

COMPARATIVE ANALYSIS OF NATURAL OBSERVATIONS WITH CALCULATED INDICATORS OF BUILDING SEDIMENTS IN THE XOJELI DISTRICT

Dosapnov Rakhim

Karakalpak Scientific Research Institute of Natural
Sciences of the Karakalpak Branch of the Academy of
Sciences of the Republic of Uzbekistan, Nukus

ANNOTATION: The results of calculations of the stress-strain state of the soil massif under the foundation are given. The calculations were performed using the PLAXIS program. The results of calculations and their comparison with the results of in-situ observations showed that the most optimal variant of the foundation is the strip construction with the width of 1.2 m.

Key words: Displacements, foundation, PLAXIS, reference point, soils.

In the Xojeli district, the construction of low-rise buildings continues, and 4-5-story buildings are being erected on the central streets of the district. To date, no monitoring of building subsidence has been conducted in this area. Due to the lack of data on the physical and mechanical properties of saline soils, significant strength reserves are often allocated for foundations during design. In recent years, housing construction has been developing rapidly in the district, and strip and slab foundations are mainly used in the construction of buildings.

According to the results of engineering and geological surveys conducted in the Xojeli district, strong bedrock is located at a depth of 45 meters. All the upper layers are composed of soft, non-solid rocks with relatively low density. Currently, when designing 4-5-story buildings in Karakalpakstan [3], slab (monolithic) foundations are often provided. Comparative analysis of the results of theoretical calculations with the results of natural observations of foundation settlement in the engineering-geological conditions of the city of Nukus and the Nukus district shows that the plate foundation variant is larger in terms of settlement indicators than the ribbon foundation. This is due to the fact that as the size of the foundation increases, with the same pressure intensity, the values of vertical pressure reach the deeper layers of the foundation and cause settlement. At the same time, for strip foundations, vertical stresses dissipate faster than for slab foundations.

To determine the optimal width of the strip foundation and the feasibility of designing a slab foundation in the conditions of the Xojeli district, special studies were conducted to

observe the settlement of the building in the conditions of the city of Xojeli and to compare the results of natural observations with the settlement of the strip foundation at different widths. During these studies, settlement of the building was observed, and the results of field observations were compared with settlements of different widths of the strip foundation under the conditions of the city of Xojeli. In the process of observing the settlement of buildings and structures, the technical condition of foundations, load-bearing walls, wall centers, supporting structures was visually and instrumentally checked by the organization's specialists, as well as damage was measured and described.

The object of observation was a two-story building with a ribbon-like foundation in the Xojeli district. The settlement of the building was observed from the beginning to the end of the construction. Figure 1 shows the general view of the building facade, in which the settlement was measured.



Figure 1. Overview of the building where subsidence observations were made

The study was conducted using the example of the construction of a two-story preschool educational institution being built in the "Zhana jap" rural community of the Xojeli district. The height of the building is 9.1 m, the area is 550 m², the walls are made of brick. Solid anti-seismic corridors are provided on the floor and roof surfaces. The foundation laying depth is 1.2 m. Foundation type - ribbon, width 1.2 m, height 0.3 m. Fig. 2 shows the general view of the foundation after its construction.



Figure 2. General view of the foundation after construction (Xojeli district, "Zhana jap" rural community, February 2024)

Measurement of the building's settlement was carried out by means of leveling. Settlement measurements were carried out after the completion of foundation construction, after the installation of floor slabs of each floor and after the completion of building construction. The settlement of the building was recorded by averaging settlements measured along all benchmarks. Before each measurement, the pressure on the soil base was calculated.



Figure 3. Measurement of building settlement after the installation of first-floor floor slabs (May 2024)

For the joint calculation of the strip foundation and the base, the "PLAXIS 3D" computing complex, a set of applied geotechnical programs for finite-element analysis of the stress state of the "Base-Foundation" system, was selected. The "finite element method" considers a set of a finite number of elements when solving continuum problems. In this work,

when forming the computational scheme, 6 nodal elements and 16 nodal interface elements were used to model the operation of the structure and the interaction of the soil with the structure, respectively [2].

