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CONTENTS

Storozhenko D.O., Dryuchko O.G., Bunyakina N.V., Ivanytska I.O., Kyslyachenko O.V.
***Physical and chemical study of the structural components interaction at preparatory stades of oxidal ree–containing functional materials synthesis processes* 5**

Solovieva N.V., Chernenko L.A.
***Resource processing technology waste tungsten carbide-cobalt phosphoric acid solution to maintain the purity nature prevention and correction of environmental pathologies* 12**

Chernenko L.A., Solovieva N.V.
***Energy-saving and environmentally-friendly methods extraction of tungsten and tungsten ore concentrate - an integral part of environment and human healt* 18**

Pavlenko A.M., Koshlak H.V., Usenko B.O.
***Solution of equations thermal conductivity* 23**

Senenko N.B.1, Maliuchenko Yu.S.1, Senenko A.I.
***Analysis of the possibility of improving the quality of decentralized drinking water* 36**

Dubyna O.S., Fediay B.M., Myagkohlib R.S.
***Modeling of quality regulation process of steam supply systems* 40**

Bandurina H.
***Analysis of trace elements content in the stratal waters of chyzhivske field* 48**

Vynnykov Y.L., Kovalenko V.I., Lytvynenko T.V.
***Investigation of compacted clay embankment stabilized moisture* 53**

Dorokhov M.A., Kostriba I.V.
***A new approach to the calculation of rubber seals downhole packer* 58**

Kugaevska T.S., Shulgin V.V.
***Thermal treatment the concrete samples heated air in the collector energy* 66**

Vynnykov Yu.L., Miroshnychenko I.V., Razduy R.V., Zotsenko V.L.
***The simulation of deformed state system "reinforced base - strip foundations"* 74**

Pavlenko A.M., Cheylitko A.O.
***Basis of forming pores in the material based on argil and their effect on thermal conductivity* 81**

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THE SIMULATION OF DEFORMED STATE SYSTEM "REINFORCED BASE - STRIP FOUNDATIONS"

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Problem formulation: Significant subsidence bases of building foundations in weak soils occur through a small deformation modulus. Therefore, the use of soil without reinforcement is almost impossible. Reinforcing bases for reinforced SCE by boring and mixing technology and jet-technology is a promising direction [1 – 4]. The main advantage of soil-cement is economical in the fabrication and accessibility of materials, and disadvantage is the difficulty of predicting the deformation of bases and quality control. This proves the relevance of research using soil-cement when constructing bases and foundations [5 – 7].

From the analysis tray studies of natural and reinforced soil hard plate strip was determined that an increase in the percentage of reinforcement SCE values of the first and second critical pressure at the base increasing by linear dependence. And the effectiveness of reinforcement SCE bases foundations and depending their subsidence of loads hasn't been studied enough. The task: to improve the technique of modeling using FEM elastic-plastic model of soil strain state (DS) of the "reinforced base - strip foundation".

To simulate the DS system "reinforced base - strip foundation" we used their data of tray experiment. Diagram of the experiment such (fig. 1): the size of tray 580×530×560 mm; the soil – heavy loam silty, fluid plastic (density of the skeleton ρ_d=1,45 g/sm^3, coefficient of water saturation $S_r = 0,85$, specific gravity $\gamma = 18,415$ kN/m^3, angle of internal friction $\varphi = 18^\circ$, specific cohesion $c = 1$ kPa); SCE of depth $h = 100$ mm and diameter $d = 5$ mm; the percentage of reinforcing bases i was from 0 to 7,1%; the hard strip plate had wide 35 mm, length 420 and height 70 mm; the step SCE $\ell_w = 25$ mm. Linear load had to $F = 4,15$ kN/m. Parameters reinforced SCE bases for modeling FEM plate bearing test in the tray shown in Table 1.

