ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 1, January 2019

Pilot Study Of Process Of Washout In Channels Coherent Soil

Sobir Eshev, Ashraf Raximov, Abdulla Norchayev, Musliddin Zaripov

Professor, Karshi Engineering and Economic Institute, Karshi, Uzbekistan
Assistant, Karshi Engineering and Economic Institute, Karshi, Uzbekistan
Assistant, Karshi Engineering and Economic Institute, Karshi, Uzbekistan
Assistant, Karshi Engineering and Economic Institute, Karshi, Uzbekistan

ABSTRACT. In article results of pilot studies on establishment of not washing away speeds of a water stream are given in channels the lying coherent soil. The modified dependences for determination of not washing away flow rates in trapezoidal channels coherent soil are offered.

KEYWORDS: Not washing away speed, force of adhesion, coherent soil, washout, the trapezoid channel.

I. INTRODUCTION

In initial design stages one of the main questions of a problem of hydraulic calculation of the channel is determination of the sizes of its cross section and the value allowed not washing away speed providing stability of the course and durability of a construction. At a right choice of value of not washing away speed of a possibility of planned and deep deformations of the course of the channel and also deformations on its length are considerably reduced. In literature there is a large number of estimated dependences of recommendations about establishment of the sizes of cross section and values of not washing away flow rates in earth courses.

Studying of not washing away speeds is connected with a research of a channel stream. Interaction of a stream and the course is studied by the experimental and theoretical way based on identification of extreme balance of separate particles or the initial moment of their shift with a bottom. At washout of courses the nature of a stream determines active forces, and properties of soil – passive (resistance forces).

II. SIGNIFICANCE OF THE SYSTEM

In article results of pilot studies on establishment of not washing away speeds of a water stream are given in channels the lying coherent soil. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion

III. LITERATURE SURVEY

The study of not washing away speed of the water flow has been involved since the 17th century, and so far this issue has not been completely resolved. Currently, there are a large number of formulas for defining non-blurring water flow rates for disconnected and cohesive soils, both empirical and derived from various prerequisites for the limiting equilibrium of particles, with the introduction of a number of additional parameters to take into account various factors affecting soil erosion and empirical coefficients [1, 2, 3,4, 5, 7, 9.].

For an approximate assessment of the resistance to erosion of cohesive soils, existing dependencies for cohesive soils can be used. V.N. Goncharova [1], I.V. Egizarova[2], V.S. Knoroza [3], G.I. Shamov [6] and others.

The analysis of the existing dependences shows that, both as non-cohesive soils and for more fully, in cohesive soils conditions, the main factors in the Ts.E.Mirtskhulava [4] formula, which are reflected in the regulations, are taken into account.

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IV. METHODOLOGY

The issue of process of washout of a water stream in coherent soil is a little studied in comparison with incoherent soil. The analysis of the existing dependences shows that as well as for incoherent soil more fully in the conditions of coherent soil major factors in dependences the academician S.E. Mirtskhulava which found reflection in normative documents are considered:

$$\vartheta_H = \left(\lg \frac{8 \cdot 8h}{d}\right)\sqrt{\frac{2m_2}{2,6\rho n_1}\left[g(\rho_s - \rho)d + a_1 C_{y2}^H K_2\right]} \quad (1)$$

$$\vartheta_{\Delta H} = 1,25\sqrt{\frac{2m_2}{2,6\rho n_2}\left[g(\rho_s - \rho)d + a_1 C_{y2}^H K_2\right]} \quad (2)$$

where; $a_1 - 1,25$; $C_{y2}^{н}$ – standard fatigue durability of soil for coherent soil, Pa; $C_{y2}^{н} = 0,35C_n$ where C_n – standard specific coupling of a blanket of soil in line with the channel; K_2 – coefficient of a deviation of forces of adhesion from average value, usually $K_2 = 0,5$; m_2 - coefficient of working conditions; n_2 - overload coefficient under the influence of the pulsation nature of speeds and other cases of change of the washing-away ability of a stream $n_2 = \left(\vartheta_{\Delta \max} / \vartheta_{\Delta m}\right)^2$, $\vartheta_{\Delta \max}, \vartheta_{\Delta m}$ - respectively maximum instant and average (on time) ground speeds.

