E-ISSN: 2706-8927
P-ISSN: 2706-8919
IJAAS 2019; 1(2): 101-104
Received: 24-08-2019
Accepted: 28-09-2019

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Bearing capacity and deformation of soil bases, reinforced with vertical and horizontal elements

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Abstract
The results of research of influence phased static load on the soil model with vertical and horizontal reinforcement. When conducting the flume tests defined deformation of the soil.
Load application is made in stages with the load changes. Based on these data, a graph of the dependence of precipitation on the number of stages.
The analysis of the graphic dependencies, which shows that the deformation of the soil varies.

Keywords: vertical and horizontal reinforcing elements, combined reinforcement, soil, sediment, stress

Introduction
The most important problem for the Republic of Tatarstan and the Russian Federation is the construction in areas composed of soft soils. In modern conditions, when building on such soils, the tendency to increase loads on the foundations contributed to the fact that one of the common ways to increase the bearing capacity and reduce settlement is vertical and horizontal soil reinforcement. The bearing capacity and precipitation of the reinforced bases are practically not investigated. In this regard, a number of laboratory tests were conducted in a volumetric tray with dimensions of 1.0 x 1.0 x 1.0 m. Medium-sized sand was used as soil. The vertical reinforcing elements were modeled with plastic tubes with a diameter of 7 mm and a length of 200 mm. Horizontal reinforcement modeled geogrids with mesh sizes 50 x 50 mm. Experimental studies have established the effect of combined reinforcement on the carrier ability and precipitation of the foundation foundation.

Main part
Experimental studies were carried out in a volumetric laboratory tray with dimensions of 1.0x1.0x1.0m (Fig. 1). As a foundation model was used reinforced concrete slab with dimensions 400x400x40mm.

Fig 1: Appearance of the test bench

To study the behavior of the foundation foundation with combined reinforcement was used modeling theory. Based on the theory of modeling and analysis of test results experimental studies vertical reinforcement modeled hollow plastic tubes with a diameter of 7 mm, with a length of 200 mm and a wall thickness of 1 mm, horizontal reinforcement was modeled by an A-40 type geogrid with dimensions of 50x50 cm. The base soil was sand of medium size (density ρ = 1.49 kg / m3; humidity W = 4%; angle of internal tragia φ = 23.8˚; E0 = 1.3 MPa). At each stage of loading, after stabilization readings of indicators of the type of ICh, deflection meters 6 PAO, as well as voltage in soil base and forces arising in the reinforcing elements.

The pressure in the soil was determined using pressure sensors. Pressure Sensors were installed in a soil base according to the height of the studied array and connected to strain gauge station AID - 4.

At each stage of loading, the values of base sediment were recorded according to indicators of dial gauges such as IC, deflection meters, pressure in the ground using pressure sensors.

8 tests were carried out (Fig. 3):

Test No. 1 - without reinforcing element

Test No. 2 - vertical reinforcement and 1 geogrid

Test No. 3 - vertical reinforcement and 2 geogrid

Test No. 4 - vertical reinforcement and 3 geogrid

Test No. 5 - vertical reinforcement and 0 geogrid

Test No. 6 - 1 geogrid without vertical reinforcement

Test No. 7- 2 geogrid without vertical reinforcement

Test No. 8- 3 geogrid without vertical reinforcement;

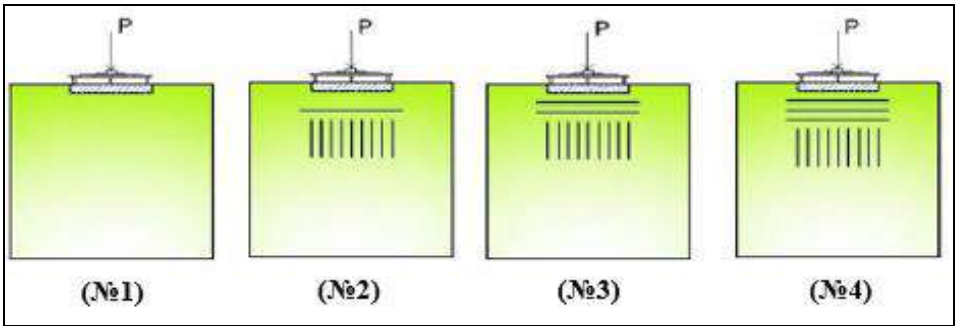

Fig 2: Series of tray tests №1 (without reinforcement). №2 (1 network horizontal and 1 geogrid vertical reinforcement). №3 (2 geogrid horizontal and geogrid vertical reinforcement). №4 (3 geogrid horizontal geogrid vertical reinforcement)

