Influence Of Soil Backfill From The Sides Of The Pipe On Its Strength And Rigidity.

Abdimuminov Erkin. [1]

Radjabov Mansur Rustamovich. [2]

Jamankulov Hamid Ochilovich [3]

Elyor Safarovich Nabiev. [4]

Associate Professor Karshi Engineering Economic Institute. [1]

Senior Lecturer Karshi Engineering Economic Institute. [2]

Senior lecturer Karshi Engineering Economic Institute. [3]

Senior Lecturer Karshi Engineering Economic Institute. [4]

Abstract:

The aim of the article is to study the stress-strain state of rigid underground pipes in different conditions of laying and loading. Here attention is paid to the testing of pipes according to the scheme of two forces in underground conditions.

***Key words*:** Stress, strain, pipe, strength, soil. Stress, deformation, pipe, strength, soil, stiffness, soil pressure, conditions of laying, immersion, stretching, compression.

Article Received: 18 October 2020, Revised: 3 November 2020, Accepted: 24 December 2020

Introduction.

Improving the reliability and safety of hydraulic structures (HTS), including culverts in the form of round rigid pipes located in underground conditions, is one of the main directions in their operation in the world.

Currently, the Republic of Uzbekistan is using the laying of rigid pipes of circular cross-section in underground conditions, made of such materials as concrete, reinforced concrete, asbestos cement, ceramics, cast iron, etc., pipelines for water supply, sewerage, drainage and oil pipelines.

Rigid pipelines for various purposes, ranging from large-diameter main pipelines to irrigation pipes, are becoming more and more widely used in hydraulic engineering, industrial and civil construction.

The device of closed drainage systems in conditions of water supply and irrigation, including rigid pipes laid in the ground, is of great importance.

In addition, with the development of technology and technology, the production of pipes from various materials has improved qualitatively and quantitatively.

In this regard, it is especially important to conduct experimental research and develop methods for calculating rigid pipelines in underground conditions.

For the construction of closed systems, rigid pipes are often used, they are cheap, reliable in operation, and the service life of such pipes is very long. Although rigid pipes have been in use for many years, their load-carrying capacity has not yet been investigated enough. This applies to experimental studies and calculation methods for buried pipelines. In particular, the influence of the soil filling from the sides of the pipe on its strength and rigidity has not been studied.

Therefore, we conducted a study of the stress-strain state of underground pipes (ceramic, asbestos-cement, reinforced concrete, etc.) in various conditions of laying and immersion. Carrying out detailed experimental studies in order to obtain reliable results on the operation of such pipes in various conditions. Development of an engineering method for calculating these pipes in a plane problem. Development of recommendations for the use of rigid pipes.

The main attention is paid to testing pipes in underground locations under various conditions of laying and soil density. As a result of the experiments, the actual picture of the stress-strain state of the pipes under study under loads up to destruction was revealed. Comparison of the results of testing pipes in air with the results for underground pipes is given. The dependence of the bearing capacity of rigid pipes on the density of the soil and the type of foundation under the pipe has been established. An engineering method for calculating pipes of circular cross-section has been developed.

Research methods.

The main objective of this work is to study underground rigid pipes. However, in order to compare the results later, some of the pipes were tested in air using a two-force scheme.

The experiments measured the load, the displacements of the pipe wall at the top and at the bottom, as well as at the level of the horizontal diameter; relative deformations in the circumferential direction, and for underground pipes, in addition, the characteristics of soil density and soil pressure on the pipe.

Tests of pipes in air were carried out according to the scheme of two forces under pressure on a UMM-5 testing machine.

This work presents loading schemes and test results in air and soil for ceramic pipes d = 200mm.

After preparing the pipe for testing, it was laid in a horizontal position between wooden blocks. Bars with a section of 10x10 cm had a length equal to the length of the pipe.The surfaces of the bars were not specially processed and were left flat. The load on the pipes was transferred in steps of 0.5 kN and the pipes were brought to failure. (fig. 2.a)

To reveal the elastic resistance of the soil to the strength of pipes tested according to the scheme of two forces, it was also decided by testing for pipes immersed in the soil.

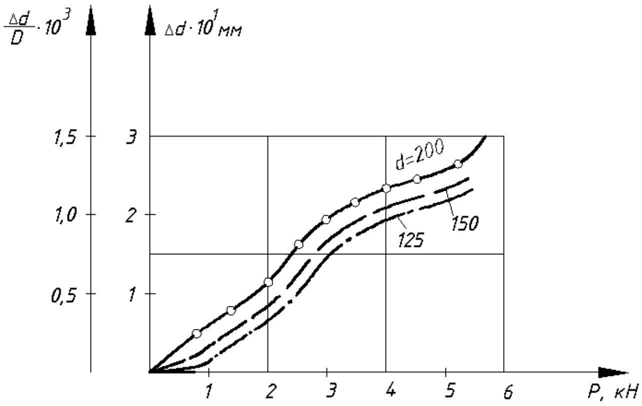
The pipes were placed in a box between wooden blocks (Fig. 3, a.) And then backfilling was carried out. At the same time, the ends of the pipes were protected with gaskets so that the inner cavity of the pipe was free of sand.

