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Research of Tension of the Diaphragm of the Tubular Hydro construction from Action of own Weight

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ABSTRACT: In article discusses the practice of irrigation development of subsiding land points to the often occurring cases of disruption of hydraulic structures. This is largely due to the lack of knowledge and neglect in the design of the interaction features of the GTS and their subsiding bases.
As a result of the conducted research, a number of regularities of joint work of network hydraulic structures and subsiding bases were clarified, which allowed the development of practical design methods aimed at improving the reliability of hydraulic structures.
On the basis of experimental data, the regularities of changes in the stress-deformative state of the "structure-wetted subsiding base" system are specified; a table was compiled to determine the vertical normal stresses according to the depth of the base depending on the load, which differ significantly from those calculated in accordance with the theory of elasticity; Recommendations are given for calculating the effective value of soil subsidence depending on a combination of time-varying moisture stresses.
According to the results of the study of the work of full-scale hydraulic structures, possible typical schemes of loading their elements (flat tips) have been established. This allows you to make calculations for the most dangerous state, which allows the reliability of the results.

KEYWORDS: deformation, process, priming, growth, Circuit, depth, zone, diameter, stamp, pressure, horizontal, flyer, border, humidity.

I. INTRODUCTION

Intense deformative the condition of structural elements more depends on distribution of tension on contact of the base of a construction and its basis [1;2;3;4;5;6, etc.].
In practice of design contact tension pays off, proceeding from idea of soil as about an isotropic elastic medium or, more rare, from hypotheses of linear distribution of jet pressure of soil. It should be noted that the calculations which are carried out with application of various hypotheses can yield the results significantly differing from each other [1;7]
Distribution of pressure in GTS bases rather unevenly is also subject to serious changes in use of constructions. Especially brightly such transformation of tension appears during the operation of hydraulic engineering constructions on unevenly soaked and strongly deformable collapsible soil [9;10;11;12].

II. SIGNIFICANCE OF THE SYSTEM

In article discusses the practice of irrigation development of subsiding land points to the often occurring cases of disruption of hydraulic structures.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

A significant amount of refusals and accidents of the standard network constructions having the reason noted by a circumstance, indicates the need of further improvement of methods of their design of these constructions built on loess