In the numerical calculations, the physical and mechanical properties of the soils and foundation materials presented in Tables 1 and 2 were used.

Table 1

Physico-mechanical properties of soils

Properties name	Unit of measurement	Loam	Sand
Soil density	t/m ³	1,94	1,95
Porosity coefficient		0,767	0,755
Natural moisture	share of a unit	0,264	0,278
Moisture at the yield point	share of a unit	0,333	-
Moisture at the spreading boundary	share of a unit	0,222	-
Plasticity number	share of a unit	0,111	-
Flow rate		0,34	-
Relative dependence on water saturation	kPa	20	0,5
Angle of internal friction at water saturation	degree	26	34
Deformation modulus: upon saturation with water	MPa	4,0	11,6

Table 2

Physico-mechanical properties of the foundation material

Characteristic	Unit of	Quantity
Elasticity modulus (E _{ref})	kN/m ²	29000000
Poisson's ratio (ν)	-	0,2
Material density (g _{sat})	kN/m ³	24,0

Equivalent thickness (d)	m	0,3
--------------------------	---	-----

The gravity of the foundation and the main soil was taken as the volumetric forces. The external force P was applied as a uniformly distributed load. When applying a step-by-step load to the foundation, the subsidence and stress state in the soil mass were calculated for each step.

Figures 4-5 show the results of calculating the settlement of the foundation under full load, which shows that the maximum settlement of the foundation is 2.247 cm. According to the standards, the permissible settlement for this structural building is 15.0 cm.

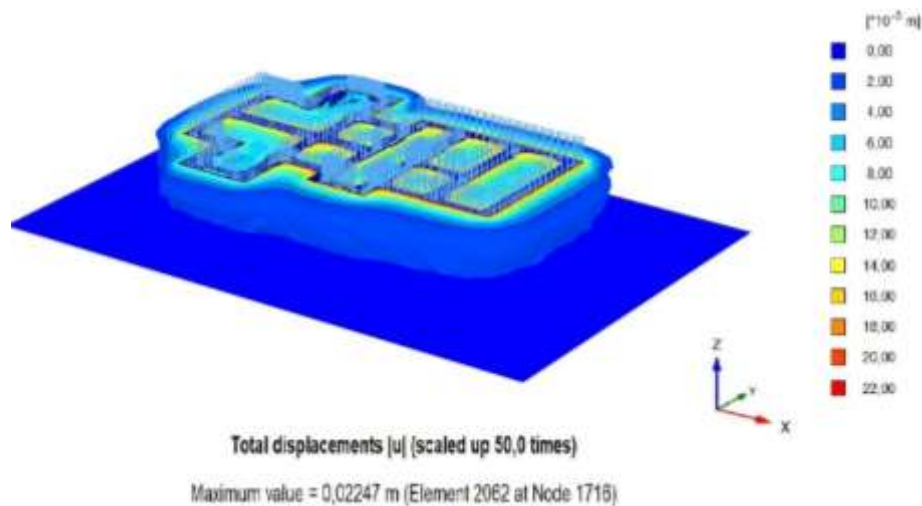


Figure 4. Change in total soil settlement with depth under the foundation (pressure under the foundation varies from 50 kN to 110 kN)

