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CALCULATION OF THE PARAMETERS OF THE BASE ROWS IN A NON-STATIONARY FLOW

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Abstract. *To date, numerous field and laboratory studies have been conducted worldwide on the movement of bedforms occurring in alluvial channels. Some authors have attempted to generalize this information, but so far they have not been able to achieve completely reliable results. Analysis of the available literature shows that this problem remains one of the main challenges in open channel hydraulics. The analysis of the obtained data indicates that the parameters of the bedforms also change depending on the variation in wave parameters. From this, we can conclude that the bedforms that occur under the influence of wind waves have larger dimensions compared to those in a steady state of channel flow. Indeed, under the influence of waves, an increase in the tangential stresses on the channel bed is observed, which leads to an increase in the parameters of the bedforms.*

Key words: *unsteady flow, ridges, steepness of ridges, gullies, gullies movement, deformation, bedrock, roughness, hydraulic resistance, dynamic velocity, shear velocity, wind waves, drag force.*

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NOSTATSIONAR OQIMDA O‘ZAN TUBI GRYADLARNING PARAMETRLARI HISOBI

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Annotatsiya. *Bugungi kunga qadar dunyoda grunt o‘zanli kanallarda sodir bo‘ladigan gryadlarning harakati bo‘yicha ko‘plab dala va laboratoriya tadqiqotlari ma’lumotlari olingan. Ba’zi mualliflar ushbu ma’lumotni umumlashtirishga urinishgan, ammo hozirgacha ular to‘liq ishonchli natijalarga erisha olishmagan va mavjud adabiyotlarni tahlili shuni ko‘rsatadiki, bu muammo ochiq o‘zanlar gidravlikasining asosiy masalalaridan biri bo‘lib hisoblanadi. Olingan ma’lumotlarning tahlil natijalaridan shuni ko‘rsatish mumkinki, to‘lqin parametrlarining o‘zgarishiga bog‘liq holda gryadlarning ham parametrlari o‘zgaradi. Bundan kanal oqimining statsionar holatidagi gryadlarga nisbatan ularga shamol to‘lqinlari ta’sir etganda sodir bo‘ladigan gryadlar kattaroq o‘lchamlarga ega bo‘ladi deb qarashimiz mumkin. Haqiqatan ham, to‘lqinlar ta’siri ostida o‘zan tubi tangentsial kuchlanishlarning ortishi kuzatiladi va buning natijasida gryadlarning parametrlarini kattalashishiga olib keladi.*

Ochiq o‘zanlardagi oqiziqlarning gryadli ko‘rinishda tashilishing hisob usuli negizida kanaldagi suvning statsionar va nostatsionar harakatlari sharoitlarida oqiziqlar tashilishining hisob usuli takomillashtirildi.

Kalit so‘zlar: *nostatsionar oqim, gryadlar, gryadlarning tikligi, oqiziqlar, oqiziqlar harakati, deformasiya, o‘zan tubi, g‘adir-budirligi, gidravlik qarshilik, dinamik tezlik, siljish tezligi, shamol to‘lqinlar, olib ketuvchi kuch.*

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РАСЧЕТ ПАРАМЕТРОВ ДОННЫХ ГРЯД В НЕСТАЦИОНАРНОМ ПОТОКЕ

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Аннотация. *На сегодняшний день в мире получены данные многочисленных полевых и лабораторных исследований движения гряд, происходящих в каналах с грунтовым руслом. Некоторые авторы пытались обобщить эту информацию, но до сих пор они не достигли полностью достоверных результатов, и анализ имеющейся литературы показывает, что* *эта проблема остается одной из основных задач гидравлики открытых русел. Результаты анализа полученных данных показывают, что параметры гряд изменяются в зависимости от изменения параметров волны. Исходя из этого, можно предположить, что гряды, возникающие при воздействии на них ветровых волн, имеют большие размеры по сравнению с грядами в стационарном состоянии потока канала. Действительно, под воздействием волн наблюдается увеличение донных тангенциальных напряжений, что приводит к увеличению параметров гряд.*

На основе метода расчета грядового перемещения наносов в открытых руслах усовершенствован метод расчета транспорта наносов в условиях стационарного и нестационарного движения воды в канале.