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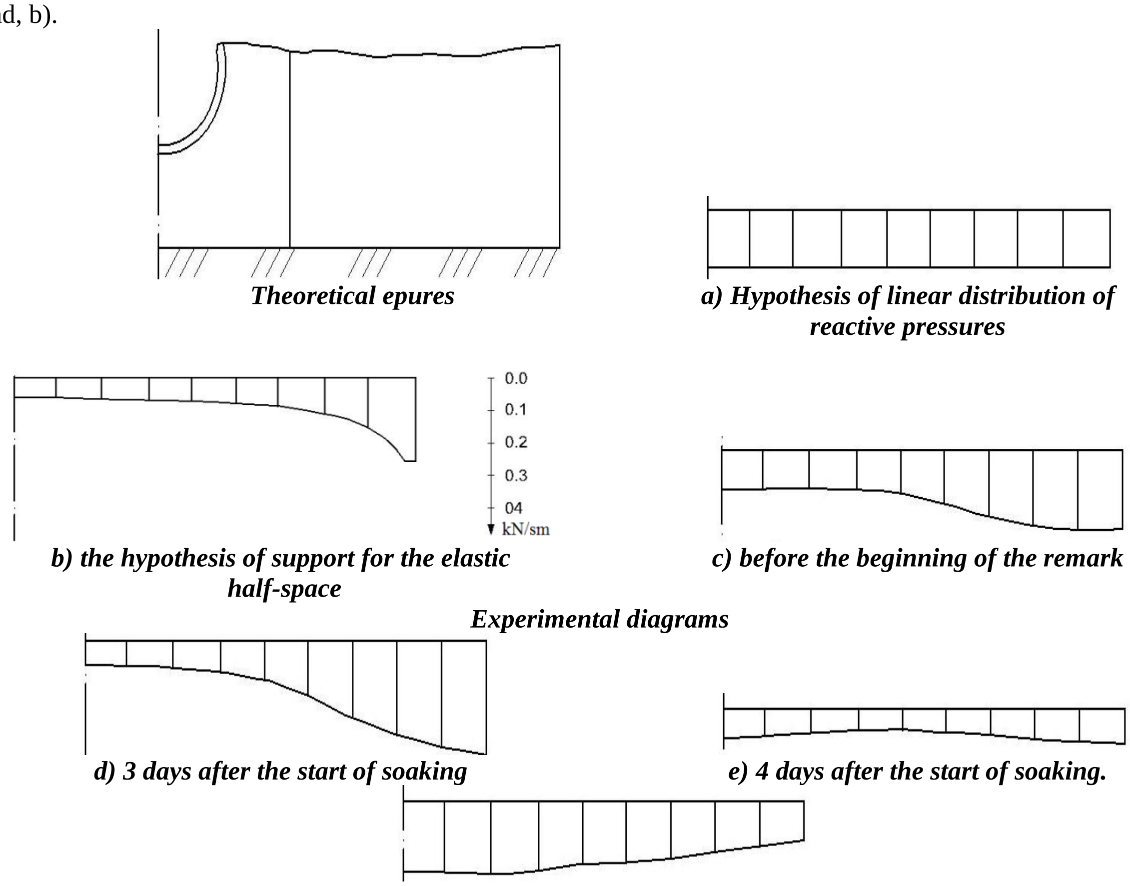
Vol. 6, Issue 5 , May 2019

soil [11;12;13]. The normative documents existing now [14;15, etc.] do not consider influence of uneven sags and moistening of soil on the size of pressure on the area of contact of a construction with the basis.

In the course of the researches we in detail studied work of three tubular moving which are constructed on collapsible loess soil in the south of Uzbekistan.

IV. METHODOLOGY

Typical epyura of jet efforts of loess soil to pressure of a diaphragm of tubular moving – difference, received during the pilot studies are given below (fig. 1 в, г, d, e). The epyura corresponding to the period of lag of a diaphragm on a pipe and also to the period of partial moistening of the basis of a diaphragm are of the greatest interest to the further analysis. In these cases experimental epyura of jet efforts of loess soil most considerably differ from theoretical (fig. 1 and, b).



Theoretical epures

a) Hypothesis of linear distribution of reactive pressures

b) the hypothesis of support for the elastic half-space

c) before the beginning of the remark

Experimental diagrams

d) 3 days after the start of soaking

e) 4 days after the start of soaking.

e) 6 days after the start of soaking

Fig. 1. Plots of soil reactive force on the pressure from the diaphragm.

We assume that the diaphragm works as a monolithic structure. This situation is true if the strength of the seams connecting the individual diaphragm plates is ensured.

The greatest efforts in these seams occur in the case of "freezing" of the diaphragm on the pipe. The force perceived by one joint in this case will be equal to:

$$N_{ш} = Q_1 - P \cdot b \cdot l \qquad \textbf{(1)}$$

where, Q_1 is the weight of the extreme plate of the diaphragm, kH; Prs- average contact pressure between the extreme plate and the base; b - width of the diaphragm plates, cm; l1 is the length of the longitudinal edge of the base of the extreme plate of the diaphragm, cm;

For the case of wetting the soil under the entire diaphragm, it can be taken equal to the initial subsiding $P_{mi}=P_{st}$, **kN/sm²;**

The friction force between the plates and the ground is relatively small and goes to the safety margin in formula (1) is not taken into account.

ISSN: 2350-0328
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Vol. 6, Issue 5 , May 2019

Then the required cutting area of the weld joining the diaphragm plates will be equal to:

$$F_{ш} = \frac{N_{ш}}{R_s}, \quad \mathbf{sm^2}$$

where, Rs is the calculated resistance for the shear material cut, kN/sm^2.