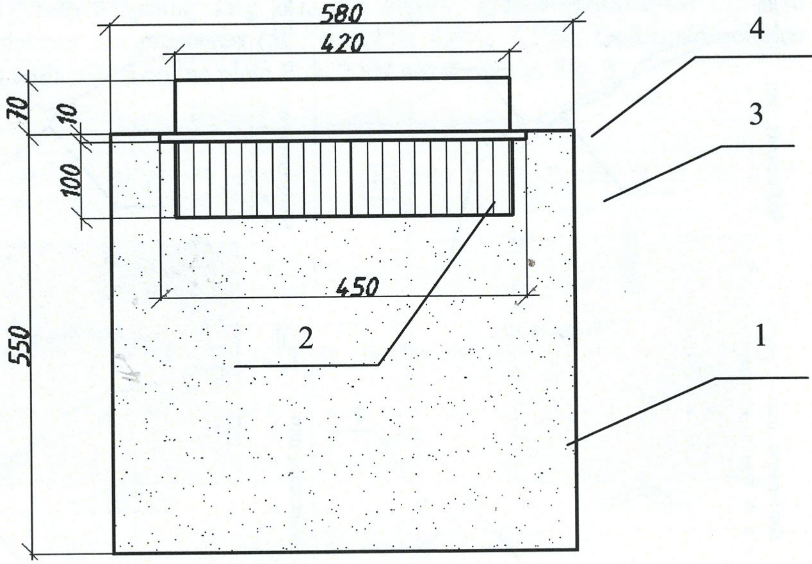

Fig. 1. The scheme of tray research: 1 – soil; 2 – The part of base, reinforced SCE; 3 – layer of gravel; 4 – hard strip plate

Table 1. Characteristics of reinforced SCE basis for modeling

Percentage of reinforcing, i, %	Module soil deformation, E, MPa	Angle of internal friction of soil, φ, °	Specific cohesion of soil, c, kPa
0	0,3	1	8,5
2,1	0,9	1	17,5
4,4	1,6	1	27,6
7,1	2,4	1	93,5

Dependence of subsidence of load simulated soil base according Mohr Coulomb strength criterion. Simulation results in a flat version of Plaxis software system and the tray experiment results: when unreinforced base (fig. 2, a); when the base is reinforced SCE *i*=2,1% (fig. 2, b); *i*=4,4% (fig. 2, c); *i*=7,1% (fig. 2, d).

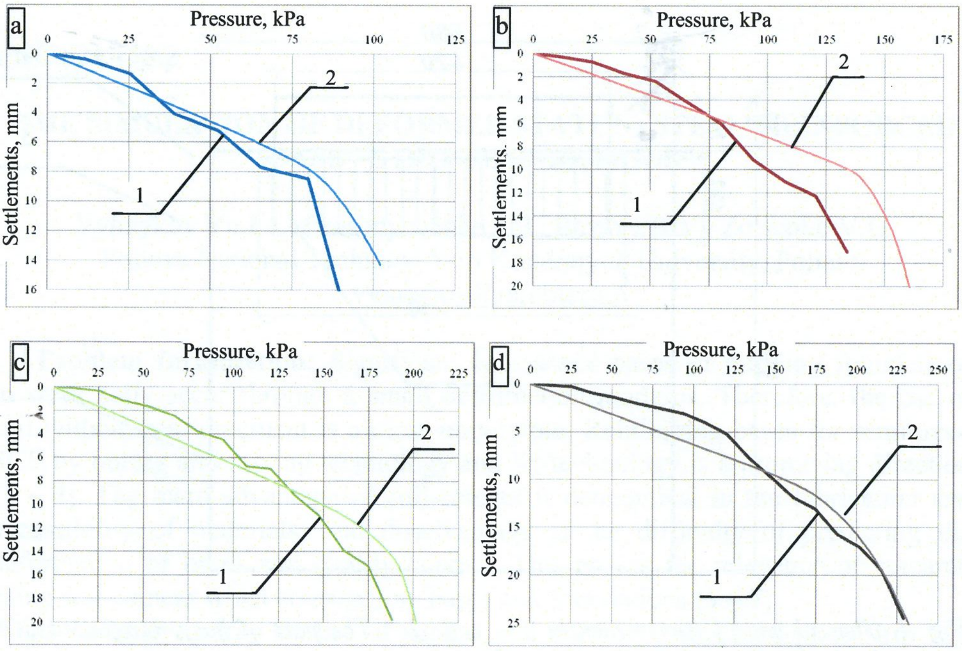

Fig. 2. Comparing the results of research: a) unreinforced base; b) reinforced for i = 2,1% of base; c) reinforced at i = 4,4%; d) reinforced at i = 7,1% of base: 1 – plate bearing test; 2 – FEM modeling

Assessing obtained graphs, we note the following. For unreinforced bases of strip plate second critical pressure was 79.9 kPa in the tray and 90 kPa at FEM modeling, that is the relative error between 11.2%. For reinforced bases of hard strip plate at percentage of reinforcing 2,1% second critical pressure was 120,6 kPa in the tray and 157 kPa at FEM modeling, that is the relative error of 23,2%. For reinforced bases of hard strip plate at percentage of reinforcing 4,4% second critical pressure was 174,8 kPa in the tray and 201 kPa at FEM modeling, that is the relative error of 13%. For reinforced bases of hard strip plate at percentage of reinforcing 7,1% second critical pressure was 215,3 kPa in the tray and 222 kPa at FEM modeling, that is the relative error of 3,1%.