Ключевые слова: *неустановившийся поток, хребты, крутизна хребтов, овраги, движение оврагов, деформация, коренная порода, шероховатость, гидравлическое сопротивление, динамическая скорость, скорость сдвига, ветровые волны, сила сопротивления.*

Introduction

This article aims to determine the dimensions of ridges that form at the bottom of a canal when wind waves affect the water flow, i.e., during non-stationary movement. In this non-stationary flow state, the process of ridge formation being studied is much more complex than the bed ridges that occur in steady flow. In addition to the kinematic parameters of the flow, the parameters of wind waves also influence the course of this process. Therefore, today, solving the problem of determining the parameters of ridges that arise under the influence of waves on unidirectional flow plays an important role in the design, construction, and operation of canals and is of great interest to researchers. Numerous theoretical, laboratory, and field studies on determining the flow rate of sediments in channels with and without ridges were conducted by S.T. Altunin, V.S. Altunin, V.S. Borovkov, K.V. Grishanin, V.K. Debolsky, Y.A. Ibadzade, I.G. Kantardji, I.F. Karasev, V.S. Knoroz, Z.D. Kopaliani, Y.M. Kuzminov, E.I. Mass, I.I. Levi, B.F. Snishchenko, E.K. Rabkova, N.S. Znamenskaya, P. Akkers, L. Van-Rijn, J.D. Johnson, J. Kennedy, H. Einstein, R. Engelund, A.H. Abalyans, K.Sh. Latipov, Kh.A. Ismagilov, A.M. Mukhamedov, R.M. Karimov, M.R. Bakiyev, E.J. Makhmudov, A.M. Arifjanov, D.R. Bazarov, S.S. Eshev, T. Majidov and other researchers [1-6, 9, 10, 11, 12].

Style and Materials

Currently, research on the process of bedforms occurring in unsteady flow conditions is being conducted based on existing theoretical and experimental studies. The movement of sediments in bedform patterns begins with the initiation of sediment motion and concludes with their rolling, saltation, and suspended states.

The following factors have a greater influence on the formation of ridges:

turbulence of the flow;

The steepness of the ridges. h_{gr} / ℓ_{gr}

The article examines the formation of ridges that occur when wind waves affect unidirectional flow in channels, and the determination of their parameters. To investigate this issue, research was conducted in the flume of the Karshi State Technical University laboratory. Trapezoidal channel models with various side slope coefficients $m = 2{,}0;\ 2{,}5;\ 3{,}0;\ 3{,}5$ were constructed from sand inside an iron flume, and experiments were carried out in three stages for each side slope [9, 10].

The experimental data were statistically processed. The analysis of the obtained results shows that the parameters (h_v, λ_v) of the ridges also change depending on the variation in wave parameters $\left(h_{vgr}, \ell_{vgr}\right)$. From this, we can conclude that the ridges formed under the influence of wind waves have larger dimensions compared to those in the stationary state of the channel flow. Indeed, under the influence of waves, an increase in tangential stresses on the channel bed is observed, which leads to an increase in the parameters of the ridges. First, we will consider calculating the height of the ridges for the aforementioned case. For this purpose, we will use both laboratory and field data.

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Based on our observations mentioned above, it is possible to formulate empirical relationships for calculating the changes in ridges formed during stationary motion under the influence of waves.

For the height of ridges occurring under the influence of non-stationary flow

$$\frac{h_{vgr}}{h_{gr}} = 1 + 2,21\frac{\lambda_v}{h_0}, \qquad (1)$$

and as for its length

$$\frac{\ell_{vgr}}{\ell_{gr}} = 1 + 0,20\frac{\lambda_v}{h_0}. \qquad (2)$$

We write down the relationships.

We express these empirical formulas in the following corresponding form:

$$h_{vgr} = h_{gr}\left(1 + 2,21\frac{\lambda_v}{h_0}\right); \qquad (3)$$

$$\ell_{vgr} = \ell_{gr}\left(1 + 0,20\frac{\lambda_v}{h_0}\right), \qquad (4)$$

here, (h_v, λ_v) represent the height and length of waves, respectively; (h_{gr}, ℓ_{gr}) denote the height and length of ridges that occur in flow without waves in channels, which are determined by the formulas [3-6, 9, 10] we proposed; (h_{vgr}, ℓ_{vgr}) represent the height and length of ridges, respectively, that form when waves affect the flow; and h_0 is the average flow depth.

The laboratory experimental data and calculated values using formula (4) for determining the height of riverbed dunes occurring during unsteady water flow have been incorporated into the obtained results. Additionally, regression analysis is shown in Figure 2.