V. EXPERIMENTAL RESULTS

If the integrity of the joints connecting the cap plates is ensured, the diaphragm can be approximately calculated as a beam with a large h / b ratio according to the scheme shown in Fig. 2 and corresponding to the aperture period of the diaphragm (Fig. 1e).

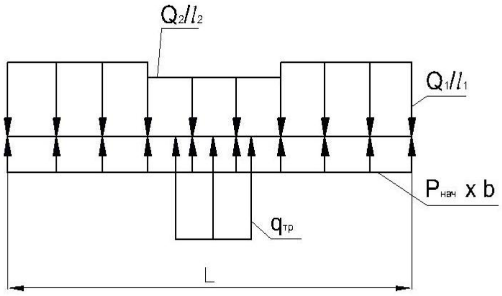

Fig. 2.Design diagram of the diaphragm, corresponding to the case of its hanging on the water supply pipe.

With a degree of accuracy sufficient for practical purposes, it is possible to consider the soil repulse response uniformly distributed and equal to Pnach. Based on the above, the maximum bending moment in the diaphragm for the case of its hanging on the water supply pipe will matter:

$$M_1 = \frac{Q(l_1 + l_2) - P_{нач.в}(l_1 + \frac{l_2}{2})^2}{2} + \frac{Q_2 l_2 - q_{Tp} d_{Tp}^2}{8} \qquad (2)$$

where, l_2 is the length of the longitudinal face of the base of the middle plate of the diaphragm, cm; qtr is the intensity of the reaction of repulsing a pipe, kN/sm^2; Q_2 - weight of the middle plate, kN; dt is the diameter of the pipe, see

When $l_1 = l_2 = l$, which is often the case, formula (2) can be represented as follows:

$$M_1 = \frac{l^2(8q_1 + q_2 - 9P_{нач.в}в - q_{Tp} d_{Tp}^2) - q_{mp} d_t^2)^2}{8}$$

where, $q_1 = Q_1/l_1$; $q_2 = Q_2/l_2$.

In accordance with the provisions of structural mechanics, you can determine the intensity of the reactive forces of the pipe:

$$q_{mp} = \frac{2Q_1 + Q_2 - 3P_{нач} bl}{d_{Tp}}$$

However, it should be noted that the above formulas are valid only if the soil is wetted over the entire area of contact of the diaphragm with the base. In practice, this is true when the distribution of water along the diaphragm's contact with the ground away from the axis of the structure meets the requirement:

$$\frac{B}{2} + (H + h_{зачл}) tg\beta \geq \frac{L}{2} \quad (3)$$

where, B is the width of the soaked area, m; L - span of the tip - diaphragm, m; β - spreading angle of filtering moisture and vertical, for loess loams β = 500, for loess sandy loops, β = 350; H - water pressure in the channel, m; h- the distance between the bottom edge of the diaphragm and the bottom of the reservoir. If this requirement (3) is not fulfilled, then there is a concentration of contact stresses under the edges of the tip, which rest on non-wetted soil.

ISSN: 2350-0328
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Vol. 6, Issue 5 , May 2019

The design diagram corresponding to this mode of operation of the diaphragm is shown in Fig. 3. The reactive efforts of the non-wetted part of the base are replaced by concentrated reactions A and B, which corresponds to the extreme conditions of the diaphragm. Reactions A and B are determined in the usual way from the equilibrium equation of the system.

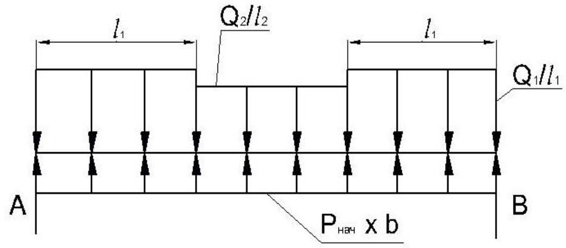

Fig. 3.Design diagram of the diaphragm, corresponding to the case of the support of its edges on non-humid soil.