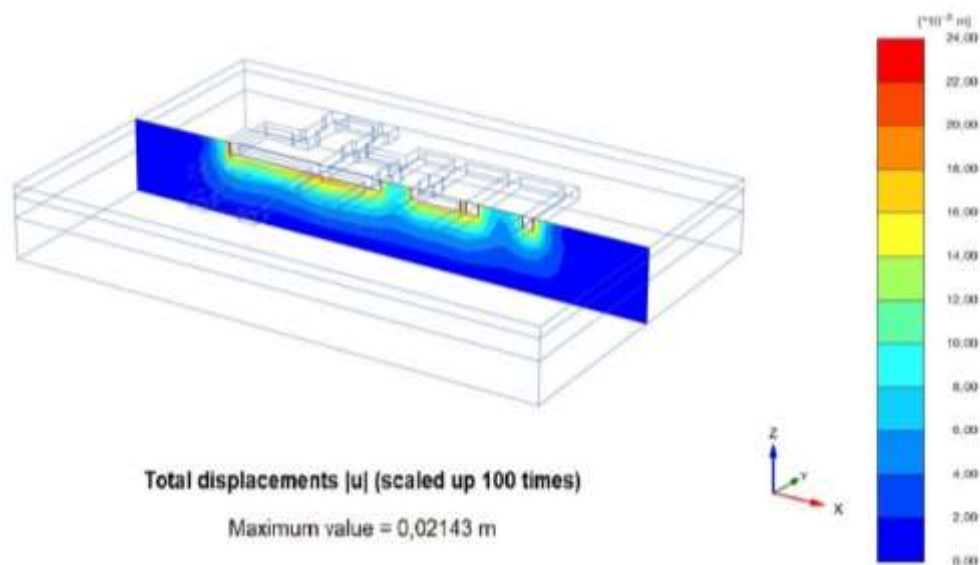


Figure 5. Change in total soil settlement along the central longitudinal axis at the depth under the foundation (pressure under the foundation varies from 50 kN to 110 kN)

For the purpose of assessing the influence of the foundation width on the stress-strain state of the soil mass, a strip foundation was constructed at a depth of 1.0; Calculations were carried out for the plate variant of the foundation with a width of 1.2 and 1.4 m and a plan dimensions of 24 x 36 m.

Fig. 6 shows the dependence of foundation settlement on pressure, obtained as a result of numerical calculations and natural observations. Comparative analysis of the graphs characterizing the settlement of strip foundations shows that the results of numerical calculations coincide with the results of field observations of the foundation with a design width of 1.4 m. With an increase in the width of the strip foundation, the settlement of the foundation increases. The greatest settlement of the foundation is observed during the adoption of the slab variant of the foundation. This phenomenon is associated with the growth of the active subsidence zone of the foundation as a result of increasing the foundation width.

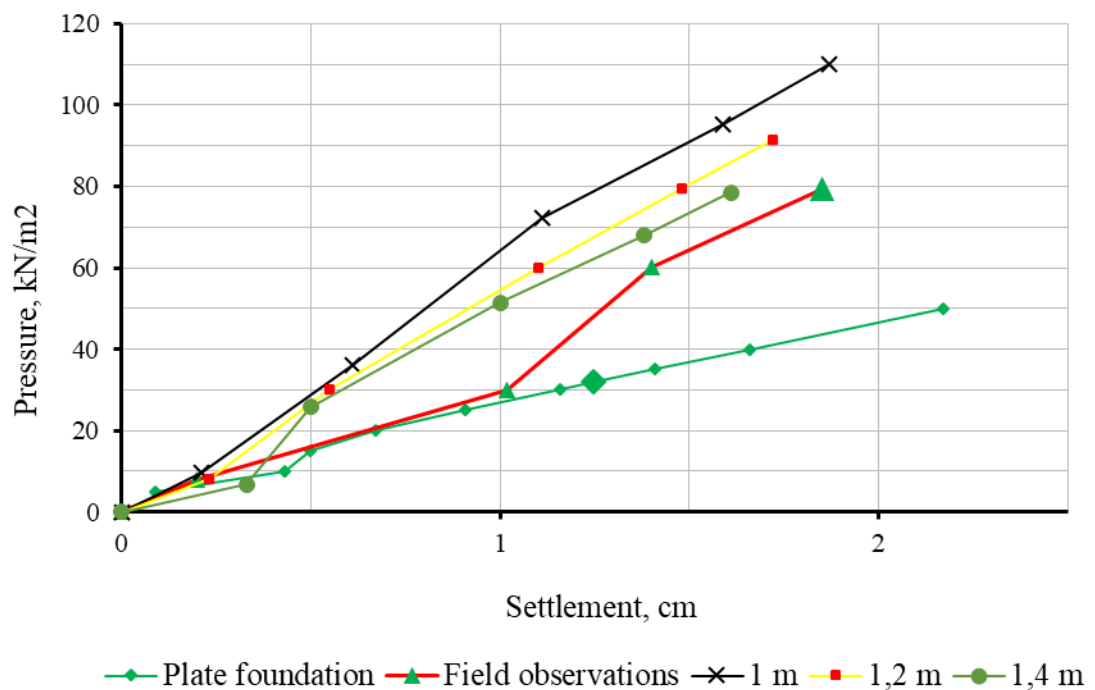


Figure 6. Dependence of foundation settlement on pressure

Fig. 7 shows the results of calculating the settlement of strip foundations, which characterize the distribution of soil settlement under the foundation by depth. Analysis of these figures shows that with an increase in the width of the foundations, the intensity of sediment distribution along the depth increases.

