DYNAMIC ACTION OF IMPULSE WAVES ON A FRONT FACE OF A WAVE DAMPENER

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Based on a linear theory about the potential wave motion of water, the author earlier obtained an analytic dependance according to which the entire process of the wave interaction with a front face of a hydraulic structure and partially with a wave dampener located by the water surface on a sea shelf or on a bank of the basin which is fixed to the bottom by the cables.

According to the proposed model, as a result of an impulse action of spring (schematizing strong gust) the wave having a complicated shape is generated. An interaction of the wave with the structure will be described by a dynamic wave load varying in time as a result of both the wave setup on the structure and the return from it.

Key words: impulse wave, hydraulic structure, wave load, shelf, bank of basin.

In deterministic and analytic approaches the wave loads on the hydraulic structures are usually considered based on modelling the wave process as a motion of a periodic progressive wave with constant height, length and shape [1,2]. In case of the impulse, partially storm, actions another approach is applied in studying the wave process [3].

At the same time, it is suggested that in the boundary section ab of the area abcd of the sea shelf (figure), the wave is generated as a result of the impulse actions (of strong gust) during the short time interval $0<t\leq t_s$. It is required to determine the wave load on the front face of the wave dampener (in section cd) fixed to the bottom by the cables.

Mathematical modelling of an involved phenomenon is performed based on a theory of nonstationary flow of the potential plane wave. General solution of the mentioned two-dimensional task was obtained by the author in form of velocity potential φ(x,z,t) [3].

Under the mentioned solution, the dynamic load on the structure, H/m^2, in section x=*l* (figure) is specified in form of:

$$\mathbf{p}_{din} = \rho\frac{\partial\varphi}{\partial \mathbf{t}} - \mathbf{p}_s = \rho\frac{\partial\varphi}{\partial \mathbf{t}} + \rho \mathbf{gz}, \tag{1}$$

where ρ - water density, g – acceleration of a free fall, p_s – hydrostatic pressure,

$$\frac{\partial\varphi}{\partial \mathbf{t}} = \frac{1}{2}\varphi_0' + \sum_{n=1}^{\infty}\frac{\partial\varphi_n}{\partial \mathbf{t}}\cos \mathbf{a}_n \boldsymbol{l}\,; \tag{2}$$

$$\mathbf{a}_n = \frac{n\pi}{\boldsymbol{l}},\ n = 1,2,\ldots;\quad l \text{ – sea shelf length;}$$

$$\varphi_0' = -\mathbf{g}\frac{2}{\boldsymbol{l}}\left[\mathbf{W}_m\mathbf{h} - \mathbf{V}(\mathbf{d}_c - \mathbf{h})\right]\mathbf{t}_s\,;$$

$$\frac{\partial\varphi_n}{\partial t} = -\frac{2}{l}\left[W_m I_n^{(1)} - V\cdot I_n^{(2)}\right] B_n(z) i_n^{'};$$

$$i_n^{'} = \sin\gamma_n\frac{t_s}{2}\cos\gamma_n\left(t-\frac{t_s}{2}\right), \quad \gamma_n = \sqrt{a_n g t h a_n h};$$

$$I_n^{(1)} = -\frac{1}{a_n} sh a_n h, \quad I_n^{(2)} = -\frac{1}{a_n} sh a_n (h - d_c);$$

$$B_n(z) = \frac{1}{ch a_n h}\left(\frac{\gamma_n}{a_n} sh a_n z + \frac{g}{\gamma_n} ch a_n z\right);$$

W_m – calculated value of a wind action (velocity) ; v – velocity of the wave flow under the structure (in section cd) in $-h\le z\le -d_c$ (figure); h – basin depth.

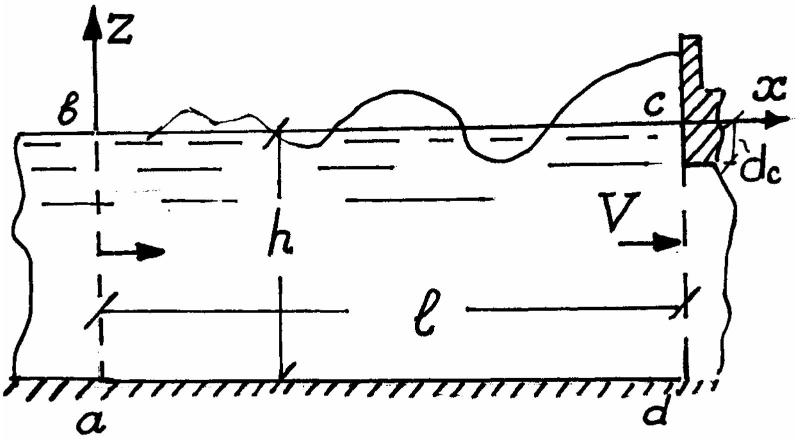

Figure 1. Design scheme of interaction of an impulse wind wave with a wave dampener located on a sea shelf

Based on (2), total horizontal dynamic pressure on a submarine part of the front face of a barrier is estimated according to the following dependence:

$$P_{din} = \rho g z b_c d_c - \rho g b_c d_c \frac{1}{l}\left[W_n h - V(d_1 - h)\right] t_s -$$

$$-\rho\frac{2}{l} b_c \sum_{n=1}^{\infty}\left[W_n I_n^{(1)} - (-1)^n V I_n^{(2)}\right]\left(\frac{\gamma_n}{a_n} J_{1,n} + \frac{g}{\gamma_n} J_{2,n}\right)\frac{i_n^{'}}{ch a_n h}\cos a_n l, \qquad (3)$$

where,

$$J_{1,n} = \int_{-d_c}^{0} sh a_n z d_z = \frac{1}{a_n}(1 - ch a_n d_c); \quad J_{2,n} = \int_{-d_c}^{0} sh a_n z d_z = \frac{1}{a_n} sh a_n d_c.$$

In a simpler case, if it is assumed that the wave has a form of a periodic progressive wave, the formula for approximate determination of the value P_{din} is significantly simplified compared to the expression (3) [3].

R E F E R E N C E S

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