \qquad (1)$$

$\Delta = \sqrt{(x-\xi)^2 + r^2 + r'^2 - 2rr'\cos(\theta - \vartheta)}$ - (x, r, θ) and (x', r', θ') distance between points. S_T - body surface (cavitator); $S_к$ - cavern surface; ς_T and $\varsigma_к$ - the intensity of the layer on which the body and the cavern lie. The intensity of the eddy layer is equal to the velocity of the flowing current and is obtained with the opposite sign.

Homogeneous flow $\psi = \frac{V_\infty r^2}{2}$ - If we work with the function current (1) together with the formula, we get the following system of equations consisting of two integral equations:

$$\sum_{n=1}^{N}\int_{S_T}\frac{\varsigma_{Tn}\cos(\theta-\vartheta)}{\Delta}ds - V_к\int_{S_N}\frac{\cos(\theta-\vartheta)}{\Delta}ds = -2\pi V_\infty r_i \quad (2)$$

$$R = \frac{V_к}{2\pi V_\infty}\int_{S_N}\frac{\cos(\theta-\vartheta)}{\Delta}ds - \frac{1}{2\pi V_\infty}\int_{S_T}\frac{\varsigma_T\cos(\theta-\vartheta)}{\Delta}ds, \quad (x,r)\in S_к \quad (3)$$

We get the initial shape of the cavity from equation (2), and the vorticity distribution ς_{Tn} and speed $V_к$ we will find.soon. Putting the found values on the right side of the equation (3), we get the new size of the cavern, i.e. the new R - find its radius and find its other dimensions. These lines will be continued again.

In modern computational hydromechanics, there is a problem of showing the values and results found in a multi-dimensional problem. L. for approximating formulas in navigation flows. G. Guzevskii obtained results, and these results give the dimensions of the cavern in front of the cones, and we will be able to find the resistance coefficients:

$$\left.\begin{aligned} &\frac{R_к}{R_н} = \sqrt{\frac{C_x}{k\sigma}},.k = \frac{1+50\sigma}{1+56{,}2\sigma} \\ &\frac{L_к}{2R_н} = \left[\frac{1{,}1}{\sigma} - \frac{4(1-2\alpha)}{1+144\alpha^2}\right]\sqrt{C_x\ln\frac{1}{\sigma}} \end{aligned}\right\} \quad (4)$$

$$C_x(\sigma) = C_x(0) + (0{,}524 + 0{,}672\alpha)\sigma_T \qquad 0 \le \sigma \le 0{,}25; \qquad \frac{1}{12} \le \alpha \le \frac{1}{2}.$$

$$C_x = \begin{cases} 0{,}5 + 1{,}81(\alpha - 0{,}25) - 2(\alpha - 0{,}25)^2, \frac{1}{12} \le \alpha \le \frac{1}{2} \\ \alpha(0{,}915 + 9{,}5\alpha)..0 \prec \alpha \prec \frac{1}{12} \end{cases} \quad (5)$$

There $\alpha\pi$ - semi-rotational angle of the cone. If there is a disk in the path of the flow, we get the following formula for its resistance:

$$C_x(\sigma) = 0{,}8275 + 0{,}86\sigma$$

In this formula, if , poluchaetsya Garabedyan's asymptotic result follows.

An example. Advanced cavitation flow in the Pachkamar reservoir hydrochannel

$H = 0{,}5м$ located in depth, radius $R_н = 0{,}01м$ happening behind the disc. The speed of the disk trolley $V_\infty = 15\frac{м}{с}$. According to the calculations, the resistance of the disk $X = 30H$, pressure in the cavern $p_к = 0{,}9825 \cdot 10^5 Па.$ Find the dimensions of the cavern and write the equation of the cavern profile.

