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Correction of the design dependence of the continuous wave force formed during the movement of continuous mudflow with constant flow rate

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Abstract
Taking into account the continuous wave velocity formed during the movement of continuous mudflow with constant flow rate, the design dependence of the mudflow impact force was corrected, according to which the wave impact of continuous mudflow on a structure is more accurately reflected, which is of great importance in the development of effective anti-mudflow engineering technologies.

Keywords: mudflow, anti-mudflow structure, continuous wave.

Introduction

The steady (stationary) one value of the parameters of the mudflow movement, due to the sluggish flow rate change, gradually turns into another steady motion, without dynamic effects, which are associated with inertia or momentum. In this case, continuous waves are always observed. This quasi-stationary phenomenon is observed everywhere, when the forces of gravity are gradually balanced by the forces of resistance. Let us consider two cases: the motion of continuous waves with constant and variable flows [1].

Naturally, the flow rate of a continuous mudflow, in the mode of stationary equal movement, depends on the depth H.

The continuous wave velocity Vw, which passes through control sections 1-1 and 2-2 (Fig. 1) can be determined from the continuity condition; In this case, we have the following equation:

$Q - \omega Vw = Q + \delta Q - Vw(\omega + \delta\omega)$, (1)

Where:

Q – is a flow rate in 1-1 section; Q + δQ - is a flow rate in 2-2 section; ω – is an effective cross- section of flow in 1-1 section; ω + δω - - is an effective cross-section of flow in 2-2 section; Vw - continuous wave velocity.

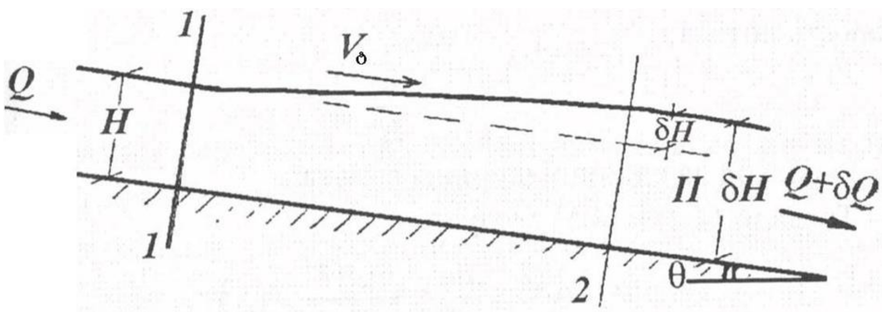

Fig. 1: The design scheme of continuous mudflow wave with constant flow rate along the riverbed.

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(1) According to formula:

Vw = 6Q, (2)
6ω

Considering, that

Q = Vω, (3)

Accordingly, instead of (2) formula we have:
Vw = 6(ωV) = V 6ω + ω 6V (4)
6ω 6ω 6ω

or Vw = V + ω 6V, (5)
6ω

Where,
V – is the average flow velocity in effective cross-section.
(5) According to the formula, the continuous wave velocity Vw in the effective cross-section
is greater by ω 6V value than the average flow velocity.
6ω
The flow rate of continuous mudflow with equal modes of motion is equal to:

Q = BgiH3 ƒ(β), (6)
ꮛъ

Where,
νъ = μъ/ρъ - is a kinematic viscosity of continuous mudflow; μъ - is a dynamic viscosity of continuous mudflow; ρъ - is a density of continuous mudflow.
ƒ(β) = β (β2 — 1) + 1 (1 — β3). (7)
2 3
The average flow velocity in the riverbad with a rectangular cross section is equal to:

V = q
H (8)
Where q – is a discharge per unit flow width.
Then, from formulas (2) and (5) the following is obtained:

V = 6Q = dq = 3giH2 ƒ(β) (9)
W 6ω dH ꮛ
(7) Considering the (7) formula:

V = Q = q = giH2 ƒ(β). (10)
Ω H ꮛъ

By comparing formulas (8) and (9), we obtain:
Vw = 3 V . (11)

Thus, a continuous wave velocity is three times higher than the average flow velocity in the effective cross-section.
In order to consider the result of the above reasoning in the formula [2, 3] for assessing the impact of mudflow on permeable type anti-mudflow structures, during the movement of the straight flow of continuous waves with a contant flow, the mean velocity of continuous mudflow must be multiplied by 3, i.e. we'll have 3 V instead of V , which will more accurately reflect the wave effect of continuous mudflow on the structure. Accordingly, the dependence will take the following form:

mudflow on the structure. Accordingly, the dependence will take the following form:

$$P = \frac{1,5\cdot\gamma\cdot\omega\cdot 3V^2}{g}\cdot\left[\cos\alpha\cdot tg\varphi + \frac{h_0}{2\cdot H}\left(\frac{1-\sin\varphi}{\cos\varphi}\right)\right] \qquad (12)$$

To clarify the validity of the corrected formula, the results obtained were compared with the results received through dependences, presented by other authors [4] (Fig. 2).

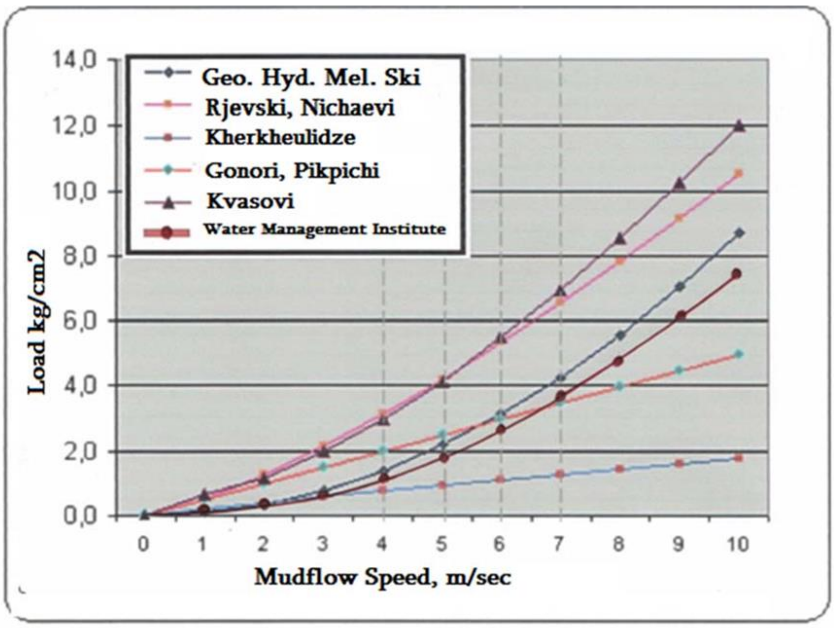

Fig 2:. Comparative diagram of the dependence of the increase and speed of mudflow loads on the impedance

Thus, it can be seen from the diagram that the results obtained with the clarified dependence are close to the results obtained in the experiment carried out in kind, which gives us reason to recommend
this dependence for assessing the impact of continuous mudflow on anti-mudflow structures, during the movement of the straight flow with a contant flow rate.

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