These error (3.1 – 23.2%) occurred because not enough defined parameters strength, posed during calculation in the software sector. In the laboratory obtain homogeneous soil base is difficult. The basis of the tray was created artificially, and modeling these factors doesn't take into account. Therefore, the graphs should be noted the different nature of the plastic zones of soil. In general, the results of plate bearing test in the tray and for modeling FEM flattened version of Plaxis

Foundation sufficiently similar (fig. 2). For clarity, graphic simulation FEM to reinforced foundations are presented (at i = 2,1%; 4,4%; 7,1%). Deformed scheme reinforced bases with a load on the plate F_V = 2 kN are shown in Fig. 3.

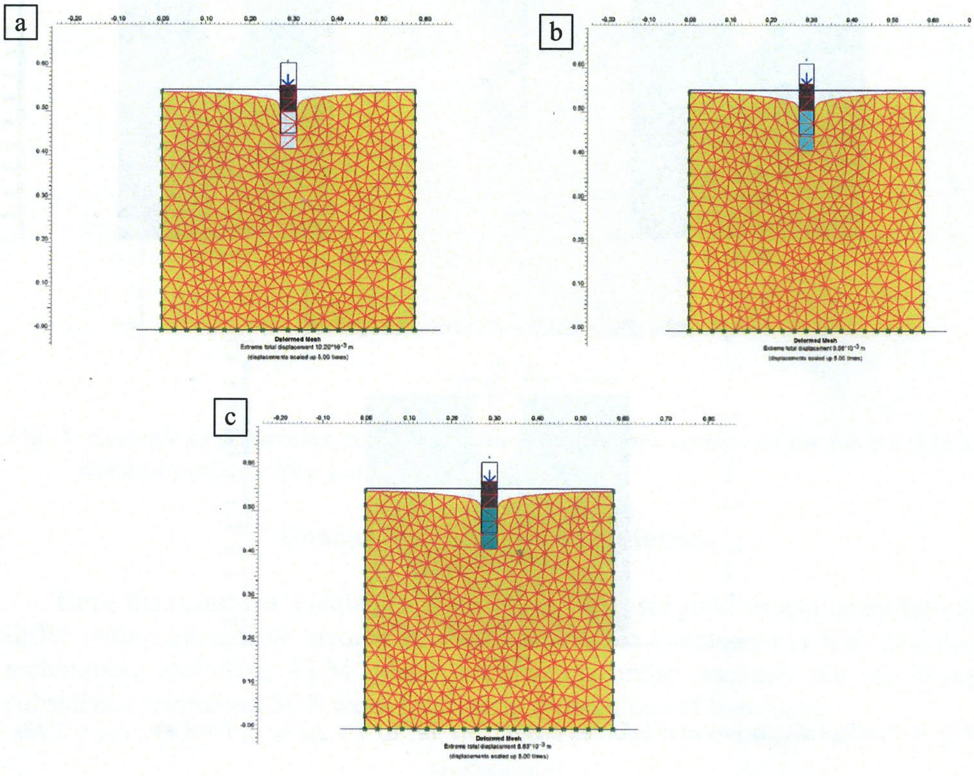

Fig. 3. Deformed mesh reinforced bases plate for: a) i = 2,1%; b) i = 4,4%; c) i = 7,1%

The vertical displacement hard strip plate and soil bases plate with a load on the plate F_V = 2 кН are presented in Fig. 4. Points at which plastic deformation having shown in Fig. 5 (for example reinforced bases for i = 4,4%, but the points almost identical in all cases).