Factor levels	ȷ (kn/m^3)	h_o (cm)	d (mm)
According to the scheme of two forces in the air	-	-	150 200
According to the scheme of two forces in a soil environment	14.1 16.8	- -	150 200

Research results

Based on the results of the experiment, graphs of the dependence of the change in the vertical and horizontal pipe diameters on the load Δd = f (P) were constructed. Three deformation areas can be distinguished on the graphs (Fig. 1). Areas of elastic deformation are clearly expressed, areas of conditional yield and hardening are poorly expressed.

It can be seen from the graph that the change in pipe diameters is the more significant, the larger the diameter.



Changes in the vertical diameter of the pipe when testing it according to the scheme of two forces is:

$$\Delta d = 1{,}788 \frac{P}{E} (\frac{r}{\delta})^3 ; \qquad \xi_d = A(\frac{r^2}{\delta^3}), \tag{1}$$

Fig.1 Change of pipe diameter d=200mm, d=150mm, d=125mm

where A are some constant numbers; r – pipe radius; δ – wall thickness.

In our experiments, the ratio $(r : \delta)^3$ for a large diameter pipe is $(10 : 2{,}4)^3 = (4{,}166)^3$, for small diameter pipe $(6{,}25 : 1{,}3)^3 = =(3{,}472)^3$. And also the ratio $(r^2 : \delta^3)$ respectively: $10^2 : 2{,}4^3 = 7{,}234$ and $6{,}25^2 : 1{,}8^3 = 6{,}698$. In the formula (1) reduction of the vertical pipe diameter is directly proportional to the ratio $(r{:}\delta)^3$ and $(r^2 : \delta^3)$, which corresponds to the test results shown in Fig. 1.

The results of testing pipes in air in the form of graphs of the dependence of the deformation of the pipe wall in the annular direction in stretched zones ($\xi^P_{кц}$)and in compressed zones ($\xi^C_{кц}$)from load (P) are shown in Fig. 2.

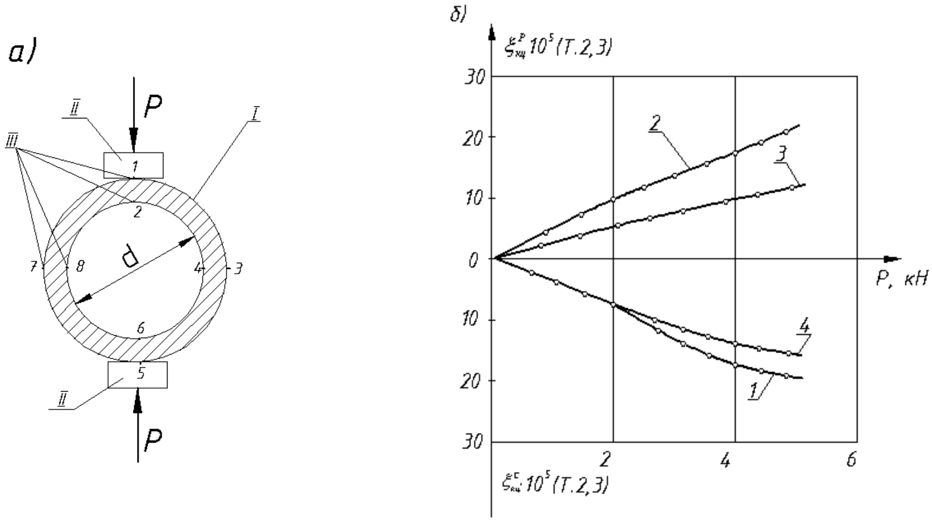


Figure: 2. Loading the pipe according to the scheme of two forces in the air: a) loading scheme - I - pipe; II - bars; III - strain gauges; b) relative deformations for a pipe d = 200 mm.

It can be seen from the graphs that the deformation on the extended wall surface at the ends of the vertical diameter (points 2 and 6) of the pipe is greater than at the ends of the horizontal diameter (points 3 and 7) of the pipe under the same loads. Deformations in the compressed zones of the pipe wall surface (points 1 and 4) are almost the same (Fig. 2, b). The first circumstance is explained by the fact that the calculated bending moment under the place of application of the load is much greater than in the sections at the ends of the horizontal diameter (ratio 0.318: 0.182). The deformations in the compressed zones are almost the same, therefore, in the section at the level of the horizontal diameter, the action of the moment is accompanied by the action of a longitudinal compressive force.