The washing-away speeds of a water stream in coherent soil, are caused by many interacting and interconnected factors. Physic-mechanical properties of soil concern them. These are such factors as humidity, moisture capacity, water proofers, coupling, density, specific weight, mechanical structure, structure, plastic properties, mineralogical structure, salinity and suffusions properties, water permeability, etc.

Table-1
Physic-mechanical indicators of soil

Soil	1 Medium loam	2. Medium loam	3. Medium loam	4. Sandy loam	5. Sandy loam	6. Small. sand.
$V_{гр}$, g/sm^3	27,10	27,98	24,09	21,27	18,39	13,69
V_{ck} g/sm^3	1,95	1,93	1,96	2,03	2,11	1,98
ρ , g/sm^3	1,53	1,51	1,58	1,67	1,78	1,74
n, %	2,72	2,70	2,72	2,69	2,68	2,68
ε	43,75	44,07	41,91	37,92	33,58	35,07
I_w	0,78	0,79	0,72	0,61	0,50	0,54
W_{max} , %	0,94	0,96	0,91	0,94	0,98	0,66
γ ,g/sm^3	28,68	29,26	26,47	22,68	18,66	20,15
W_T, %	0,97	0,45	1,0	1,05	1,12	1,09
W_p, %	24,04	26,0	21,53	20,0	-	-
I_p	17,40	18,0	15,39	14,0	-	-
I_L	0.07	0,08	0,061	0,06	-	-

ISSN: 2350-0328
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V. EXPERIMENTAL RESULTS

Laboratory researches on establishment of the key physic-mechanical indicators of soil were conducted by the standard methods. Tests of samples of soil were carried out in laboratories of "The bases and the bases" and "Engineering – geological researches" of TSNIIS of the Russian Federation.

The technique of preparation of coherent soil for tests completely corresponded to S. E. Mirtskhulava's technique stated in work [4].

The erosion of coherent soil strongly depends on the size of their coupling. Coupling of coherent soil at their full water saturation in many respects determines durability of communications and the water resistance of clay breeds better than other indicators integrally reflects all complex of properties of the soil characterizing the resilience of coherent soil to washout (fig. 1).

It is established that with increase in coupling (in a condition of full water saturation) resistance of soil to washout (fig. 1) increases. Resistance of coherent soil to shift is expressed by a formula [8]:

$$\tau = Ptg\varphi + C \qquad (3)$$

where - resistance to shift depending on the normal pressure and density humidity; - normal pressure; - the angle of internal friction which is also depending on density humidity – coupling.

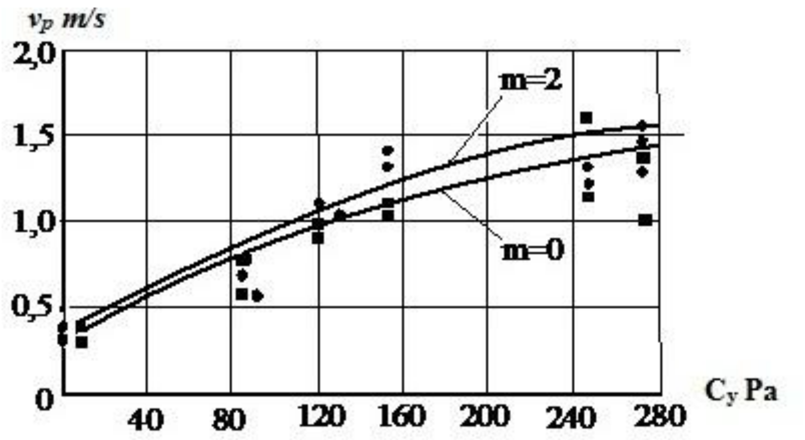

Fig. 1. Dependence of the washing-away average flow rates on the fatigue strength of a rupture of coherent soil: - at the bottom (m=0); - on a slope (m=2).

The carried-out tests of soil showed what resistance to shift grows with increase in maintenance of clay particles and minerals (fig.2).