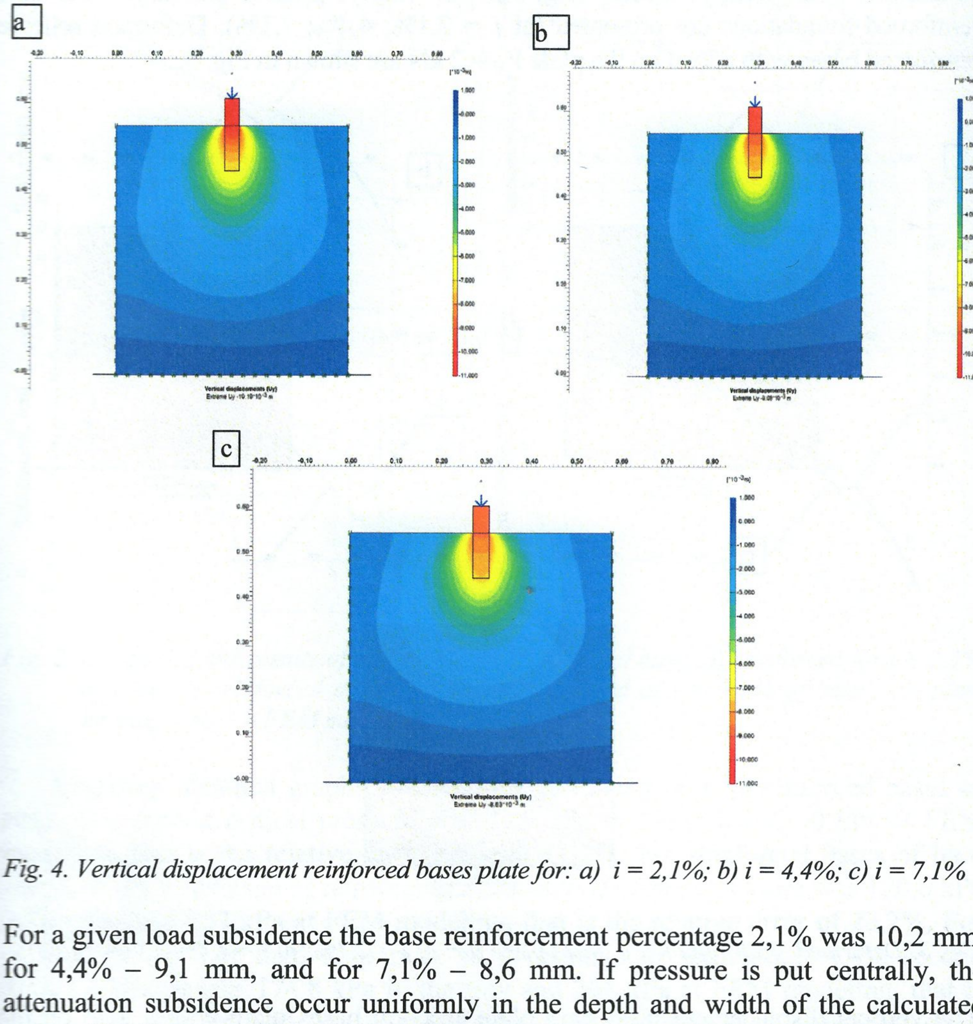

Fig. 4. Vertical displacement reinforced bases plate for: a) i = 2,1%; b) i = 4,4%; c) i = 7,1%

For a given load subsidence the base reinforcement percentage 2,1% was 10,2 mm, for 4,4% – 9,1 mm, and for 7,1% – 8,6 mm. If pressure is put centrally, the attenuation subsidence occur uniformly in the depth and width of the calculated area with distance from the model plate. Zones in which the formed plastic deformation are mostly under plate and under the reinforced area. This is due to the location of these zones on the axle of application of the load and large deformations of the base.

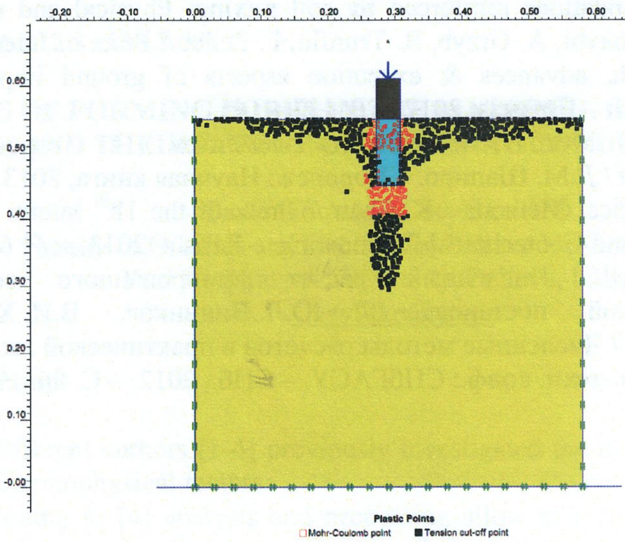

Fig. 5. Example of occurrence zones of plastic deformations reinforced for i = 4,4% bases hard strip plate with a load $F_V = 3$ kN

Conclusions and recommendations

Thus, the results of simulation studies and tray tests good fit and quantitatively differ within acceptable error. Therefore, a possible conclusion is that modeling techniques, including FEM plane problem is most accurate for predicting subsidence reinforced SCE weak bases strip foundations of buildings.

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