Cracks appear at loads of about 0.8 parts of the breaking load. First, on the inner surface of the pipe wall in a vertical alignment and later on the outer surface - in a horizontal alignment, which corresponds to the outline of the moment diagram. The pipe was destroyed by breaking it into four parts.

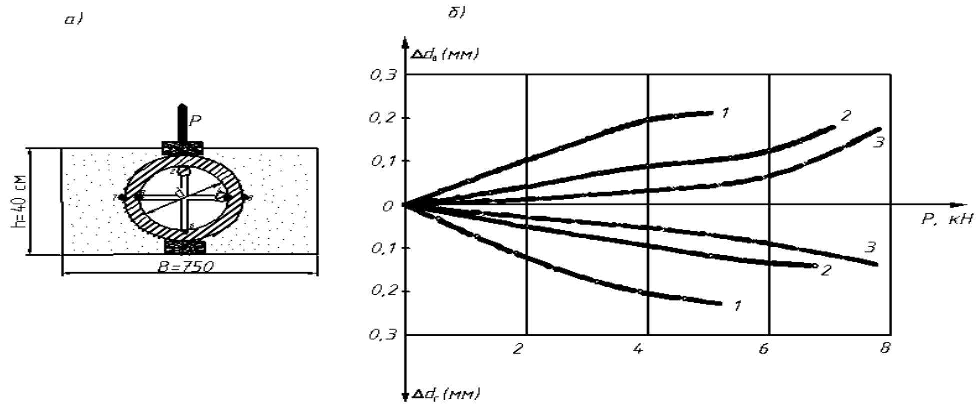


Fig 3. Loading the pipe according to the scheme of two forces in the soil environment: a) loading scheme; b) increments of diameters for a pipe d = 200mm. 1-in the air; 2-soil is not compacted; 3-soil is compacted

The pipes were tested in unconsolidated and compacted soil. The load on the pipes was transferred in steps of 1 kN and the pipes were brought to failure.

The graph shows that in compacted soil, the deformation of the vertical diameter of the pipe is 1.5 times less than in uncompacted soil under the same loads.

Graphs of changes in pipe diameters d = 200 mm, with different degrees of soil compaction ($\gamma = 14{,}1 кН/м^3$ and $\gamma = 16{,}8 кН/м^3$), as well as in the absence of soil (in the air) are shown in Fig. 3, b.

As in the experiments with pipes in air, in these experiments the change in pipe diameters was more significant for pipes of large diameter.

Graphs of changes in the vertical and horizontal pipe diameters depending on the load are shown in (Fig. 4)

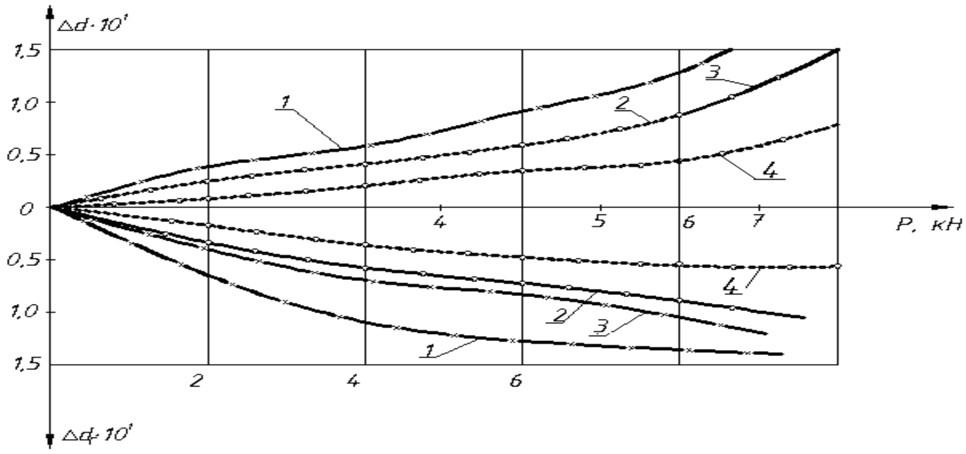


Fig. 4. Changes in the vertical and horizontal pipe diameters depending on the load 1 and 2, - d = 200 mm, 3 and 4, - d = 150 mm in unconsolidated and compacted soils, respectively.

It can be seen from the graph that the deformation of the diameters of the pipe buried in the ground is reduced by more than two times in comparison with the pipe outside the ground under the same loads. When the soil is compacted, this difference increases up to 3.5 times. In this case, the dependences d = f (p) with significant loads deviate from linear ones.