In this case, with an increase in the width of the strip foundation, the settlement of the foundation increases, which is associated with an increase in the depth of settlement attenuation. This is confirmed by the isolines of vertical displacements in the soil mass under the foundation, shown in the figure.

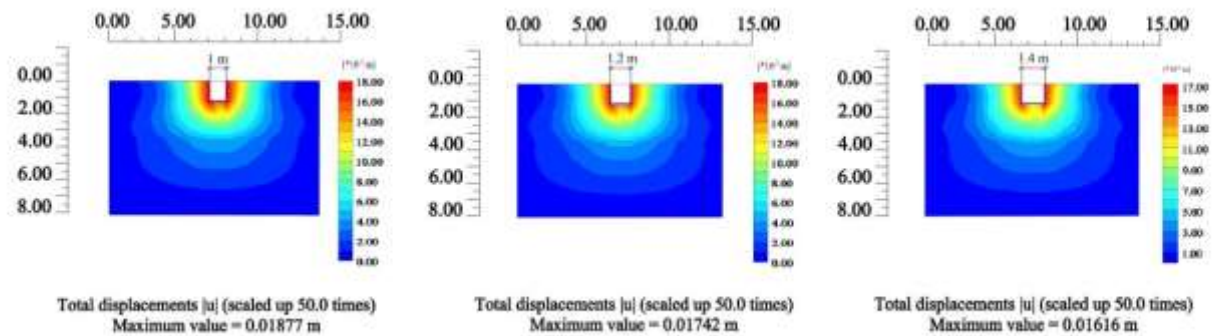


Figure 7. Change in vertical soil settlement at a depth under a foundation with widths of 1; 1.2 and 1.4 m. Pressure under the foundation $P=110$ kPa (foundation width 1 m), 91.6 kPa (foundation width 1.2 m) and 78.5 kPa (foundation width 1.4 m)

Similar results were obtained during experimental studies of subsidence at various sizes of the load area of the soil mass. For example, X.R. Xakimov and D.Ye. In Polish experiments [4; p. 6], an increase in vertical settlements was observed with an increase in the load area at the same stresses. This is due to the growth of the active zone of the soil mass with an increase in the area of loads.

CONCLUSION

1. Comparative analysis of natural observations and numerical calculations of foundation settlement in the Xojeli district showed that natural observations coincide with the results of numerical calculations performed using the PLAXIS program.
2. The results of numerical calculations of strip foundations of different widths showed that with an increase in the width of the foundation, settlement increases. This is due to the fact that with an increase in the width of the foundation, the depth of subsidence with depth increases.
3. The research results showed that the adopted width of the strip foundation is 1.2 m, which allows for excessive consumption of building materials during the preparation of the foundation. For the designed building, it is sufficient to accept a foundation with a width of 1 m as the most economical.

REFERENCES

1. SHNK 2.02.01-19. Fundamentals of Buildings and Structures.
2. Аимбетов И. К., Бекимбетов Р. Т. Численные расчеты напряженно-деформированного состояния основания здания города Нукуса. – 2025.
3. Izzet A., Rakhim D. Assessment of salinization of soils and groundwater of the Khojaly district (Southern Aral sea region) //E3S Web of Conferences. – EDP Sciences, 2023. – Т. 407. – С. 02013.
4. Чаповский Е.Г. Лабораторные работы по грунтоведению и механике грунтов. - М.: Недра, 1975. - 302 с.
5. Аимбетов И. К., Доспанов Р. Р. Несущая способность железобетонных свай в инженерно-геологических условиях Ходжейлийского района Республики Каракалпакстан. – 2025.