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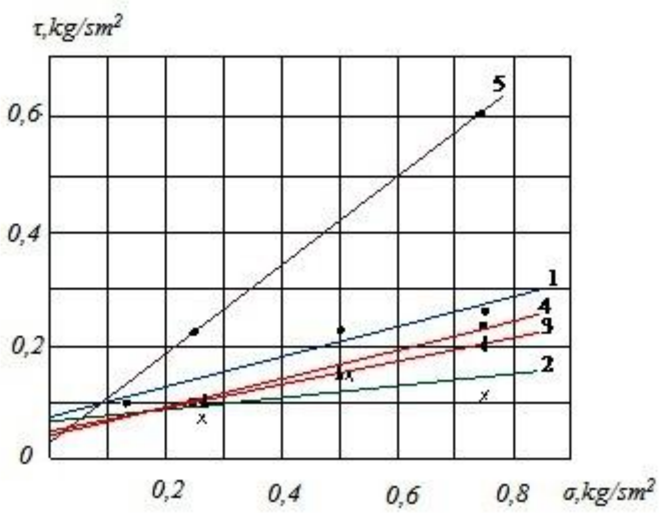

Fig. 2. Extreme resistance of the connected soil to shift

Washout of coherent soil results from dynamic impact of a water stream on separate particles and their units which causes destruction of communications of these particles and units with the soil massif and the subsequent their separation from the massif.

For use of dependences of not washing away speeds of a water stream in open channels rather full data on structure of a stream and properties of soil of a bed of the channel are required.

However in the offered formulas (1)-(2) not all factors are considered. For example, the cross section of the trapezoid channel as earth channels is under construction in a trapezoid form of section.

For the purpose of obtaining parameter considering a form of cross section of the trapezoid channel in the conditions of coherent soil on the basis of dependences of the academician Ts.E. Mirtskhulava pilot studies on a small hydraulic tray were conducted. On this tray the model of the trapezoid channel which has the following sizes was reproduced: length - 8.5 m; width on a bottom – 0.30 m; height – 0.15 m; laying of a slope – m = 2.

The technique of preparation of coherent soil for tests completely corresponded to S.E. Mirtskhulava's technique stated in work [4].

At observation of process of washout it was found out that washout of soil happens in several stages. In the beginning elementary disperse particles (units, separateness) which communication generally is broken by the massif of soil are washed away. This process continues before formation of a rough surface. At further increase of speeds of a water stream undermining of particles (unit) begins with the party turned against the current, causing increase pulsing front and lifting efforts. Increase in the pulsing front and lifting effort of a current increases vibration and dynamic effort to a ledge (unit) that leads to gradual destruction and at last when equally effective active forces surpasses passive – forces of adhesion between units and unit weight, the last instantly breaks

Us taken attempts of specification of coefficient in dependences (1-2) for conditions of trapezoid channels [9]. It is as a result received that the average value is equal for a bottom, and for when laying a slope it is equal i.e. the dependence (1)-(2) not washing away speeds respectively has the following appearance:

$$\vartheta_H = \lg\frac{8.8h}{d}\sqrt{\frac{2m_2}{2,6\rho n_2}\left[g(\rho_S-\rho)d+3,25C_{y2}^H K_2\right]}; \qquad (4)$$

$$\vartheta_{\Delta H} = 1,25\sqrt{\frac{2m_2}{2,6\rho n_2}\left[g(\rho_S-\rho)d+3,25C_{y2}^H K_2\right]}, \qquad (5)$$

$$\vartheta_H = \lg\frac{8.8h}{d}\sqrt{\frac{2m_2}{2,6\rho n_2}\left[g(\rho_S-\rho)d+3,42C_{y2}^H K_2\right]}; \qquad (6)$$

$$\vartheta_{\Delta H} = 1,25\sqrt{\frac{2m_2}{2,6\rho n_2}\left[g(\rho_S-\rho)d + 3,42C_{y2}^{H}K_2\right]}. \qquad (7)$$

In fig. 4 results of comparison of the experimental data with calculated on dependences are displayed