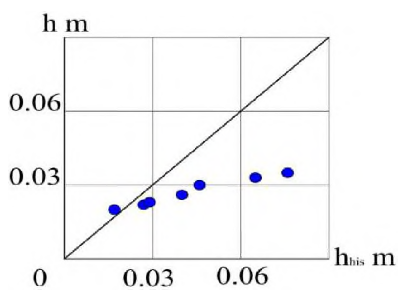

Figure 1. Comparison of experimental ridge heights with calculated ridge values

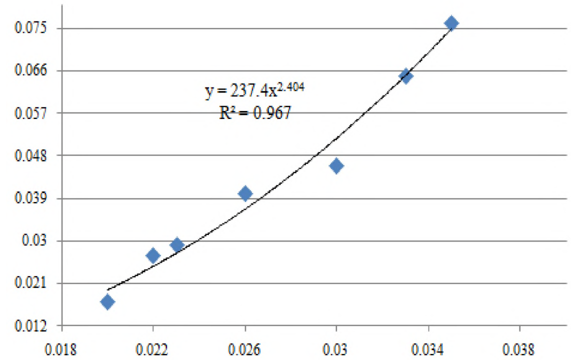

Figure 2. Regression Analysis

Additionally, Figure 3 shows a comparison between the calculated data and the information obtained from laboratory and field experiments regarding the heights of ridges.

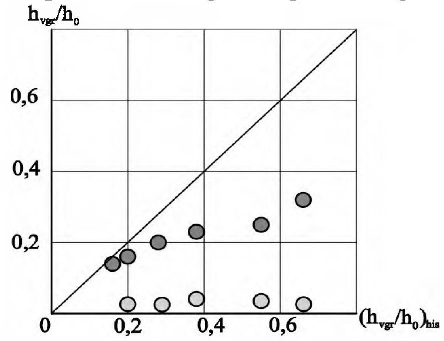

Figure 3. Comparison of the ratio h_{gr}/h_0 obtained from laboratory and field experiments under non-stationary flow conditions with the ratios derived from calculations

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We will examine the validity of determining the length of ridges formed under non-stationary flow conditions. A comparison between ridge lengths obtained from laboratory experiments and values calculated using formula (4) is shown in Figure 4, while the regression analysis is presented in Figure 5.

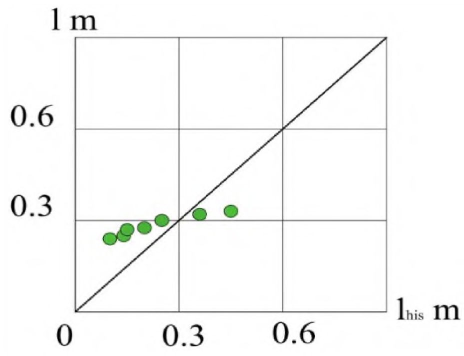

Figure 4. Comparison of experimental and calculated gradients

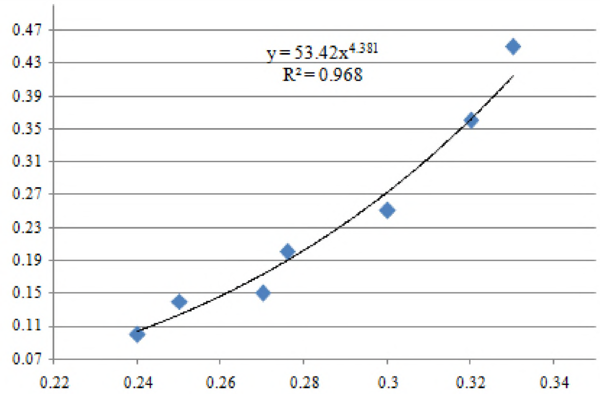

Figure 5. Regression Analysis

Data on the lengths of ridges occurring in the non-stationary flow of the channel bed, obtained under laboratory and field conditions, have been incorporated. The comparison of these data with the values calculated according to the relationship (4) demonstrates their close similarity, as shown in Figure 6.

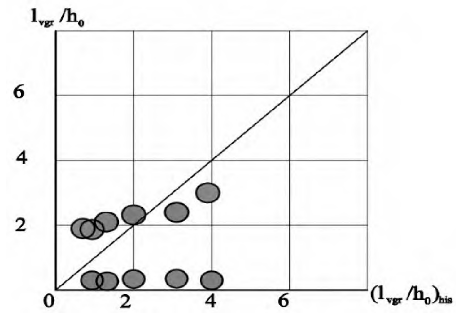

Figure 6. Comparison of the ratio (ℓ_{gr} / h_0) obtained from laboratory and field experiments under non-stationary flow conditions with the ratios derived from calculations.

Therefore, formulas (3) and (4) can be utilized in calculating the heights and lengths of bed forms that occur under non-stationary flow conditions associated with wind waves in the hydraulics of deformable open channels.

Conclusions

1. Based on laboratory experiments conducted under steady and unsteady flow conditions in the canal, relationships were derived to determine the height and length of bedforms occurring at the bottom of the canal bed. Comparison of laboratory and calculated values demonstrated their close correlation with each other.

2. The method for calculating sediment transport in open channels with bedforms has been improved for both steady and unsteady flow conditions in the canal. The calculation method reflects the primary characteristic of wave influence on sediment transport, namely, a significant increase in sediment transport under wave flow conditions.

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