Conclusion. Figure 5. shows the graphs of the dependence of the annular relative deformations on the load. It turned out that the deformations of the stretched surface of the pipe wall embedded in the soil are, on average, 1.5 times less than similar deformations for a pipe in air and 3 times less if the soil was compacted. On the compressed surface of the pipe, the deformations turned out to be almost the same, and only after compaction of the soil did these deformations decrease by more than 2 times. Dependences of deformation on load turned out to be close to linear.

For the destruction of the pipe buried in the ground, it took 1.5 times more load than for the pipe in the air, and with the compaction of the soil, this ratio increases and reaches 2.

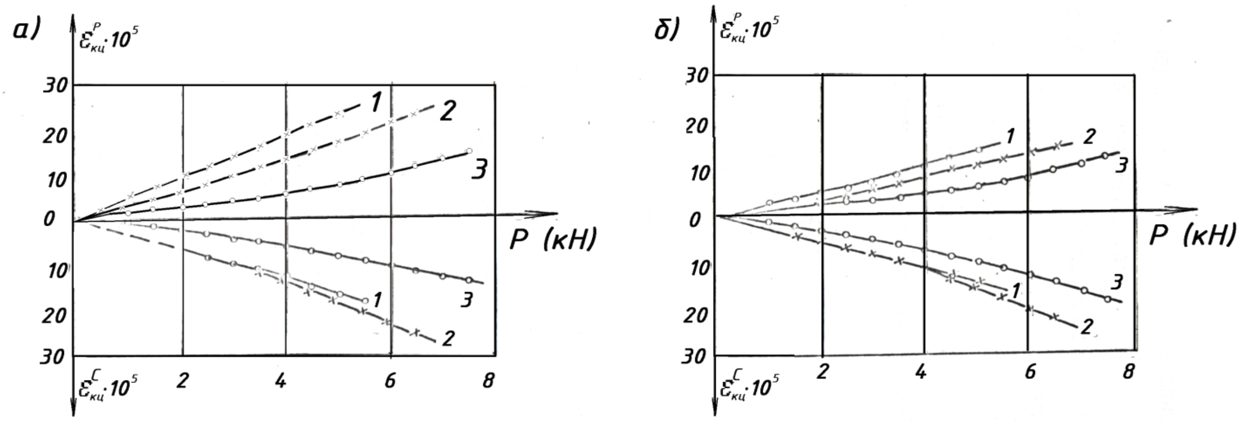


Fig. 5. Relative deformations of the pipe wall d = 200 mm in the shell (a) and at the level of the horizontal diameter (b). 1 - in the air; 2 - the soil is not compacted; 3 - the soil is compacted.

This means the bearing capacity of rigid pipes in underground conditions is significantly increased than in the air environment, and with soil compaction, the strength of the pipes even improves.

REFERENCES:

1. E. Abdumuminov, M. R. Radjabov, X. O. Jamankulov Methods of calculating the collision method and moving in hard tubes. Sb. nauchnyx trudov mejdunarodnoy nauchno-prakticheskoy konferentsii. Volgograd 2015.

2. E.. Abdumuminov, M. R. Radjabov, Ekspremental'nye issledovaniya napryajenno-deformativnogo sostoyaniya keramicheskix drenajnyx trub po scheme dvux sil v gruntovoy srede. Internauka M.2018.

3. E.. Abdumuminov, M. R. Radjabov, E.S.Nabiev Ispytaniya podzemnyx trub pod raspredelennoy nagruzkoy pri opiranii na jestkoe osnavanie. Internauka M.2019.

4. Abdumuminov E. , Vinogradov S.V. Issledovanie napryajenno- deformirovannogo sostoyaniya podzemnyx keramicheskix trub meliorativnogo naznacheniya. M. , MGMI, 1988

5. Bergen R.I. , Frolov M.I. Yaxshnev R.D. Vertical pressure of the soil on the hard pipelines in the high nasypax. Sb. «Calculation of soorujeniy, vzaimodeystvuyushchix s okrujayushchey sredoy». Sb. nauchnyx trudov MGMI, M., 1984, p. 99-105.

6. Abdumuminov E. Экспериментальные исследования прочность drenajnyx keramicheskix trub. Sb. tr. MGMI Sovmestnaya rabota gruntovyx osnovaniy i zasypok s konstruktsiyami gidrotekhnicheskix soorujeniy. M. : 1985

7. Vinogradov S.V. Calculation of underground pipelines on external loads. Stroyizdat, M. , 1980

8.Emelyanov L.M. O davlenie zemli na podzemпые soorujeniya vozvodimye otkгыtым sposobom. Hydraulic engineering and reclamation.№3

9.GOST 6942-98 Sewerage pipes. Technical conditions

10.Turbay kanalizatsionnye: GOST i predъyavlyaeмыe trebovaniya.1989

11 «Construction directory: a complete complex of construction and departmental work for the delivery of the house to operation». A. G. Borisov. - M .: AST: Astrel, 2008.

12. M., 2004.