The reactive pressure of the pipe can be neglected, since in this case it is negligible.
The maximum bending moment in mid-span of the diaphragm will have the following expression:

$$M_2 = \frac{(9P_{нач}bl + 4Q_1 - 5Q_2)l}{8} \quad (4)$$

The above formulas (2) and (4) correspond to the extreme modes of operation of the diaphragm. If a significant part of the base of the diaphragm is not wetted, the design scheme will have the form shown in Fig. 4.

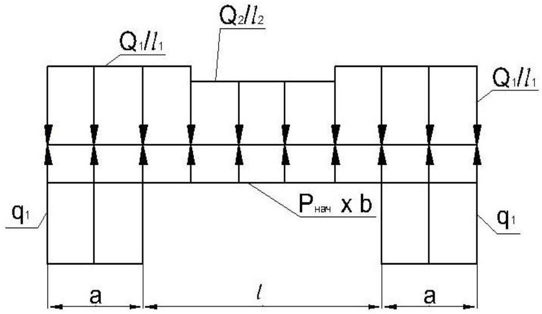

Fig. 4.Design diagram of the diaphragm corresponding to the case of a partially moistened soil.

The length of the non-wetted area for an array of soil with a steady moisture contour can be determined by the formula:

$$a = \frac{L}{2} - \frac{B}{2} - (H + h_{зачл})tg\beta \quad (5)$$

where B is the width of the water mirror in the corresponding pool; h-distance between the lower face of the tip - the diaphragm and the bottom of the reservoir.
The length of the moistened part ℓ of the base of the head-diaphragm will be

$$\boldsymbol{\ell = L - 2a = 2\ell_1 + \ell_2 - 2a}$$

In accordance with the design scheme shown in Fig.4.6, the maximum bending moment in the diaphragm is equal to:

$$M_3 = \frac{Q_2 l_2 - P_{нач} l^2 b}{8} + \frac{Q_1(l_1 + l_2) - q_0(a + l)a}{2} \quad (6)$$

where, q0 is the intensity of the reaction of the non-humid part of the base of the diaphragm (n/sm).
With ℓ1 = 2 = ℓ, but with $Q_1 \neq Q_2$, the diaphragm of three plates has a moment

$$M_3 = \frac{Q_2(2a - 5l) + 4Q_1(a - l) + 3P_{нач}вl - 2a)}{8} \quad (7)$$

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 5 , May 2019

If the difference in weight of the average and extreme plates is negligible, then the formula takes the form

$$M_3 = \frac{3}{8}(P_{нач}\textit{в}l - Q)(3l - 2a) \quad (8)$$

Taking in formula (7) a = 0, we again obtain the expression (8).

As can be seen from formula (7), with decreasing a, the moment increases, since the difference increases (3ℓ-2a).

Formulas (6), (7) and (8) and are valid in the case when the load on the non-wetted part of the base does not reach a value that exceeds its carrying capacity. Otherwise, spalling of the soil without wetting will occur under the edges of the tip (Fig. 5).

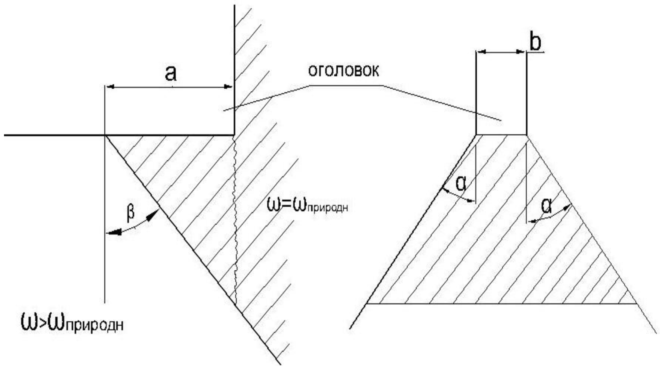

Fig. 5.Diagram of the support of the tip-diaphragm on the wet ground wedge.