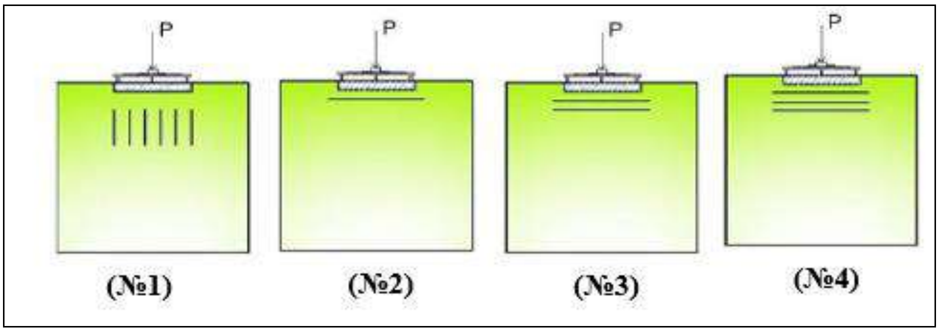

Fig 3: Reinforcement of soil №1 (vertical reinforcement). №2 (1 geogrid horizontal reinforcement). №3 (2geogrid horizontal reinforcement). № 4 (4 geogrid horizontal reinforcement)

Fig 4: Pile installation scheme

Fig 5: geogrid installation scheme

Fig 6: General view of the reinforced base after the test

Fig 7: Sectional view of the reinforced base after the test

References

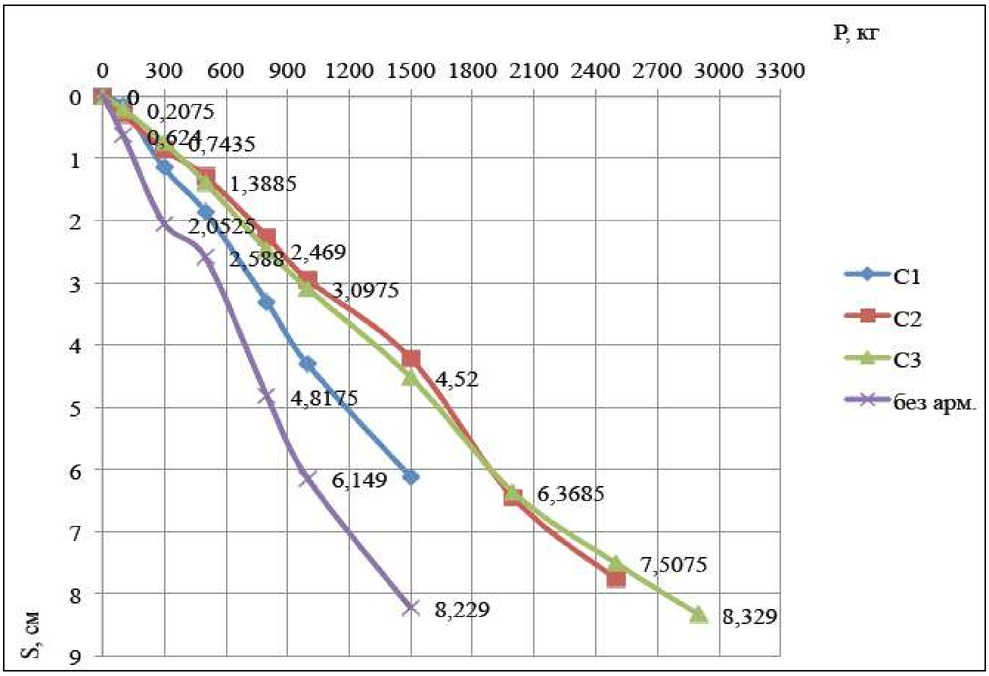

Fig 8: graph of changes in sediment of soil mass with horizontal reinforcement

C1 - reinforcement with the 1st geogrid of type A-40;
C2 - reinforcement with 2 geogrid of type A-40;
C3 - reinforcement with 3 geogrid of type A-40;

As can be seen from graph 1, the critical load on the soil mass without reinforcement is 300 kg, the settlement at this load is 2.1 cm. Then, up to 470 kg, the 2nd phase of soil deformation (phase of shear) is observed, the settlement is 2.5 cm. And then after 470 kg we observe the 3rd phase (phase of bulging of the soil).

Graphs of settlement of soil massifs with horizontal reinforcements compared to a soil mass without reinforcements are more linear, at 300 kg the draft is 1.2 cm; 0.9 cm; 0.7 cm (with 1, 2, 3 grids), bulging phases are not observed. Precipitation decreased by 1.4 - 2 times.

