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ANALIZA DOŚWIADCZALNA WPŁYWU WYMIANY DYNAMICZNEJ GRUNTU NA OTOCZENIE

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ABSTRACT

This dissertation discusses the influence of dynamic replacement method on the soil adjacent to the column. Due to the specific and complex character of the topic, the author decided to choose experimental analysis as the most appropriate way to enhance knowledge on the presented topic. The specificity of the dynamic replacement method results in large deformations of soil adjacent to the column and in changes of soil properties. The existing methods of columns designing do not take into account the above mentioned changes. This is probably due to the difficulty of describing the processes occurring during and after column formation. The research presented in the dissertation give the basic information on these processes, their complexity and interdependencies. The following aspects of the research are analyzed: changes of mechanical parameters of the soil adjacent to the column, horizontal displacements of the soil, its uplift and the corresponding column shape.

The first tests were conducted in laboratory conditions and consisted in stone column formation (with the use of a 10-kg barrel-like rammer) in a test chamber which dimensions were 1 x 1 x 1 m. The chamber was filled with 40-cm layer of medium dense sand covered with another 40-cm layer of silty clay of LI=0,55. During the period of 28 day after the completion of column formation process, tests of cone resistance of CPT and of moisture changes were carried out in points located at different distances from the column. There was one test performed for a system without load and one in which the column was covered with granular mat and loaded with soil of the embankment. The largest displacements were identified in the closest vicinity to the column and the values decreased with increasing distance. The uplifts in the soil surrounding the column were asymmetric and their values were very small. Another analyzed values were the results of cone resistance of CPT, which showed that the main changes (qc increase) concerned only two points located in the closest vicinity to. They were due to the column formation process and to the fact that the column behaved as a drain. It was determined that as the result of soil loading, the consolidation occurs quicker. The analysis of moisture changes of weak soil indicated that regardless of the time after the process completion and the distance from the column, the values of moisture were similar in all the measuring points. However, the differences were observed when verifying the moisture at the same time in points located at different distances from the column. The values were the lowest in the close vicinity to the column and increased with the distance. This regularity was observed in all the measurements that were performed in the course of the research.

The main stage of the research consisted in field test during which a single column was formed in a mixture of silty and sandy soils using a 10-tonnes rammer. During column formation process and 28 days after its completion, soil parameters were measured using CPTU and DMT tests, as well as inclinometer measurements to verify horizontal displacements of soil surrounding the column. All the measurements were performed in a few

points located at different distances from the column. The results of field tests indicate that the processes occurring in soil during and after column formation are very complex. The extent of deformations around a single stone column is larger than the one considered usually during the design of column spacing. The results of the soil strength and deformation parameters changes are different and vary depending on the applied method (CPTU or DMT). The differences may be related to the test procedure or may be the proof of anisotropy resulting from the column formation. On the basis of these results, we may assume that the bearing capacity of the column-weak soil system is highly underestimated during stone column design. It is due to the fact that soil deformations and anisotropic changes in the soil adjacent to the column are not taken into consideration. The results of field tests indicate that the mechanical parameters of the soil surrounding the stone column decrease during column formation and increase after the process completion. It suggests that the acceptance tests for DR columns should be carried out as long time after the column formation as possible.

Additional field tests were performed in order to determine the spacial distribution of uplifts in the vicinity of DR column. Thanks to the results and analysis of the tests, it was possible to establish the technical conditions that may have the influence on the observed changes of soil uplift.

The mentioned changes occurring in the vicinity of DR column were different in laboratory and in situ conditions. Despite the rammer energy applied in laboratory which was 10 000 times smaller than the energy used during field tests, a significant increase of CPT parameters was noted close to the formed column, which was not observed during in situ tests. That may be related to the different character of soil used in laboratory (macropore, saturated clays) and field test (non-fully saturated silts with sandy interbeddings).

The author's research differs from other tests presented in the literature on the subject and can be considered as pioneering. It was possible to conduct the research as they are described thanks to the grant no 1989/B/T02/2011/40 funded by the Polish National Science Centre.