Solving. I. We find the number of cavitation:

$$\sigma = \frac{p_a + \rho gH - p_к}{\frac{1}{2}\rho V_\infty^2} = \frac{(1 + 0{,}05 - 0{,}9825)\cdot 10^5}{\frac{1}{2}\cdot 1000 \cdot 225} = 0{,}06$$

2. We find the stickiness.

$$\mu^{(m)} = \frac{1}{2}\ln\left[\frac{2\chi^2}{\sigma}\mu^{(m-1)}\right], \mu^{(0)} = 1, \quad \mu = 1{,}789 .$$

3. We calculate the coefficient of resistance: (1.2.33)

$$C_{x.н} = \frac{X}{\frac{1}{2}\rho V_\infty^2 S_н} = \frac{30}{\frac{1}{2}\cdot 1000 \cdot 225 \cdot 3{,}14 \cdot 10^{-4}} = 0{,}87$$

4. The medial shear radius of the cavern is equal to the following:

$$R_к = R_н\sqrt{\frac{C_{хн}}{\sigma}} = 0{,}01\sqrt{\frac{0{,}87}{0{,}06}} = 0{,}038$$

5. Half length of ellipsoidal cavern:

$$L_к = R_и \frac{\sqrt{2\mu C_{хи}}}{\sigma} = 0{,}01\frac{\sqrt{2\cdot 1{,}789 \cdot 0{,}87}}{0{,}06} = 0{,}294$$

6. The equation that determines the initial part of the cavitating section;

$$R = R_н\left[1 + \frac{1}{2}\left(\frac{\xi}{R_н}\right)^{\frac{2}{3}}\right] = 0{,}01\left[1 + \frac{1}{2}\left(\frac{\xi}{0{,}01}\right)^{\frac{2}{3}}\right]$$

7. Profile of the cavern in the main section:

$$R^2(x) = \frac{\sigma}{2\mu}L_к x\left(2 - \frac{x}{L_к}\right) = \frac{0{,}06}{2\cdot 1{,}789}\cdot 0{,}294x\left(2 - \frac{x}{0{,}294}\right)$$

8. The cutting of the cavern starting from the ellipsoid nose starts at the following distance.

$$x_1 = 4\sqrt{\frac{\mu}{2C_{хн}}}R_н = 4\cdot 0{,}01\sqrt{\frac{1{,}789}{2\cdot 0{,}87}} = 0{,}04м$$

Solving the problem of cavitation flows was carried out by the iteration method. In the initial step, the simple shape of the cavern is taken and the correct problem is solved. In this case, the condition that the pressure does not change in the section of the flow where the cavern is located is not fulfilled. In the next step, the shape of the cavern is corrected without damaging the physical shape, and the cycle of calculations is returned. Accounts jobs are stopped when they get the limt value of the cavern form.

In solving the problem of cavitation flows, two methods are mainly used: the method of integral equations and the method of finite differences. Theoretical Ryabushnnsky or Zhukovsky-Roshko schemes of cavitation flow are used.

REFERENCES:

1. Буйвол В. Н., Лапин В. А., Шевчук Ю. Р. О форме тонких пространственных каверн за круговым диском в весомой жидкости.— Прикл. механика, 1976, 12, № 6, с. 105-110.
2. Нилсен. Дж. Аэродинамика управляемых снарядов.— М. : Оборонгиз, 1962— 474 с.
3. Буйвол В. Н., Степанский П. М. Об уравнениях возмущений границы кавер¬ны, движущейся вблизи твердой стенки.- Гидромеханика, 1973, вып. 24, с. 51-56.
4. Буйвол В. Н., Шевчук Ю. Р. Деформация каверны за наклонным кавитатором.— Гидромеханика, 1981, вып. 43, с.3-10.
5. Шевчук Ю. Р. Об эквивалентных кавитаторах при расчете каверн за эллип¬тическими насадками.— Там же, 1978, вып. 37, с. 67—72.
6. Бегимов Ў.И., Худайкулов С.И. “Моделирование движений возмущенной каверны и появления кавитации, пульсации потока”, «Муҳаммад ал-хоразмий авлодлари» №3(9), Тошкент-2019. С. 39-41.
7. U.I. Begimov, “Spatial caverns in flows with disturbances and their influence on the safety of hydraulic structures” International scientific journal «Global science and innovations 2020: Central Asia» Nur-Sultan, Kazakhstan, Feb-march 2020.