The shear area can be represented as an isosceles trapezium with an upper base equal to the thickness of the diaphragm. The height of the trapezoid, in accordance with those adopted in Fig. 5 designations, is equal to h = α/tgβ. The bottom base of the trapezium has the size:

$$b^1 = b + 2htg\alpha = b + \frac{2atg\alpha}{tg\beta}$$

where α is the angle of dispersion of pressures in the soil from the action of an additional load. Based on this, the area of the trapezoid will be equal to:

$$F_{cd} = (\frac{b + b^{'}}{2})h = \frac{ab}{tg\beta} + \frac{a^2 tg\alpha}{tg^2\beta}$$

Accepted with some assumption that the weight of the plates is perceived moistened loess soil over the entire area of the base of the diaphragm.

The difference between the weight of the diaphragm and the total response of repelled wetted soil corresponds to the load on the shear areas under both edges of the diaphragm. Its value can be determined from the results of laboratory tests of soils. For loess low moisture soil C = 0.005 ÷ 0.05 MPa.

$$2Q_1 + Q_2 - P_{нач}b(2l_1 + l_2) = 2F_{cd}c \quad (9)$$

where C - specific cohesion of the soil of natural moisture.

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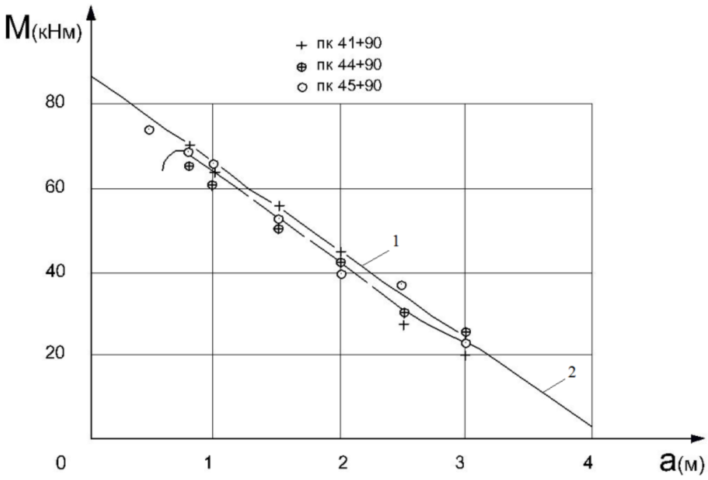

Fig. 6. Graphs of the change of the maximum bending moment in the tip of the crossing-differential depending on the parameter "a": 1- by the formula (8); 2- according to experimental data.

Internal friction of the ground is neglected as a relatively small value, which goes to the safety margin.

Expressing Fsd through the parameter "a", we find its boundary value at which expression (6) will be true.

$$Q_1 + 0,5Q_2 - P_{нач}bl_1 - 0.5P_{нач}bl_2 = \frac{abc}{tg\beta} + \frac{a^2ctg\alpha}{tg^2\beta} \quad (10)$$

To do this, we solve the equation for "a", substituting in it the initial data for the tubular differential PC 45 + 90, whose work was studied in the course of the experiment:

$в$ =0,25m; C=40 кN/m^2; ω= 11%; Q_1=50 кN; Q_2=40 кN; P_{st}=25 кN/m^2; L=9 m;

As a result, we obtain the value a = 0.68 m.

For comparison, in Fig. 6 shows the graphs of the maximum bending moment in the diaphragm of a one-point differential, calculated by the formula (7) and determined on the basis of the experimental diagrams of contact stresses, on the value of the parameter “a”.