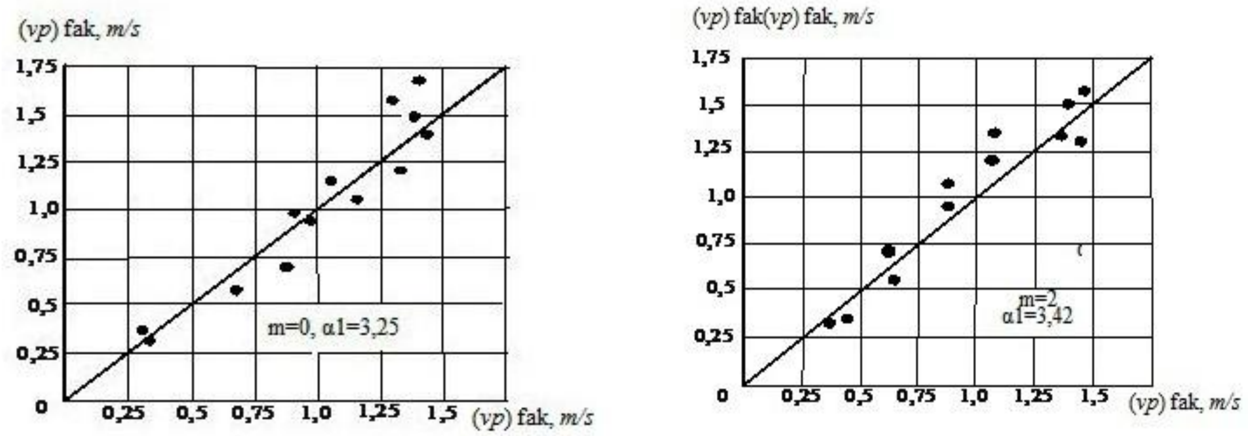

Fig. 4. Comparison of the washing-away speeds in the conditions of coherent soil from a settlement dependences.

From tab. 1. it is visible what with growth of value decreases values that demonstrates communication of these sizes (fig. 5).

Table-1

B/h	4	5	6	7	8	9	10	11	12	13
a_1''/a_1'	2,25	1,9	1,65	1,4	1,25	1,15	1,05	1,03	1,01	1,0

In fig. 5 it is shown the curve constructed on dependence

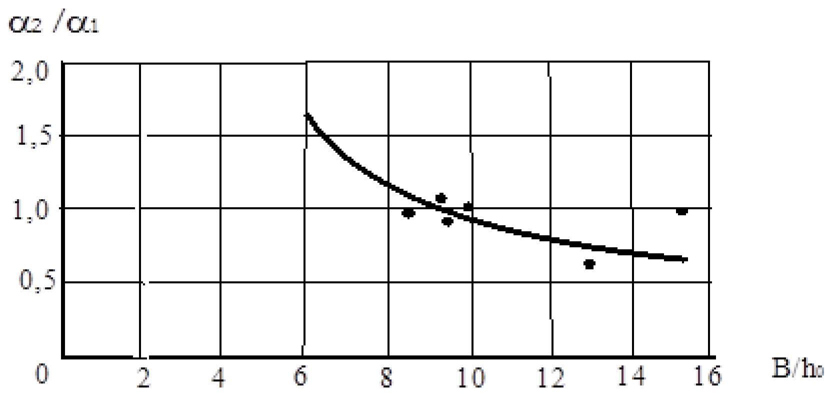

Fig. 5. Schedule of dependence $a_1''/a_1' = f\left(B/h\right)$

Comparison of the experimental data on washout in the coherent soil calculated on Mirtskhulava's formula shows what the actual values of the washing-away speeds considerably exceeds settlement. This results from the fact that our skilled points are received for conditions of the trapezoid channel in which coastal slopes of considerable degree define stream hydraulics.

VI. CONCLUSION AND FUTURE WORK

Thus, the analysis of these calculations allows to draw a conclusion on reliability of the offered formulas (4) … (7) and it is possible to recommend them for establishment of not washing away speeds of a water stream at design of the earth trapezoid channels lying in coherent soil.

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Issue 1, January 2019

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