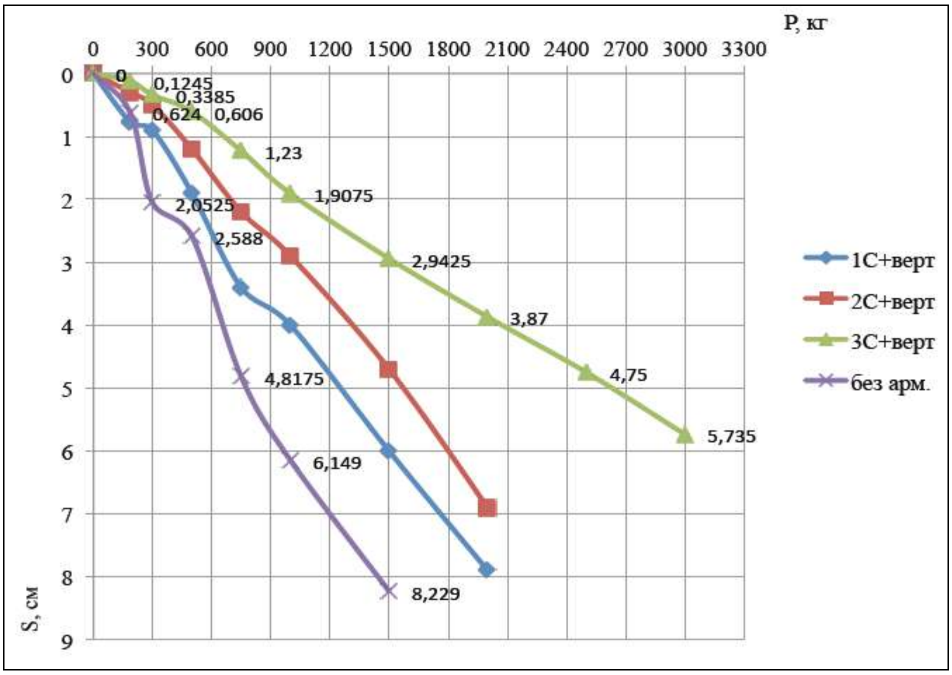

Fig 9: graphs of changes in settlement of the soil massif with horizontal and vertical reinforcement

As can be seen from graph 2 at 300 kg (Critical load for the soil mass without reinforcement) the settlement of the soil masses with vertical and horizontal reinforcement is 0.9 cm; 0.5 cm; 0.33 cm (from 1 network + vertical arm., 2 network + vertical arm., 3 network + vertical arm.). Reinforcement vertical and horizontal elements also reduce sediment, as in the case of reinforcing with only horizontal elements of the soil massif, but already 1.5-3.4 times in comparison with the soil massif without reinforcing.

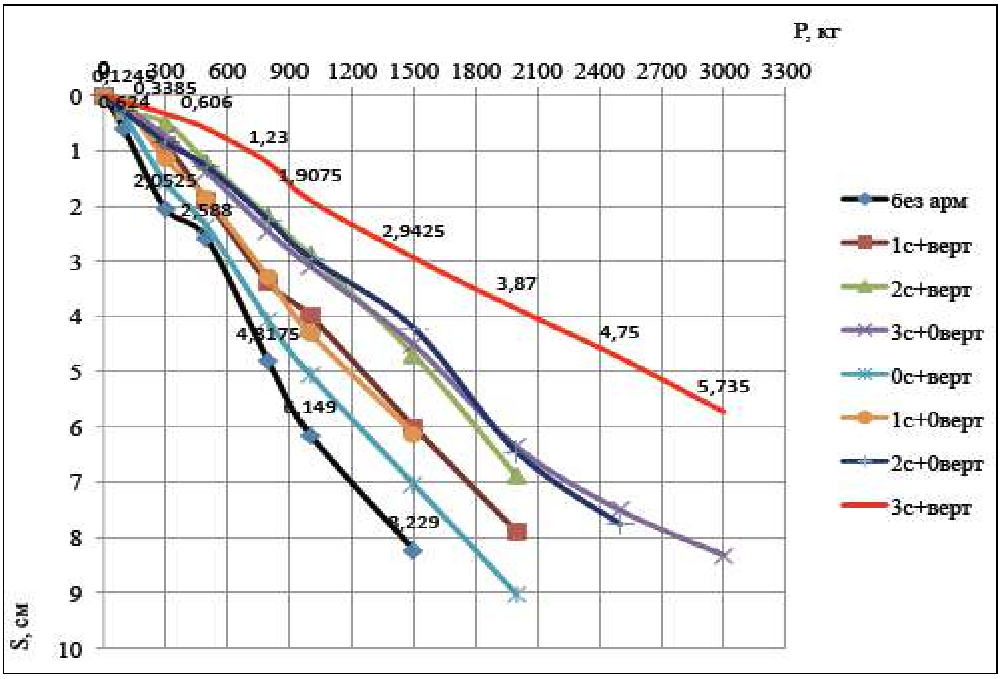

Fig 10: Graph comparing changes in settlement of the soil mass with various types of Reinforcement

Conclusion

Table 1: Comparison of settlement results

Number of experiment	at 100Kg		at 150Kg	
N91	without reinforcement	6,2 cm	without reinforcement	8,3 cm
N92	1 network+ vertical	4 cm	1 network+ vertical	6 cm
N93	2 network+ vertical	2,8 cm	2 network+ vertical	4,7 cm
N94	3 network+ vertical	1,8 cm	3 network+ vertical	2,9 cm
N95	0 network+ vertical	5,1 cm	0 network+ vertical	7,1 cm
N96	1 network+ vertical	4,3 cm	1 network+ 0 vertical	6,1 cm
N97	2 network+ vertical	2,9 cm	2 network+ 0 vertical	4,2 cm
N98	3 network+ vertical	3,1 cm	3 network+ 0 vertical	4,5 cm

The research results showed (Table 1) that reinforcing with vertical and horizontal elements reduces base settlement by 1.25 - 3.3 times depending on the nature of the reinforcement.

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