From fig. 6 that the majority of experimental points are located below the theoretical dependence: the average difference is 2.4 kNm, which is only 3% in the area of maximum values of the bending moment. The standard deviation of the experimental points from the straight line is Σ = 2.7 kNm.

It was established experimentally that the cleaving of the soil without moistening under the edges of the tip occurs at values of "a" = 0.4 ÷ 0.7 m, which is close enough to the theoretically determined value of this parameter. After cleaving the wedges of the soil without moisture, the stresses on the contact of the diaphragm with the base will correspond to the diagram of Fig.1. g) and the scheme in Fig.2.

The pressure of the bulk compacted soil affects the inner edge of the differential head. The magnitude of this pressure on the diaphragm is:

$$q = \varphi \cdot \rho \cdot h \quad (11)$$

where, φ is the coefficient of lateral pressure; ρ- specific all bulk soil, kN / m3; h– depth from the surface of the embankment, m

The design diagram of the diaphragm operation in this case can be represented as a console of unit widths with embedment at the level of the concrete anchorage of the channel bottom (Fig. 7).

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Vol. 6, Issue 5 , May 2019

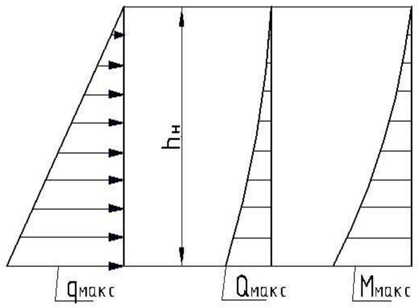

Fig. 7. Design scheme of the work of the diaphragm from the pile of soil on the side of the water supply pipe.

Reliability of fastening is ensured by a considerable depth of embedding and the presence of a pipe rigidly connected with the diaphragm.

The length of the console corresponds to the height of the mound, hn (Fig. 7 and 8):

$$\boldsymbol{h = h_1 - h_2 - h_3} \quad (12)$$

where, h3 is the height of the part of the diaphragm plate located above the ground surface. Take h3 = 0, which goes to the safety margin.

Distributed by the law of the triangle the load on the console has a maximum intensity at the embedment, which can be determined for the conditional cut-out strip of unit width by the formula:

$$\boldsymbol{q'_{max} = \varphi \rho h_н} \text{, кN/m} \quad (13)$$

The maximum bending moment in the diaphragm from the action of the pile of soil occurs in the embedment section

$$M_{H(\max)} = \frac{q'_{\max} h_H^2}{6} = \frac{\varphi \rho h_H^3 1m}{6}, \quad \text{кN/m} \quad (14)$$

Proceeding from the above, it should be concluded that the end caps-diaphragms of tubular irrigation facilities operating on loess filler soils can be in different loading conditions depending on the nature of wetting of the base and features of interaction with water-conducting elements (Fig. 8-9).

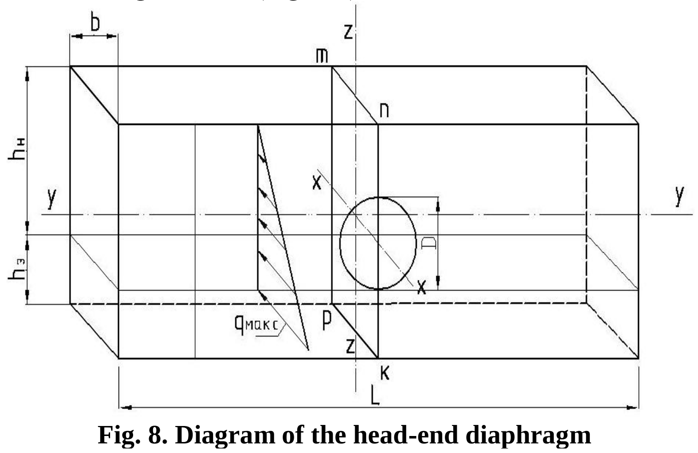

Fig. 8. Diagram of the head-end diaphragm

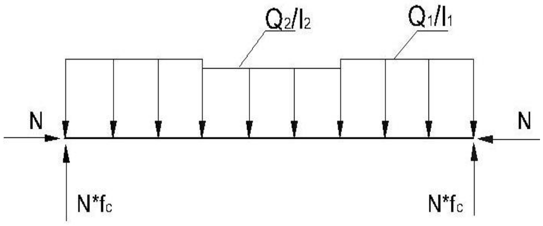

Fig. 9.Design diagram of the diaphragm for the case of pile of soil on its side faces.

