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Subject of doctoral dissertation: Theoretical and experimental analysis of the reinforcement of soil with cushion and geomattress.
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Summary in English.

One method of improving the subsoil under foundations is reinforcing cushions, which are an example of shallow, partial soil replacement. The loads transferred to the cushion create tensile stresses in their base. Various types of cushion reinforcement, including in the form of geosythetics, are used to increase their load-bearing capacity.

The purpose of this study was to verify the effect on bearing capacity and settlement of the installation of cushion reinforcement in the form of geomattress, and to identify the correct way to model this issue using available software.

The analysis of the reinforcement of subsoil with a geomattress-reinforced cushion included model laboratory tests (two series of tests), large-scale field tests (test loads at two locations) and numerical analysis using the Finite Element Method of all laboratory tests and a selected field test. In each of these stages, experiments were conducted on native and reinforced soil, according to the established program.

Model laboratory tests were carried out in a medium-sized (1.0x1.0x1.0 m) test box, in which the response of the soil to the loading of a linear foundation model with a base of B=140 mm and a length of 1000 mm was analyzed. Loads were applied in the first series of tests by a hydraulic actuator, in the second by a specially constructed lever system - by gravity. During the model tests, the value of the loading force was recorded, as well as the response of the tested model in the form of foundation settlements.

Natural-scale load tests were carried out at the construction site of multi-family houses and an industrial hall. The foundation model was road reinforced concrete slabs and reinforced concrete footing, loaded with concrete elements. Settlements were measured geodetically, manually recorded on measurement cards.

Based on laboratory results, semi-reverse analysis was performed in the Z-Soil program in the plane strain state, performing calibration of numerical models. The elastic and elastio-plastic constitutive models implemented in the program were used.

The theoretical analysis of the life-scale test load was performed using the finite element method in 3D space. Elastic and elasto-plastic constitutive models available in Z-Soil software were used.

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The tests and analyses carried out allowed to determine the correct values of strength-strain parameters of the various components of the models. Obtaining satisfactory agreement required in models with geosynthetics that interact well with the soil (geonet and geogrid), the introduction of additional zones with increased strength-strain parameters, as an effect of using this type of material.

The dissertation is concluded with conclusions, the most important of which are::

- all laboratory and field experiments have shown that the use of geomattress increases the load-bearing capacity of the foundation and reduces settlement,
- all laboratory and field tests have shown that a greater reinforcement effect is obtained for geosynthetics that interact well with the surrounding aggregate (nets and geogrids),
- it is advisable to take into account in numerical analyses the type of geosynthetic and aggregate and the flowing cooperation between them,
- with FEM analyses, proper modeling of the interaction of geosynthetic materials requires an increase in their stiffness (if a membrane model is used), compared to the values obtained on isolated samples provided by geosynthetic suppliers,
- obtaining satisfactory convergence of FEM solutions of models with geosynthetics, that interact well with the soil (geonets, geogrids), requires increasing the stiffness of the interlocking material, in order to model the effect of confinement of the aggregate, which is becoming the dominant mode of cooperation of this type of geosynthetic with the environment.

A porposal for further research is also submitted.

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