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International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 5 , May 2019

VI. CONCLUSION AND FUTURE WORK

At the same time, the specific stress state of the tips depends on both their mass and geometrical dimensions, and on the physical and mechanical properties and the state of the soils of the bases. This indicates the need to determine at the design stage the most dangerous state of the diaphragm in accordance with the proposed calculation formulas and diagrams.

REFERENCES

[1].Ber J., Zaslavsky D., Irley S. Physical and mathematical foundations of water filtration. –In book.: Earth sciences (fundamental works of foreign scientists in geology, geophysics and geochemistry). L .: Mir, 1971, pp117-126.
[2]. 36.Dokin V.A, Zasov S.V. Features of the work of hydraulic tubular structures on subsiding loess soils. –In Kn.: Constructions and foundations of land reclamation facilities. M .: MGMI, 1962, pp 69-73.
[3]. Zasov S.V., Frolov N.N. Investigation of the stress-deformative state of loess subsiding bases of structures. In the book: Hydraulic structures, foundations and foundations, engineering structures. M .: MGMI. 1982, pp 36-43.
[4]. Zasov S.V. Interaction of hydroconstructions of irrigation systems with subsiding bases. Autoreferat.cand.tech.science. M., 1986.pp20.
[5]. Zasov, SV, Frolov, NN, Khuzhakulov, R., Features of the stress-strain state of the loess subsidence bases of the NIITZI-agroprom of the Ministry of Agriculture of the Russian Federation, № 68, BC-96, Dep. M., 1996. pp8.
[6]. Zasov S.V., Khuzhakulov R Waterworks on subsiding soils. Mater.Conf. KIEI, Karshi, "Nasaf", 2002, pp147-148.
[7].Kazakbayev KK, Adilov I.A. Construction of irrigation facilities in areas of new development. T.: Uzbekistan, 1981, pp2222.
[8]. Kuleshov G. Recommendations for assessing and ensuring the safety of hydraulic structures. Agency of the International Fund for the Salvation of Aral. Tashkent 2009. pp224.
[9]. Mavlyanov, GA. Engineering-geological properties of loess in irrigated areas of Uzbekistan.T .: Fan, 1974. pp170.
[10]. Mavlyanov G.A., Pulatov KP. Methods for studying subsidence of loess species for the purpose of irrigational development of virgin lands.T .: Fan, 1975.
[11]. Khuzhakulov R., Zasov S.V. Issues of designing hydraulic structures on subsiding soils in the south of Uzbekistan. On Sat materials of the Republican Scientific Practical Conference. Karshi Engineering and Economic Institute, Karshi, March 11-12, 2016, pp266-269.
[12]. Khuzhakulov R. Hydrotechnical constructions of irrigation systems on loess subsiding soils of the Republic of Uzbekistan. In the journal "Innovative Technologies", №1 (33), 2019.pp52-57.
[13]. A. c.1717700. A conductive structure on subsiding soils. / Mosk. irrigation and drainage institute: Avizobot.Zasov S.V. Khuzhakulov R. -Zayavl. 06/15/1990, №.4839512.-B.I.1992.№ 9.
[14]. QMQ 2.06.04-97. Loads and effects of hydrotechnical engineering (wire, banana and ships). T., 1998.
[15]. SM 2.02.02-98. Hydrotechnical Induction Walls.T., 1998.